Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

ROOST SURVEYS AND MONITORING FOR LOWER COLORADO RIVER BAT SPECIES

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

November 2010

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Lower Colorado River Multi-Species Conservation Program

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Multi-Species Conservation Program
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ABSTRACT

The Lower Colorado River (LCR) Multi-Species Conservation Program (LCR MSCP) , implemented in 2005, included two bat species as covered: the western red bat (*Lasiurus blossevillii*) and the western yellow bat (*Lasiurus xanthinus*), while the Townsend's big-eared bat (*Corynorhinus townsendii*) and California leaf-nosed bat (*Macrotus californicus*) were added as evaluation species. The latter two species are colonial and roost in mines adjacent to the floodplain of the LCR. Over the past 60 years, declines have been observed in some bat species, such as the cave myotis (*Myotis velifer*) and Townsend's big-eared bat, that were at one time relatively abundant along the LCR. Colonial bats offer the opportunity to directly monitor numbers of bats through roost exit counts, and thereby determine population trends. Since 2000, biannual censuses have been conducted of eight winter and summer mine roosts along the LCR from near Davis Dam to near Laguna Dam. Both hand and video counts were used to estimate annual number of bats. The Eureka Mine appears to be the only roost that has had a noticeable decline since 2008. Most other roosts showed variability between years but not a specific upward or downward trend.

INTRODUCTION

The Lower Colorado River (LCR) historically sustained a diverse bat assemblage of at least 14 species (Allen; 1864; J. Grinnell, 1914; H.W.Grinnell, 1918; Barbour and Davis, 1969; Stager, 1939; Constantine, 1998; Vaughan, 1959; Cockrum, Musgrove and Petryszyn; 1996; and Brown and Berry, 2003), with another six species potentially occurring (Table 1). A total of 25 bat species have been reported from the state of California and 29 from Arizona. Some bats roost in trees along the LCR, others in mines and caves, while others (such as Mexican free-tailed and western mastiff bats) may commute nightly over 25 miles from a cliff roost to forage over the LCR. All can be construed to be dependent on the LCR for their survival. Colonies of several thousand bats have been documented roosting in mines in the Riverside Mountains in the 1930's (Stager, 1939). As described by Stager, "these rugged, volcanic mountains are bordered on the east by the almost impenetrable, broad, lower valley of the Colorado River which separates California from Arizona. From them one obtains a view of countless square miles of the broad river valley, cloaked in a covering of luxuriant vegetation. This mass of green, consisting mainly of cottonwood (*Populus*) and arrowweed (*Pluchea*), extends to the foot of the mountains where it is suddenly replaced by the more typical desert plants, such as smoke tree (*Dalea*), palo verde (*Cercidium*), iron wood (*Olneya*), and creosote bush (*Larrea*). From this blanket of vegetation over the river valley, rise countless millions of insects, which provide food for bats". When I visit the mines in the Riverside Mountains now, I witness a blanket of agricultural fields bordered by *Tamarisk* spp. and interspersed with river camps. Times have indeed changed along the Lower Colorado River, and so has the biota. However, this trend will hopefully be reversed to some extent by the restoration activities led by the Bureau of Reclamation (Reclamation) for the LCR MSCP. Two bat species were listed as covered: the western red bat (*Lasiurus blossevillii*) and the western yellow bat (*Lasiurus xanthinus*), while the Townsend's big-eared bat (*Corynorhinus townsendii*) and California leaf-nosed bat (*Macrotus californicus*) were added as evaluation species.

Over the past 60 years, some bat species appear to have declined in numbers, such as the cave myotis (*Myotis velifer*) and Townsend's big-eared bat, which were at one time relatively abundant along the Colorado River. Large deposits of the distinctive guano of these colonial species are found in abandoned mines that border the LCR, although the bats are now absent or are present in relatively small numbers. Only four maternity colonies of cave myotis are now known along the Colorado River south of Lake Mead, and one is imperiled by closure of the mine from wash debris. Colonies of the Arizona myotis (*Myotis occultus*) appeared to have disappeared from the LCR (Stager 1943), with the last museum specimen collected by Constantine in 1945. However, recently Arizona myotis has been captured in a habitat creation area in the 'Ahakhav Tribal Preserve south of Parker, AZ, as well as the Cibola Valley Conservation Area north of Cibola, Arizona (Calvert 2009a, 2010 and 2011). The type locality for this bat species was Ft. Mojave north of Needles. One hypothesis for the decline of some bat species is the removal and replacement of native floodplain vegetation that supported the insect diets of these bats. Another is the heavy pesticide spraying in agricultural areas (conducted principally at night) that would directly reduce the prey base and poison the bats. A third possible

cause is the disturbance of roosts by the increased resident and recreational human populations along the Colorado River.

Although some historic data exists on the distribution and relative abundance of bats along the Lower Colorado River, many areas had never been surveyed for bats. Traditional methods of collecting bats (shooting and mist netting) would sample only those bats flying at low altitude. Capturing bats in mines and caves would overlook those species roosting in trees and cliffs. In 2001-2002 Brown and Berry (2003) were funded to conduct baseline surveys and to develop monitoring protocol for Lower Colorado River bat species. One goal of the surveys was to determine if the apparent reduction in numbers and species of some bats, such as *Myotis occultus* and *velifer,* was the result of sampling bias, or if these species had in fact disappeared or declined along the LCR. The survey employed relatively new methods of acoustic monitoring (O'Farrell and Gannon, 1999), as well as roost surveys and some mist netting to give a more complete picture of the bat species present along the LCR.

The goals stated in the original 2001 bat proposal to the LCR Multi-Species Conservation Program (MSCP) committee were fourfold:

1) To provide a better understanding of the past versus current bat assemblage along the Lower Colorado River
2) To establish a long-term monitoring protocol for bats utilizing current technology
3) To identify potential species-specific threats to bats
4) To assist in the protection of critical roosts

In 2005, the LCR MSCP was implemented. The most visible effects of this plan have been the revegetation of parcels of previous agricultural land with native cottonwood, willow and mesquite. The tree-roosting western red and yellow bats covered by the plan are being monitored by mist-netting and acoustic surveys by Reclamation and Arizona Game and Fish biologists (Calvert 2009a,b and 2010; Vizcarra and Piest 2010), and appear to be increasing in numbers as the program proceeds. The two evaluation species, California leaf-nosed bats, and Townsend's big-eared bats, emit low intensity echolocation signals, and are therefore more difficult to monitor. They do however roost in mines along the LCR, and their populations can be monitored through roost exit surveys. The cave myotis is considered to be an indicator species of good cottonwood riparian habitat, and the remaining LCR colonies were included in the roost surveys to provide another measure of the success of the revegetation projects.

Table 1. Status of bats potentially occurring along the Lower Colorado River

Table 1. Bats of LCR and their Status.[1]						
Species Name	USFWS	CDFG	BLM	AGFD	WBWG	IUCN
Phyllostomidae						
Choeronycteris mexicana	SC	CSC	Sensitive	Threatened	High	LR: nt
Leptonycteris curasoae	Endangered		Endangered	Endangered	High	VU: A1c
Macrotus californicus	SC	CSC	Sensitive	Candidate	High	VU: A2c
Vespertilionidae						
Myotis yumanensis	SC	-	-	-	Low	LR: lc
Myotis velifer	SC	CSC	Sensitive	-	Medium	LR: lc
Myotis occultus	SC	CSC	Sensitive	-	Medium	LR: lc
Myotis californicus	-	-	-	-	Low	LR: lc
Parastrellus hesperus	-	-	-	-	Low	LR: lc
Eptesicus fuscus	-	-	-	-	Low	LR: lc
Lasiurus blossevillii	-	CSC	-	Candidate	High	LR: lc
Lasiurus xanthinus	-	-	-	Candidate	High	LR: lc
Lasiurus cinereus	-	-	-	-	Medium	LR: lc
Euderma maculatum	SC	CSC	Sensitive	Candidate	Medium	LR: lc
Idionycteris phyllotis	SC	N/A	Sensitive	-	High	LR: lc
Corynorhinus townsendii	SC	CSC	-	-	High	VU: A2c
Antrozous pallidus	-	CSC	-	-	Low	LR: lc
Molossidae						
Tadarida brasiliensis	-	-	-	-	Low	LR: nt
Nyctinomops femorosaccus	-	CSC	Sensitive	-	Medium	LR: lc
Nyctinomops macrotis	SC	CSC	Sensitive	-	Medium	LR: lc
Eumops perotis	SC	CSC	-	-	Medium	LR: lc

[1]Sources for status determination are as follows:

USFWS = U.S. Fish and Wildlife Service's Endangered Species Act listing. SC refers to Species of Concern. These are currently all former Category 2 species. These are species whose conservation status may be of concern to the US Fish and Wildlife Service, but do not have official status.

CDFG = California Department of Fish and Game Species of Special Management Concern. There are no listed bats in California.

BLM = Bureau of Land Management's Sensitive Species list (October 2000).

AGFD = Arizona Game and Fish Department. Wildlife of Special Concern in Arizona. Arizona Game and Fish Department Publication. Phoenix, Arizona. 32 pp.

WBWG = Western Bat Working Group *The Western Bat Species: Regional Priority Matrix*. High priority species may be imperiled or at risk of imperilment, medium priority indicates a level of concern, but information regarding the species and perceived threats is lacking, and low priority indicates that most of the existing data suggests species' populations are stable and the potential for major changes in status is considered unlikely.

IUCN = The World Conservation Union conservation status. EN=endangered, VU=vulnerable, R:nt=lower risk, near threatened, LR:lc=lower risk, least concern. Red list (EN and VU) subcategories include A=threshold levels of population reduction either in the past (1) or predicted for the future (2), c=reduction based on decline in area of occupancy, extent of occurrence or quality of habitat (Hutson et al. 2001).

Bold: Bats that roost in mines along the LCR during the current survey

METHODS

The field surveys for the current LCR MSCP funded project were conducted along the lower Colorado River from mines near Lake Mojave in Lake Mead National Recreation Area (LMNRA) to Laguna Dam (Figure 1) for 224 days and/or nights between October 6, 2002 and May 13, 2010, primarily on land administered by the National Park Service (NPS), Fish and Wildlife Service (FWS), and Bureau of Land Management (BLM). All survey areas (acoustic, mist netting and roost) were documented and located using a Magellan GPS.

Roost Surveys

Roost Surveys were conducted of buildings, bridges, dams and mines along the LCR both during the day and at night for evidence of bats and guano. Occasionally, bats were captured in hand nets inside the roost or in mist nets or a harp trap erected at the portal in order to obtain information on sex and reproductive status. In some roosts, guano was collected for subsequent species identification through DNA.

Several factors were involved in the selection of mines for long-term monitoring. Some had prior baseline population data gathered by Stager (1939), Vaughan (1959) or Brown and Berry (pers. obs., Brown and Berry 1998, 2003, 2004). The ten major mine complexes selected occurred in different geographic sections of the LCR and were within five miles of the floodplain. The winter surveys focused on mines with large populations of *Macrotus.* This species concentrates in relatively few mines in the winter. The spring or summer monitoring sites included the only known maternity colony of *Corynorhinus* along the LCR, and the larger maternity colonies of *Macrotus.* Some large colonies of *Myotis yumanensis* and *velifer* were included as indicator species. Winter surveys were conducted in January or February, a time when the winter *Macrotus* colonies are at their greatest size. The spring surveys are usually conducted between mid- April and mid-May in an attempt to count the maternity colony before any of the juveniles became volant. However, sometime the *Myotis* give birth in early April, before all of the *Macrotus* females have arrived in the mine. *Macrotus* usually deliver their pups the latter part of May.

Weather data was recorded at the time of the surveys, and exit counts were not attempted if wind speed was greater than 20 km/hr or if it was raining. In January 2003, we became aware that moon phase was recognized as a significant variable in determining population size by exit counts for *Macrotus* when paired counts were conducted during the week before and after the full moon on selected mines in Southeastern California. There was a several fold increase in the number of bats exiting the mine in the hour after dark in the absence of moonlight. For example, 12 *Macrotus* exited the American Boy adit on January 14, 2003 (full moon) and 172 on January 22, 2003 (no moon). The absolute numbers of bats were greater in the 3C exit counts in January 2003 (1515 with the moon, and 2491 the following week). Since past exit counts over the last 20 years did not factor in the moon phase variable, we are now attempting to do the *Macrotus* census when no appreciable moonlight is available (and avoid the week before the full moon).

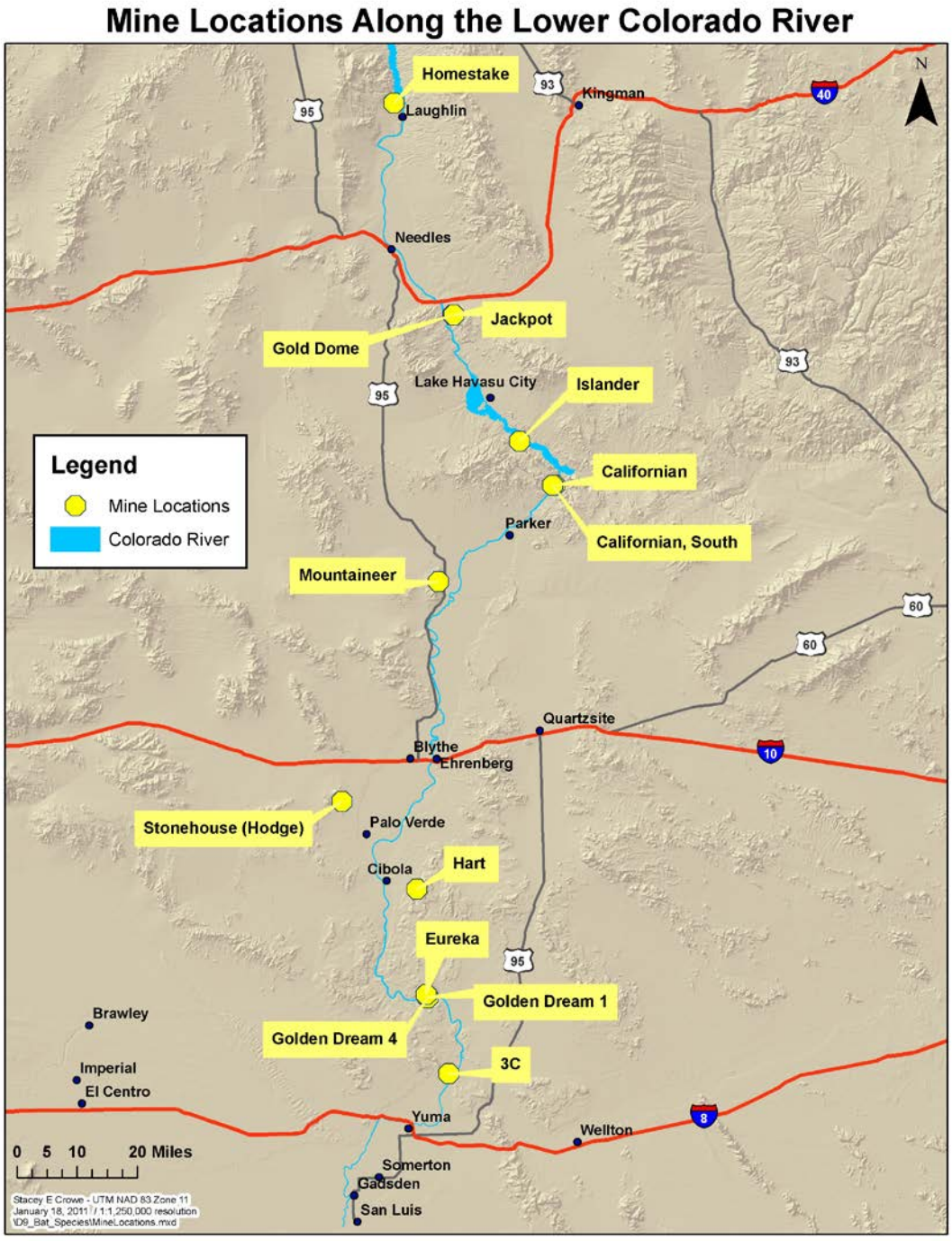

Figure 1. Map of mine survey sites

To obtain accurate exit counts, occupied mines were monitored at dusk by surveyors with night vision equipment (augmented with infrared light sources) and two finger tallies: one for bats exiting and one for those entering a mine. The counts continued for at least 60 minutes after the first bat exited, or until more bats began to enter than exit the mine. For mines where the bats exited very rapidly in great numbers, several people might watch the same portal, and their net exit counts averaged. Some of the mines (Hart, Californian and Jackpot) can be safely entered after the exodus dwindles to verify the number of bats still remaining. Sony "Nightshot" video cameras with auxiliary infrared lights were used to remotely monitor mines, and to obtain permanent records of exiting bats (even for some mines that were watched by people real time). This was especially important in those mines in which hundreds of bats might exit within 5 minutes. The tapes could be counted later at half speed. Depending on the number of bats, the speed of their exodus and the experience of the observers, real time counts could be either greater or lesser than the videotaped record.

Acoustic Surveys

Acoustic recordings were made with ultrasonic detectors (i.e., Anabat II and 1A detectors, Pettersson D240X detector and associated analysis systems. Echolocation signals recorded via an Anabat detector on laptop computers and/or storage ZCAIMs (Zero Crossing Analysis Interface Modules) were used for identification of bat species and to document general bat activity levels. Usually acoustic recordings on Anabat SD1 detectors were made concurrently near the mine. Until 2008, one to five locations were sampled acoustically each evening using Anabat equipment (O'Farrell, 1998; O'Farrell *et al*. 1999). Acoustic survey locations were selected to typify different habitat conditions (native and exotic vegetation, restoration projects, agriculture, recreational development, marsh, etc.) along the LCR from Lake Mojave south to Yuma on land principally administered by NPS, FWS and BLM. Often the signals of western mastiff bats (*Eumops perotis*) are not recorded on the Anabat because their low frequency calls (in the range of many insects) are purposely attenuated by electronic filtering. The calls are audible to most (younger) people with good hearing, and the bats may be heard long before being recorded with an Anabat. We recorded information on the time and location of audible calls. The results of the acoustic survey will be presented in a future report.

Mist Netting Surveys

Mist netting was conducted in a few areas on the Bill Williams River (BWR) and in revegetation plots at Havasu, Cibola and Imperial NWR, concurrent with acoustic sampling. Mist nets were set across water, roads and areas where the vegetation and terrain were likely to funnel bat activity.

RESULTS

Mist Netting

Although good mist-netting opportunities were limited, 182 bats of nine species were captured during 21 surveys at seven locations between 2002 and 2010, with approximately 188 mist net hours (#nets x #hours) of effort (Table 2). An ephemeral pond below a cliff face along the BWR was the best netting location, where all nine species were captured, including the only *Corynorhinus*. Most effort was concentrated within the Bill Williams River NWR. Evidence of reproduction (juveniles or reproductive females) was found in all species captured. Other successful mist-netting locations were revegetation sites at Imperial, Cibola and Havasu NWR, and the palm grove at Cienega Springs. Mist nets or harp traps were also placed across portals of the Mountaineer, 3C, Californian, Golden Dream, Homestake and Stonehouse Mines to ascertain if maternity colonies were using the mines. These results are discussed below.

Table 2. Mist netting results at non-mine locations

Species	Bill Williams River NWR	Cibola NWR	Cienega Springs	Havasu NWR	Imperial NWR	Picacho State Park	Proctor Palms	Totals
Antrozous pallidus	28	3	0	0	9	0	0	40
Corynorhinus townsendii	5	0	0	0	0	0	0	5
Eptesicus fuscus	4	0	0	0	0	0	0	4
Macrotus californicus	12	3	3	1	10	0	0	29
Myotis californicus	4	1	2	0	0	0	0	7
Myotis velifer	4	0	0	0	0	0	0	4
Myotis yumanensis	18	0	0	0	0	0	0	18
Nyctinomops femorosaccus	12	0	0	0	0	0	0	12
Parastrellus hesperus	63	0	0	0	0	0	0	63
Totals	150	7	5	1	19	0	0	182

Roosts

Ten mine areas along the LCR were regularly monitored for bats and several more were surveyed for bats. Six of the mines had baseline data spanning two decades or more. Most of the mines sheltered *Macrotus* at some season and some also had maternity colonies of *Myotis*. A total of nine bat species were discovered using these mines as day or night roosts (Table 1). The mines described below were selected for monitoring because they represented roost areas along different sections of the LCR, starting north and heading down river, as well as sheltering large colonies of target species at some time of the year. Both real time observer counts and video data is presented in the figures for comparison. The raw counts will not be presented in this report, but are available upon request to Reclamation.

Homestake Mine: This complex mine is located in the Newberry Mountains within the LMNRA northwest of Davis Dam. We are convinced that this is the "lost" Jackass Flats Mine surveyed by Musgrove in 1961-62 (Cockrum, Musgrove and Petryszyn, 1996), although the geographic location given in the paper is inaccurate. This mine shelters the only known colony of *Myotis velifer* in Nevada (Cockrum and Musgrove, 1964). From the summer banding records of Musgrove, the colony contained approximately 70 male and female bats and was probably a maternity site. Other species present at the time included over 200 male and female California leaf-nosed bats, over 100 male and female Yuma myotis and a small number of male and female Townsend's big-eared bats. Since the mine was "rediscovered" in May 1999, we have observed fewer bats (individuals and species) than were reported in 1961. The main adit entrance has collapsed and the mine is now entered through three shafts. An adit on the wash, leads into stopes only accessible to bats. Large piles of old *Myotis velifer* guano remain in the mine, but only about 12 cave myotis were seen in May 2001, including two males which were captured. Only male *Myotis velifer* and *Macrotus* have been captured in the spring or summer surveys. Both sexes of *Macrotus* have been captured in the winter. Bryan Moore (LMNRA) gated the lower wash adit in 2002 and installed cupolas on the shafts in 2009. The resident bat populations appear to be increasing, possibly because of the installation of the gates and cupolas (Figure 2).

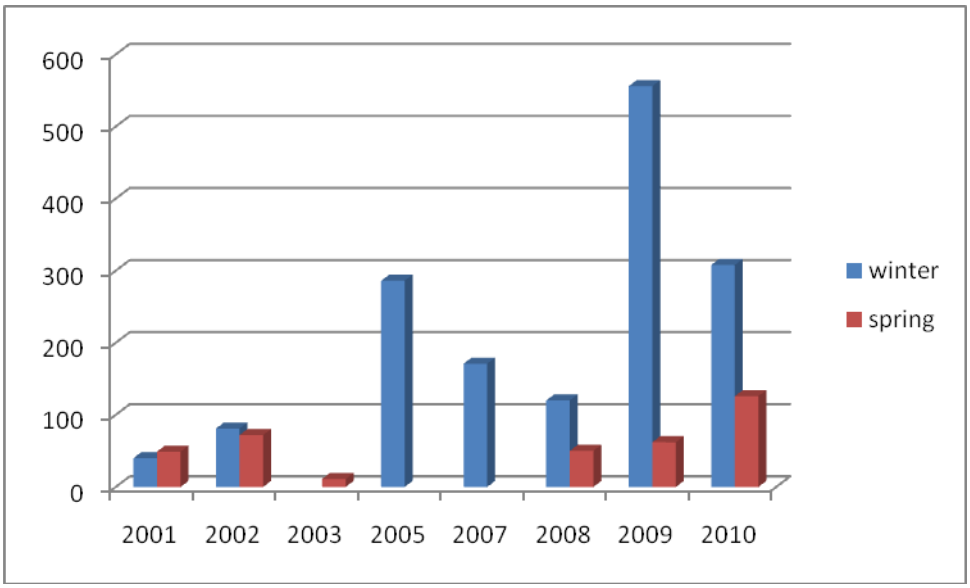

Figure 2. Homestake Mine winter and spring exit counts

Jackpot Mine: The Jackpot is the only known active maternity colony for cave myotis along the LCR on the Arizona side. This mine is located two km from the LCR in the Mojave Mountains within designated wilderness on the Havasu NWR. Because the main workings of the mine are not properly sited on the topographic map, this mine does not appear to have been previously surveyed by Musgrove (Cockrum *et. al*, 1996). The main Jackpot adit (~200m long) is almost sealed by dirt washed down from above, leaving a two-foot diameter hole from which the bats emerge. When the mine was first visited in January 2002, almost 500 *Macrotus* exited after dark. A post-outflight exploration of the mine revealed large piles of guano that smelled like cave myotis. This was confirmed when we returned on May 8, 2002, and watched about 950 *Myotis velifer* (and ~30 Macrotus) exit from the mine. A quick internal survey confirmed the presence of a maternity roost when clusters of newborn cave myotis were discovered in the mine, and we hastily retreated. The *Myotis velifer* maternity colony outflight fluctuates between 600 and 1000 bats; however, in May 2005 the video recorded over 2,000 bats exiting the mine. The Jackpot is a mine that can be entered after the outflight has ceased to ascertain if any bats remain in the mine. In May 2005, there were still females with juveniles inside. During the May census, only male *Macrotus* are captured in the mine, and these often enter to "night" roost. The winter *Macrotus* population varies between 500 to 800 bats of both sexes. On several occasions, active *Myotis velifer* have been captured in the mine in the winter. Overall, except for the increase in bats during the winter and spring 2005 counts, the population has fluctuated relatively little between 2002 and 2010 (Figures 3 and 4).

In addition to the main adit (Jackpot 1), two shorter workings (Jackpot 2 and 3) in the next drainage are used as night roosts by *Macrotus* and *Myotis*. During the day in May, Jackpot 2 shelters between 3 and 17 male *Macrotus*, and in October the number increases to about 30. The mine appears to function as a reproductive display or "lek" location.

Jackpot 3 sometimes contains small numbers of male *Macrotus*, *Myotis yumanensis* and *Myotis velifer*. A male *Corynorhinus* was captured here in October 2003. None of the Jackpot workings appear to have much human visitation, probably due to the hidden location in a Wilderness area, and bat gates are not recommended at this time. A diversion above the portal of Jackpot 1 is needed to prevent rock and debris from washing down and sealing the mine. The catchment area above the mine is relatively small, and this modification should not be difficult.

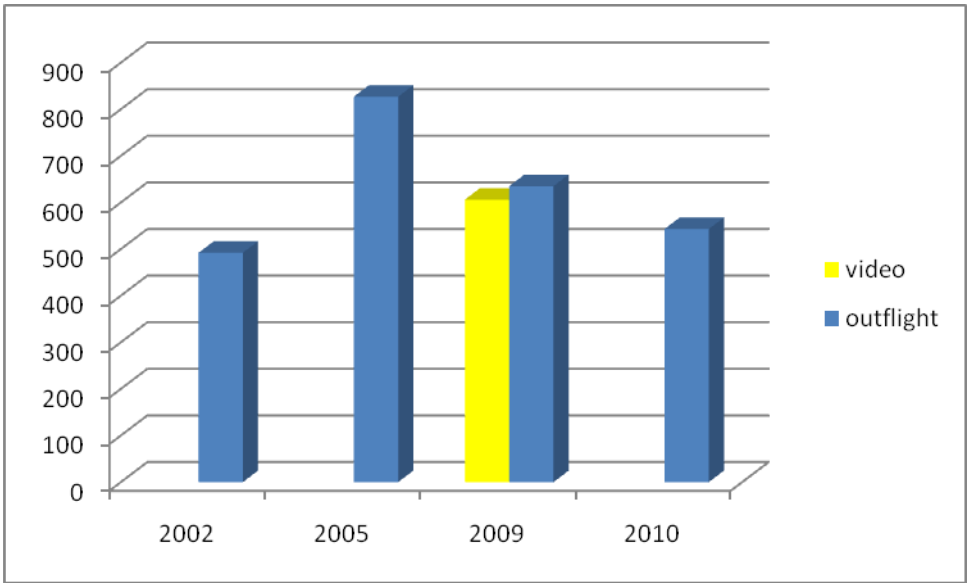

Figure 3: Jackpot Mine winter exit counts

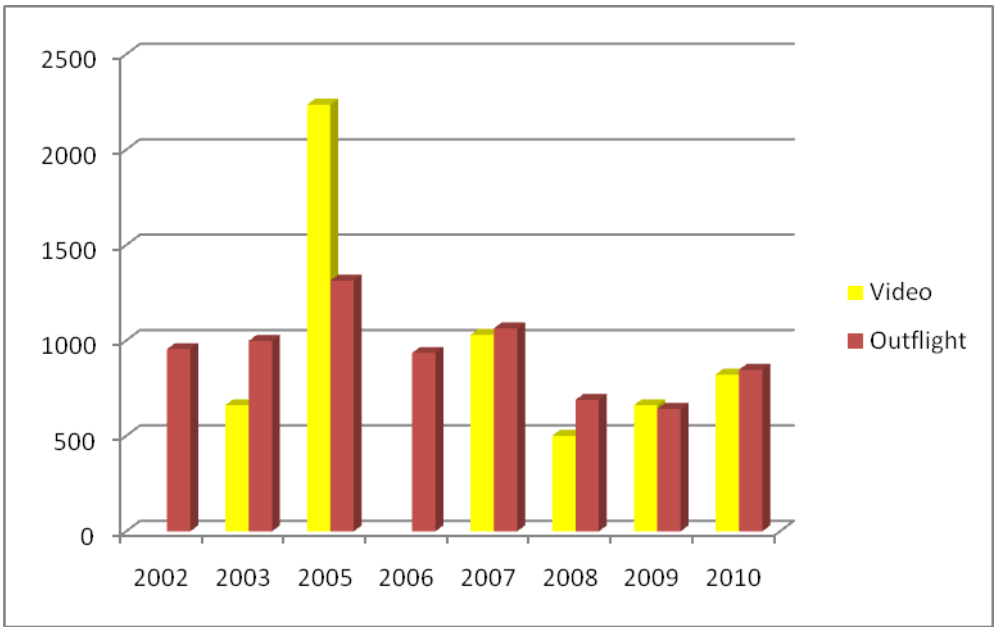

Figure 4: Jackpot Mine spring exit count

Gold Dome Mine: The Gold Dome Mine is located about one km (as the bat flies) south of the Jackpot just below the Needles formation, but takes about an hour to hike there from the Jackpot. The mine was visited by Musgrove (Cockrum *et al*., 1996) in January 1962, when he captured and banded 109 female and male *Macrotus* (out of an estimated 150 bats present). In April 1962, he captured seven male *Macrotus*, two male Yuma myotis, and 19 male and five female cave myotis. In July 1990, Mitch Ellis (then Assistant Refuge Manager) mist-netted 62 male Yuma myotis, 20 male cave myotis and a male canyon bat (*Parastrellus hesperus*) at the mine portal. When we first visited the mine in January 2002, we counted 81 *Macrotus* exiting after dark. In May, five male Yuma myotis and a male cave myotis were caught in the mine during the day, and 47 myotis and *Macrotus* (combined) emerged after dusk. There is no evidence that this mine is used by any other than male bats, and then primarily in the warmer months. The spring exit counts have ranged between a low of 55 in May 2002 to a high of 840 in 2003 (a year with a lower census in the Jackpot 1) (Figure 5). Few bats are present in the winter, with none observed in February 2010.

In his notes, Musgrove refers to two adits nearby containing 200 lbs of guano. The topographic map indicated another adit above the Gold Dome that we had been surveying. However, a shear wall rose above the lower mine, and no trail was apparent. Finally in October 2003, using a rope, we succeeded in reaching the Upper Gold Dome adit, which contained a colony of about 30 *Macrotus*. It is possible that the Upper Gold Dome is a Macrotus maternity site, but it is too inaccessible to be regularly monitored. The Lower Gold Dome will continue to be monitored sporadically in spring in conjunction with the Jackpot, even though it does not appear to be a maternity site.

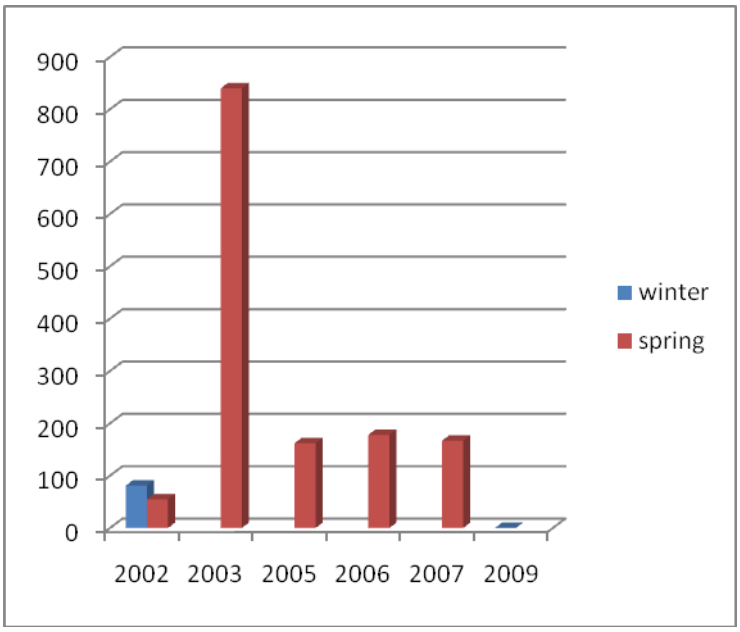

Figure 5: Lower Gold Dome Mine spring and winter exit counts

Islander Mine: This mine complex is located about one km west of Lake Havasu between Black Meadow Landing and Havasu Palms and was one of the most exciting discoveries of a survey conducted for Lake Havasu BLM of mines in the Parker Strip (Brown and Berry 2005). The easiest access is by boat, however in some years (especially winter) the water level of Lake Havasu has been too low in the cove to land. The largest working (Islander 1) has three entrances: a lower east-facing adit, a stope above that and a shaft on the ridge above that is almost plugged with timbers. The stoped area is used by a small maternity colony of *Macrotus* during some years. Some Yuma myotis also roost in the Islander 1, although the main colony is in the Islander 2. The Islander 1 is too cool in the winter for *Macrotus*; however, a Townsend's big-eared bat was hibernating here in January 2005. The Islander 2 across the wash is a relatively short, warm adit with enormous bat use (Table 9). The mine shelters a colony of less than 50 California leaf-nosed bats year-round. In the spring a maternity colony of between 900 and 5500 Yuma myotis use this adit. This adit has great fluctuations between years, with the peak in 2003, and great declines in 2007 and 2009. The 2010 spring count is about 1000 bats less than 2003. A few Yuma myotis are present even in the winter.

However, the most amazing event was observed starting at dusk on January 26, 2003, when over 6000 Mexican free-tailed bats (*Tadarida brasiliensis*) poured into the mine in an hour (and they were still coming when we stopped counting). When we entered the mine, the ceiling was covered with bats. This is the mating time for this species, and the mine is probably a key site for breeding bats (the Lake Havasu "singles bar"). When we visited the mine again on February 5, 2003 to video tape this mass entry, only about 300 *Tadarida* were present. Instead, Yuma myotis (*Myotis yumanensis*) were entering the mine to night roost. We have returned on January 31, 2004 and January 28 & 30, 2005 to document the *Tadarida* inflight, but less than a net of 100 bats entered the mine. On January 24, 2009, 24 *Macrotus* exited the mine and no *Tadarida* entered. The Islander 3 is up the wash on the right side, and is a chamber with some *Macrotus* guano, although no bats have been found day roosting in the mines. It may be used in the fall as a "lek site" or for night roosting. The Islander 4 located across the wash from #3 is a tunnel that has little evidence of bat use.

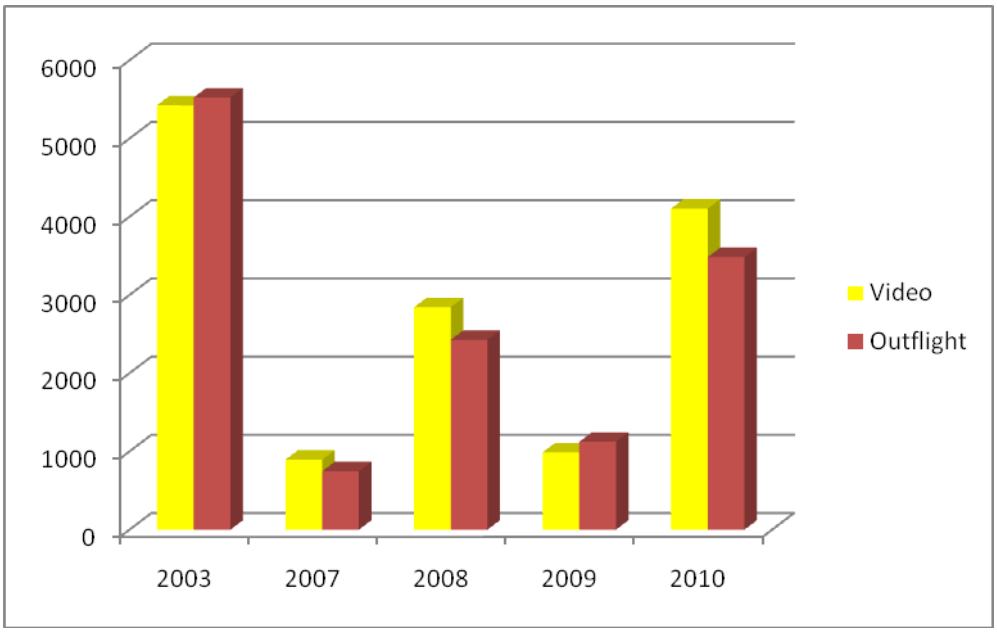

Figure 6: Islander Mine spring exit counts

Californian Mine: This adit in the Whipple Mountains south of Parker Dam on the California side (Lake Havasu BLM) was named by P. Brown in August 1968 at the time of her first visit to the mine as it was near the "Californian" River Camp. A local youth referred to it as the "bat mine", and the mine contained thousands of *Myotis velifer*. In the winter, several hundred *Macrotus* replace the cave myotis. Beginning in 1969, this mine was selected by P. Brown for long-term banding of *Macrotus* for longevity and home range studies. Visits were made every winter through 1979 to band bats, and then on an average of every fourth year to the present. The winter population fluctuated between 300 and 650 *Macrotus* as indicated by banding captures (all bats in the mine were caught), until 2010 when 810 bats were present. There was a jump in winter 2008 when over 1200 bats were counted. The Macrotus population has increased overall between 2002 and 2010 (Figure 7). In some years, a few *Myotis velifer* (both male and female) were also present in the mine during the winter---the first winter records for cave myotis in California. This is a mine that I regularly enter in the winter after the exodus is over to check for any remaining bats. This entry is not done in the spring when a maternity colony of between 3500 and 6000 cave myotis move in (along with several rattlesnakes). This is the largest cave myotis colony along the LCR, and is a long-term bat monitoring site, with a peak population of over 5500 bats in 2005 (the same year as the Jackpot peak). However, by 2010, the count had declined by about 2000 bats (Figure 8). Less than 100 male *Macrotus* use the mine in the warm months. The bats are not disturbed by human entry due to its location in a small drainage with no road leading to it. The overpowering odor of ammonia from the cave myotis guano makes warm season entry unpleasant. At this time, a bat gate is not recommended. The portal dimensions have been reduced two fold in the past 30 years due to wash debris. A gabian or other diversion is necessary to deflect water and mud from flowing into the mine during flood events and potentially sealing the portal.

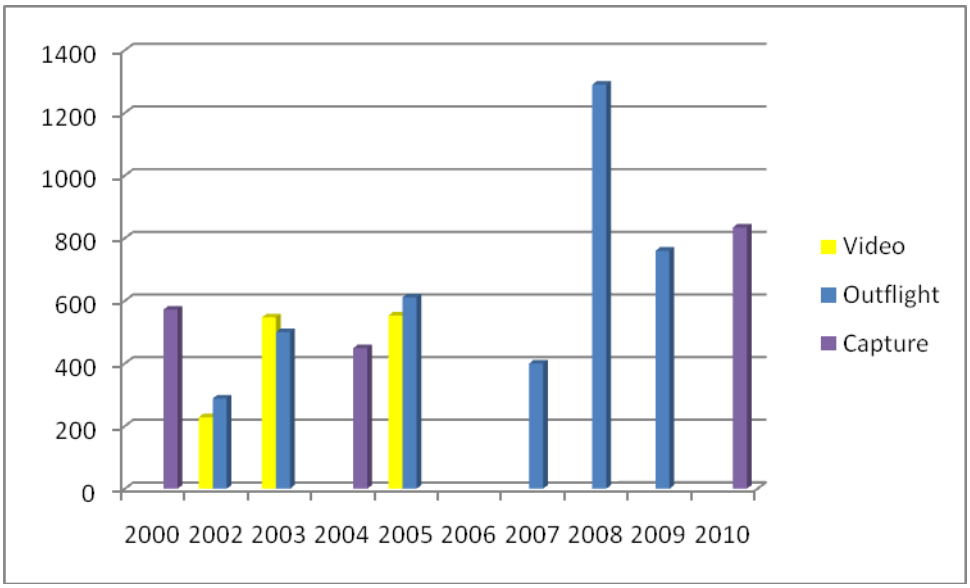

Figure 7: Californian Mine winter exit counts

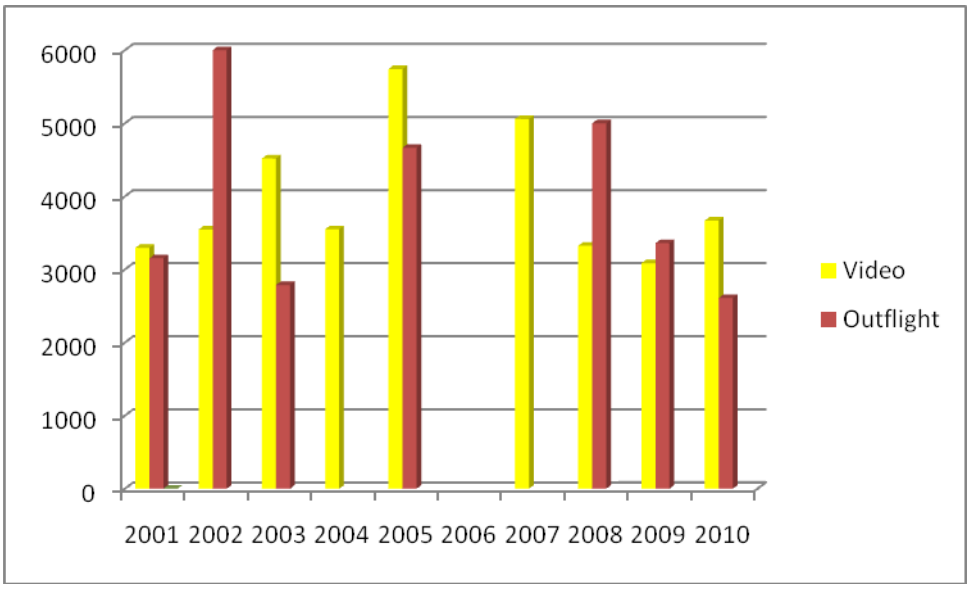

Figure 8: Californian Mine spring exit counts

South Californian: Located in the next drainage west of the Californian, this adit (with an intersecting shaft from the surface) has always been the alternate roost for *Macrotus* disturbed by our banding activities in the Californian. Without disturbance in the Californian, the mine has a winter colony of between 5 and 86 *Macrotus*. In the warm season a maternity colony of about 30 *Macrotus*, plus male *Myotis velifer* and *yumanensis* roost in the mine (Figure 9). In May 2002, we observed clusters of about 200 cave myotis in the adit, possibly in response to the recent protection of this mine by gate

installation as a result of a human injury that occurred in the mine several years ago. This gate was subsequently vandalized, and then repaired in 2007. The spring population increased following this protection, although the winter population declined. This mine is monitored to provide baseline data in case a disturbance occurs at the main Californian adit.

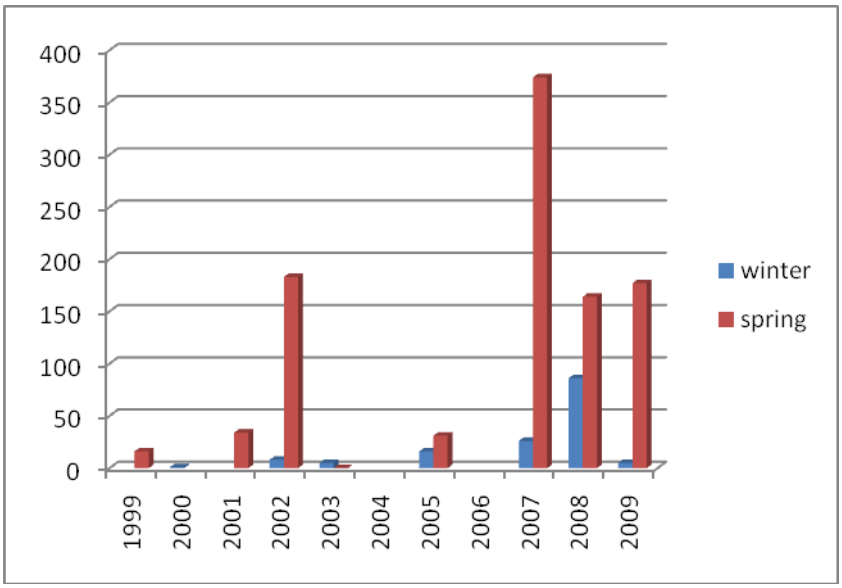

Figure 9: South Californian winter and spring exit counts

Mountaineer Mine: This Riverside Mountains mine on BLM (Palm Springs) land was a collection site for Dr. Ken Stager in the 1930s. P. Brown has been monitoring the bat population since1968. The mine has over three levels accessed by a winze, with multiple stopes and warm roosting sites for the bats. It has the greatest diversity of bats of any mine in the California desert, and is the last known maternity roost for *Corynorhinus townsendii* along the LCR. The lowest level crosses under the wash and can be accessed from the surface by a declined shaft on the opposite side of the wash. Most of the bats exit via the adit portal rather than the shaft, although since 2006 an increasing number of bats are exiting via the shaft in the warm season (and this may be in response to our trapping at the adit portal). The winter population of between 300 and 800 *Macrotus* exit via the adit. In the past, this mine sheltered maternity colonies of *Macrotus californicus, Myotis velifer, Eptesicus fuscus, Corynorhinus townsendii* and *Antrozous pallidus* with males of *Tadarida, Myotis yumanensis* and *californicus* also being captured. With so many species using this mine, the only way to document reproductive behavior is by capture of exiting bats at the portal with mist nets or harp traps. In May 2002, the six species listed above were confirmed as having maternity colonies in the mine through captures of reproductive females in a mist-net set at the portal. In July 2003, and May 2006, 2007, 2009 and 2010, bats were captured at the portal. In 2010, only reproductive female *Eptesicus, Antrozous* and *Corynorhinus townsendii* exited the mine, and no female *Macrotus* were captured. The *Myotis velifer* maternity colony appears to now be

located in a stope above the Mountaineer shaft, and the females are captured entering the adit after dark. Spring exit counts when there is no capture at the adit portal document about 300 bats exiting. We now count and record one night, and then capture bats on a subsequent night in the spring (Figure 10). In the winter, approximately 500-600 *Macrotus* roost in the mine (Figure 11). Since this is the only *Corynorhinus* colony monitored along the LCR, it would be desirable to know how many of this species are present. However, since six species (and three with large ears) roost in the mine, this is impossible to do from exit observations, even of video tapes. In addition, the orientation of the Mountaineer portal makes accurate outflight observations or recordings difficult without disturbing the bats. It is typical that observer counts are higher than video counts, because the view of bats reentering the mine is often obscured.

Between 1969 until the 1980s, the Mountaineer was one of Dr. Brown's long-term winter banding sites for *Macrotus*. We have witnessed increased OHV visitation over the years that has created disturbance problems for the bats in the mines. Vandals have burned the hoist over the shaft, and graffiti and shotgun shells are apparent throughout the adit. This is a hazardous mine that will benefit by a bat gate over the adit, and some barrier on the shaft that allows airflow and bat access. Removal of a decaying bridge over a deep, narrow wash along the dead-end road leading to the mine would alleviate a safety issue, and eliminate vehicular traffic and most human visitation. Beginning in the 1990s, I have met with representatives of Palm Springs BLM) and contacted Bat Conservation International (BCI) and the California Department of Conservation (CDC) AML program about protecting this site. Although scheduled for gating, this action has not happened yet.

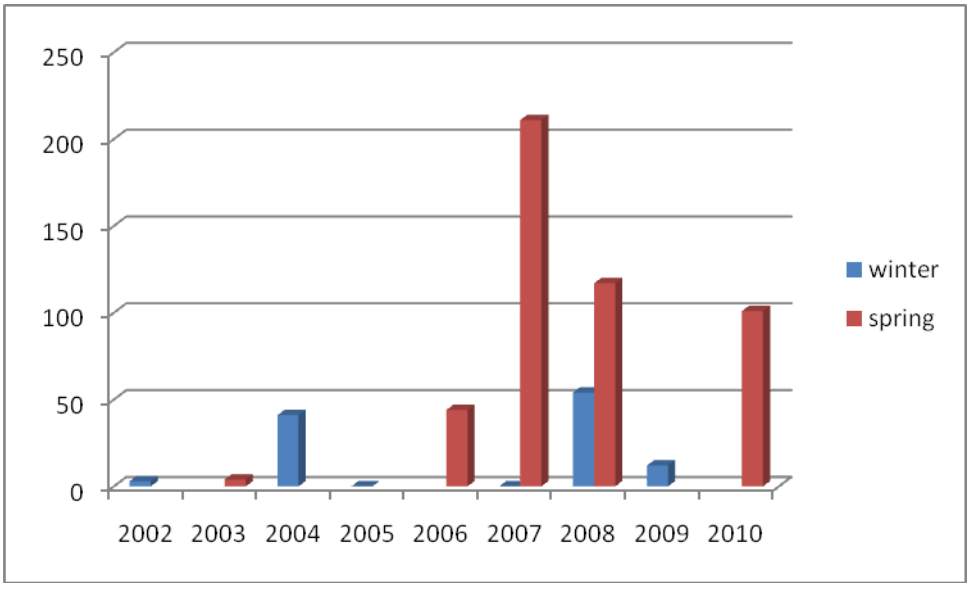

Figure 10: Mountaineer Mine shaft exit counts

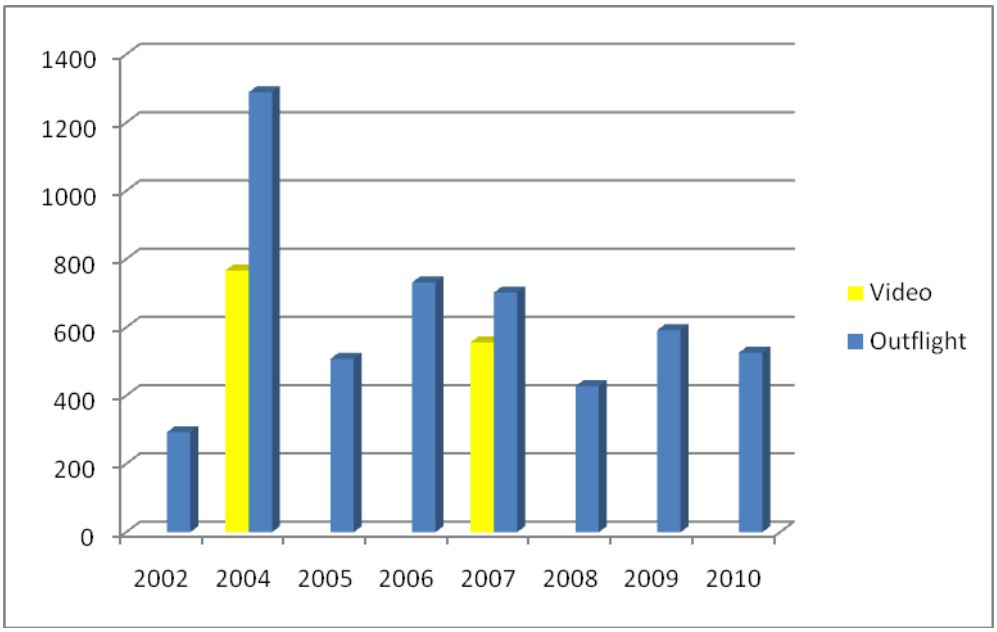

Figure 11: Mountaineer Mine winter exit count

Stonehouse Mine (a.k.a.Hodge): This mine complex is located in the Mule Mountains southwest of Blythe on BLM land (Palm Springs). I was directed to the mine in 1976 by locals in Blythe who referred to it as the "Bat Cave" or "Stonehouse" due to the stone building ruins on the road to the mine, although the name of the topographic map is the Hodge Mine. Through the 1980s, this was another banding site for *Macrotus* in the winter, with several thousand bats present. Capturing bats was always difficult due to large stope areas and hazardous winzes. Until 2002, only the two adits (lower and upper) were monitored for bats. An upper shaft complex with three openings was first surveyed in January 2002, and another 1400 *Macrotus* emerged from there, in addition to the over 2700 bats from the lower adits. The Stonehouse complex, with a total exit count often of over 4000 bats (5000 in 2005), is the largest known winter colony of *Macrotus* in the United States (Figures 12 and 13). In the spring, a colony of about 1500 male *Macrotus* and *Myotis velifer* (maternity colony and males) roost in the upper adit, while the upper shafts shelter a large *Macrotus* maternity colony. The lowest adit shelters an increasing number of bats since it was gated in 2006 (*Macrotus*, *Antrozous* and *Myotis velifer*) but is still used primarily as a night roost. The gating of the upper adit in 2006 was very important for preventing human accidents since it is VERY hazardous due to an internal winze near the portal. Since the upper three shaft openings are difficult to reach, and do not appear to receive human visitation, no closure action is recommended.

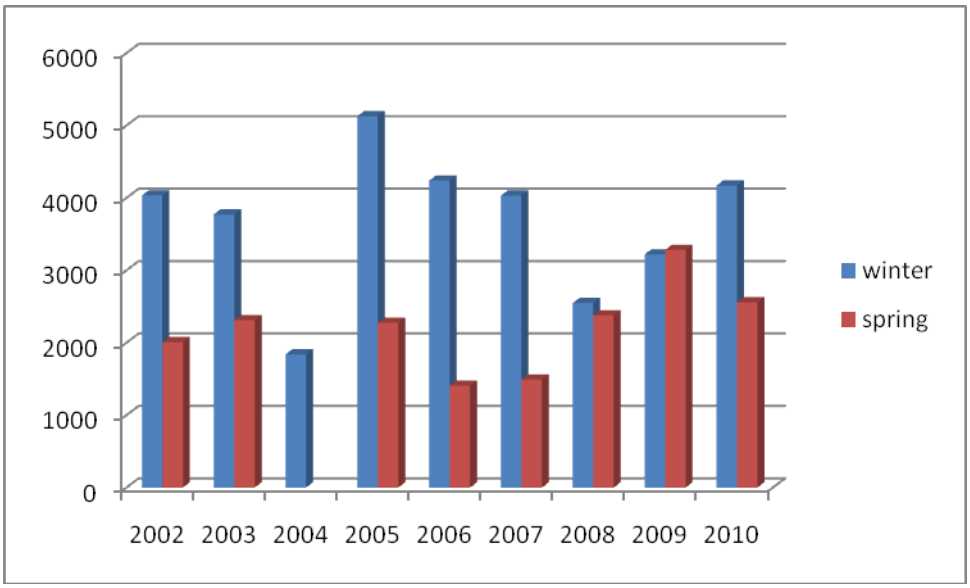

Figure 12: Stonehouse Mine complex winter and spring exit counts

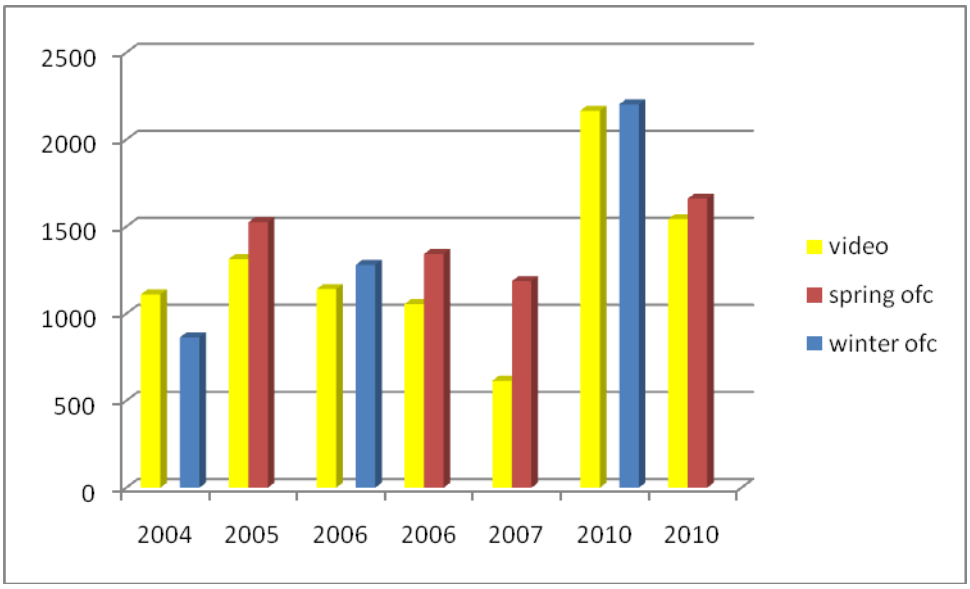

Figure 13: Comparison of video and observer counts for Stonehouse upper adit

Hart Mine: When *Macrotus* were discovered night-roosting and engaging in courtship displays under the Island Bridge on Cibola NWR, we searched for the closest mine roost to the bridge. The Hart Mine is located about 12 km. from the bridge up Hart Mine Wash in the Trigo Mountains of Arizona (Yuma BLM). In February 2002, over 3,500 *Macrotus* emerged from the mine's single portal, although no exit counts since that time have reached that value (Figure 14). Both sexes occupy the mine in the winter; however, between 100-500 males are present in the spring and summer (Figure 15). In the fall, the

mine is a lek site, and males display at the portal. The mine was gated in 2007 with support from a BCI grant. Lin Piest has added this mine to the list of Arizona Game and Fish Department's long-term bat monitoring sites.

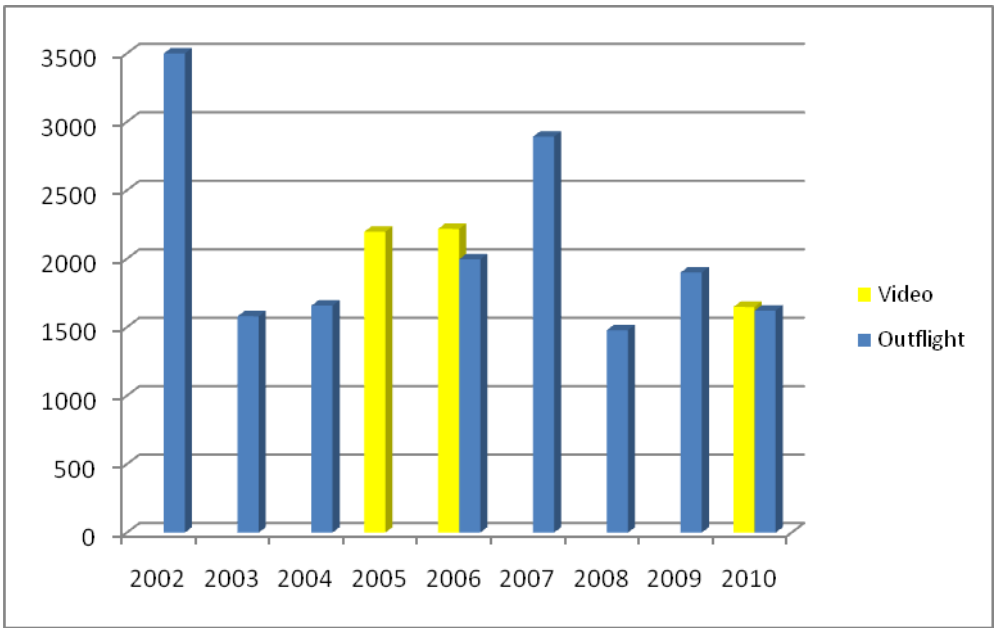

Figure 14: Hart Mine winter exit counts

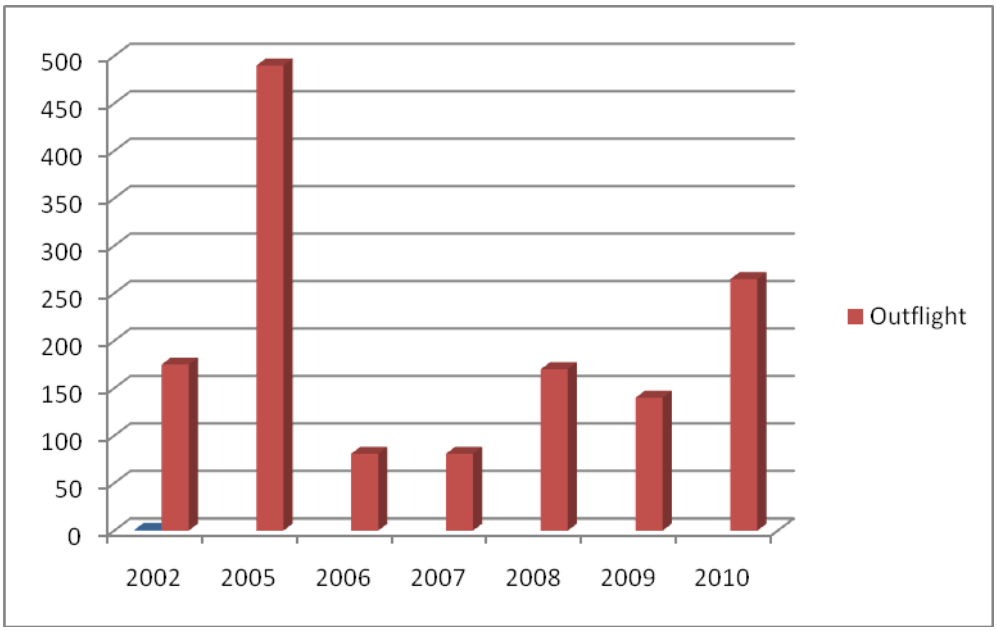

Figure 15: Hart Mine spring or summer exit counts

Eureka Mine: This complex mine is located in the Chocolate Mountains on the Arizona side of the LCR within Wilderness area on Imperial NWR. The mine is a historic locality for a maternity colony of several thousand Yuma myotis. The mine is located close to a popular landing for boaters on the LCR and receives considerable visitation. In 1995 the two lower adits were gated, followed by cupolas on the two upper shafts in 2006. AGFD and INWR biologists have monitored the mine since 1994. The spring count (before the young are volant) varies between 1,822 and 3,316, while the mid-summer count is almost double (2,480 to 6,022) through 2004. The equipment used to make the counts varied from just back-lighting in the earlier counts, to the use of night vision equipment and/or Nightshot cameras at all four entrances in the later census. Since 2008, the population has declined and there are now less than 1,000 bats exiting from the four portals (Figure 16). This coincides with the installation of the cupolas and gates on the upper shafts. A colony of approximately 200 *Macrotus* also use the mine during the warm season. At times, a maternity colony of as many as 168 bats use a separate three-entrance mine at the head of the Eureka drainage. In the winter, less than 20 *Macrotus* are present in the Eureka Mine complex. This mine is a long-term monitoring site for INWR and AGFD biologists. Currently the mine is surveyed only in the spring.

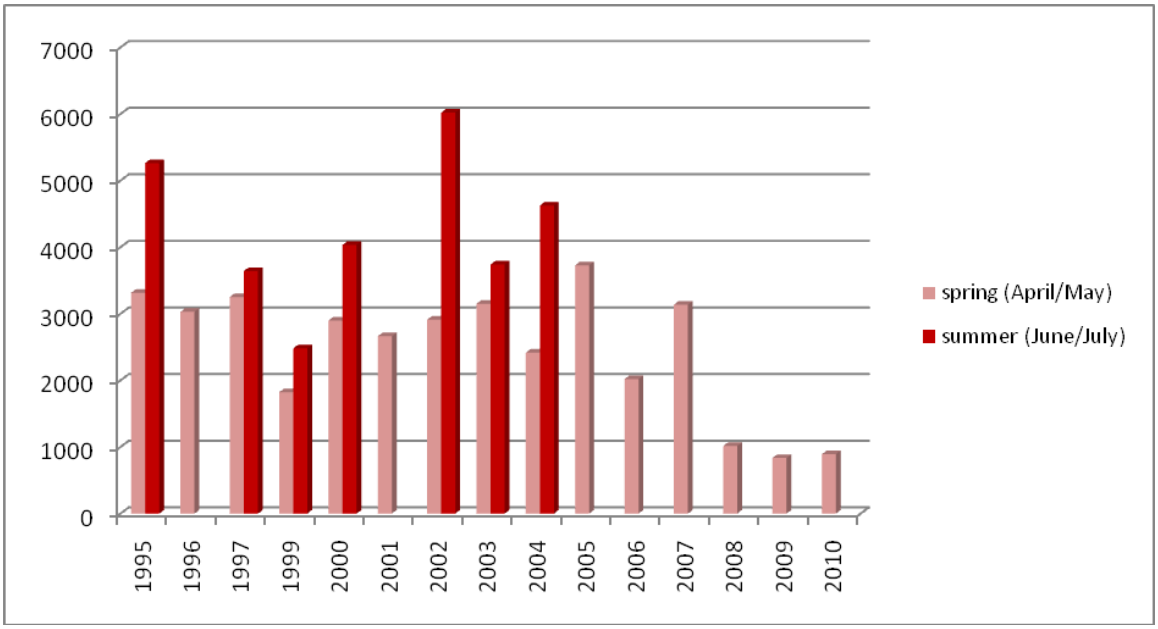

Figure 16: Eureka Mine spring and summer exit counts

Golden Dream Mine: This collection of several adits and shafts is located on Imperial NWR on the California side of the LCR, slightly downstream of the Eureka Mine. Kirke King (King *et al.*, 2001) used the mine as a collecting site for bats and guano. When we visited the mine in July 2001, we discovered a large maternity colony of *Macrotus* (>700 bats) in the upper tunnel (Table 18), and a maternity colony of about 30 big brown bats in a lower adit (3). The population in both these workings has declined precipitously, and less than 100 *Macrotus* have been counted in the past three years, and no *Eptesicus* have

been observed in adit #3 in the past 3 years. In the winter, a few *Macrotus* roost in the upper tunnel. One of the three shafts located closer to the river contained a colony of about 2000 Yuma myotis (Figure 17). In July 2003, this mine was verified as a maternity colony when lactating Yuma myotis were captured in mist nets as they exited the mine. The population in this shaft has been relatively stable, and does not appear to have increased as the Eureka count decreased (Figure 18). This mine complex does not seem to receive much visitation (there is not a good landing site for boaters), but one end of the tunnel is clearly visible from the LCR. There are no fences around the shafts, and the tunnel contains a hazardous winze. In the future, some bat-compatible closures may be required.

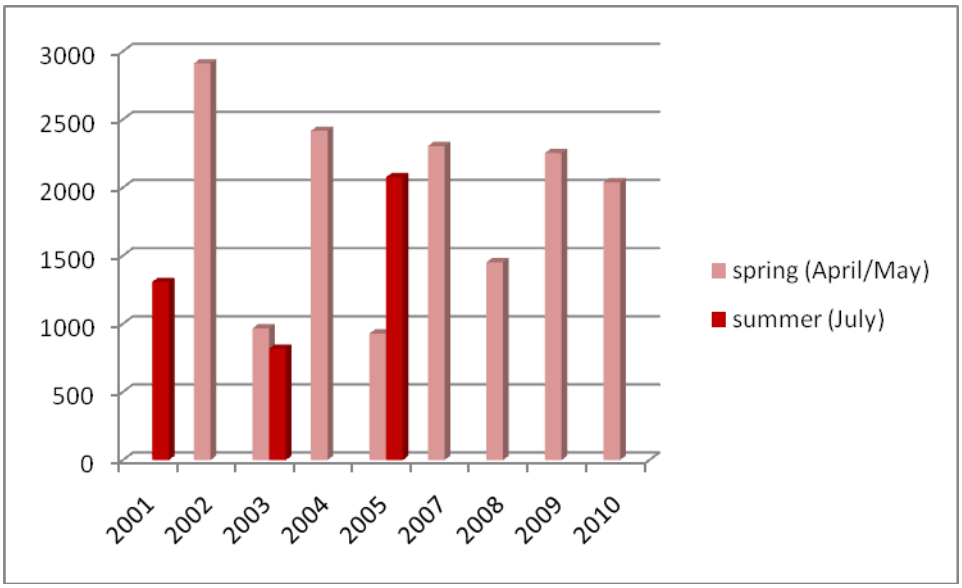

Figure 17: Golden Dream shaft spring and summer exit counts

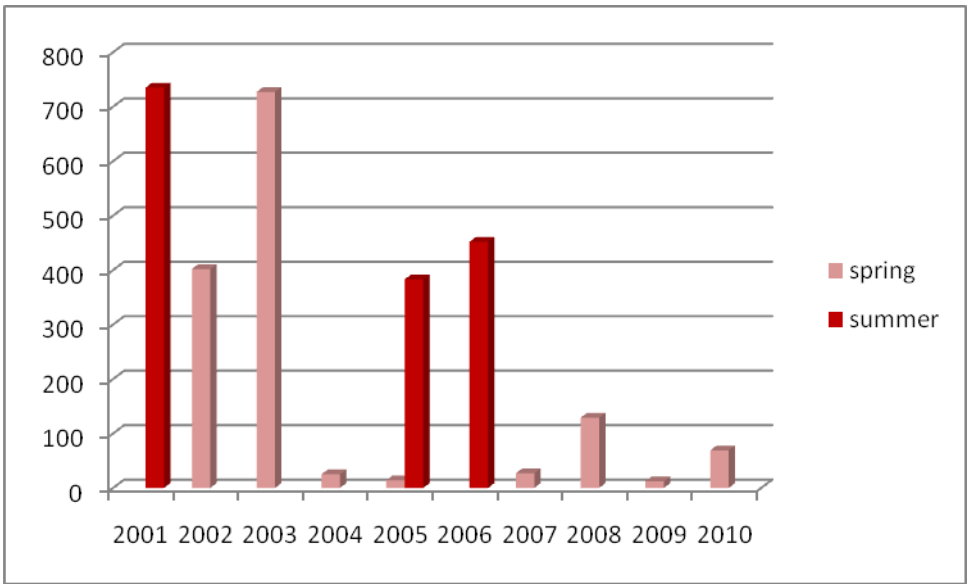

Figure 18: Golden Dream #4 spring and summer exit counts

3C Mine: This complex mine is located on the California side about 2 miles north of the historic site of Potholes (which is just north of Laguna Dam on the boundary of El Centro and Yuma BLM Districts). The mine site was visited by Denny Constantine in the 1950s (pers. comm.), and consisted of an adit connected to an open stope and shaft, plus another separate adit (Duncan adit). In 1985, all but the 3C adit entrance had been closed by the claimant. Through the efforts of BLM and BCI, a bat gate was installed in 1994. The mine currently has a large winter population of *Macrotus* (~2,500 bats) that has increased overall since 2001, and a spring population of about 400 male *Macrotus* and a maternity colony of up to 1,500 Yuma myotis, that has about the same number of bats exiting in 2001 as in 2010 (although with some declines in the intervening years) (Figures 19 and 20). A small adit near Potholes is used as a night roost and "courtship site" by hundreds of Mexican free-tailed bats in January and February. This mine was visited in May 2010, and a small maternity colony of approximately 20 *Eptesicus* was present as well as about 50 *Macrotus.* Both the Potholes and 3C mines are long-term bat monitoring sites.

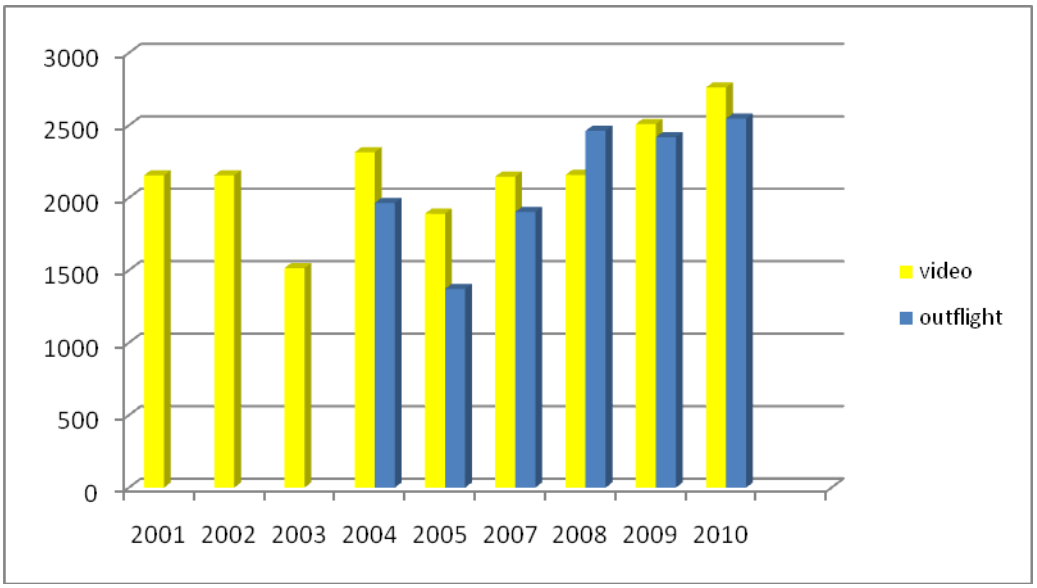

Figure 19: 3C Mine winter exit counts

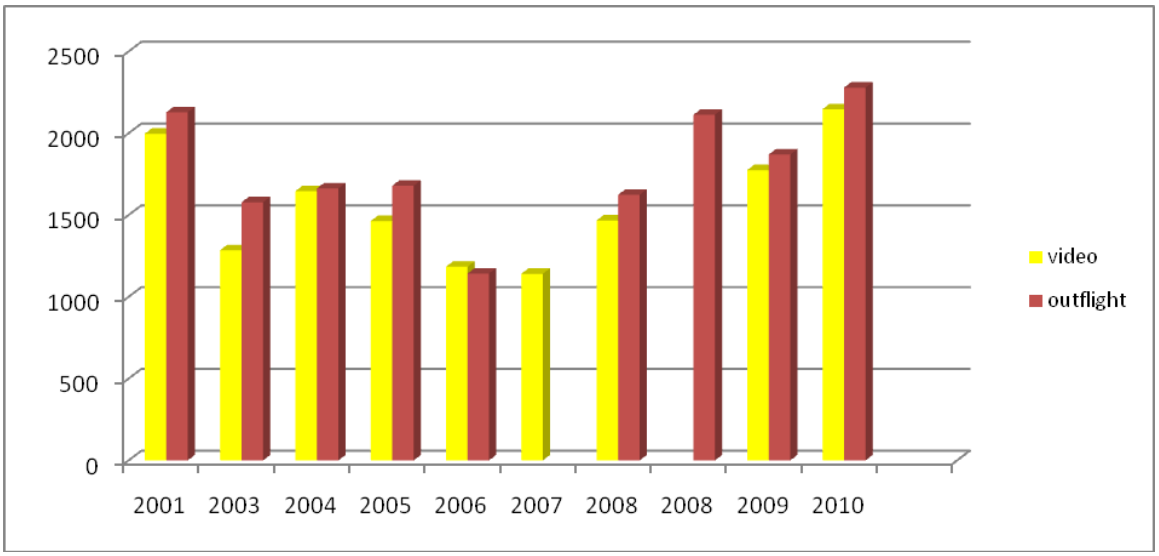

Figure 20: 3C Mine spring exit counts

DISCUSSION

Colonial bats that roost in mines or caves provide a unique opportunity to track population trends by counting bats emerging in the evening to forage. It is hoped that their numbers will increase with revegetation projects underway and scheduled along the LCR. Since 2000, biannual census have been conducted of eight *Macrotus* winter and summer mine roosts along the LCR from the Homestake Mine above Davis Dam to the 3 C Mine near Laguna Dam. The Mountaineer Mine in the Riverside Mountains also shelters a maternity colony of *Corynorhinus*. Several of the *Macrotus* mines are also used in the spring and summer by large numbers of cave and Yuma myotis. The latter is currently one of the most abundant bat species along the LCR, and relative changes in their population could indicate changes in ecosystem health. *Myotis velifer* were at one time more abundant in the mines along LCR, and increases in their population in the remaining roosts or the re-colonization of abandoned roosts would indicate restoration success.

Several factors influence the exit count data presented above, and can contribute to the sometimes considerable variation in numbers between years and which can differ from the fluctuation of the absolute number of bats that reside in a mine. By counting for the first 60 to 90 minutes of the exodus in a manner that is standardized under favorable environmental conditions, we hope to get an index of relative abundance between years. The absolute number of bats present in the mine is determined only by entering the mine during the day and capturing or counting all of the bats. The most accurate census comes from the banding survey that I have conducted at the Californian Mine since 1969 where all of the bats are captured. This is disturbing to the bats, and currently banding happens about every four years. Rarely do all bats exit simultaneously after dark as evidenced by entering mines where the whole mine is visible after the count has ended. The only mines on the LCR monitoring list where this is possible are the Californian, Jackpot, Hart, Islander, and Lower Stonehouse adit (if the key is available). Fewer bats remain inside the mine after dark during the winter verses the spring or summer surveys. However, bats enter a mine to night roost often before the resident bats finish exiting. The entering bats may be bats that do not actually reside in the mine during the day, and so when entering bats are subtracted from exiting bats for the "net" count, the number of resident bats is under-counted.

As previously mentioned, winter surveys target *Macrotus* at a time when they concentrate in relatively few roosts along the LCR. Occasionally a few *Parastrellus*, *Myotis californicus* or *yumanensis* are present in the mines, especially in warm winter weather. The Islander #2 and Potholes adits attract reproductive *Tadarida* during the winter months. During other times of the year, a "pure" species count is usually impossible, except for the Hart (*Macrotus*) and Golden Dream #1(*M. yumanensis*). The greatest number of species reside in the Mountaineer, and where it is possible to determine differences in the exit behavior of *Macrotus* and *Myotis*, differentiating between the three big-eared species (*Macrotus*, *Corynorhinus* and *Antrozous*) is impossible during an exit count.

The time of parturition varies between and within species and between years. I have observed two-week-old baby *Yuma myotis* in the Riverview Mine in the Whipple Mountains on April 1, at a time when others in the roost were still several weeks from delivering. Other years, *M. yumanensis* are still pregnant in mid-May. The time of parturition of *Macrotus* can occur from early May through early June. The average time for juveniles to begin to fly and exit the time can be between three to six weeks post-natally, depending on species and roost temperature. The female *Macrotus* often are still arriving at the maternity roost at the time that myotis are already delivering. All of these variables contribute to some inaccuracy of the exit counts, especially in mines shared by *Myotis* species and *Macrotus*. Lactating females may not readily exit a roost, and circle many times at the portal. If juvenile bats are learning to fly, they often may accompany their mothers after this repeated circling. In maternity colonies with non-volant young in the roost, adult females will always be present after dark throughout the night, so an absolute census is impossible without entering and disturbing the colony.

The absolute numbers of bats living in a mine is determined by the carrying capacity of the foraging habitat rather than the size of the mine. The number of juveniles that survive is determined by the complex interplay between the quality of the foraging habitat, the distance between the roost and the foraging site, the temperature of the roost, and the lack of disturbance from people and predators.

In addition to biological variability, other factors influence the exit data presented. In the winter, *Macrotus* will not exit the roost on very cold nights, preferring to remain in the warm mines that match their narrow thermal neutral zone. For that reason, we are missing data for some cold years, such as 2006. At all seasons, most bats will not exit to forage during rain, or when wind speeds exceed 20 km (Figure 21). Most *Macrotus* will not exit during bright moon at any season, probably as a genetic response to ancestral predation since we do not observe owls or other predators lurking outside of *Macrotus* roosts during full moon. Since we made this correlation in 2003, we avoid counting the roosts the week before the full moon. Figure 21 compares *Macrotus* exit counts from the Cargo Mine in the Cargo Muchacho Mountains in January between 1990 and 2003, documenting the effects of wind and moonlight, with the lowest counts occurring on nights with moonlight and wind. Figure 22 compares exit counts conducted a week apart during the week before and the week following the full moon in January 2003. We do not know whether lunar-phobia occurs for bat species other than *Macrotus*. Paired counts of myotis mines would contribute valuable data.

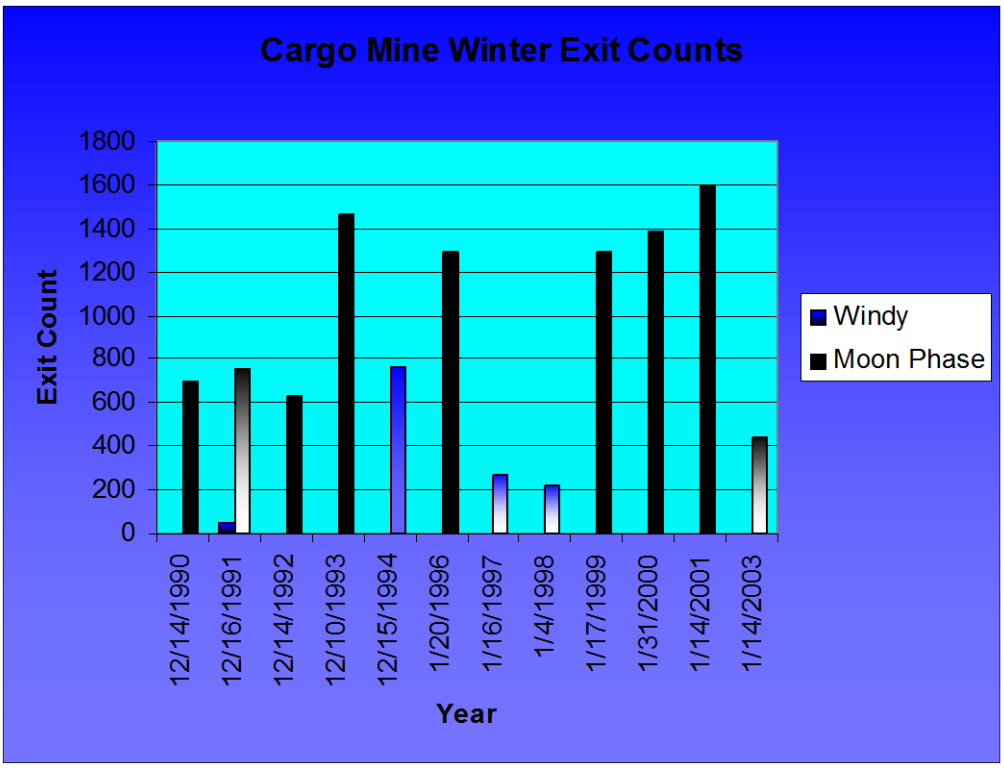

Figure 21: The effects of wind and moonlight on *Macrotus* exit counts

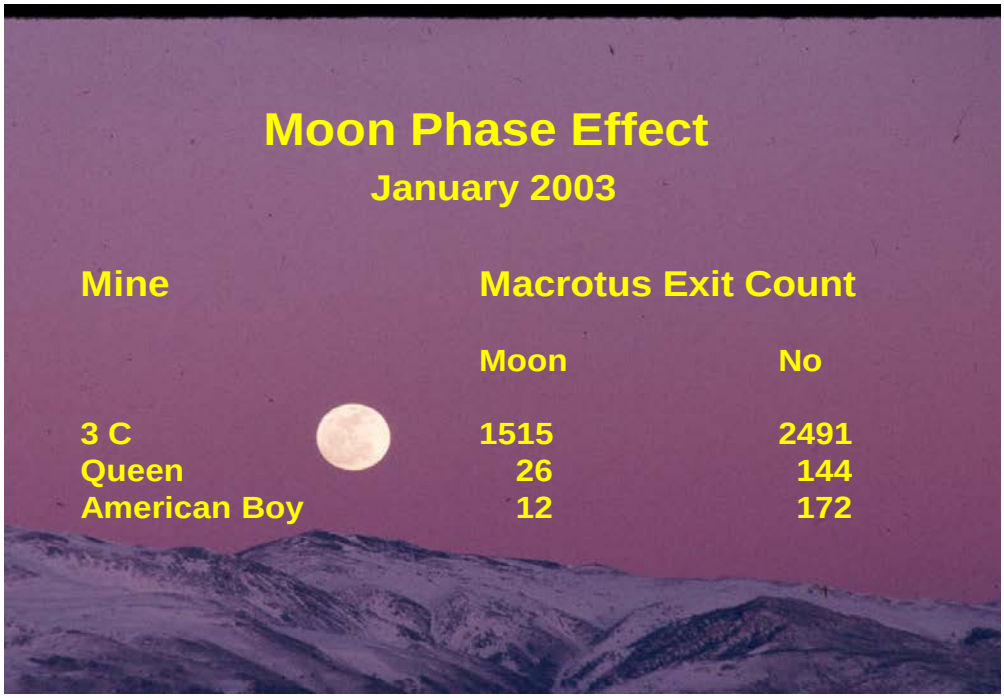

Figure 22: *Macrotus* exit counts the week before and after the full moon

The final variable is the skill and experience of the observers with finger tallies to keep up with the rapid entry and exits of hundreds of bats swirling around the mine portal. When several people observe the same portal as several thousand bats exit, the counts may differ twofold or even threefold. For this reason, infrared sensitive Nightshot cameras are used to simultaneously record exiting bats, especially on those mines with several thousand residents. When compared to the taped exodus, the observers will both over and under count (see figures above), but over half the time the counts are close to the tapes when they are reviewed. The 3C is usually undercounted by observers in the winter, but over counted in the spring (Figure 19) and only consistency when the tapes are slowed to half speed when they are counted. Even then, the results of different people watching the same tape can vary as much as 10%. The portal size or configuration of some mines make videotaping difficult (i.e. Stonehouse shaft 1, Golden Dream 1 and 4, Homestake shafts, and Mountaineer). The maximum tape duration is 90 minutes and during the maternity season, the exodus may continue longer than this, since the camera must be turned on prior to the first bat exiting so as not to influence the emerging bats.

Even with all of the variables and pitfalls in conducting roost exit surveys, the data acquired is a better indicator of the population trends of colonial bats in an area than mist-netting or acoustic surveys. Despite peaks and troughs, overall many colonies appear to have been stable or slightly increasing between 2002 and 2010. The exceptions are precipitous declines in the Eureka Mine *Myotis yumanensis* and the *Macrotus* Golden Dream tunnel maternity colonies, and lesser declines in the Californian *Myotis velifer* and the Islander *Myotis yumanensis* maternity populations. The status of the LCR MSCP target and Indicator species as determined by exit counts is discussed below.

Townsend's Big-eared Bat: Along the LCR, all known *Corynorhinus* roosts (historic and current) are in abandoned mines (Brown and Berry, 2003). Grinnell (1914) first discovered the "pale lump-nosed bat" in the Riverside Mountains roosting "at the end of a sloping drift in the Steece copper mine". Howell (1920) visited the Old Senator Mine near the LCR (6 miles north of Potholes) on May 14, 1918 and "found about a hundred females, each with a naked young from a few days old to a quarter grown, clinging to the roof of a gallery at the two-hundred-foot level. They were in close formation, but not touching one another, and, although not as wild as *Macrotus*, they were quite ready to fly. The only way we could capture them was wildly to grab at a bunch with both hands." At the time Howell also found large maternity colonies of *Myotis yumanensis* and *Macrotus.* After some fatalities of U.S. Marines in the mine, the main shaft was covered with chain link fence by the claimant. An open stope still provides access for bats, although only *Macrotus* are now present. About 360 bats exited the mine in June 1991, and 168 bats emerged in January 2001.

As noted by Stager (1939), *Myotis velifer* in the Alice Mine were "rivaled in numbers by *Corynorhinus rafinesquii pallescens* and *Macrotus californicus* only". Stager (pers. com.) describes a cluster of *Corynorhinus* 3 x 12 feet across in the main level of the Alice Mine. The estimated cluster density in most maternity colonies is 100 bats/ square foot (Pierson and Rainey, 1996). At this density, the colony in the Alice Mine in the 1930s would have been over 3000 bats. The last specimen collected from the Alice was in

April 1954. When I first visited the Alice Mine in August 1968, piles of old guano remained, but these have now been trampled to dust. During several visits in the early 1960s, Musgrove (Cockrum *et al*., 1996), banded or collected from a *Corynorhinus* maternity colony in the Homestake Mine near Davis Dam. During several visits to this mine since May 2001, we have not found any evidence of this species.

The Mountaineer Mine in the Riverside Mountains is the only mine along the main LCR that is currently known to shelter a *Corynorhinus* maternity colony. A male was captured at the Jackpot #3 mine and a hibernating bat was observed in the Islander Mine #1 in winter. Pregnant females are captured in mist nets or harp traps as they exited the Mountaineer Mine after dark (Table 12).The number of bats captured has been increasing since we started to employ a harp trap. This may not be an indication of the increase in the colony size. As noted previously, it is impossible to differentiate between the three big-eared bat species as they exit the mine. Entry into the roost can be disturbing and could cause abandonment. A cluster of less than 50 bats was present on the third level down the mine in July 2003 when we entered during the day. Fresh (not dusty) beer cans were evidence of human intrusion even at the lower levels, which require climbing down dangerous old mining ladders. A bat gate is needed on the Mountaineer to protect people and bats.

Along the Bill Williams River, two mines contained maternity colonies of several hundred *Corynorhinus* during our surveys in 1994-95 (Brown, 1996). One of the mines near Planet is a cold air trap in the winter and serves as a hibernaculum (Brown, 1996). The riparian system in this area is relatively intact compared to the LCR. The dense native vegetation documented by Stager has been removed along the LCR over the past 50 years and replaced with agricultural fields that are subjected to extensive pesticide spraying. In forested areas, spraying for lepidopteran species may alter the prey base for big-eared bats (Perkins and Schommer, 1991; Brown *et al.* 1994). The loss of foraging habitat, combined with pesticide spraying may be contributing factors in the decline of Townsend's big-eared bat populations. Along the relatively pristine floodplain of the BWR, *Corynorhinus* are mist-netted in the warmer months (Table 4; Brown and Berry 2003; Calvert 2011; Vizcarra and Piest 2010). Usually acoustic studies are not a good method to determine the presence of this species, since the bats emit very faint calls, usually detectable only within ten feet. A few *Corynorhinus* calls were recorded during our surveys (Brown and Berry 2003): outside the known roost at the Mountaineer Mine and near the Black Rock Mine on BLM land adjacent to INWR.

This sensitive species has declined in numbers across the western United States, as documented in the Conservation Assessment and Strategy (Pierson *et al*., 1999) prepared by scientists and land managers for the Idaho Conservation Effort. The former Category 2 Candidate is currently a USFWS and CDFG Species of Concern, and considered Sensitive by most districts of the BLM and Forest Service. The Western Bat Working Group rates *Corynorhinus* as having a high risk of imperilment across its range. Studies conducted by Pierson and Rainey (1996) for the California Department of Fish and Game showed marked population declines for this species in many areas of California, and they recommended that Townsend's big-eared bats be proposed for Threatened status in the

state. Although, several causative factors can be identified, roost disturbance or destruction appears to be the most important reason for the decline of *Corynorhinus* in most areas (Pierson *et al*., 1999). The tendency for this species to roost in highly visible clusters on open surfaces near roost entrances makes them highly vulnerable to disturbance. Additionally, low reproductive potential and high roost fidelity increase the risks for the species. In all but two of 38 documented cases, roost loss in California was directly linked to human activity (e.g., demolition, renewed mining, entrance closure, human-induced fire, renovation, or roost disturbance; Pierson and Rainey, 1996). Townsend's big-eared bats are so sensitive to human disturbance that a single entry into a maternity roost can cause a colony to abandon or move to an alternate roost (Graham, 1966; Stebbings, 1966; Stihler and Hall, 1993; P.Brown pers. obs.). Inappropriate behavior on the part of well-intentioned researchers and others (i.e., entry into maternity roosts or hibernacula, and capturing animals in roosts) can also contribute to population declines.

California leaf-nosed bat: The California leaf-nosed bat is the most northerly representative of the Phyllostomidae, a predominantly Neotropical family. The type locality of *Macrotus* is Ft. Yuma, California (Baird, 1858). This species occurs in the Lower Sonoran life zone in the deserts of California, southern Nevada, Arizona and south to northwestern Mexico (Sonora and Sinaloa) and Baja California (Hall, 1981; Hoffmeister, 1986). In the 1900s, California leaf-nosed bats were collected in several locations across southern California (Howell, 1920; Anderson, 1969; Constantine 1998). As recently as 25 years ago, it was observed in southern San Diego County (Brown pers. obs.). Extensive surveys conducted over the past 35 years indicate that the species now appears to be limited to the eastern portion of its former range in California (Brown and Berry,1998), and is found primarily in the mountain ranges bordering the Colorado River basin. Grinnell (1914) only captured one *Macrotus* along the LCR, as it was night-roosting in an abandoned adobe building south of Cibola. Stager (1939) and Vaughan (1959) found *Macrotus* to be one of the most common bats in the mines of the Riverside Mountains, and this is still the case (Brown and Berry, 1998). During their survey of all mines on the Arizona side of INWR, AGFD biologists (Castner *et al*., 1995) located *Macrotus* roosting in 14 mines in addition to the Eureka. Currently about six major (>100 bats) maternity colonies occur in mines near the LCR (Senator, Eureka, Roosevelt, Morningstar, Steece and Californian, with smaller colonies in the Alice, Islander, Homestake and Jackpot). The maternity colony in the Golden Dream has declined considerably in the past three years. At least seven mines up the BWR contain colonies of 100 to 1000 *Macrotus* (Brown, 1996). Larger winter roosts (>300 bats) occur in only eight mines along the LCR (3C, Hart, Stonehouse, Steece, Mountaineer, Alice, Californian and Jackpot, with smaller colonies in the Islander, Reid and Homestake), as well as two along the BWR. The largest colony of over 4,000 inhabits the Stonehouse Mine complex, followed in numbers by the Hart and 3C mines.

California leaf-nosed bats are dependent on either caves or mines for roosting habitat. While they have been found night roosting in buildings or bridges (Brown and Berry, 1998; Constantine, 1961; Hatfield, 1937), all major maternity and over-wintering sites are in mines or caves. During extensive field investigations of this species over the last 35

years, Brown and Berry (1998) found that all known winter and most maternity diurnal roost sites are in abandoned mines in California. The exceptions are two small maternity colonies of less than 10 bats each in small natural caves, one of which (Itaglio) is in the Big Maria Mountains near the LCR. Several caves, which were used earlier in the century and which may have sheltered hundreds of bats (Grinnell, 1918; Howell, 1920; Constantine, 1998), have been abandoned due to human disturbance and development or habitat alteration in the vicinity.

In Southern Nevada, *Macrotus* occurred in at least three mines that were inundated by the formation of Lakes Mojave and Mead (O'Farrell, 1970). They still occur in several mines (Rockefeller Mine, Reid adit and Homestake Mine) on Lake Mead NRA. The numbers are reduced in the Homestake Mine from the over 200 observed by Musgrove (Cockrum *et al*., 1996). In Arizona, he also banded *Macrotus* at the mine tunnel at Telephone Pole Cove near Katherine Landing, which has subsequently been sealed by the Park Service. Another Musgrove location at the Gold Dome Mine on Havasu NWR is still used by *Macrotus*, primarily in the winter.

Macrotus neither hibernate nor migrate, and have a narrow thermal-neutral zone. They are incapable of lowering their body temperature to become torpid. No special physiological adaptations occur in *Macrotus* for desert existence, and behavioral adaptations such as foraging methods and roost selection contribute to their successful exploitation of the temperate zone desert even during the cooler months (Bell *et al*., 1986). To remain active yearlong in the temperate zone deserts, *Macrotus* uses warm diurnal roosts in caves, mines and buildings with temperatures that often exceed 80º F. Depending on the season, they roost singly or in groups of up to several hundred individuals, hanging separately from the ceiling, rather than clustering. Often the bats hang from one foot, using the other to scratch or groom themselves. Most diurnal winter roosts are in warm mine tunnels at least 100 meters long. At this season, the large colonies of over 1000 bats may contain both males and females, although the sexes may also roost separately. All known winter roosts in the deserts of California, Arizona and southern Nevada exhibit stable temperatures greater than 27º C (80º F) and relative humidities above 22%. The annual mean temperature in the California desert in the range of *Macrotus* is approximately 23º C (73º F) and the mean winter temperature is 14º C (57º F). The temperature of the occupied mines is warmer than the annual mean temperature, and the mines may be located in geo-thermally-heated rock formations (Higgins and Martin 1980). Except for the approximately two-hour nightly foraging period in winter, *Macrotus* inhabits a stable warm environment.

A long-term banding study was initiated in January 1964 by Dr. Phil Leitner, and was joined by Dr. Patricia Brown in 1970 (unpublished data; Brown and Berry, 1996) to study movements and longevity in this species. During the last 40 years, over 25,000 *Macrotus* from mine roosts along the Colorado River from Parker Dam to Yuma were banded with U.S. Fish and Wildlife Service bat bands. On yearly trips, usually in the winter, many of these bats were recaptured up to 10 times with an average 50% recapture success rate suggesting strong roost fidelity, although seasonal movements do occur between roosts. The longest distance between the site of banding and that of recapture was a movement over two mountain ranges for a linear distance of 87 km (54 mi). Most banded *Macrotus*

traveled only a few miles between summer and winter roosts (Brown and Berry, 1998). However, recently bats banded in the winter at the Californian have been recaptured in mist nets in the summer near Planet along the Bill Williams River (Calvert pers. comm.). Musgrove (Cockrum, *et. al*., 1996) documented movement of two bats banded in the summer at the Rawhide Mine (north of the BWR) and recovered in mines in the Riverside Mountains in the winter—a distance of 56 miles. The greatest interval so far between initial banding and recapture is 15 years. Assuming that the bat was born in the spring previous to the winter banding, this would indicate a possible longevity of at least 15 1/2 years. This record for *Macrotus* is remarkable because long life in bats is usually attributed in some part to their ability to undergo daily and seasonal torpor.

Females congregate in large (>100 bats) maternity colonies in the spring and summer, utilizing different mines or areas within a mine separate from those occupied in the winter, although colonies of only 6-20 bats are also found (Barbour and Davis, 1969; Vaughan, 1959; Brown and Berry, 1998). Complex mines often provide both summer and winter roosting areas, with the females moving closer to the entrance in the maternity season. The males may continue to roost in the deeper sections of the mine. Multiple entrance mines are a common feature for most maternity colonies. This creates cross-ventilation, which may make the roosts warmer during the day, a factor that could facilitate development of the young bats. The single young (weighing 25-30% of the mother's mass) is born between mid-May and early July, following a gestation of almost 9 months. This species exhibits "delayed development" following ovulation, insemination and fertilization in September (Bradshaw, 1962). In March, with increased temperatures and insect availability, embryonic development accelerates. Since the newborn bats are poikilothermic, the maternity colony is located fairly close to the entrance, where temperatures range between 30-40º C (86-100º F). This allows the bats to use shallow natural rock caves that would be too cold for a winter roost. Maternity colonies disband once the young are independent in late summer (Brown and Berry, 1998).

Within the larger colonies, clusters of five to 25 females will be associated with a single "harem" male that defends the cluster against intruding males (Berry and Brown, 1995). The discovery of possible "harem" formation within the maternity colony has several interesting interpretations (Brown and Berry, 1991). Males are observed "wing-flapping" and vocalizing in the presence of pregnant females and those with young babies at a time when viable sperm are not present. The males appear to drive away other males that enter their sphere of influence. Although some male wing flapping is observed at all times of the year, this behavior is most pronounced when females have babies. Possible explanations are that the male has sired the young and is protecting them, or that the females are "imprinting" on the male for future breeding purposes. Large male only roosts may also form in the spring and summer, such as at the Hart Mine.

In the early fall, males aggregate in display roosts and attempt to attract females with a courtship display consisting of wing flapping and vocalizations. Aggression between males occurs at this time. The areas used as "lek" sites are usually in or near a mine that had been occupied by a maternity colony (Berry and Brown, 1995). During the current

survey, displaying males and associated females were discovered under the Island unit bridge in Cibola NWR and at an abandoned house near Mitchell's Camp on the California side of the LCR. This Island Bridge is used as a night roost by some bats throughout the year, but the largest congregation is in October. In an attempt to locate the day roost, the closest mine in the area was visited---the Hart Mine, up Hart Mine Wash about 7 miles from the bridge, where one of the largest winter roosts in a single mine working was discovered.

California leaf-nosed bats feed primarily on large moths and immobile diurnal insects such as butterflies, grasshoppers and katydids, which they glean from surfaces (Anderson, 1969; Huey, 1925; Stager, 1943; Vaughan, 1959). Although *Macrotus* can echolocate, they appear to forage by utilizing prey-produced sounds and vision, even at low ambient light levels. More evidence for this foraging mode is that wings of diurnally-active painted lady butterflies are found in the night roosts in great numbers during the spring. During the current project, we discovered a *Macrotus* in a night roost at Jackpot #3 chewing on the head of a wiggling tree lizard (*Urosaurus ornatus*). This reptile spends most of its time in trees and scrubs, often clinging head downward (Stebbins, 1985). The *Macrotus* probably gleaned it from the branches of a desert tree when the lizard was sleeping. Since then, we have observed with night vision equipment as *Macrotus* carry lizards back into the mines after dark. The intestinal tract appears to be all that remains after the bat consumes the lizard. The strategy of gleaning larger prey from the substrate as compared to aerial insectivory appears to reduce the total time and energy necessary for foraging (Bell, 1985; Bell and Fenton, 1986).

Radio-telemetry studies of *Macrotus* in the California Cargo Muchacho Mountains west of Yuma showed that the bats foraged almost exclusively among desert wash vegetation within one to three miles of their roost. The close proximity of foraging areas to the roost is most important in winter, when the bats forage closer to the roost and are above ground for shorter periods than in the summer. The bats emerge from their roosts 30 or more minutes after sunset, and fly near the ground or vegetation in slow, maneuverable flight (Vaughan, 1959; Brown *et al*., 1993). Shallow caves and mines, buildings and bridges are used by both sexes as night roosts between foraging bouts at all seasons, except for the coldest winter months. Wings and other culled prey parts are found under night roosts.

Open water for drinking does not appear to be a criterion for roost selection since some roosts are located over 50 km (31 miles) away from the nearest known water source. The bats exist primarily on moisture contained in the juicy insects that they consume (Bell *et al.*, 1986). Radio telemetry studies designed to determine foraging habitat of *Macrotus* in the California and Arizona deserts indicated that the bats did not visit areas of open water (Brown *et al.*, 1993; Brown *et al.*, 1999; Dalton *et al.*, 2000). Schmidt (1999) did mist net *Macrotus* (especially lactating females) over water sources in the southern Arizona desert. *Macrotus* are regularly netted at a pool along the Bill Williams River (Brown and Berry, 2003).

In most areas of the Californian desert, *Macrotus* appear to forage among dry wash vegetation (Brown *et al*., 1993). At least some of the bats that roost near the LCR forage in the cottonwood and willow restoration sites (Brown and Berry 2003; Calvert 2009a,b, 2010). AGFD biologists (Castner *et al*., 1995) mist netted 57 leaf-nosed bats in eight locations at INWR, all of them in dry washes. As mentioned previously, *Macrotus* is a visually orienting bat that uses prey-produced sounds while foraging. When echolocation signals are used, they are of relatively low intensity. Therefore, acoustic surveys may not detect this species, and would potentially underestimate their abundance. Other than near known roosts, we most frequently recorded along the BWR and at the revegetation site at Monkeyhead (Brown and Berry 2003). Roost exit counts are still the best method for censusing *Macrotus*.

Within the past 50 years, the range of California leaf-nosed bats has contracted, and the species no longer occurs outside of desert habitats in California. The primary factors responsible for the declines are roost disturbance, the closure of mines for renewed mining and hazard abatement, and the destruction of foraging habitat. The combination of limited distribution, restrictive roosting requirements, and the tendency to form large, but relatively few colonies make this species especially vulnerable. The numbers of California leaf-nosed bat appear to be stable in mines near the LCR, as judged by exit counts and banding studies conducted over the last 40 years (Brown and Berry, 2003).

Cave myotis (*Myotis velifer*): The largest myotis in North America occurs in large colonies (100s to 1000s) in caves and mines across the southwestern United States (Barbour and Davis, 1969). In California, most records are from the mountains bordering the LCR, with a few isolated specimens from Southern California (Constantine, 1998) and the Kingston Mountains (LACMNH). This species was first collected along the LCR in 1909 from a warehouse in Needles (Grinnell, 1918). Joseph Grinnell (1914) did not take any cave myotis on his 1910 survey down the LCR. In 1935, Ken Stager (1939) studied this species in several mines in the Riverside Mountains. In the Alice Mine, "*Myotis velifer* was observed throughout the mine in countless hundreds, and was by far the commonest of the seven species known to be occupying the mine. It was rivaled in numbers by *Corynorhinus rafinesquii pallescens* and *Macrotus californicus* only". In 1953, Terry Vaughan (1954 and1959), studied *Macrotus* and *Myotis velifer* in the Riverside Mountains in the same mine "tunnels" reported by Stager, where "each of several tunnels contained roughly 1000 cave myotis, and each of the other tunnels was inhabited by several hundred individuals". As Vaughan's focus was functional morphology and not natural history, he did not provide exact locations of the mines he surveyed, other than mentioning the Mountaineer. At least four mines in the Riverside Mountains (the Alice, Gold Dollar, Mountaineer and Steece) contained maternity colonies, as determined by museum specimens and information provided by Ken Stager. We have visited all of these sites (and other mines in the area) in the summer, and only the Steece and the Mountaineer in some years still shelter maternity colonies, although not the thousands of bats witnessed by Stager. Since *Myotis yumanensis* also use the Steece, determining how many of each species is present is not possible. The Mountaineer used to have a maternity colony present on the second level down the winze, but recent mist-netting and harp trapping at the portal (Table 12) has not captured

any exiting bats, only a few lactating females entering. There appears that there may be a small maternity colony in a stope near the shaft entrance across the wash, but it is difficult without ropes to enter this portion of the mine. A few male cave myotis occur in the other mines in the Riverside Mountains during the warm season. In addition, large amounts of old *velifer* guano blanket the Jean mine, which now only houses male *Macrotus*. Human trash and signs of visitation are abundant at most of these mines. Gating the Alice, Mountaineer and Steece Mines would protect the bats, and possibly the maternity colonies would return. The Gold Dollar is located in a wilderness area, and is a steep hike, therefore receiving less human visitation. The demise of the maternity colony here is probably not linked to human disturbance.

The Stonehouse (Hodge) Mine in the Mule Mountains southwest of Blythe also contains a cave myotis maternity colony of several hundred bats, but an accurate census is difficult since the mine is used by both male and female cave myotis, as well as *Macrotus*. Local teenagers and young adults visit the site and litter the ground with broken beer bottles, ammunition casings and firecrackers. Before the bat gates were installed in 2006, the bats escaped disturbance by roosting down a deep and dangerous winze (internal shaft) inside the mine.

The largest colony along the LCR is in the Californian Mine in the Whipple Mountains south of Parker Dam, where between 3000 and 5000 cave myotis roost depending on the month or year (Table 10). We have also found a few *Myotis velifer* roosting here in the winter among the hundreds of *Macrotus*. I was first introduced to the mine in 1968 by a local teenager, who referred to it as the "bat cave". However, the mine does not appear to receive much visitation as it is not shown on a topography map, and is located up a small nondescript canyon about a half mile from the LCR. The greatest danger is the dirt and debris that are gradually filling in the portal. A major flash flood event could totally close the mine, possibly entombing the bats. For this reason, a gabian or some other method to deflect the water and flood debris is recommended rather than a bat gate.

The Jackpot Mine on the Arizona side in Havasu NWR south of Needles is the northernmost cave myotis maternity roost on the LCR. Currently about 700-800 cave myotis occupy the site in the warm season. As mentioned in the roost section, the mine is located within a wilderness area, and is not sited properly on the topography map. At this time, no additional protection is necessary except to prevent dirt and rocks from washing down and sealing the portal. The Gold Dome Mine to the south of the Jackpot is currently used by male cave myotis and Yuma myotis. In 1962, Musgrove (Cockrum *et al.*, 1996) banded both males and females at this mine. The Homestake Mine (a.k.a.Jackass Flat) is the only known cave myotis roost in Nevada (Cockrum and Musgrove, 1964), and in the 1960s sheltered a maternity colony (Cockrum *et al.*, 1996). Currently, only a few males are found here in the warm season (Brown, pers. obs.). Hoffmeister (1986) examined specimens from 8 miles north of Parker (Empire Flat), Ehrenberg and a mine tunnel at Picacho (CA). AGFD biologists (Castner *et al.*, 1995) located a mine (Imperial #8) east of the Eureka on the Yuma Proving Grounds with a small maternity colony of cave myotis in June 1994. When we visited this mine in late

May 2003, no bats were present, and only an old pile of guano remained. DNA analysis of the guano confirmed that it was from *Myotis velifer* (Zinck, pers.comm.).

In October 2003, two adits not sited on the topo sheets were discovered during an airplane to search for mines on BLM land along the Parker Strip (Brown and Berry 2005). A BLM intern was the first to reach the mine after a boat trip across Lake Havasu. "Luba's" Mine is reachable only by boat, and is located approximately one mile east of the Islander (as the bat flies). The lowest and longest adit contains mounds of *Myotis* sp. guano several feet deep, which has the odor of *M. velifer,* although the top guano layer is more typical of *M. yumanensis*. Both species have been captured in the mine in low numbers, as well as single *Corynorhinus* and *Macrotus.* More Yuma myotis have been seen after dark in the mine, and our tentative hypothesis is that the mine is used as a night roost by Yuma myotis foraging over Lake Havasu, and possibly day roosting in the Islander. However, it is probably also an example of another colony of cave myotis that has disappeared.

Cave myotis can travel great distances and cross state boundaries as evidenced by the recovery of two banded females by Al Beck on July 30, 1961 and August 4, 1964 at mines in the Riverside Mountains. Both bats had been initially banded at a mine tunnel on Burro Creek in Mojave County (the same as the Arizona myotis record) on May 17, 1961 and October 1, 1961 respectively (Cockrum *et al.*, 1996). The bats probably used the Big Sandy, BWR and LCR as travel corridors. In addition to the Burro Creek site, several large *Myotis velifer* maternity colonies roost in mines bordering the BWR in the vicinity of Planet, Rankin and Lincoln Ranches (Brown, 1996). Here the cottonwoods stretch along the banks of the river, although the trees are not as large or the floodplain as wide as described by Grinnell (1914) or Stager (1939) for the LCR. During the 1994-95 mist-netting surveys, cave myotis were second only to canyon bats in the frequency of capture along the BWR (172 individuals in seven locations). In 1953, Vaughan (1959) noted that "in the Riverside Mountains area, after leaving their daytime retreats, cave myotis usually flew directly down the eastern slope of the range to the floodplain of the Colorado River where they foraged…..and where they pursue foraging beats over low vegetation, along files of dense vegetation that line the oxbows and main channel of the river, between the scattered thick patches of vegetation that dot the floodplain, or above bodies of water ". Evidently, the insects associated with floodplain riparian habitat are important to cave myotis, making this species a good indicator of the success of MSCP restoration activities.

During the 2001-2002 acoustic survey (Brown and Berry 2003), echolocation signals attributable to *Myotis velifer* (ending frequency 40 KHz) were recorded along the LCR between May and October near the known roosts: in Havasu NWR over Topock Marsh; along the BWR; in the wash below the Californian Mine and at nearby Quail Hollow and Monkeyhead below Parker Dam; at the Mountaineer Mine and at Lost Lake River Camp on the east side of the Riverside Mountains. Only a few call minutes that may be attributed to *Myotis velifer* were recorded south of the Mule Mountains. More mine searches are needed to confirm if populations of cave myotis exist in the areas where we have not located active roosts.

Yuma myotis (*Myotis yumanensis*): This species is probably the bat that has most benefited by human activities along the LCR. Historically present, it was first collected at Ft. Yuma by Major G.H. Thomas prior to 1864 (Allen, 1864). Another specimen was taken at Ft. Mojave in 1911 (Grinnell, 1918). However, Grinnell (1914) did not report or collect any bat of this species during his 1910 float trip along the LCR. Howell (1920) reported a colony of about 600 in the old Senator Mine near Potholes at the one and two-hundred foot levels where they "were gathered in two knots of a hundred each and one lot of over three hundred, in a compact mass, on the uneven roof of a chamber." Stager (LACM records) collected females from a mine in the Riverside Mountains in 1939 and from the bridge at Blythe in 1940 and 1943 (that also sheltered *M. occultus*). He recalls that they were not a common bat in the mines relative to *M. velifer*. During our previous survey along the BWR (Brown, 1996), Yuma myotis were not encountered as frequently as cave myotis, except in the vicinity of Alamo Dam. In the 2001-2002 survey, Yuma myotis were not netted at the pond along the BWR (Brown 1996).

Yuma myotis are now one of the most common bats along most stretches of the main LCR (both visually and acoustically), especially in the vicinity of water impoundments. Foraging habitat is usually near open water (Brigham et al. 1992), and the bats fly low over the water feeding on emerging aquatic insects. They can be viewed working the water surface also everywhere along the LCR. This species is more closely associated with lakes and reservoirs than any other bat in the Southwest, often roosting in bridges and dams. Musgrove (Cockrum *et al*., 1996) noted that "large numbers were seen in crevices of Davis Dam on the Colorado River where an estimated 3500 were present on 15 Apr 1962 and estimated 10,000 were present on 17 Sep 1960. Since that time various efforts have been made by professional pest control groups on behalf of the U.S. Army Corps of Engineers to eliminate bats from Davis Dam." We were not able to verify when this effort was successful. However, we did observe Yuma myotis during the current survey roosting in Parker Dam. During the AGFD study at Imperial NWR (Castner *et al*., 1995), Yuma myotis were the most frequently mist-netted species, especially near or over the LCR. Of the 303 bats captured in 20 nights, 88 were Yuma myotis, and 69 of these were netted over a sandbar on one night.

Musgrove also noted a relatively small maternity colony in the Jackass Flat mine (a.k.a Homestake) in southern Nevada. However, on a visit in July 2003, we only captured male *Myotis velifer* and *yumanensis*, and saw some *Macrotus*. Currently along the LCR, several mines (3C, Eureka, Golden Dream, Steece, Roulette, Islander, and possibly the Katherine) support large Yuma myotis maternity colonies, all of them over 1000 individuals. Males roost singly or in smaller groups, sometimes in the same mine as the maternity colony, or in other mines in the vicinity. For example, of six mine workings visited in July 2003 in the Riverside Mountains, all sheltered male Yuma myotis, while only one (the Steece) had a maternity colony. The old Senator Mine was no longer a roosting location when surveyed in 1991. This colony could have possible relocated to the 3C mine. However, the London Bridge at Lake Havasu is home to a maternity colony of several thousand bats. They emerge from many cracks and crevices of the bridge, some almost at waterline, and are difficult to census. The Baseline Bridge over the LCR at Cibola also shelters a maternity colony of several hundred Yuma myotis and *Tadarida*.

Since 2003, the number of Yuma myotis has declined in the Eureka and Islander mines. Possibly the gating of the Eureka mine in 2007 may have contributed to the decline. Some maternity colonies of myotis (i.e. *Myotis griscesens*) have declined after gate installation. However, the 3 C colony of *Myotis yumanensis* appear to be tolerating the gate. Increased entry by boat people into the Islander may be disturbing the bats. Yuma myotis is a good indicator species as it is numerous and should remain so.

MANAGEMENT RECOMMENDATIONS AND FUTURE RESEARCH

When new bat roosts are discovered, they can be evaluated as candidates for protective measures such as gates. The largest known cave myotis (*Myotis velifer*) maternity colony on the LCR (the Californian Mine located in the Whipple Mountains on Lake Havasu BLM land) requires diversion of wash debris that is threatening to seal the mine. The mine is also an important winter roost for *Macrotus*. Although close to the LCR, this mine is hidden in a side canyon. To prevent human visitation, the road leading to the mine should be obliterated. The Jackpot Mine on HNWR is another cave myotis maternity roost, and a *Macrotus* winter roost. It is located in Wilderness area, and receives minimal human visitation. A gabian structure or some other method of water diversion needs to be placed above the mine to prevent soil from washing down and closing the portal.

The Mountaineer Mine in the Riverside Mountains (on Palm Springs BLM land) was at one time a maternity roost for at least five bat species (*Myotis velifer, Corynorhinus, Antrozous, Macrotus,* and *Eptesicus*). The mine receives high human recreational disturbance, and the bat numbers have declined dramatically over the past 30 years. This is now the only known maternity colony of Townsend's big-eared bats along the LCR. One of the primary impacts to the species is roost disturbance, and a gate on this mine could reverse the population decline. In addition, it is a very dangerous mine, with a dilapidated ladder giving access to lower levels. The road leading to the mine should also be closed by removing the dilapidated bridge across the deep, narrow wash. The Alice Mine in the Riverside Mountains was the site of the largest *Corynorhinus* colony along the LCR. The old guano pile (still visible during my first visit in 1968) has been ground to dust by human feet. Gating the three portals, and closing the road to the Alice would also protect people from a potentially hazardous mine. The Steece Mine is also on Palm Springs BLM land and more difficult to access. As of the last visit in 2003, this was a maternity colony for five species of bats (*Antrozous, Macrotus, Eptesicus, Myotis yumanensis* and *velifer).* A more recent survey should be conducted and the upper and lower adits gated to protect both bats and humans.

As many mines as possible that are currently monitored should be videotaped with Sony night-shot cameras (augmented with auxiliary IR lights) even when they are watched real time in an attempt to eliminate observer bias. After mines are gated, they should be monitored on a regular basis by videotaping exit flights. If bat populations increase, this

documented success will provide an incentive for future gates. If bat populations decline following gating, the gate may need to be redesigned. This may be the case for the Eureka Mine if populations continue to decline. A properly constructed and installed bat gate should be free from vandalism, but regular monitoring will determine if repairs are necessary. Currently the Islander #1 stope and the upper South Californian gates have been breached and require repair.

Additional areas to survey for bat colonies include the mines along the LCR south of Parker Dam on the Arizona side, and mines either within or just east of Cibola and Imperial Refuges (some of which were visited by AGFD biologists T. Snow and S. Castner). The Senator Mine was one of the most important historic bat roosts along the LCR, especially for *Corynorhinus*. The mine is patented; however, it would be worthwhile to contact the owners and gain permission to survey the site. Possibly this important roost could be acquired by the Bureau and have appropriate bat compatible closures installed.

The hoped-for goal of this program will be to demonstrate that monitored bat populations remain constant or even increase, hopefully as a result of MSCP restoration activities.

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