

Monitoring *Macrotus californicus* and *Myotis velifer* in the Tucson Mountains, 2005-2006

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CONTAINS SENSITIVE DATA

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INTRODUCTION

The Tucson Mountains are adjacent to the city of Tucson, Arizona, and contain over 200 abandoned mines. Our previous work (Wolf and Dalton 2003, Wolf and Dalton 2005) documented California leaf-nosed bats (*Macrotus californicus*), an Arizona state species of concern, or their guano in many of these mines. Six mines are used most frequently and one, in Tucson Mountain Park (TMP) is inhabited year-round. Large colonies of cave myotis (*Myotis velifer*) occupy two mines during summer in the Tucson Mountains, one in the Tucson Mountain District of Saguaro National Park (SNP), and the other on Bureau of Land Management (BLM) land about 11 km (6.7 miles) away (App. A). Cave myotis also use several mines in TMP and BLM in late-summer as transitory roost sites.

California leaf-nosed bats do not migrate and do not hibernate, and therefore inhabit an area year-round. A single colony of this species will use multiple roosts within a geographic area. Roost switching is common, on a daily basis, as well as between seasons (Dalton 2001). Some sites only used as night roosts may be important mating locations, used only in the fall (P. Brown, pers. comm.). Monitoring for multiple years is necessary to obtain a complete picture of this species' ecology.

Wildhorse Mine, in Saguaro National Park, and 400 Yard Mine, on BLM land, house the two largest colonies of cave myotis in the mountain range. Conducting simultaneous counts at both mines is necessary for a more complete picture of the total population in the area, and an opportunity to compare seasonal trends between the colonies.

Wildhorse Mine was gated in 2001 to protect the bachelor colony of bats. After the installation of the gate, abundance of bats decreased, perhaps due to natural annual variation, but perhaps because the gate restricted maximum colony size. Before the bats returned in 2004, a bar in the gate was removed to determine if colony size would increase, and to observe changes in exit behavior. Abundance increased from ~2,400 the previous year to ~3,100, and bats clearly preferred exiting through the larger space (Dalton and Wolf 2005). Maximum number of bats exiting per minute was higher than the three previous years but lower than pre-gate numbers. It is important to continue monitoring the colony and determine the best gate configuration for this colony.

Two other mines, one in SNP and one in BLM, house hundreds of cave myotis in late summer, however, use in spring has not been documented. Monitoring bats in these two mines April-October would yield additional information on the ecology of cave myotis in the Tucson Mountains.

Although the Tucson Mountains are largely owned by federal and county agencies and therefore protected from development, the area surrounding the mountains is being developed rapidly. The increase in the human population has, and will continue, to increase the number of people hiking in the mountains, increasing the risk of disturbance and vandalism to bat roosts. Disregard for signs for closed trails, and warning signs and fences around abandoned mines is common (pers. obs.). Over half of the gates at mines in SNP have been breached, and evidence of human visitation at mines is abundant (pers. obs.). The mine used by California leaf-nosed bats in TMP appears to be well-known to local residents; it has a gate, but it is easily bypassed. Old Yuma Mine (SNP) houses a winter colony of California leaf-nosed bats and is a well-known rock-hounding site. The BLM land adjacent

to TMP has many mines used by bats and a high density of 4-wheel drive/ATV trails that are used regularly. Monitoring mines used by bats to assess the amount of human visitation is necessary to prioritize roosts in need of protection.

The purpose of this project was to continue previous work by monitoring mines used by California leaf-nosed bats and cave myotis in the Tucson Mountains and to provide information on human visitation to these mines so wildlife managers can take appropriate actions to protect roost sites.

Objectives

Specific objectives were as follows:

1. Monitor roost sites of California leaf-nosed bats throughout the year for abundance and seasonal movements.
2. Continue the post-gate monitoring of abundance and exit behavior of cave myotis in Wildhorse Mine by videotaping emergences.
3. Obtain a more regional perspective of abundance and seasonal trends of cave myotis summer colonies by conducting simultaneous counts at Wildhorse Mine and 400 Yard Mine.
4. Confirm colony type of cave myotis at 400 Yard Mine.
5. Monitor sites that appear to be transitory roost sites for cave myotis to confirm dates of use.
6. Confirm species identification and colony type at colonies suspected to be cave myotis.
7. Determine the amount of human disturbance to bats in six mines by installing light-triggered data loggers.

STUDY AREA

The Tucson Mountains, on the western edge of Tucson, Arizona, are comprised mostly of extrusive igneous rock, primarily rhyolite. Vegetation is the Arizona Uplands Division of the Sonoran Desert (Turner and Brown 1994). Elevations range from about 730-1,400 m (2,400-4,600 ft). The mountains are managed by National Park Service, Pima County Parks, Recreation, and Natural Resources, and Bureau of Land Management. Boundaries are adjacent, so that except for some peripheral areas, the entire mountain range falls under the jurisdiction of these agencies. Total land area is about 234 km² (90.5 mi²).

METHODS

Mine Identification System

We used SNP's numbering system to identify their mines; in our records the number is prefaced with an "S." For TMP and BLM we created a sequential numbering system (Wolf and Dalton 2005), prefacing TMP's mines with "T," and BLM's mines with "B."

Surveys

On surveys, we carried standard safety equipment for fieldwork in rough, desert terrain. In addition, for underground work, we each had MSHA-approved hard hats with mounted lights and two back-up lights. We used a gas meter (Gastech GX-82) to check for bad air. We used standard safety techniques for underground work. For example, we evaluated the competence of rock at the portal of each mine before entering, and continued the evaluation as we proceeded through the mine. We used

respirators with ammonia cartridges to enter 400 Yard Mine because previous surveys indicated high ammonia levels.

If bats were present, we identified species and estimated numbers as quickly as possible, then exited the mine to minimize disturbance and prevent the possibility of driving bats out of the mine. We used white light to minimize time of disturbance and to obtain an accurate count. If no bats were present, we looked for insectivorous guano, distinguishing it from rodent scat by size and texture (bat guano crumbles between your thumb and fingers, rodent scat does not), and also looked for red or yellow fecal splats left by lesser long-nosed bats (*Leptonycteris curasoae*). We recorded the location and description of guano. We also looked for stringy green guano that is associated with California leaf-nosed bats, and culled moth wings and insect parts dropped from feeding bats.

We recorded use of a mine by other wildlife species, evidence of human visitation, and the condition of fences and gates if noteworthy.

Censuses

For evening exit counts, we set up a video-camera (Sony DCR-TRV19 or TRV9) outside the mine entrance, and used supplemental infrared lighting (Wildlife Engineering Model IRLamp6) to obtain sufficient light for an accurate count.

Bat captures

During internal surveys, we captured individual bats from the ceiling by hand (wearing a glove), examined it, and released it back to the same spot on the ceiling. At 400 Yard Mine, we captured bats with a harp trap (G5 Cave Catcher, Bat Conservation and Management) placed just outside the entrance to the mine. Bats were taken out of the collecting bag, examined for sex and reproductive condition, and released immediately.

Wildhorse Mine gate

We removed the removable bar (6th from the top) from the gate at Wildhorse Mine (Figure 1) on 31 March, 2005 (before bats arrived) and monitored the colony throughout the season for abundance and behavior of exiting bats. We videotaped evening emergences to observe the proportion of bats exiting from each space between the bars, as well as obtain a count of the total number of bats exiting. The bar on the gate was replaced at the end of the season to prevent human access.

Documenting human disturbance

We installed light-detecting data loggers (Hobo® H-6 Light On/Off, Onset Computer Corporation) in several mines to record dates and times of human visitors. We modified the sensor to make it more sensitive, so that if placed in darkness, it would detect and record light as dim as a mini-mag flashlight not directly aimed at the sensor. We sometimes attached the light sensor to an external wire about 30.5 cm (1 ft) long. To minimize vandalism, we camouflaged the logger by placing it in a plastic bag which was covered with duct or electrical tape, and then glued dirt to the tape.

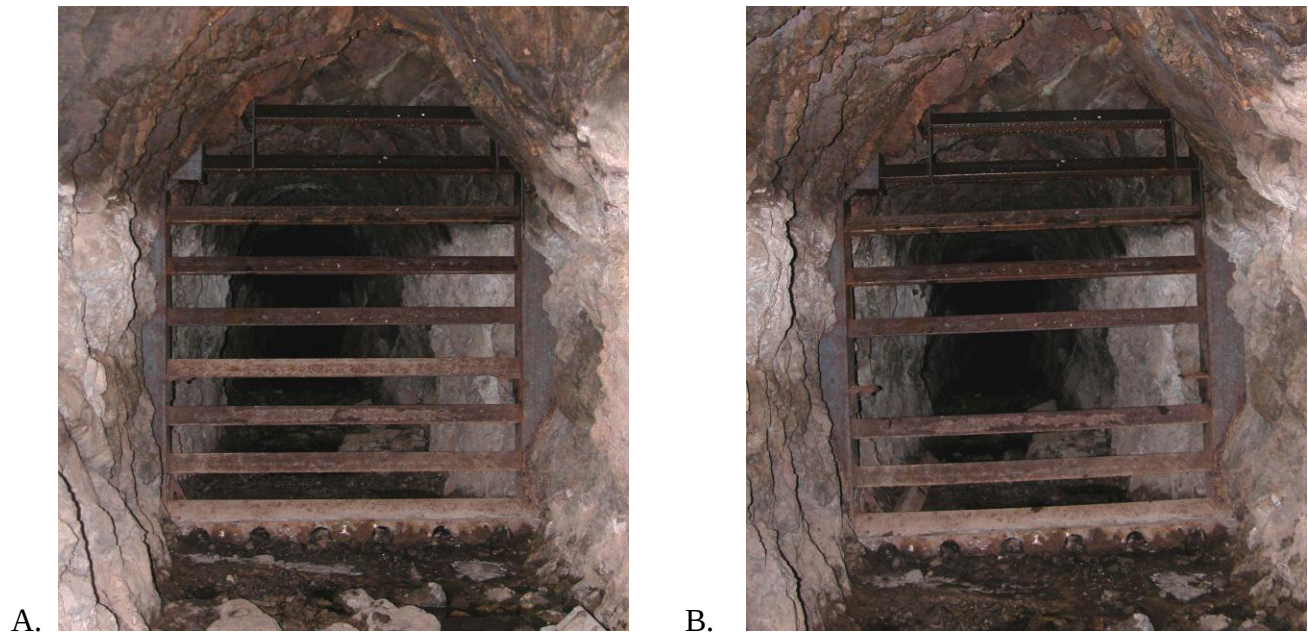


Figure 1. Gate at Wildhorse Mine, Saguaro National Park. Bars and spaces are numbered starting at the top (space #1 is below bar #1). A. full gate, B. bar #6 removed

Our objective was to place the logger at the beginning of the dark zone and before a visitor would encounter roosting bats. If this wasn't possible due to the configuration of the mine, we placed the logger closer to the portal rather than farther, and in a dark, recessed area of the wall. We hid the logger about 15-61 cm (0.5-2 ft) above the floor of the mine in the wall and camouflaged it further with rocks if necessary, so that only the tiny sensor was visible. The logger could be downloaded in the field (Hobo® Shuttle, Onset Computer Corporation).

In 400 Yard Mine, cave myotis roost on the far side of the large rock pile created by a ceiling collapse. We intended to place a logger on each side of the collapse; we hypothesized that most casual explorers would not go past the collapse because of the unpleasant conditions, and thus would probably not encounter bats. Unfortunately, we did not have enough loggers to monitor both areas, and put one logger on the portal side of the collapse.

Data analysis and compilation

We recorded information from field notes in the database that we created in 2004.

We obtained census data by watching the videotapes of evening emergences. Tapes were viewed, in slow motion if necessary, to obtain the most accurate counts. From these data, we created spreadsheets that show the number of bats exiting per minute, number of bats entering the mine per minute, net number exiting, and cumulative number exiting.

To quantify the behavior of bats exiting from Wildhorse Mine, we used methods described in Wolf and Dalton (2005). No bats flew through the small space above the top bar, therefore we designated the space below the top bar as #1. We analyzed the proportion of bats exiting through each gate space, the maximum number of bats exiting per minute, and the total length of emergence time.

RESULTS

Surveys and censuses

We made a total of 99 visits to 20 mines from April 1, 2005 - March 31, 2006 (Appendix A,B). There were 38 visits to six mines in TMP, 34 visits to nine mines in SNP, and 27 visits to five mines on BLM land.

We observed California leaf-nosed bats in seven mines: one in TMP, four in SNP, and two on BLM land (Table 1). Size of colonies ranged from 1-630 bats. We observed cave myotis in nine mines: two in TMP, three in SNP, and four on BLM land (Table 1). We confirmed identification of the species by visual inspection, capture and release of individuals in Mines T002 and B08, and identification of a dead bat in B08. We observed evidence of bats in an additional six mines: three in TMP and three in SNP (Table 2). Only two mines visited, B09 (incomplete survey because of bees) and S037, showed no evidence of use by bats.

Six evening emergences of California leaf-nosed bats at Mine T001 were videotaped May, 2005-March, 2006 (Table 1). Evening emergences of cave myotis were videotaped at two SNP mines and two BLM mines (Table 1). These included four simultaneous counts at Wildhorse Mine (S050) and 400-Yard Mine (B11) (Table 3), and counts that were simultaneous or on consecutive nights at Fenceline Mine (B13) and Mine 21 (S021) (Table 4).

Bat captures

On 4 July, 2005 during an internal survey of Mine T002, we captured an adult male *Myotis velifer* from the ceiling by hand. On 6 March, 2006, during an internal survey of Mine B08, we captured a female *Myotis velifer* from the ceiling by hand. She had a hole in the proximal uropatagium and distal portion of the body at the tail, but was volant.

We captured 80 cave myotis at 400 Yard Mine on 30 July. Fifty-nine (74%) were males (including 1 juvenile), and 21 (26%) were females (11 post-lactating, 9 non-reproductive, and 1 juvenile).

Wildhorse Mine gate

This year was the second season that we removed bar #6 (the removable bar) before bats arrived (Figure 1). We analyzed the proportion of bats flying through each space between the bars of the gate for 15 minutes during the peak of the emergence for 29 July 2005. Approximately two-thirds of the bats, twice as many as in 2004, flew through the larger space (Table 5).

Maximum number of bats exiting per minute was 264 on 29 July 2005, the census with the highest abundance.

Table 1. Bats observed in mines in the Tucson Mountains, April, 2005- March, 2006. Mine: T = Tucson Mountain Park, S = Saguaro National Park, B = BLM land. Species: MACA = *Macrotus californicus*, MYVE = *Myotis velifer*, MYVE? = probably *Myotis velifer*, UNK = unknown. Method: external census = evening emergence videotaped from outside the mine entrance, from gate = bats observed inside but near portal and from outside the gate, internal = internal survey

Mine	Species	Method	Date	Number of bats
T001	MACA	from gate	4/19/05	8+
		external census	5/25/05	49
		external census	6/15/05	35
		from gate	6/19/05	38
		from gate	7/4/05	45
		from gate	7/11/05	20+
		from gate	8/8/05	42
		from gate	9/5/05	30
		from gate	10/2/05	30
		from gate	11/1/05	20
		external census	11/2/05	568
		from gate	12/17/05	1
		external census	12/24/05	630
		internal, incomplete	12/31/05	~12
		internal, incomplete	1/14/06	~20
T002	MYVE? MYVE	internal	4/19/05	2
		internal	7/4/05	1
T004	MYVE?	internal	4/19/05	1
	MYVE	internal	5/25/05	1
	UNK	internal	6/19/05	1
	MYVE	internal	7/4/05	1
S021	MYVE	internal, incomplete	4/21/05	~100
	MYVE	internal	5/23/05	35
	MYVE	internal	6/4/05	12
	UNK	internal	7/6/05	2
	MYVE	external census	8/4/05	15
	MYVE	external census	8/26/05	496
	MYVE	external census	9/15/05	414
	MACA	internal	2/24/06	2
	MACA	internal	2/27/06	1
	MACA	internal	3/24/06	2
S022	MYVE	internal	4/21/05	1
	MACA	internal	2/27/06	1
S043	MACA	internal	1/5/06	~20
		internal	2/20/06	30
S50 (Wildhorse)	MYVE	external census w/ internal survey	7/6/05	1545
		external census w/ internal survey	7/15/05	2082
		external census w/ internal survey	7/29/05	3731
		external census w/ internal survey	8/13/05	934
S147 (Old Yuma)	MACA?	internal	12/3/05	1
	MACA	internal	3/11/05	7
B05	MYVE?	internal	4/21/05	1
B08	MYVE	internal	3/6/05	1
B11 (400-Yard)	MYVE	internal, incomplete	5/29/05	lots
	MYVE	external census	7/6/05	356
	MYVE	external census	7/15/05	70
	MYVE	external census	7/29/05	554

B11 (400-Yard)	MYVE	capture	7/30/05	80
	MYVE	external census	8/13/05	199
	MACA	internal	1/1/06	2
B13	MYVE	internal, incomplete	4/21/05	100+
	MYVE	internal	5/29/05	3
	MYVE	internal, incomplete	7/17/05	40+
	MYVE	external census w/ internal survey	8/3/05	334
	MYVE	external census	8/25/05	399
	MYVE	external census w/ internal survey	9/15/05	370
	MACA	internal, incomplete	2/9/06	~40
	MACA	internal	3/6/06	~20

*technical difficulties

Table 2. Evidence of bats observed in mines in which live bats were not observed, Tucson Mountains, April, 2005- March, 2006. Mine: T = Tucson Mountain Park, S = Saguaro National Park.

Mine	Date	Evidence of bats
T003	4/19/05	guano
T005	4/19/05	guano, moth wings
T006	4/19/05	guano, moth wings
S017	4/21/05	moth wings
S036	2/17/06	guano, moth wings
S152	4/21/05	moth wings

Table 3. Number of cave myotis in Wildhorse Mine compared to 400 Yard Mine, 2005.

Date	Wildhorse (S050)	400 Yard Line (B11)
7/6/05	1545	356
7/15/05	2082	70
7/29/05	3731	554
8/13/05	934	199

Table 4. Number of cave myotis in Fenceline Mine compared to Mine 21, 2005.

Date	Fenceline (B13)	Mine 21 (S021)
4/21/05	100+	~100
5/20/05	0	35 (5/23)
6/4/05	no data	12
7/17/05	40+	no data
8/3/05	334	15 (8/4)
8/25/05	399	496 (8/26)
9/15/05	370	141

Table 5. Proportions of cave myotis exiting through gate spaces in Wildhorse Mine during 15 minutes at the peak of emergence, 2001-2005. Space #1 = top space below bar #1. Percentages may not sum to 100% because of rounding.

Space	2001-2003 <u>All bars in</u> % bats	2004 <u>Bar #6 removed</u> % bats	2005 <u>Bar #6 removed</u> % bats
1	58	47	22
2	18	13	5
3	12	5	3
4	7	2	3
5-6	5	32	66
7	0	0.4	0.6
8	0	0	0

Documenting human visitation in mines

We installed light-detecting loggers in six mines: B11, B13, S021, S050, S147, and T001. We tested that the loggers were working by triggering them on visits between the days when we downloaded data. We recorded evidence of human visitation other than us in B11, S021, S147, and T001 (Table 6). We were not able to record data continuously because of equipment failures caused by dirt or dust, a faulty sensor, and in one case, damage.

In addition to logger data, we observed evidence of human visitation at B08, B11, S021, S147, and T001. Evidence included beer cans, food wrappers, torches made of sticks and rags, burnt wood and cholla joints, and broken branches on trees and bushes outside the portal. In B11, the hole at the top of the collapse had been enlarged.

Other wildlife species observed

In addition to bats, live vertebrates observed during mine surveys included ringtails, javelina, mice, rattlesnakes, and a spiny lizard (Table 7). Active bees were observed in one mine, S022. We also observed dead birds and a cottontail, and sign such as whitewash and scat from various animals (Appendix B).

On two occasions, we observed dead javelina worthy of mention. On 5 January 2006, about two meters inside an adit, we found an adult male javelina that had just died; blood was dripping from its nostrils. We found no external injuries but the right front shoulder felt dislocated or broken and the blood indicated internal injuries. We hypothesized that the javelina had fallen, possibly on the steep rocky slope above the portal, and had crawled into the mine.

On 24 March 2006, several meters inside another adit, we found a dead adult javelina. It was laying on its right side with the body cavity empty. The stomach and intestines were about two meters away. There appeared to be punctures on both sides at the base of the skull. Although there were no signs of an attempt to cover the javelina with dirt, all other evidence indicated a mountain lion had killed and fed on it (L. Haynes, pers. comm.).

Table 6. Human visits inside mines, recorded by light-detecting data loggers, Tucson Mountains, 2005-2006. Time is 24 hour military time.

Mine	Dates monitored	Human visits			Comments
		Date	Time start	Duration	
T001	12/31/05-1/14/06	no data	-	-	equipment failure
	1/14/06-2/13/06	1/14	1427	26 min	
		1/31	1437	22 secs	
		2/2	1456	6 min	
		2/11	1507	14 min	
	2/13/06- present	-	-	-	tested once, not downloaded yet
S021 mid-way	6/4/05-12/9/05	10/15	1117	2 min	tested twice, sun triggered logger
		11/5	1632	3 min	almost every day 11/12/05-2/16/06
	12/20/05-2/24/06	2/11	1205	2 min	
		2/12	1554	7 min	
	2/24/06-3/24/06	3/3	1712	2 min	tested once
S021 near back	2/27/06- present	-	-	-	tested once, not downloaded yet
S050 Wildhorse	7/6/05-8/13/05	none	0	0	tested twice
	8/13/05-11/10/05	no data	-	-	equipment failure
	3/26/06-present	-	-	-	not downloaded yet
S147 upper Old Yuma	7/10-12/3/05	none	0	0	
	12/3/05-3/11/06	12/21	1155	15 min	
		2/14	1816	1 min	
		2/18	1410	6 min	
	3/11/06-present	-	-	-	not downloaded yet
S147 lower Old Yuma	7/10-12/3/05	none	0	0	
	12/3/05-3/11/06	2/18	1432	6 min	
	3/11/06-present	-	-	-	not downloaded yet
B11 400 Yard	5/29/06-1/1/06	6/19	0945	6 secs	
		6/20	0724	~12.5 hrs	
		6/23	1856	2 min	
		7/5	1408	4 min	
		7/08	logger stopped	-	logger stopped, damaged by javelina?
	1/29/06-present	-	-	-	tested twice, not downloaded yet
B13 Fenceline	5/29/05-12/13/05	none	0	0	tested 3 times
	12/13/05-3/6/06	no data	-	-	equipment failure
	3/6/06-present	-	-	-	not downloaded yet

Table 7. Live vertebrates other than bats observed in mines in the Tucson Mountains, 2005-2006. Mine: T = Tucson Mountain Park, S = Saguaro National Park, B = BLM land.

Mine	Date	Species
T004	7/4/05	javelina
T006	5/25/05	tiger rattlesnake
	6/19/05	tiger rattlesnake
	7/4/05	tiger rattlesnake
S021	12/9/05	2 ringtails
	12/20/05	1 ringtail
S036	2/17/06	mouse (<i>Peromyscus</i> sp.) on nest
B08	5/20/05	spiny lizard in crevice
B11	7/15/05	4 javelina
	7/29/05	javelina
	7/30/05	javelina
	8/13/05	several javelina
B13	8/3/05	black-tailed rattlesnake

DISCUSSION

Macrotus californicus

Since 2003, we have documented California leaf-nosed bats using 10 sites in the Tucson Mountains. Six of these (B11, B13, S036, S043, S147, T001) were used most frequently and by larger numbers of bats. Except for the Tucson Bat Mine (T001), which is inhabited all year, we have observed this species at the five other sites from November to March only. More spring, summer, and fall surveys are needed, but presently the only known summer site is T001.

Based on the large numbers of bats at Tucson Bat Mine during winter 2005-2006, and the fact that we observed less than 50 bats there in summer, we obviously have not located all the maternity colonies in the area. From past experience, the most efficient way of finding other sites is by radio telemetry. It is important to locate as many maternity sites as possible to be able to study movement patterns of the Tucson Mountain population throughout the year. In addition, present sample size of known roost sites is too small to study microhabitat characteristics of roost sites.

Winter use of sites was different from what we had observed in the past. In late winter this year, there were no bats in S036 and fewer bats in S043. There were far fewer bats in Old Yuma than in previous years. However, we observed over 500 bats at Tucson Bat Mine (T001), November 2005-February, 2006. During the same months the previous winter, we conducted only incomplete internal surveys to ascertain presence/absence, and to minimize disturbance we left as soon as we encountered bats. However, we feel that the number of bats this past winter at T001 is much larger than the winter before.

Our observations illustrate the importance of preserving all roosts used by California leaf-nosed bats. All mines (and caves) used by this population must be considered collectively as roost habitat. A particular mine may be the “best” roost for a period of time based on factors that change, not only seasonally, but also perhaps within a season, and also from year to year. A mine that served as a minor alternate roost one year may be the preferred roost when conditions change the next year.

Multiple factors, alone or in combination, could be responsible for the change in abundance in the mines we monitored. The weather, warmer and drier than normal all winter, could have resulted in less preferable micro-habitat conditions at some roost sites. California leaf-nosed bats do not need free water during winter; however, water availability and temperatures may have affected local insect populations, which may in turn have affected roost selection. We observed no evidence that human disturbance at winter sites other than T001 caused roost switching. Our knowledge of all roost sites used by this population is incomplete, so we can only speculate the reasons for changes. We cannot even assume that the population inhabiting the Tucson Mountains restricts itself to this mountain range throughout the year; it is possible these bats roost in nearby mountains at certain times.

Myotis velifer

At Wildhorse Mine (S050), the seasonal pattern of use by cave myotis remained the same as in previous years. The increase from last year in peak abundance by about 700 bats is encouraging (see discussion below on the gate), although possible factors influencing abundance from year to year are numerous and presently unidentified.

At 400 Yard Mine (B11), the sharp decrease in abundance of bats from 2004 is cause for concern. The number of bats in 2005 peaked at only 554, a third of the peak in 2004. Furthermore, there was a decrease from over 350 bats to 70 in one week mid-July, then an increase to over 550 bats the next week. The most likely reason is that human disturbance caused the decline. The adit is about 100 m (329 ft) long. About 60 m (197 ft) from the portal a ceiling collapse almost completely obstructs the passage, although continuing on is possible by climbing up the rock pile and crawling through the small hole at the top of the collapse. On the far side of the collapse, where the cave myotis roost, the air is noticeably more humid, and the entire floor consists of dirt, guano, and water mixed into a thick, odiferous goop. In spite of these conditions, people explore the mine.

People entered the mine four times between 19 June and 5 July (Table 6) and probably after 8 July (the date the logger was broken). Two visits were long enough that the visitor(s) had sufficient time to climb over the collapse and enter the roosting area, including the day (20 June) that lights were on continuously from 7:24 A.M. to 8:00 P.M. This is probably when the hole at the top of the collapse was enlarged, and the collapse smoothed out to make crawling easier. If the bats had not already been driven out of the mine that day, they would have started exiting about 8:00 P.M., and may have encountered the people. We have logger data only for 29 May- 8 July, and census data only for 6 July-13 August. Although the data do not really overlap, it is likely that human disturbance was the cause for the low numbers at 400 Yard Mine. Continuing to monitor both bats and visitors next summer may yield additional insight.

Both Mine 21 (S021) and Fenceline (B13) showed the same pattern of use by cave myotis. About 100 bats were present in April, numbers decreased during the summer, and abundance peaked to 400-500 in August. Light-logger data showed no human disturbance during this time period in either mine. After Wildhorse and 400 Yard Mines, Mine 21 and Fenceline appear to be the most significant sites for cave myotis in the Tucson Mountains.

Wildhorse Mine gate

The increase in abundance of cave myotis at Wildhorse Mine and their exit behavior in 2005 support evidence from 2004 that the full gate may be restricting colony size. Colony size increased by about 20% from 2004, which was an increase of 29% from 2003. In 2005, the proportion of bats exiting through the large space created by removing the bar was double that of 2004, and shows even more clearly the colony's preference for larger spaces. Although the maximum number of bats exiting per minute was lower than in 2004, it was still intermediate between pre-gate and full gate numbers. The data from the two years of bar removal are encouraging, and confirm the need to continue experimenting with gate configuration and monitoring. Because cave myotis prefer to fly near the ceiling of the adit rather than lower down, the next step is to observe exit behavior when a higher bar is removed.

With the growing popularity of 'bat-friendly' gates throughout the U.S. in the last 20 years, wildlife managers may believe sufficient research has been conducted, and that the current recommended gate designs are the best for every situation. Unfortunately, most gates are installed without sufficient (or any) pre- or post-gate monitoring (see Wolf and Dalton 2005 for background information). Researchers and managers who are monitoring the effects of gates are discovering that many factors may affect the response by bats, including species morphology and ecology, season, size of colony, and size of entrance, as well as gate design. To our knowledge, no other large cave myotis colony at

a gated site is being studied to determine if the gate is affecting abundance or behavior. It is important to continue work at Wildhorse to find the most suitable gate configuration.

Human disturbance to roosts

The modified light-detecting loggers are an excellent method for recording human visitation to mines. After a few problems, we are learning how best to protect the logger and place it to minimize the chances of failure.

Four of six mines we monitored were visited by humans. We often find signs of recent visitation at mines, but sometimes only at the portal or just inside. The light-detecting loggers support these observations with quantifiable data well inside the adits, where explorers must use an artificial light source to navigate, and where they are most likely to disturb bats. The large bat colonies at both 400 Yard and the Tucson Bat Mine are especially vulnerable because both mines are easily accessible.

Beer cans, beer and liquor bottles, and food wrappers are the most common human evidence we see. However, this past year in T001 and Mine 21, we also found burnt torches, made of broomsticks or tree branches with rags wrapped around one end. Although we observed no burned bats, fire produces carbon dioxide and carbon monoxide, which can build up and displace oxygen in the rear of an adit where air exchange is slow. Explorers using torches may not intentionally harm bats, but may do so indirectly, as well as unknowingly risk their own lives.

Old Yuma Mine has been a popular rock-hounding site for decades; two of the three times human visits were recorded by the light logger were in mid-February during the Tucson Gem and Mineral Show. Through our four years of monitoring, we have also observed signs of visitation. Although we have no evidence that rock-hounds have adversely affected the colony of California leaf-nosed bats, colony size was greater in the past. Bats have wintered in the mine since at least the 1930's; in February, 1932, 76 bats were collected (Dice and Blossom, 1937), whereas the most we have observed is about 20 (Appendix B). Over the years, the physical structure has changed, and may have altered roost characteristics (e.g., temperatures) and created less desirable conditions. Blasting, gophering, and timbering by rock-hounds have been documented (Currier 2001), in addition to natural cave-ins (Jones 1983). The 300-foot level of the mine is now completely inaccessible due to collapse.

The entrance to Old Yuma is a steep decline leading to the 100- and 200-foot levels. Due to loose rock debris, and old, damaged timbers, entering this mine is extremely dangerous. Respirators are necessary to filter out thick dust that probably contains zinc, lead, arsenic, and molybdenum. Rockfall is common, and the walls and ceiling are unstable. We see recent signs of deterioration on every visit. Continuing to record human visitation is important not only to determine the amount of disturbance to the bat colony, but also to provide evidence for the park so that it can obtain funds for visitor protection.

RECOMMENDATIONS

1. Replace the existing gate at the Tucson Bat Mine (T001) with a more vandal-resistant gate that cannot be bypassed by humans.
2. Continue to monitor human visitation at mines to determine the level of disturbance to bats.

3. Continue monitoring Wildhorse Mine, and experimenting with gate design to determine if acceptance of the gate continues to increase.
4. Continue simultaneous monitoring of 400-Yard Mine to compare seasonal trends and abundance.
5. Continue monitoring known roost sites of California leaf-nosed bats and search for undocumented roosts, particularly maternity sites.

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APPENDIX A

CONFIDENTIAL: SENSITIVE DATA

TUCSON MOUNTAIN MINE LOCATIONS AND ATTRIBUTES

Explanation of Database Fields

Mine ID	S = Saguaro Nat Park, T = Tucson Mtn Park, B = BLM
Mine name	Historical name or Wolf/Dalton name
T/R/S	Township Range Section
UTM X	Easting Datum NAD Conus 27
UTM Y	Northing Datum NAD Conus 27
Length	Length of adit main passage in feet

(Soft copy in separate file: App A Mine locations 2005-06)

APPENDIX B

TUCSON MOUNTAIN MINE FIELD NOTES: 1 APRIL 2005- 31 MARCH 2006

Explanation of Database Fields

Mine ID	S= Saguaro Nat Park, T= Tucson Mtn Park, B= BLM
Surveyor	DD = Dave Dalton, SW = Sandy Wolf, MV = Marion Vittetoe, LH = Lisa Haynes, RK = Rocky Kloster, MH = Mark Holden
Number of Bats	Number of bats seen in mine
Species	MACA = <i>Macrotus californicus</i> MYVE = <i>Myotis velifer</i> MYVE? = probably MYVE
Wildlife	Wildlife or sign in mine
Notes	

(Soft copy in separate file: App B Mine Field Notes 1 Apr 05-31 Mar 06.xls)