

BAT INVENTORY OF THE IMPERIAL NATIONAL WILDLIFE REFUGE

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INTRODUCTION

The lower Colorado River ecosystem has changed dramatically since settlement by Europeans. Agriculture, ranching, and mining are among the principal factors involved. Flood control, bank stabilization, channel dredging, and water retention projects have altered the Colorado's flow patterns, and the plant communities along the river. Urbanization and recreational development have also become factors in continued habitat modification and loss.

These changes have been well documented by Hastings and Turner (1965), Fradkin (1984), Valencia et al. (1993), and others. Their relationship to changes in the area's avifauna is also relatively well known (e.g. Carothers and Brown 1991; Rosenberg et al. 1991; Todd 1985). However, their relationship to the area's bat fauna is not clearly understood. Loss of native vegetation has undoubtedly reduced some types of roosting habitat, but mining and construction of buildings, dams, and bridges have created new roosting habitat for some bats. The net effect, whether positive or negative, is unknown.

Vegetation changes are the most notable differences in the lower Colorado River ecosystem today, in comparison to historical times. Gallery forests of cottonwood (*Populus fremontii*) and Goodding willow (*Salix gooddingii*) are but a fraction of their former size, being replaced in many areas by the exotic salt cedar (*Tamarix chinensis*) (Ohmart et al. 1988). Agricultural fields have replaced much of the natural vegetation. Also, native plant regeneration has been inhibited by channelization and flow management of the river (Ohmart et al. 1988). These changes have altered both roost availability and foraging opportunities for bats.

Abandonment of mines has created new roosting habitat for several bats. Some of these human-made caves are very important bat roost sites. Nineteen of the 28 species of bats found in Arizona use mines to some extent as day, night, transitory, maternity, or hibernating roosts. These sites are not safe from human disturbance, which can be very detrimental to bat colonies. Public safety and environmental concerns have prompted increased interest in abandoned mines, leading to their closure in certain areas. Visitation by the unaware, and sometimes malicious, public has eradicated bat colonies in some mines. Protection of roost sites is extremely important in ensuring the continued existence of some bats.

One bat occurring in Arizona is listed by the U.S. Fish and Wildlife Service (USFWS) as endangered. Recently USFWS elevated eight other Arizona bats to candidate status, thus bringing the number of federally listed bats in Arizona to one endangered and 13 candidates. The Arizona Game and Fish Department (Department, or AGFD) list of *Threatened Native Wildlife in Arizona* (TNW)

(AGFD 1988) recognizes one endangered and five threatened bats. These two lists support the need to locate and protect bat roosts.

For these reasons, the Department began statewide surveys to document species occurrence and locate and protect bat roosts and important habitats. The presence of abandoned mines, lack of historical data, and changes in the lower Colorado River ecosystem prompted a bat survey of the Imperial National Wildlife Refuge (hereafter the Refuge, or INWR).

SURVEY AREA

The Refuge is located along the Colorado River in southwestern Arizona and southeastern California, between Yuma and Blythe (Fig. 1). It is a several mile wide strip that borders 30 miles of the river. For this project, only the Arizona side of the river was surveyed, and all references made in this report apply only to this portion of the Refuge.

The Refuge has two distinct ecosystems: the riparian system associated with the Colorado River, and the uplands. The riparian corridor is continuous along the river, except in a few places where cliffs meet the water. Emergent vegetation typical of marshes, such as cattail (*Typha* sp.), cane (*Phragmites* sp.), and bullrush (*Scirpus* sp.) dominates the shallow shorelines and backwaters (Ohmart et al. 1988). Woody vegetation, primarily salt cedar, appears on low lying areas above the water line, but cottonwood and willow are also present.

Away from the river's edge, the vegetation drastically changes in species composition and density. Drainages are dominated by ironwood (*Olneya tesota*), palo verde (*Cercidium* sp.), and mesquite (*Prosopis* sp.). Catclaw (*Acacia greggii*) and smoke tree (*Psoralea spinosa*) are also present in the major washes. The uplands are primarily creosote (*Larrea tridentata*), bursage (*Ambrosia* sp.), and palo verde (Brown 1994).

The Refuge averages 184 days with temperatures over 32° C (90° F), and summer temperatures can climb to over 49° C (120° F) (Sellers and Hill 1974). Precipitation averages 3.1 inches per year (Sellers and Hill 1974). Elevation on the Refuge ranges from about 180 ft to 1085 ft above sea level.

SPECIES OCCURRENCE

We gathered historical roost site information and collection records by contacting the: Museum of Vertebrate Zoology, Berkeley, California; Los Angeles County Museum of Natural History; U.S. Museum of Natural History, Smithsonian Institution; and the Department's Heritage Data Management System. We also reviewed the records in *Mammals of Arizona* (Hoffmeister 1996).

Little information on bat occurrences is available for the extreme southwest corner of Arizona. Most of the records are from early collectors before 1945. Very few of these are for bat roosts. The most recent information is from a Department survey of the U.S. Army Yuma Proving Grounds, in which many roosts were located (Castner et al. 1993).

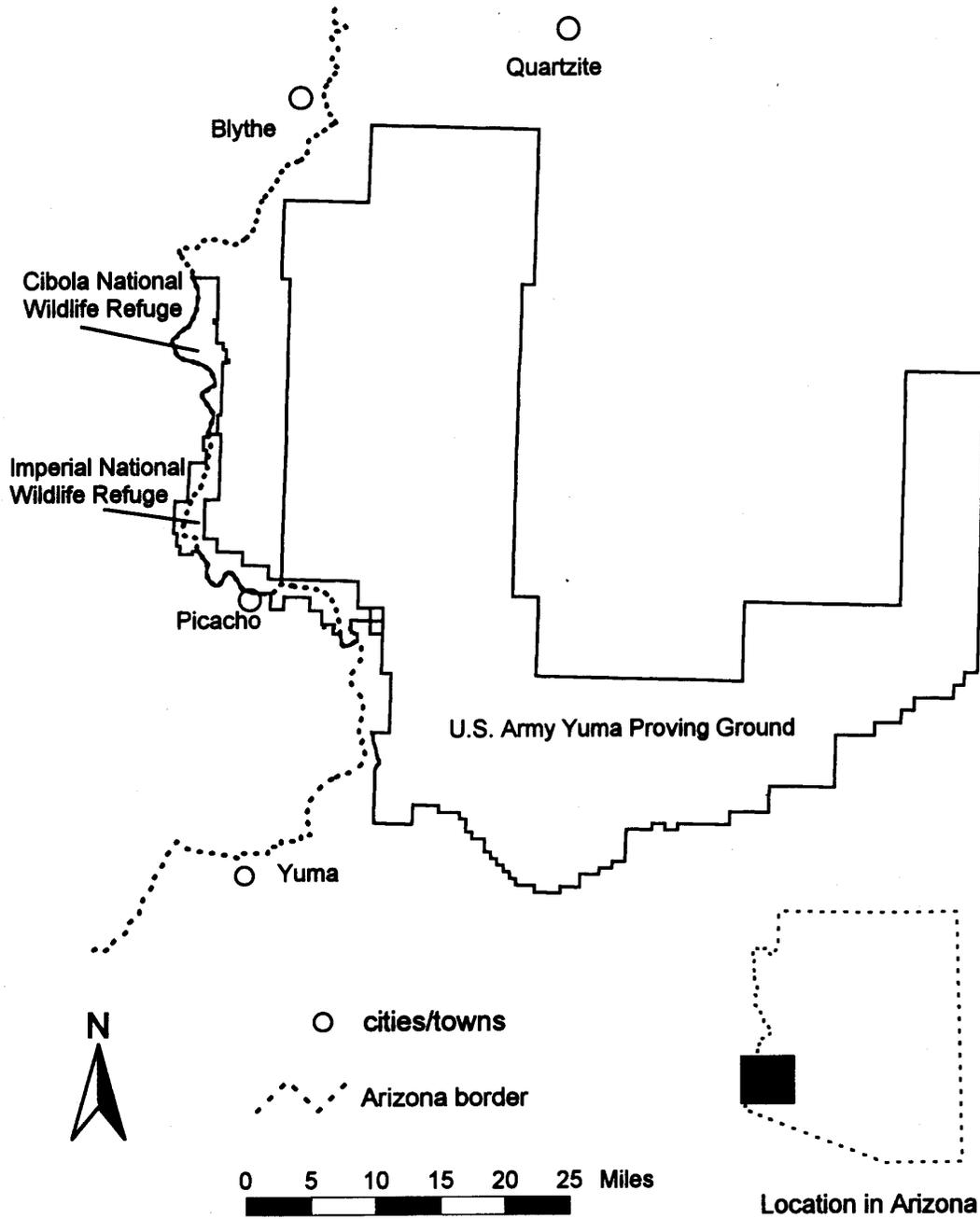


Figure 1. Map of the Imperial National Wildlife Refuge and surrounding area.

A literature search produced two historical occurrences on the Refuge. Eureka #1 and Eureka #2: Yuma myotis (*Myotis yumanensis*) and California leaf-nosed bats (*Macrotus californicus*) were found at Eureka #1, and the latter was also found at Eureka #2. Hoffmeister (1986) also lists a record of Cave myotis (*Myotis velifer*) and Mexican free-tailed bats (*Tadarida brasiliensis*) from an unnamed mine tunnel (Picacho), but does not specify the exact location.

Based on this information, we compiled a list of all bat species and their legal status likely to be found on the Refuge (Table 1).

METHODS

We employed a variety of methods, depending on the type of survey being conducted. The discussion of methods below is categorized by the respective survey type or structure: mine, cave, and building surveys, mist netting, and exit counts.

Mine Surveys

We located mines by reviewing U.S. Geological Survey (USGS) 7 1/2' topographic maps, consulting with Refuge personnel, and by visual observation. According to all accounts, only the area northeast of Picacho experienced underground mining. Because most of the mines were not mapped or easily visible from the river, we conducted a systematic ground search from Yuma Wash to one mile west of Arrastra Wash (Fig. 2).

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 topographical maps and is as follows:

Adits - horizontal tunnels that vary in length from 10 to hundreds of feet. These can be straight or with many twists and turns. It is possible to have additional drifts (horizontal passageways) within adits. The USGS topographical symbol is "Y."

Shafts - vertical entrances with depths greater than 10 feet. These may be straight or declining with varying slopes and may or may not contain drifts. One of the vertical shafts could 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 10 feet in depth when shaft like or length when adit like. The USGS topographical symbol is "X."

Table 1. Bats likely to occur on Imperial National Wildlife Refuge, Arizona. Status: ESA = Endangered Species Act, C2 = Category 2; TNW = <i>Threatened Native Wildlife in Arizona</i> (AGFD 1988), SC = State Candidate.				
Species	Status		Habitat	Primary Roost Structure
	ESA	TNW		
California leaf-nosed bat (<i>Macrotus californicus</i>)	C2	SC	Sonoran Desertscrub below 4000 ft	Caves/mines
Yuma myotis (<i>Myotis yumanensis</i>)	C2	-	Desert to Pinyon-Juniper, forages over open water	Caves/mines, buildings
Cave myotis (<i>Myotis velifer</i>)	C2	-	Desert; may hibernate in mines above 6000 ft	Caves/mines, bridges
Occult little brown bat (<i>Myotis lucifugus occultus</i>)	C2	-	Desert to Pine	Caves/mines, tree cavities
California myotis (<i>Myotis californicus</i>)	-	-	Desert to Pine	Caves/mines, crevices
Western pipistrelle (<i>Pipistrellus hesperus</i>)	-	-	Desert to Pine	Caves/mines, crevices
Big brown bat (<i>Eptesicus fuscus</i>)	-	-	Desertscrub to Mixed Conifer	Caves/mines, buildings
Western red bat (<i>Lasiurus blossevillii</i>)	-	SC	Broad-leafed Woodlands, Riparian	Tree foliage
Southern yellow bat (<i>Lasiurus ega</i>)	-	SC	Desert to Oak Woodland	Tree foliage (palm trees)
Hoary bat (<i>Lasiurus cinereus</i>)	-	-	Desertscrub to Mixed Conifer	Tree foliage and bark
Spotted bat (<i>Euderma maculatum</i>)	C2	SC	Desertscrub to Pine, near cliffs	Cliff crevices
Townsend's big-eared bat (<i>Plecotus townsendii</i>)	C2	-	Desert to Pine	Caves/mines, buildings
Pallid bat (<i>Antrozous pallidus</i>)	-	-	Desert to Pine	Caves/mines, buildings
Mexican free-tailed bat (<i>Tadarida brasiliensis</i>)	-	-	Desert to Pine	Caves/mines, buildings
Pocketed free-tailed bat (<i>Nyctinomops femorosaccus</i>)	-	-	Desert to Chaparral	Cliffs, buildings
Big free-tailed bat (<i>Nyctinomops macrotis</i>)	C2	-	Desertscrub to Pine	Cliffs
Western mastiff bat (<i>Eumops perotis</i>)	C2	-	Desert to Pine	Cliffs

We explored 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. We used a sling psychrometer to measure relative humidity.

We also assessed each site according to the following guano accumulation index: (1) no guano, (2) scattered or small piles (less than 12 inches in diameter or 1.5 inches deep), (3) large piles (greater than 12 inches in diameter or 1.5 inches deep) or complete coverage of the floor.

Cave Surveys

The caves on the Refuge are not extensive, typically being less than 10 feet in depth. Caves were surveyed in the same manner as mines.

Mist Netting

Mist netting was conducted to document the occurrence of species that forage on the Refuge and species, such as tree and crevice roosters, whose roosts are difficult to locate. Netting was conducted on a representative sample of all habitat types on the Refuge. Sites were divided into two areas; the river habitats and the upland desert. Areas sampled on the river included islands and underwater sandbars (with and without associated vegetation), open sections of shoreline, and backwaters. Upland areas netted were major washes.

We used 30-50 denier, 2 ply black nylon nets with a 3.8 cm mesh. The number and size of nets used varied depending on the 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 and monitor populations. Prior to sunset, observers were stationed at all exits to ensure that all exiting bats were counted. Night vision equipment was used whenever possible for greater accuracy. A red filter lens over a flashlight was used to increase visibility for observers who did not have this equipment. Roosts were entered after the exodus had ceased to record any remaining bats.

Buildings

Daytime searches of all possible roosting locations in or on buildings were conducted to determine if they were being used as a day or night roost. A nighttime survey was required since no bats were found during the daytime search but there was evidence of roosting. Both surveys were performed in the same manner. Any bats found were identified visually by species, and the number of individuals was estimated.

RESULTS

We located 30 new bat roosts during our roost surveys on the Refuge and monitored the bat colonies at the Eureka mines. Roosts of four bat species were found in mines, buildings and a cave. Our 20 nights of mist netting resulted in the capture of six bat species. These results are detailed in the appropriate sections below.

Mine Surveys

Mine surveys were conducted at 111 sites (Table 2). Of these, 26 showed evidence of bat use and 19 had at least one bat present. Eleven mines were classified as significant roosts based on the number of bats or amount of guano present. Seven maternity sites and two potential maternity sites were located for *Macrotus californicus*. Two bachelor colonies of *Macrotus californicus* and a large maternity colony of *M. yumanensis* were also found. Other species observed during the mine survey included *Myotis californicus* and *P. hesperus*.

Caves

Wind caves are common in some areas of the Refuge, but most are shallow and not used by large numbers of bats. One cave was surveyed revealing 3 *Myotis californicus*. One of the bats captured was a lactating female, indicating that the cave is a maternity site.

Mist Netting

Mist netting was conducted over 20 nights at 19 sites (Fig. 2). One site, Ironwood Wash, was netted twice due to poor weather conditions during the first attempt. We spent nine nights netting river areas and 11 nights in dry washes. A total of 206.5 net hours (number of nets x total hours) resulted in the capture of 303 individuals representing six species (Table 3). The species caught were *A. pallidus*, *E. fuscus*, *Macrotus californicus*, *Myotis californicus*, *M. yumanensis*, and *P. hesperus*. A description of each netting site and the sex and reproductive status of captured bats is provided in Appendix 1.

Exit Counts

Exit counts were conducted at Eureka #1 mine in June and in September. The June count was 9,111 individuals. It was estimated that all but about 200 of these were adult and volant juvenile *M. yumanensis*. The remaining 200 were *Macrotus californicus*. A brief interior survey of the mine after the outflight revealed non-volant *Macrotus californicus*.

The September count was much lower than the June count; only 5,638 individuals were observed exiting the mine. Again, the majority of these were *M. yumanensis*.

Building Surveys

Five buildings on the Refuge were surveyed in response to reports of bat use by Refuge personnel. The headquarters and main shop are significant night roosts for at least two species of bats. The main shop had 200-300 *M. yumanensis* roosting under the eaves in the covered entrance. The headquarters was being used by about 70 *Macrotus californicus*. Most of them were roosting on the outside of the building under the eaves, but a few were using the headquarters picnic room.

Some of the other buildings at the Refuge headquarters were also used as night roosts. Several dozen *M. yumanensis* were observed roosting under the eaves of the oil house and a single *M. yumanensis* was found roosting on the exterior wall at one of the crew houses. Guano was found in the barn shop as well.

Additional Surveys

In addition to the mine surveys conducted on the Refuge, 24 mines were surveyed as part of the Department's ongoing mine survey program (Table 4). These sites were located just north of the Refuge boundary near the Eureka mines. Of these, 12 were considered potential roosts and three had bats or bat sign. One mine supported a maternity colony of *M. velifer* and possibly *Myotis californicus* and a bachelor colony of *Macrotus californicus*. A bachelor colony of *Macrotus californicus* was found in another mine as well.

Table 2. Results of mine and cave surveys conducted during 1994 on the Imperial National Wildlife Refuge, Arizona.					
Roost	Date	Guano Rating ¹	Roost Description	Species Found	Potential Roost?
Eureka #1	6/20	3	complex mine w/ 4 entrances, extensive	<i>Macrotus californicus</i> <i>Myotis velifer</i>	yes
Eureka #2	6/20	3	complex mine w/ 2 entrances, not extensive	<i>Macrotus californicus</i>	yes
Lighthouse	6/21	2	wind cave at base of cliff	<i>Myotis californicus</i>	yes
Imperial #1	6/27	1	3 ft. deep shaft-like prospect	none	no
Imperial #2	6/27	1	4 ft. deep shaft-like prospect	none	no
Imperial #3	6/27	1	4 ft. deep shaft-like prospect	none	no
Imperial #4	6/27	1	5 ft. deep scrape-like prospect	none	no
Imperial #5	6/27	2	25 ft decline with internal 10 ft drift	none	yes
Imperial #12	6/27	1	vertical stope, filled in @ 10 ft	none	no
Imperial #13	6/27	2	23 ft long adit	none	yes
Imperial #18	6/27	1	4 ft deep shaft-like prospect	none	no
Imperial #19	6/27	1	4 ft deep trench-like prospect	none	no
Imperial #20	6/27	1	12 ft deep shaft	none	no
Imperial #21	6/27	1	3 ft deep scrape-like prospect	none	no
Imperial #22	6/27	1	70° decline, filled in @ 20 ft	none	yes
Imperial #23	6/27	1	6 ft deep shaft-like prospect	none	no
Imperial #24	6/28	1	2 ft deep scrape-like prospect	none	no
Imperial #25	6/28	1	3 ft deep scrape-like prospect	none	no
Imperial #26	6/28	1	5 ft deep shaft-like prospect	none	no
Imperial #27	6/28	1	two 6 ft deep shaft-like prospects	none	no
Imperial #28	6/28	1	60° decline, filled in @ 20 ft	none	yes
Imperial #29	6/28	2	13 ft long adit	<i>Myotis californicus</i>	yes
Imperial #30	6/28	2	complex mine w/ three entrances	<i>Macrotus californicus</i> , <i>Myotis californicus</i>	yes
Imperial #31	6/28	2	20 long adit	<i>Myotis californicus</i> , <i>Pipistrellus hesperus</i>	yes
Imperial #32	6/28	1	10 ft long adit	none	yes
Imperial #33	6/28	1	2 ft deep scrape-like prospect	none	no

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

Table 2 (continued). Results of mine and cave surveys conducted during 1994 on the Imperial National Wildlife Refuge, Arizona.					
Roost	Date	Guano Rating ¹	Roost Description	Species Found	Potential Roost?
Imperial #34	6/28	1	entrance has completely collapsed	none	no
Imperial #35	6/29	2	open trench w/ 46 ft long adit	none	yes
Imperial #36	6/29	1	3 ft long adit-like prospect	none	yes
Imperial #37	6/29	1	2 ft deep scrape-like prospect	none	no
Imperial #46	7/11	1	1 ft deep scrape like prospect	none	no
Imperial #47	7/11	1	6 ft long adit-like prospect	none	yes
Imperial #48	7/12	1	6 ft deep shaft-like prospect	none	no
Imperial #49	7/12	1	2 ft deep scrape-like prospect	none	no
Imperial #50	7/12	2	20 long adit	<i>Myotis californicus</i>	yes
Imperial #51	7/12	2	26 ft long adit	<i>Myotis californicus,</i> <i>Pipistrellus hesperus</i>	yes
Imperial #52	7/12	1	3 ft deep scrape-like prospect	none	no
Imperial #53	7/12	1	3 ft deep scrape-like prospect	none	no
Imperial #54	7/12	1	12 ft deep shaft	none	no
Imperial #55	7/12	2	complex mine w/ 2 shaft entrances-not extensive	none	yes
Imperial #56	7/12	2	complex mine w/ 2 shaft entrances-not extensive	none	yes
Imperial #57	7/12	2	complex mine w/ 2 shaft entrances-not extensive	none	yes
Imperial #58	7/12	1	6 ft deep shaft-like prospect	none	no
Imperial #59	7/12	1	12 ft deep shaft	none	no
Imperial #60	7/12	1	7 ft deep shaft-like prospect	none	no
Imperial #61,62	7/12	2	30° decline (16 ft), connects w/ 33 ft long adit	none	yes
Imperial #63	7/12	1	4 ft deep trench-like prospect	none	no
Imperial #64	7/12	1	2 ft deep shaft-like prospect	none	no
Imperial #65	9/16	2	80+ ft shaft, not completely surveyed, air stale @ bottom	<i>Myotis sp.</i> (<i>yumanensis</i> ?)	yes

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

Table 2 (continued). Results of mine and cave surveys conducted during 1994 on the Imperial National Wildlife Refuge, Arizona.					
Roost	Date	Guano Rating ¹	Roost Description	Species Found	Potential Roost?
Imperial #67	7/12	1	4 ft deep trench-like prospect	none	no
Imperial #68	7/12	1	3 ft deep shaft-like prospect	none	no
Imperial #69	7/12	1	3 ft deep shaft-like prospect	none	no
Imperial #71	7/12	1	60° decline drops 15 ft to 23 ft drift	none	yes
Imperial #72	7/12	1	4 ft deep shaft-like prospect	none	no
Imperial #73	7/12	1	3 ft deep shaft-like prospect	none	no
Imperial #70	7/13	1	3 ft deep trench-like prospect	none	no
Imperial #74	7/18	1	3 ft deep trench-like prospect	none	no
Imperial #75	7/18	1	3 ft deep trench-like prospect	none	no
Imperial #76	7/18	1	3 ft deep shaft-like prospect	none	no
Imperial #77	9/15	2	65 ft deep shaft w/ 6 ft drift	none	yes
Imperial #77a	7/18	1	two 3 ft deep scrape-like prospects	none	no
Imperial #78a	7/19	3	26 ft long adit	<i>Macrotus californicus</i>	yes
Imperial #79	9/15	2	55 ft shaft with 16 ft drift @ 25 ft	none	yes
Imperial #80	7/19	1	surface scrapes (old dump site ?)	none	no
Imperial #81	7/19	1	5 ft deep trench-like prospect	none	no
Imperial #82	7/19	1	surface scrape (from old road)	none	no
Imperial #83	7/19	1	1 ft deep scrape-like prospect	none	no
Imperial #84	7/19	1	4 ft deep shaft-like prospect	none	no
Imperial #85	7/19	1	4 ft deep shaft-like prospect	none	no
Imperial #86	7/19	1	3 ft deep trench-like prospect	none	no
Imperial #87	7/19	1	four scrape-like prospects (<4 ft)	none	no
Imperial #88	7/19	1	2 ft long adit-like prospect	none	yes
Imperial #89	7/19	1	4 ft deep shaft-like prospect	none	no
Imperial #90	7/19	1	3 ft deep trench-like prospect	none	no
Imperial #91	7/19	1	quarry mine, nothing underground	none	no

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

Table 2 (continued). Results of mine and cave surveys conducted during 1994 on the Imperial National Wildlife Refuge, Arizona.					
Roost	Date	Guano Rating ¹	Roost Description	Species Found	Potential Roost?
Imperial #92	7/19	1	4 ft deep shaft-like prospect	none	no
Imperial #93	7/19	2	50 ft long adit	<i>Macrotus californicus</i>	yes
Imperial #94	7/19	1	shaft collapsed, only 3 ft deep	none	no
Imperial #95	9/15	2	25 ft shaft w/ 66 ft drift @ bottom	<i>Macrotus californicus</i>	yes
Imperial #96	7/20	1	5 ft deep shaft-like prospect	none	no
Imperial #97	7/20	1	1 ft deep scrape-like prospect	none	no
Imperial #98a	9/15	3	20 ft shaft w/ 39 ft drift @ bottom	<i>Macrotus californicus</i>	yes
Imperial #98b	7/20	1	2 ft deep shaft-like prospect	none	no
Imperial #98c	7/20	1	1 ft deep scrape-like prospect	none	no
Imperial #98d	7/20	1	3 ft deep shaft-like prospect	none	no
Imperial #98e	7/20	1	10 ft deep shaft	none	no
Imperial #98f	7/20	1	12 ft x 100 ft trench	none	no
Imperial #98g	7/20	1	quarry-like prospect	none	no
Imperial #98h	7/20	1	5 ft deep shaft-like prospect	none	no
Imperial #98i	7/20	1	2 ft deep trench-like prospect	none	no
Imperial #98j	7/20	1	12 ft deep shaft	none	no
Imperial #98k	7/20	1	several scrape-like prospects	none	no
Imperial #99	7/25	2	82 ft long adit	<i>Macrotus californicus</i>	yes
Imperial #a	7/25	2	39 ft long adit	<i>Macrotus californicus</i>	yes
Imperial #f	7/25	2	33 ft long adit	<i>Macrotus californicus</i>	yes
Imperial #g	7/26	1	2 ft long adit-like prospect	none	yes
Imperial #h	7/26	1	4 ft deep scrape-like prospect	non	no
Imperial #i	8/3	2	12 ft long adit	none	yes
Imperial #j	8/3	1	5 ft deep shaft-like prospect	none	no
Imperial #k	8/3	1	3 ft deep trench-like prospect	none	no
Imperial #l	8/3	1	4 ft deep trench-like prospect	none	no
Imperial #m	8/3	1	4 ft deep trench-like prospect	none	no

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

Table 2 (continued). Results of mine and cave surveys conducted during 1994 on the Imperial National Wildlife Refuge, Arizona.					
Roost	Date	Guano Rating ¹	Roost Description	Species Found	Potential Roost?
Imperial #n	8/3	3	50 ft long tunnel w/ 15 ft shaft to surface	<i>Macrotus californicus</i>	yes
Imperial #o	8/3	3	39 ft long adit	<i>Macrotus californicus</i>	yes
Imperial #p	8/3	3	50 ft long adit	<i>Macrotus californicus</i>	yes
Imperial #q	8/3	1	6 ft deep shaft-like prospect	none	no
Imperial #r	8/3	2	33 ft adit w/ shaft to surface	none	yes

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

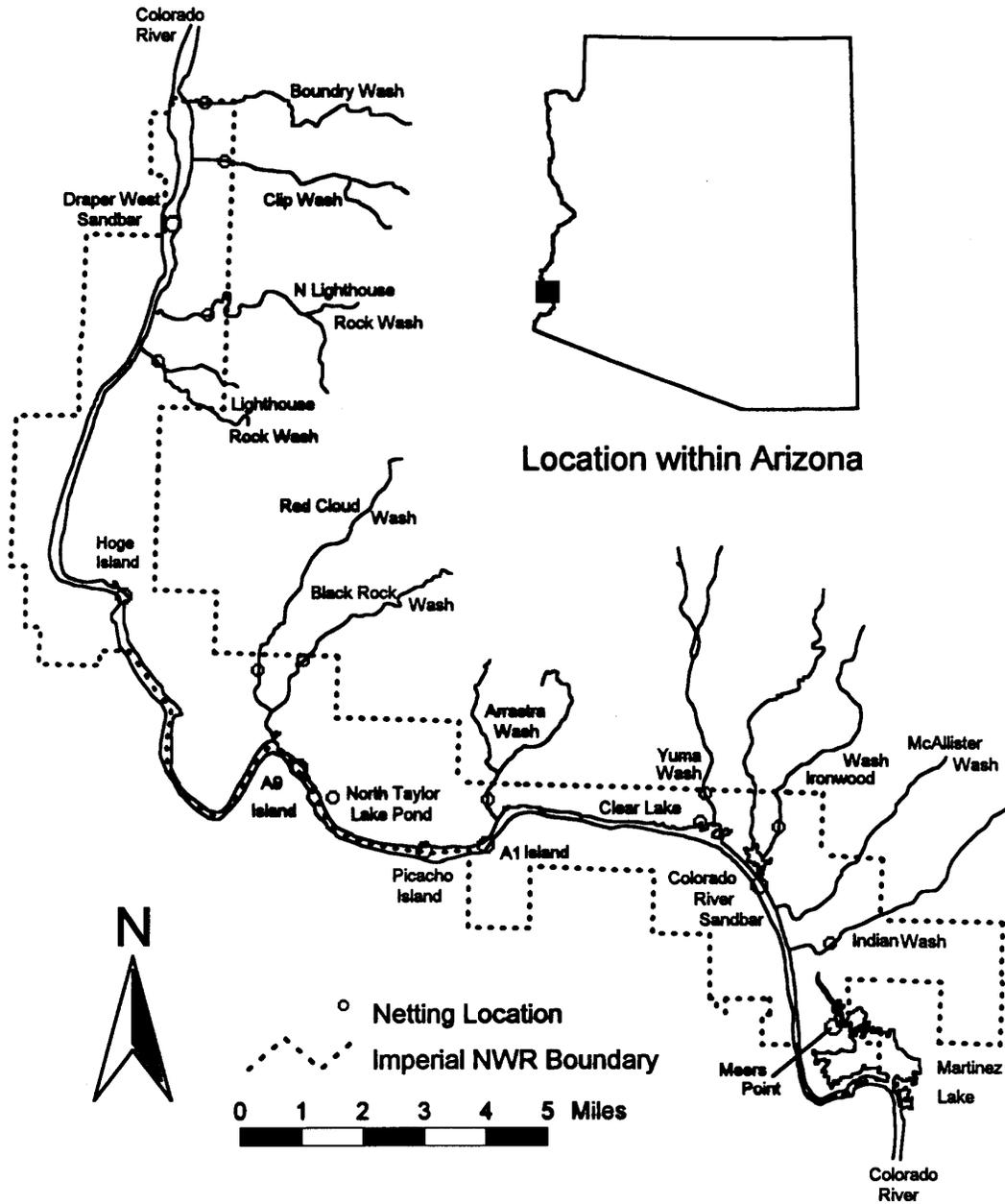


Figure 2. Location of mist netting sites on the Imperial National Wildlife Refuge, Arizona, during 1994.

Table 3. Results of mist netting conducted during 1994 on the Imperial National Wildlife Refuge

Netting Location	Legal Description (UTM)	Habitat	Date	# of Nets Set	Net Time (hrs)	Total Net Hours	Netting condition
Meers Point	E735030, N3652630	backwater	6/21	3	2.5	7.5	poor
Ironwood Wash	E733160, N3657380	dry wash	6/21	4	2.5	10	poor
			7/13	5	3.5	17.5	good
A1 Island	E725530, N3656690	river/sandbar	6/23	2	2	4	poor
Arrastra Wash	E725660, N3657840	dry wash	6/27	5	4	20	good
Lighthouse Rock Wash	E716270, N3668890	dry wash	6/28	3	4	12	good
Clear Lake	E731270, N3657690	dry wash	6/29	1	2	2	fair
North Taylor Lake Pond	E721740, N3657480	backwater	7/11	2	4	8	good
Draper West Island	E716620, N3671380	river/sandbar	7/12	2	3.5	7	poor
A9 Island	E720720, N3658380	river/sandbar	7/18	3	3	9	poor
Indian Wash	E375060, N3654850	dry wash	7/19	3	2	6	poor

* Netting conditions: 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-1 or more adverse condition for more than 50% of net time.

Table 3 (cont.). Results of mist netting conducted during 1994 on the Imperial National Wildlife Refuge

Netting Location	Legal Description (UTM)	Habitat	Date	# of Nets Set	Net Time (hrs)	Total Net Hours	Netting Condition
Hoge Island	E717420, N3659770	river/sandbar	7/20	3	3	9	poor
Yuma Wash	E731340, N3658480	dry wash	7/24	4	3.5	14	poor
Black Rock Wash	E720420, N3658480	dry wash	7/25	2	3.5	7	fair
Imperial Boundary Wash	E717410, N3675800	dry wash	7/26	4	3	12	fair
Picacho Island	E723480, N3656550	river/sandbar	8/1	3	5	15	good
Red Cloud Wash	E719530, N3660930	dry wash	8/2	3	5	15	excellent
Colorado River Sandbar	E732840, N3656020	river	8/3	3	3.5	10.5	excellent
N. Lighthouse Rock Wash	E717620, N3670270	dry wash	8/16	3	4	12	poor
Clip Wash	E718920, N3674120	dry wash	8/17	2	4.6	9	poor

* Netting conditions: 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.

Table 4. Results of mine surveys conducted in conjunction with the 1994 bat survey of Imperial National Wildlife Refuge, Arizona.					
Roost	Date	Guano Rating ¹	Roost Description	Species Found	Potential Roost?
Imperial #6 ²	6/27	1	20 ft deep shaft	none	yes
Imperial #7 ²	6/27	1	6 ft deep scrape-like prospect	none	no
Imperial #8 ²	6/27	2	complex mine w/ 3 entrances and 2 horizontal levels	<i>Macrotus californicus</i> , <i>Myotis californicus</i> , <i>Myotis velifer</i>	yes
Imperial #9 ²	6/27	1	5 ft long adit-like prospect	none	yes
Imperial #10 ²	6/27	1	5 ft deep adit-like prospect	none	yes
Imperial #11 ²	6/27	1	2 ft deep scrape-like prospect	none	no
Imperial #14 ²	6/27	1	4 ft deep shaft-like prospect	none	no
Imperial #15 ²	6/27	1	2 ft deep trench-like prospect	none	no
Imperial #16 ²	6/27	1	70 degree decline, filled in at 33 ft	none	yes
Imperial #17 ²	6/27	1	3 ft deep scrape-like prospect	none	no
Imperial #38 ²	6/29	1	3 ft deep scrape-like prospect	none	no
Imperial #39 ²	6/29	1	10 ft long adit	none	no
Imperial #40 ²	6/29	1	6 ft long adit-like prospect	none	yes
Imperial #41 ²	6/29	1	6 ft long adit-like prospect	<i>Pipistrellus hesperus</i>	yes
Imperial #42 ²	6/29	1	4 ft long adit-like prospect	none	yes
Imperial #43 ²	6/29	1	three shallow scrape-like prospects	none	no
Imperial #44 ²	6/29	1	two shallow scrape-like prospects	none	no
Imperial #45 ²	6/29	1	3 ft long adit-like prospect	none	yes
Imperial #66 ²	7/12	1	8 ft deep trench-like prospect	none	no
Imperial #78 ³	7/18	1	5 ft deep shaft-like prospect	none	no
Imperial #b ³	7/25	1	two 3 ft deep scrape-like prospects	none	no
Imperial #c ³	7/25	1	26 ft long adit, open to surface in places	none	yes
Imperial #d ³	7/25	1	16 ft long adit	none	yes
Imperial #e ³	9/14	2	25 ft deep shaft w/ two levels	<i>Macrotus californicus</i>	yes

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

² Located just off the Refuge on the U.S. Army Yuma Proving Grounds.

³ Located just off the Refuge on Bureau of Land Management Land.

DISCUSSION

Mine Roosts

When analyzing the percentage of mines used by bats, it is important to distinguish the mines that do, and those that do not, have potential for roosting bats. Not all of the mines surveyed are potential bat habitat (Table 5). One was completely collapsed making access to the underground passages impossible. More commonly, sites are only shallow digs with no underground passages. These mines, along with vertical prospects less than 3m in depth, were not included in the percentage of mines used by bats.

Table 5. Mines surveyed with potential bat habitat on and near the Imperial National Wildlife Refuge, 1994, Arizona.						
Location	Total Surveyed	Without Bat Habitat	With Bat Habitat			Percentage of Mines Being Used ¹
			Total Surveyed	No Evidence of Bat Use	With Evidence of Bat Use	
On Refuge	111	73	38	8	30	79
Off Refuge	24	12	12	9	3	25
Total	135	85	50	17	33	66

¹ Mines with evidence of bat use divided by the total number of mines with potential bat habitat.

The high percentage of mines with bat habitat on the Refuge that contained sign of bat use (79%) indicates that these mines are very important to bats. This percentage would be higher if short passages were also omitted as bat habitat. These mines, because they are so short, do not provide the stable microclimate that most bats using mines require. Twenty two of the 23 mines (95.6%) longer than 7m had evidence of bat use.

It is interesting that such a high percentage of mines are being used by bats. In our mine surveys of other areas, the percentage of use is not nearly as high (45%). There are several possible explanations for this. The proximity of the mines to the river makes flights to drink short, which is ideal for bats. The river and its associated vegetation produces a high density and diversity of insect species, allowing the area to support larger populations and perhaps more species of bats. Also, the proximity of the Refuge to the agricultural fields near Yuma and the lack of roosting habitat in this area suggest that bats may be roosting on the Refuge and foraging near Yuma.

Eureka #1 Mine

Eureka #1 is, at the very least, a maternity roost of *M. yumanensis* and *Macrotus californicus*. It is the largest known maternity roost of *M. yumanensis* in Arizona. Located near Miner's Cabin, a well visited recreation site, it is easily accessible from the river. A well traveled trail leads from the cabin to the mine. Internal visitation by humans appears to occur frequently and the colony could decrease in size or cease to exist entirely if these disturbances continue.

Eureka #1 has four entrances that lead to the underground passages. Three are located in the drainage bottom and are numbered progressively (1-3) with increasing elevation. Entrance #4 is situated about 25m above the drainage between #1 and #2 on the west side of the canyon. Entrance #1 is part of a horizontal drift that forms the bottom level of the mine. The other three entrances are connected to this level by vertical passages. Because these passages are vertical, public access into the mine through entrances #2-#4 is very dangerous. Even on the bottom level, hazards exist in the form of narrow passages resulting from cave-ins, rocks falling from above, and deteriorating support timbers (some have already collapsed).

The barriers currently in place at the four entrances are inadequate for protecting the bat colonies and the public. Entrances #1-#3 have 1 inch pipe gates and #4 has chain-link fence partially covering the entrance. Only entrance #2 is good condition, but even small people can get past the gate. The gate at entrance #1 is not completely attached to the rock and is missing a pipe. It can be pulled out, allowing people to pass between the gate and the rock. The missing pipe allows people to easily pass through the middle of the gate as well. The openings between pipes on the gate at entrance #3 are too wide, and a gap between the gate and the ground allows public access. The fence over entrance #4 is not attached on the sides, and offers little resistance to persons attempting to access the underground passages.

Mist Netting

We netted all habitat types on the Refuge, and of the potential 17 species in the area, we caught six. We know *M. velifer* is present because we found a small maternity colony just off the Refuge, leaving 10 species unaccounted for. Although some of these species may not roost or forage on the Refuge, it is unlikely that all 10 do not. We offer these explanations for why we did not capture more species.

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). The large surface area of water available makes complete coverage of the river impossible. Because the river is too wide and deep to get nets across, only small sections of the river could be surveyed. Also, the dense vegetation surrounding the backwaters makes access to them difficult. There is no defined shoreline and the water is too deep to set net poles. These factors make netting backwaters very difficult.

Riparian corridors are usually excellent locations to capture bats, but the corridor on the Refuge has no continuous stretch of large trees which provide flight paths under the canopy where bats are normally caught. The majority of the vegetation is marsh-like, and lacks flight paths. The low number of large cottonwoods and willows also reduces roosting opportunities for tree roosting species (mainly the Lasiurine species).

Weather conditions also 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. Air movement causes the nets to move and stretch. Moving nets are 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 hour of netting. The first hour is also the time when the majority of bats are caught. Moonlight was also a factor, but the moon usually rose later in the evening after bat activity had decreased. Of the 20 net nights, 10 were classified as poor, three as fair, five as good, and two as excellent. This indicates that our potential for capturing bats was less than optimal.

While one rationale alone does not explain the 10 unaccounted species, combined they may offer an explanation. Poor coverage of surface water, the lack of large continuous cottonwood and willow stands, and adverse netting conditions all affected our ability to capture bats.

Buildings

The buildings are night roosts for at least two bat species. These roosts serve as resting, grooming, feeding, and social interaction sites. The buildings located on the edge of a marsh and the Refuge agricultural fields are the closest suitable structures to the bats' foraging areas and are likely an integral component to their nightly cycle.

MANAGEMENT RECOMMENDATIONS

All recommendations related to bat surveys must be performed by experienced personnel. Any persons handling bats must have the appropriate permits.

General

1. The California portion of the Refuge should be surveyed for bats. This includes mist netting the major washes and surveying all mines and large caves.
2. Monitor all mines found to have bat use. Exit counts should be conducted every other month until seasonal use is verified. Afterwards, every other year during each season of use would be sufficient to document population trends. Exit counts should be conducted twice per year at maternity roosts; once before and once after the young are volant. Observers should also make note of any human disturbances.
3. Mines that have at least 10 bats and receive regular visitation by the public should be reviewed for gate installation. Human intrusions are detrimental to bat colonies. Roost abandonment or dead young can result from people walking through the mine. Vandalism may take a greater toll.
4. Post signs at all mine roosts with at least 10 bats. The signs should be placed at the entrance (but not obstructing the bats' flight path) and should not be visible from long distances. They should describe the sensitivity of bats to disturbance and discourage people from entering the mine. None of the mines found with bats, except Eureka #1, are easily visible from the river and they do not appear to receive human visitation. Therefore, at this time gating is not necessary.
5. Mist netting should continue, focusing on May-August when bat activity and species abundance is greatest. Netting should occur at least 10 times per year for the next three years to document occurrence of species we did not capture during this survey. Afterwards, five times per year at previously netted sites should be sufficient to determine the general level of bat activity, verify presence of species, detect population trends, and possibly document occurrence of additional species.
6. Reestablish the willow and cottonwood stands that historically were found along the river, thus improving habitat for tree roosting bats and diversifying vegetation.
7. Leave the buildings as they are. They serve an important role in the bats' nightly routine. Guano that accumulates on the sidewalks can be easily swept away. Also, the bats are only there at night, when people are absent. Installing bat boxes may attract day roosting bats, but may not draw bats away from currently used night roosts.

Eureka #1 Mine

Since none of the gates currently serve their function of keeping the public out of the underground passages, they must either be repaired or replaced. We believe that replacing all four would be the best solution, for the following reasons:

- The gates at entrances #1-#3, made of 1 inch steel pipe, can be easily cut.
- The distance between the pipes on the gates is too wide to keep small people out. Welding additional pipes to the existing gate would nearly be equivalent to erecting a new gate.
- The design of the gate at entrance #1 is not conducive to re-securing the gate to the rock and still be resistant to vandals.
- At entrance #3, the ground has eroded, leaving a gap between the gate and the ground. Expanding the gate to cover the open area is not a permanent solution. A concrete footer is required to prevent erosion and excavation by people.
- The barrier at entrance #4 is chain link. Aside from the fact that bats cannot fly through it, it is easily cut.
- Signs are not effective in keeping the public out of the mine. Evidence of public intrusion (footprints and trash-like debris) continues to be found even though signs prohibiting entry are posted.

Entrance #1 is the most visible, closest to the river, and receives the most human visitation. This entrance should be replaced first. Entrances #3 then #4 should also be replaced during the first year. Both are dangerous to the public since they are vertical. Entrance #3 is more noticeable and appears to get more use than #4. Entrance #2 should be replaced last since it is the most difficult for the public to breach and least noticeable of the entrances. Installation of all gates should take place during the winter when the colony is at its smallest size.

The Department contracted Marion Vittetoe, an experienced bat gate builder, to draft a proposal for installing new gates at Eureka #1. A copy of this proposal is attached. The cost estimates include his time, procurement of all supplies and equipment at retail prices, and contracted labor. However, this project can be completed less expensively. For example, materials and supplies can be obtained at reduced costs or even free through persistent efforts. Labor can be provided by volunteers. The Refuge can also provide labor, supplies, and equipment. Also, helicopter service may be available through interagency cooperation. To defray costs, the Department has submitted a Heritage grant proposal to install gates at Eureka #1.

In addition to replacing the gates, we also recommend the following actions:

- 1.Exit counts should be conducted immediately before and after each gate is replaced. Observers should make note of any unusual flight patterns indicating the bats do not accept the new gate.
- 2.Gates should be checked regularly for signs of vandalism and repaired if necessary.
- 3.Monitoring should begin immediately. This includes exit counts every other month until seasonal use is determined.

CONCLUSIONS

We confirmed occurrence of six species of bats and located 30 new roost sites on the Refuge during this survey. 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 site descriptions should contact the Department's Heritage Data Management System.

Hopefully, in the future, surveys such as this will begin to answer some of the many remaining questions regarding the life history, habitat requirements, and seasonal movements of Arizona's bats. Through collaborative efforts and cooperative funding, such as took place during this project, these answers will come to light.

LITERATURE CITED

- Brown, D.E. 1994. Biotic communities: southwestern United States and northwestern Mexico. University of Utah Press, Salt Lake City, Utah.
- Carothers, S.W. and B.T. Brown. 1991. The Colorado River through Grand Canyon: natural history and human change. University of Arizona Press, Tucson, Arizona.
- 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.
- Fradkin, P.L. 1984. A river no more: The Colorado River and the West. University of Arizona Press, Tucson, Arizona.
- Hastings, J.R. and R.M. Turner 1965. The changing mile: an ecological study of vegetation change with time in the lower mile of an arid and semiarid region. University of Arizona Press, Tucson, Arizona.
- Hoffmeister, D.F. 1986. Mammals of Arizona. The University of Arizona Press (Tucson) and the Arizona Game and Fish Department (Phoenix), Arizona.
- Ohmart, R.D., B.W. Anderson, and W.C. Hunter. 1988. The ecology of the lower Colorado River from Davis Dam to the Mexico-United States International Boundary: a community profile. U.S. Fish Wildl. Serv. Biol. Rep. 85(7.19).
- Rosenberg, K.V., R.D. Ohmart, W.C. Hunter, and B.W. Anderson. 1991. Birds of the lower Colorado River valley. University of Arizona Press, Tucson, Arizona.
- Sellers, W.D. and R.H. Hill (eds.). 1974. Arizona climate, 1931-1972. University of Arizona Press, Tucson, Arizona.
- 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.
- Todd, R.L. 1985. A saltwater marsh hen in Arizona. A Federal Aid Project W-95-R Completion Report. Arizona Game and Fish Department, Phoenix, Arizona.
- Valencia, R.A., J.A. Wennerlund, R.A. Winstead, S. Woods, L. Riley, E. Swanson, and S. Olson. 1993. Arizona riparian inventory and mapping project. Arizona Game and Fish Department, Phoenix, Arizona.

Appendix 1. Results of bat mist netting conducted on the Imperial National Wildlife Refuge, Arizona, during 1994.

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.

Meers Point

June 21, 1994

UTM E735030, N3652630

Set three nets; two 7' x 30' nets placed over water at an opening in the cattails (one in a 'V' with the pointed end towards the dredge canal and one straight over standing water on the shore side of the cattails) and one 7' x 18' net in the road between a salt cedar and mesquite trees. Several bats flying at dusk. Nets opened at 2000 h and taken down at 2230 h. Full moon during entire time. Clear skies. Light breeze (1-2 mph) the entire night. Only one juvenile *Myotis californicus* captured.

Ironwood Wash

June 22, 1994

UTM E733160, N3657380

Set four nets (two 7' x 60', one 7' x 42', and one 7' x 18') in canyon between large ironwood, palo verde, and mesquite trees. Canyon about 100 ft wide with vertical (~40 ft high) walls. Nets opened at 2015 h and taken down at 2245 h. Full moon during entire time. Clear skies. 5-10 mph breeze until 2050 h, calm afterward.

Species	Total	JM	JF	AM	TD	AF	LF	PLF	?
<i>Antrozous pallidus</i>	1	-	-	-	-	-	1	-	-
<i>Myotis californicus</i>	9	1	4	-	-	1	3	-	-
<i>Myotis yumanensis</i>	1	1	-	-	-	-	-	-	-

A1 Island

June 23, 1994

UTM E725530, N3656690

Set two nets (one 7' x 42', one 7' x 30') over two 'pools' of standing water on a sand bar. The 'pools' are surrounded on three sides by vegetation (mostly cattail and phragmites, but some salt cedar saplings are present). Nets opened at 2000 h and taken down at 2200 h. Full moon rose at 2023 h. Clear skies. 2-5 mph wind began at 2250 h and continued thereafter.

Species	Total	JM	JF	AM	AF	LF	PLF	?
<i>Myotis yumanensis</i>	1	-	-	-	-	-	1	-
<i>Pipistrellus hesperus</i>	2	-	2	-	-	-	-	-

Appendix 1 (cont.). Results of bat mist netting conducted on the Imperial National Wildlife Refuge, Arizona, during 1994.

Arrastra Wash **June 27, 1994** **UTM E725660, N3657840**

Set five nets (three 7' x 60', one 7' x 42', and one 7' x 30') in shallow but wide canyon. Nets set in a line across the wash between ironwood and palo verde trees. Nets opened at 2000 h and taken down at 2400 h. Half moon rose at 2330 h. Clear skies. Light (~1 mph) breezes intermittent throughout night.

Species	Total	JM	JF	AM	AF	LF	PLF	?
<i>Macrotus californicus</i>	3	-	-	-	-	2	-	1
<i>Myotis californicus</i>	13	2	1	3	-	4	3	-
<i>Pipistrellus hesperus</i>	3	2	1	-	-	-	-	-

Lighthouse Rock Wash **June 28, 1994** **UTM E716270, N3668890**

Set three nets (one 7' x 60' and two 7' x 42') in a narrow section of the canyon. Nets set between ironwood, palo verde, and mesquite trees. Nets were about 150 ft apart. Nets opened at 2015 h and taken down at 0015 h. Half moon rose at 0015 h. Clear skies. intermittent breeze (up to 7 mph) throughout evening.

Species	Total	JM	JF	AM	AF	LF	PLF	?
<i>Antrozous pallidus</i>	10	-	3	4	-	2	1	-
<i>Macrotus californicus</i>	12	-	-	-	-	12	-	-
<i>Myotis californicus</i>	4	1	-	-	1	1	-	1
<i>Myotis yumanensis</i>	2	-	-	-	-	2	-	-

Clear Lake Wash **June 29, 1994** **UTM E731270, N3657690**

One 7' x 18' net set in a 'V' (with 'V' pointing towards water) over water at an opening in the vegetation at Clear Lake. Lake bordered by dense phragmites. Nets opened at 2000h and taken down at 2200 h due to lack of activity. No moon. Clear skies. Intermittent breeze (up to 3 mph). Only one pregnant *Myotis californicus* captured.

North Taylor Lake Pond **July 11, 1994** **UTM E721740, N3657480**

Set two nets (one 7' x 60' and one 7' x 18') at a backwater pond. Both nets were set at the edge of the water (the mud was too thick and deep to put a net over the water. Salt cedar borders the pond and is very thick. Nets opened at 2015 h and taken down at 0015 h. Crescent moon all night. Clear skies. 2-4 mph breeze began at 2400 h.

Species	Total	JM	JF	AM	AF	LF	PLF	?
<i>Antrozous pallidus</i>	5	1	3	1	-	-	-	-

Appendix 1 (cont.). Results of bat mist netting conducted on the Imperial National Wildlife Refuge, Arizona, during 1994.

Hoge Island 7/20/94 UTM E717420, N3659770

Set three nets (one 7' x 60', one 7' x 42', and one 7' x 30') over water between bulrush and cattail and the sandbar. Nets opened at 2015 h and taken down at 2315 h. Partly cloudy. Near full moon rose at 2040 h. Intermittent light wind (3-6 mph) all night.

Species	Total	JM	JF	AM	AF	LF	PLF	?
<i>Eptesicus fuscus</i>	1	-	1	-	-	-	-	-
<i>Myotis yumanensis</i>	1	1	-	-	-	-	-	-
<i>Pipistrellus hesperus</i>	11	4	2	-	-	-	2	3

Yuma Wash 7/24/94 UTM E731340, N3658480

Set four nets (two 7' x 60', one 10' x 42', and one 7' x 42') between trees across 1/2 mile wide wash. Vegetation in drainage primarily ironwood, palo verde, mesquite, and smoke tree. Nets opened at 2015 h and taken down at 2345 h. Partly cloudy skies obscured full moon until 2300 h. Windy (2-10 mph) all night.

Species	Total	JM	JF	AM	AF	LF	PLF	?
<i>Antrozous pallidus</i>	10	6	1	-	-	3	-	-
<i>Macrotus californicus</i>	3	1	-	-	-	2	-	-
<i>Myotis californicus</i>	1	1	-	-	-	-	-	-

Black Rock Wash 7/25/94 UTM E720420, N3658480

Set two nets (one 10' x 42' and one 7' x 30') in narrow (50 ft wide) but shallow (walls about 25 ft high) canyon. Vegetation in drainage mostly ironwood and catchlaw. Nets opened at 2000 h and taken down at 2330 h. Scattered clouds occasionally obscured a 3/4 moon (rose at 2200 h). Light breeze (1 mph) all night with 2-5 mph gusts.

Species	Total	JM	JF	AM	AF	LF	PLF	?
<i>Antrozous pallidus</i>	9	3	5	-	-	-	1	-
<i>Eptesicus fuscus</i>	1	-	1	-	-	-	-	-
<i>Macrotus californicus</i>	11	-	1	1	1	7	1	-
<i>Myotis californicus</i>	1	-	-	1	-	-	-	-
<i>Pipistrellus hesperus</i>	2	-	2	-	-	-	-	-

Appendix 1 (cont.). Results of bat mist netting conducted on the Imperial National Wildlife Refuge, Arizona, during 1994.

Imperial Boundary Wash **7/26/94** **UTM E717410, N3675800**

Set four nets (one 7' x 42', two 7' x 30', and one 7' x 18') between large trees in 1/4 mile wide wash. Vegetation in drainage primarily ironwood, mesquite, palo verde, and smoke tree. Nets opened at 2015 h and taken down at 2315 h. Near full moon rose at 2210 h. Scattered clouds partially obscured moon. No wind.

Species	Total	JM	JF	AM	AF	LF	PLF	?
<i>Antrozous pallidus</i>	5	2	1	1	-	-	1	-
<i>Macrotus californicus</i>	3	-	-	2	-	1	-	-

Picacho Island **8/1/94** **UTM E723480, N3656550**

Set three nets (two 7' x 60' and one 7' x 42') between sandbar and cattail 'stand'. Nets opened at 2000 h and taken down at 0100 h. Clear skies. No moon. Light breeze (1-5 mph) blew periodically after 2200 h.

Species	Total	JM	JF	AM	AF	LF	PLF	?
<i>Myotis yumanensis</i>	10	2	6	-	-	-	1	1
<i>Pipistrellus hesperus</i>	2	-	1	1	-	-	-	-

Red Cloud Wash **8/2/94** **UTM E719530, N3660930**

Set three nets (two 7' x 60' and one 7' x 42') in 1/4 mile wide wash. Vegetation in drainage primarily ironwood, palo verde, and mesquite. Nets at opened 2000 h and taken down at 0100 h. Intermittent breezes (up to 7 mph) from 2100-2200 h and 2400-0100 h. No moon.

Species	Total	JM	JF	AM	AF	LF	PLF	?
<i>Antrozous pallidus</i>	16	1	9	2	-	-	3	1
<i>Macrotus californicus</i>	13	3	2	5	-	3	-	-
<i>Myotis californicus</i>	7	4	-	2	-	-	1	-
<i>Pipistrellus hesperus</i>	3	-	1	1	-	-	1	-

