

# Monitoring Bat Roosts in Mines at the Marine Corps Air Ground Combat Center, Twentynine Palms, San Bernardino County, California, 2005



Gated Benchmark 19 Mine Entrance



Pallid bat (*Antrozous pallidus*)

Draft Final Report  
Prepared for:

Natural Resources and Environmental Affairs Division,  
Twentynine Palms MCA GCC, United States Marine Corps

# Monitoring Bat Roosts in Mines at the Marine Corps Air Ground Combat Center, Twentynine Palms, San Bernardino County, California, 2005

By Drew C. Stokes and Robert N. Fisher

---

U.S. GEOLOGICAL SURVEY  
WESTERN ECOLOGICAL RESEARCH CENTER

## **Draft Final Report**

Prepared for:

Natural Resources and Environmental Affairs Division,  
Twentynine Palms MCA GCC, United States Marine Corps

USGS Western Ecological Research Center  
4165 Spruance Road, Suite 200  
San Diego, CA 92101

Sacramento, California  
2006

U.S. DEPARTMENT OF THE INTERIOR  
GALE A. NORTON, SECRETARY

U.S. GEOLOGICAL SURVEY  
Patrick Leahy, Acting Director

The use of firm, trade, or brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

---

For additional information, contact:  
Center Director  
Western Ecological Research Center  
U.S. Geological Survey  
3020 State University Drive East, Modoc Hall, Room 3006  
Sacramento, CA 95819

# Table of Contents

Abstract.....	1
Introduction.....	1
Study Area .....	2
Methods.....	3
Results and Discussion .....	4
Conclusions.....	11
Management Recommendations.....	12
Acknowledgements.....	12
Literature Cited.....	13

## List of Tables

Table 1. Mine-specific Methods.....	16
Table 2. Results Summary Table.....	17

## List of Figures

Figure 1. Map of Marine Corps Air Ground Combat Center, Twentynine Palms, CA ....	18
Figure 2. Map of Imperial Lode and Pat Maloy Mines .....	19
Figure 3. Map of Benchmark 19 Mine.....	20
Figure 4. Digital Image of Outside View of Pat Maloy Mine .....	21
Figure 5. Digital Image of Gated Entrance of Pat Maloy Mine.....	21
Figure 6. Digital Image of Outside View of Imperial Lode 'Duck-walk' Mine.....	22
Figure 7. Digital Image of Gated Entrance of Imperial Lode 'Duck-walk' Mine .....	22
Figure 8. Digital Image of Outside View of Imperial Lode 'Wooden Door' Mine.....	23
Figure 9. Digital Image of Gated Entrance of Imperial Lode 'Wooden Door ' Mine .....	23
Figure 10. Digital Image of Gated Entrance of Benchmark 19 Mine.....	24
Figure 11. Digital Image of Captured California Myotis ( <i>Myotis californicus</i> ).....	25
Figure 12. Digital Image of Captured Pallid Bat ( <i>Antrozous pallidus</i> ) .....	26

## Appendixes

Appendix I. Weather Data .....	27
Appendix II. Exit Count Data .....	28
Appendix III. Representative Bat Vocalizations .....	32
Appendix IV. Mist-net Capture Data.....	35

## Abstract

The US Geological Survey was contracted to conduct bat surveys after protective gates were installed at the entrances of several mines significant for bats in 1997 and 1999 at the Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms, California. Surveys were conducted at the Imperial Lode ‘Wooden Door’ and ‘Duck-walk’ gated mine entrances, as well as at the Pat Maloy gated mine entrance during the spring and summer of 2004. A Survey was also conducted at the gated Benchmark 19 mine entrance in summer 2005. The results of surveys at the Imperial Lode and Pat Maloy mines indicated that the bat populations using the mines were comparable to pre-gating surveys conducted in the mid- 1990s. The size of the bat population at the Benchmark 19 mine also appears to be comparable to post-gating surveys conducted by Tierra Data Systems in 1999/2000. However, the number of bats counted at the Benchmark 19 mine during our and Tierra Data System’s 1999/2000 surveys were considerably less than what was found during surveys prior to and immediately after the gate was installed. Management recommendations are presented.

## Introduction

Roosting habitat is considered a limiting ecological factor for bats, particularly cave-dwelling species (Humphrey 1975). Anthropogenic structures have created new roosting opportunities for bats. Abandoned mines have become important roosts in the southwestern United States for a variety of bats, including obligate cave-roosting species such as the Townsend’s big-eared bat (*Corynorhinus townsendii*) and California leaf-nosed bat (*Macrotus californicus*), as well as generalist-roosting species such as the California myotis (*Myotis californicus*) and pallid bat (*Antrozous pallidus*). However, abandoned mines are also often visited and entered by humans, who pose a disturbance threat to roosting bats. Protecting bat roosts in abandoned mines has become a management priority for agencies interested in protecting their natural resources. Abandoned mines can be gated with bat-compatible gates that prevent humans from entering while allowing bats to enter and exit freely (Pierson 1998).

During bat research at the Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms in the mid-1990s, several abandoned mines were identified as significant bat roosts (Brown and Berry 1998). One of the mines, the Benchmark 19 mine, was being used as a maternity site by a colony of approximately 50 pallid bats in 1994, based on an evening exit count. Over the course of a few years following the 1994 survey visit, Brown and Berry (1998) documented human entry and vandalism at this mine, and also noticed a sharp decline in the population size of the pallid bat colony. They strongly recommended that the mine be protected from human entry with a bat-compatible gate. Based on Brown and Berry’s recommendation, MCAGCC contracted the gate installation in November of 1997. The following spring (April 1998), Brown and Berry re-visited the mine and estimated that 50 pallid bats were again using the mine based on an evening exit count. Follow-up surveys at this mine in 1999 and 2000 revealed that the pallid bat colony was still present and breeding at the mine, with the colony size estimated at 18 individuals based on a standardized exit count technique that

should have yielded results comparable to Brown and Berry's estimates (Tierra Data Systems 2001). The exit count survey technique used by Tierra Data Systems differed from Brown and Berry's only in that net estimates (counts) of exiting bats were made after every half-hour of a two-hour count period (with the largest net difference used as colony size estimate/count) while Brown and Berry made a single net estimate (count) of exiting bats after an arbitrarily-chosen count period of approximately 1.5 to 3 hours. Under normal conditions of a bat exodus where most or all bats in the roost exit without returning to the roost during the exit count period, the net estimates (counts) made using the different exit count survey techniques would be similar, if not identical.

Two other mines identified as bat roosts by Brown and Berry (1998), the Pat Maloy mine and Imperial Lode mines ('Wooden Door' and 'Duck-walk' tunnels), were also receiving moderate to high levels of human visitation and disturbance, and were also recommended for gating. Brown and Berry (1998) documented California myotis and Townsend's big-eared bats using a portion of the Pat Maloy mine as both a day and night roost during the summer. They also observed over 40 California myotis hibernating inside the mine during the winter. There is a small, seep-fed source of open water approximately 100 feet inside the mine that is attractive to bats for drinking and likely also attracts insects that bats can forage on opportunistically. This water source may also help provide favorable humidity levels for hibernating bats. Evidence of summer and winter bat use of the Imperial Lode mine complex was also documented. A single Townsend's big-eared bat was found hibernating in one portion, guano of both California myotis and Townsend's big-eared bats were found throughout the mines, and acoustic signals of these and other bat species were recorded in the vicinity of the mine entrances (Brown and Berry 1998).

As a result, MCAGCC contracted the installation of bat compatible gates at the entrances of three horizontal tunnels (known as 'adits'), one at the Pat Maloy complex and two at the Imperial Lode complex ('Wooden Door' and 'Duck-walk'), in late fall of 1999. Our surveys were the first conducted at these two mine complexes since the gates were installed.

## **Study Area**

Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms, is located in San Bernardino County, California (Figure 1). It is comprised of nearly 600,000 acres in the Southwestern Mojave Desert. It is characterized by northwest-southeast trending rocky ridges rising to over 1400 meters cut by low valleys and alluvial fans as low as 200 meters in elevation. Annual rainfall is between 10-15 centimeters and occurs primarily during the winter with occasional summer thundershowers. Major vegetation types include creosote bush, saltbush, and blackbush scrub. MCAGCC is divided into 22 training areas or ranges. There are no permanent water sources away from the developed Mainside Area with the exception of a seep-fed surface water source located approximately 100 feet inside the gated entrance of the Pat Maloy mine in the Sunshine Peak Training Area. There are a few ephemeral water sources documented elsewhere on the base.

The Sunshine Peak Training Area is located in the northwest portion of MCAGCC while the Lead Mountain range is located in the northeast portion (Figure 1). Sunshine Peak contains the greatest concentration of mines on MCAGCC including the Imperial Lode mines, and the Pat Maloy mine (Figure 2). Lead Mountain contains the Benchmark 19 mine and associated prospects (Figure 3).

Digital images of the Imperial Lode ‘Duck-walk’ and ‘Wooden Door’ mines, as well as the Benchmark 19 mine can be viewed in figures 4-10.

## Methods

It is advantageous to use multiple, complimentary techniques to thoroughly survey for bats (Pierson 1993). We used four techniques in concert to survey for bats during the mine surveys at MCAGCC: exit counts using night vision binoculars, acoustic recording of bat vocalizations using an ultrasonic bat detector, mist-netting, and video recording at mine entrances. We collected weather data including temperature, humidity, wind speed, and cloud cover/precipitation using a Kestrel 3000 pocket weather meter (Nielson-Kellerman, Boothwyn, PA) when possible.

The four survey techniques were usually used in a standardized fashion and are described below:

1. Exit Counts - 3<sup>rd</sup> generation night vision binoculars (ITT Industries, White Plains, NY) were used to observe bats as they exited/entered the mine entrance(s) beginning at sunset and ending after two hours (Kunz et al. 1996a). An arbitrary area around the mine entrance(s) was chosen as the ‘field of view’ from which bats were counted exiting or entering. Two clicker-counters were used to count exiting and/or entering bats: one clicker counter was used to count exiting bats (usually held in right hand), and the other clicker-counter was used to count entering bats (usually held in left hand). During the two-hour exit count period, counts were tallied after every one-half hour (cumulatively) resulting in a total of four exit count tallies. The cumulative tally with the greatest net difference between exiting and entering bats was used to estimate the minimum number of bats inhabiting the mines. This standardized exit count technique was developed by the lead author of this USGS report (DCS), and was originally used to estimate the pallid bat colony size at the Benchmark 19 mine during surveys in 1999/2000 (Tierra Data Systems 2001). The technique used by Brown and Berry during 1997 pre-gating surveys and the 1998 post-gating differed slightly than ours. While they used the same start times (sunset), they arbitrarily chose end times (unreported) based on their best estimate of when bats were no longer exiting the mines. They used a single cumulative tally at the end of the exit count observation period (net difference between bats counted ‘out’ and bats counted ‘in’, also unreported) to estimate the colony size. We expect the results using both methods to be comparable under normal conditions of a bat roost exodus (i.e., most or all bats exit the roost and do not return during the exit count period).

2. Acoustic Monitoring – We used unaided ears and an Anabat II ultrasonic bat detector (Titley Electronics, New South Wales, Australia) to acoustically monitor bat vocalizations (O’Farrell et al. 1999). Unaided ears were used to listen for audible bat vocalizations around the mine entrances throughout the entire duration of the surveys. An Anabat II bat detector (Division Ratio 16, Sensitivity 8) combined with a Dell Latitude laptop computer running Anabat6, version 6.3f (developed by Chris Corben) was placed approximately 10 meters from the mine entrances to record bat vocalizations produced by the bats exiting/entering the mines, as well as foraging bats echolocating within the vicinity of the mines. Bat vocalizations were recorded for a minimum two-hour period beginning at sunset, simultaneous with counts and video recording. The recorded bat vocalizations were analyzed in the laboratory after the surveys and were identified to the species level when possible.

3. Mist-netting - After the initial two hours of observation, 2.6 meter tall by 6 meter long nylon mesh mist-nets (Avinet, Dryden, NY) were then erected in front of the mines (Kunz et al. 1996b). The mist-nets were used to capture bats that exited and/or entered the mine after the initial two-hour monitoring period. Bats were identified; their age, sex, and reproductive status were noted, and they were released immediately. The mist-nets were used after the initial two-hour observation period so that accurate counts of bats could be made during the initial two-hour observation period with minimal disturbance to the bats. Monitoring using mist-nets usually continued for up to two hours after the initial two-hour observation period.

4. Video Recording - A digital ‘night shot’ camera (Sony, Tokyo, Japan) was placed on a tri-pod approx 5-10 meters from and facing the mine entrance(s). The camera was used to film bats as they exited and/or entered the mine entrance(s). The camera was used primarily to provide visual proof that bats were able to negotiate the bat-compatible gate(s) and were using the mine(s) after the gating process.

A summary of the specific methods used at each mine during our surveys is found in table 1.

## **Results and Discussion**

The results of the individual mine surveys are presented below listed by mine and by survey date. A summary of the significant results of all bat surveys conducted at MCAGCC (dating back to 1994) at the Pat Maloy, Imperial Lode, and Benchmark 19 mines is found in table 2.

### *Pat Maloy Mine*

#### March 10, 2004

Weather - The temperature was mildly warm; there was no cloud cover; it was relatively windy; and the humidity was low (Appendix I).

Exit Count - The first bat observed at the mine was seen exiting the gated entrance at 1815 hrs. At the end of the 2-hour exit count period, the final tally of bats counted exiting the mine was the same as the count of bats entering the mine: '32'. During the exit count survey, the greatest net difference between bats exiting the mine versus entering the mine during any of the four tallies was '1' (entered). However, at least three small bats were seen simultaneously flying into and out of the mine entrance. And, one larger bat was seen entering and exiting the mine a number of times during the exit count period (Appendix II).

Acoustic Monitoring – The audible social calls of pallid bats were heard on several occasions in the vicinity of the mine entrance during the survey. Analysis of the bat vocalizations recorded with the Anabat revealed three species had been recorded at the mine entrance: the western pipistrelle (*Pipistrellus hesperus*), pallid bat, and California myotis (Appendix III).

Mist-netting – Two bats were caught in the mist-net erected at the mine entrance; one adult male California myotis and one adult female California myotis (Figure 11). Neither were in breeding condition, but the female did have scarred teats indicating she had nursed young in the past (Appendix IV).

Video Recording – Review of all video tapes did not reveal what we had hoped. It was impossible to see any bats in any of the recorded video tapes. Unfortunately, we were not able to make this determination until after all of the video recording had taken place. We suspect there was not enough ambient light, or light produced by the camcorder's own IR light to see small, erratically flying animals such as bats. We believe an auxiliary IR light source is needed to illuminate the mine entrance area adequately enough to record bats on video.

It was apparent that at least four individual bats representing as many as three species were using the Pat Maloy mine as either a day roost or night roost (or both) during this survey.

#### May 17, 2004

Weather - The temperature was mildly warm; there was no cloud cover; there was a light wind (not measurable at the mine entrance); and it was mildly humid (Appendix I).

Exit Count - The first bat observed at the mine was seen exiting the gated entrance at 2002 hrs. At the end of the 2-hour exit count period, the final tally of bats counted was 116 bats exited and 109 entered, a difference of 7 bats 'out'. This was the greatest net difference between bats exiting the mine versus entering the mine during any of the 4 half-hour tallies. Several small bats appearing to be California myotis, and a few large bats appearing to be pallid bats, were seen at any given time flying around the mine entrance. At least one individual of a third bat species, the Townsend's big-eared bat, was also visually observed entering and exiting the mine entrance. All of these species were observed passing through the gate at various times during the exit count period. Throughout the exit count observation period there were numerous moths flying around

the entrance of this mine and bats were frequently observed feeding on them (Appendix II).

Acoustic Monitoring – The audible social calls of pallid bats were heard on several occasions in the vicinity of the mine entrance during the survey. Analysis of the bat vocalizations recorded with the Anabat revealed four species had been recorded at the mine entrance: the pallid bat, California myotis, Townsend’s big-eared bat, and western pipistrelle (Appendix III).

Mist-netting – A single bat was captured during the mist-netting phase of this survey: an adult male pallid bat (Figure 12), not in breeding condition (Appendix IV).

Based on our spring and early summer survey visits in 2004 it appears that the Pat Maloy mine served a variety of purposes for bats in the survey area. It was used as a day and night roost by a small number of bats including the California myotis and sensitive Townsend’s big-eared bat and pallid bat. It also appeared to be used as a foraging site for bats (insects abundant around the entrance at night during summer), and we suspect bats were making use of the open surface water that exists inside as a drinking source. We could not determine if this mine was being used as a maternity site. Based on previous bat research conducted by Brown and Berry, this mine was being used during the winter as a hibernation site for at least the California myotis. We did not confirm this, as we did not conduct winter surveys. The bat gate appeared to effectively offer protection to roosting bats from disturbance by people; and bats appeared able to negotiate the gate to access the inside of the mine.

### *Imperial Lode Mines*

#### March 11, 2004

The temperature was mildly warm; there was no cloud cover; there was a light wind; and the humidity was low (Appendix I).

Exit Count (‘Wooden Door’ entrance) - The first bat observed at the mine was seen entering the gated entrance at 1810 hrs. At the end of the 2-hour exit count period, the final tally of bats counted was 0 bats exited and 1 bat entered, a difference of 1 bat ‘in’. This was the greatest net difference between bats exiting the mine versus entering the mine during any of the 4 half-hour tallies. Very little bat activity was observed at this gated mine entrance during this survey (Appendix II).

Exit Count (‘Duck-walk’ entrance) - The first bat observed at the mine was seen exiting the gated entrance at 1803 hrs. At the end of the 2-hour exit count period, the final tally of bats counted was 11 bats exited and 12 bats entered, a difference of 1 bat ‘in’. This was the greatest net difference between bats exiting the mine versus entering the mine during any of the 4 half-hour tallies (Appendix II).

Acoustic Monitoring (‘Duck-walk’ entrance) – The audible social calls of pallid bats were heard on several occasions in the vicinity of the mine entrance during the

survey. Analysis of the bat vocalizations recorded with the Anabat revealed three species had been recorded at the mine entrance: the western pipistrelle, pallid bat, and California myotis (Appendix III).

Mist-netting ('Wooden Door' entrance) – A single bat was captured during the mist-netting phase of this survey: an adult male California myotis, not in breeding condition (Appendix IV).

#### May 18, 2004

The temperature was mildly warm; there was no cloud cover; there was a light wind; and the humidity was low to mild (Appendix I).

Exit Count ('Wooden Door' entrance) - The first bat observed at the mine was seen entering the gated entrance at 2002 hrs. At the end of the 2-hour exit count period, the final tally of bats counted was 10 bats exited and 5 bats entered, a difference of 5 bats 'out'. This was the greatest net difference between bats exiting the mine versus entering the mine during any of the 4 half-hour tallies (Appendix II).

Exit Count ('Duck-walk' entrance) - The first bat observed at the mine was seen entering the gated entrance at 1955 hrs. At the end of the 2-hour exit count period, the final tally of bats counted was 9 bats exited and 10 bats entered, a difference of 1 bat 'in'. However, the greatest net difference between bats exiting the mine versus entering the mine during any of the 4 half-hour tallies was 3 bats 'in'. A small amount of bat activity was observed at this gated mine entrance during this survey (Appendix II).

Acoustic Monitoring ('Duck-walk' entrance) – The audible social calls of pallid bats were heard on several occasions in the vicinity of the mine entrance during the survey. Analysis of the bat vocalizations recorded with the Anabat revealed five species had been recorded at the mine entrance: the pallid bat, Townsend's big-eared bat, California myotis, Mexican free-tailed bat (*Tadarida brasiliensis*), and western pipistrelle (Appendix III).

Mist-netting ('Wooden Door' and 'Duck-walk' entrances) – We mist-netted at both mine entrances simultaneously during this survey, but no bats were captured.

The Imperial Lode mines appeared to be used as roost sites by a small number of bats, including the sensitive pallid bat. The position of these mines relative to the wash, where bats likely forage for insects and drink when water is present, makes them ideal opportunistic roosting sites.

## *Benchmark 19 Mine*

### May 10, 2005

The weather was warm; and it was gusty with wind speeds estimated up to 20 mph (Appendix I).

Exit Count - The first bat observed at the mine was seen entering the gated entrance at approximately 1945 hrs. At the end of the 2-hour exit count period, the final tally of bats counted was 20 bats exited and 18 bats entered, a difference of 2 bats 'out'. However, the greatest net difference between bats exiting the mine versus entering the mine during any of the 4 half-hour tallies was four bats 'out' (Appendix II).

Acoustic Monitoring – The audible social calls of pallid bats were heard on several occasions in the vicinity of the mine entrance during the survey. Analysis of the bat vocalizations recorded with the Anabat revealed two species had been recorded at the mine entrance: the pallid bat, and western pipistrelle (Appendix III).

Mist-netting – We did not mist-net for bats on this night because of heavy gusts of wind that made it near impossible to erect the mist-net, and bat activity was generally low.

### May 11, 2005

The weather was warm; and there were light gusts up to 5 mph (Appendix I).

Exit Count - The first bat observed at the mine was seen exiting the gated entrance at approximately 1955 hrs. At the end of the 2-hour exit count period, the final tally of bats counted was 24 bats exited and 7 bats entered, a difference of 17 bats 'out'. This was the greatest net difference between bats exiting the mine versus entering the mine during any of the 4 half-hour tallies (Appendix II).

Acoustic Monitoring – The audible social calls of pallid bats were heard on several occasions in the vicinity of the mine entrance during the survey. Analysis of the bat vocalizations recorded with the Anabat revealed three species had been recorded at the mine entrance: the pallid bat, California myotis, and western pipistrelle (Appendix III).

Mist-netting – We captured three bats during the mist-netting phase of this survey. All three were adult female pallid bats and all were obviously lactating (Appendix IV).

The Benchmark 19 mine was continuing to serve as a maternity site for a colony of pallid bats. The estimated colony size (17 bats) appeared to be the same as during post-gating surveys conducted in 1999 and 2000 (Tierra Data Systems 2001), but is considerably smaller than the estimated colony size (50 bats) during pre-gating surveys (1994) and surveys conducted during spring of 1998, after the gate was installed in November 1997 (Brown and Berry 1998).

### *Species Accounts*

(listed in taxonomic order)

#### California Myotis (*Myotis californicus*)

Legal Status – None.

General Biology – The California myotis is a multiple habitat-roosting species that can be found roosting alone or in small groups in caves, mines, rocky outcrops, under tree bark and in tree hollows, and in buildings and bridges. Winter roosts include mines, caves, and buildings. The California myotis forages in variety of habitat settings including woodlands, grasslands, over open water, and desert washes and scrublands. It feeds primarily on moths and flies, but will opportunistically take other flying invertebrates. The California myotis is active mainly during the summer but individuals are known to be periodically active during the winter and have been observed at temperatures below freezing (Bogan et al. 1998).

Significant Findings – The California myotis was observed at all surveyed mines. It was observed entering and exiting the gated mine entrances at the Pat Maloy and Imperial Lode mines, but was only detected acoustically near the Benchmark 19 mine. Adults of both sexes were captured at the Pat Maloy mine, including a post-lactating female.

#### Western pipistrelle (*Pipistrellus hesperus*)

Legal Status – None.

General Biology – The western pipistrelle roosts solitarily or in small groups in crevices found in rocks, caves, mines, and occasionally in buildings. It may also roost in rodent burrows in settings where rocky habitats are lacking (i.e., desert flats). This species typically hibernates in rock crevices and mines. It usually forages in close vicinity to their roosts, but does not appear to exhibit high roost site fidelity like most bat species. The western pipistrelle feeds primarily on small, swarming insects such as mosquitoes, flying ants, fruit flies, and leafhoppers (Brown 1998).

Significant Findings – The western pipistrelle was detected acoustically at all mines surveyed. It was not captured nor observed entering or exiting any of the gated mine entrances but could very well have been making use of the mines as roosts.

Townsend's big-eared bat (*Corynorhinus townsendii*)

Legal Status – California Species of Special Concern, Forest Service Sensitive, Bureau of Land Management Sensitive.

General Biology - The Townsend's big-eared bat is an obligate cave-roosting species whose distribution is strongly associated with the presence of natural caves and/or artificial cave-like structures such as mines (Sherwin 1998a). The use of specific mines by this species is dynamic and may vary among seasons and years (Sherwin et al. 2000). They prefer caves and mines with stable cool, humid environments to meet their winter roosting requirements (Pierson and Rainey 1996). The Townsend's big-eared bat appears to be vulnerable to and intolerant of human disturbance at roost sites (Pierson and Rainey 1996, Sherwin 1998a). The Townsend's big-eared bat is considered a moth specialist. It feeds by foraging close to vegetation and may glean some insects directly from the branches of shrubs and trees. It has been documented making one-way commute distances of 5 to 13 km on foraging ventures, and usually flies close to vegetation structure as opposed to out in open space while commuting (Brown et al. 1994, Fellers and Pierson 2002).

Significant Findings - The Townsend's big-eared bat was observed in very small numbers (possibly only a single individual) and recorded with the Anabat at the Pat Maloy mine during the summer survey (May 17, 2004). It was also recorded at the Imperial Lode ('Duck-walk') mine during the summer survey (May 18, 2004).

Pallid bat (*Antrozous pallidus*)

Legal Status - California Species of Special Concern, Forest Service Sensitive, Bureau of Land Management Sensitive.

General Biology - The pallid bat is a multiple habitat-roosting species. It can be found roosting in a variety of crevice and/or cavity-type situations such as rock crevices, caves, tree hollows, buildings, bridges, and mines (Sherwin 1998b). The pallid bat is unique among North American bat species in that it forages on terrestrial arthropods, and occasionally small vertebrates, that it tackles by landing on the ground (Orr 1954). It occasionally consumes flying insects (Bell 1982), but usually pins flying prey items against the ground or other surfaces during capture (Johnston and Fenton 2001). The culled legs and other parts of large-bodied arthropods are often found beneath pallid bat night roosting areas. The pallid bat has often been observed drinking shortly after emergence from roosts (Orr 1954, Bell 1982, Ball 2002), but may rely on water from large-bodied prey items in extremely arid environments.

Significant Findings – Small numbers of pallid bats were observed visually and acoustically during the spring and summer surveys at both the Pat Maloy mine and Imperial Lode mine ('Duck-walk' entrance only). One adult male (non-breeding condition) was captured outside the Pat Maloy mine during the summer survey. The Benchmark 19 mine was occupied by at least 17 pallid bats during our summer 2005

surveys. The three individuals captured in a mist-net erected in front of the mine were lactating females, indicating this mine was being used as a maternity site at the time.

### Mexican free-tailed bat (*Tadarida brasiliensis*)

Legal Status – None.

General Biology – The Mexican free-tailed bat is highly colonial. It roosts primarily in crevices and caves in cliff faces, but is also known to occupy mines and tunnels, bridges, buildings, culverts, and artificial bat houses. Mines appear to be more popular as night roosting locations for this species rather than as day roosts. Mexican free-tailed bats forage primarily on moths but will take a variety of insectivorous prey items. One-way foraging commutes for this species are known to exceed 50 kilometers, and a large colony can cover an extensive area while foraging (400 km<sup>2</sup> estimated). The Mexican free-tailed bat is migratory throughout much of its range, but this species' movement patterns in the west are still not clear (Bat Conservation International 1998).

Significant Findings – The Mexican free-tailed bat was only detected acoustically during the early summer survey at the Imperial Lode mine complex. It was unknown whether this species was using the mines as roosts; roosting in the rocky cliffs above the mines; or just simply foraging nearby. The time of year (May) was consistent with this species migrating through the area.

## **Conclusions**

### *Summary*

Based on our surveys, we have concluded that the Pat Maloy and Imperial Lode mines, at least the gated portions, are continuing to function as bat roosts at the same capacity that they were prior to gating. There is no indication that there has been an increase or decrease in the number and types of bats using the mines. Because we did not conduct winter internal surveys of these mines, we cannot assess if the Pat Maloy or Imperial Lode mines are still functioning as bat hibernation sites as they were prior to gating.

The Benchmark 19 mine was still inhabited by adult female pallid bats, and was still being used as a maternity site. The number of bats estimated inhabiting the mine was consistent with estimates made during post-gating surveys conducted in 1999 and 2000 (Tierra Data Systems 2001) but was significantly less than Brown and Berry's 1998 post-gating estimates (Brown and Berry 1998). It is unclear why there is such a discrepancy between Brown and Berry's population estimates and estimates made during 1999/2000 and in 2005. Perhaps the 30+ pallid bats unaccounted for during 1999/2000 and 2005 surveys have chosen an alternate roost site on MCAGCC. Continued monitoring at the Benchmark 19 mine is recommended to reveal population trends of the pallid bat colony.

During the 1999/2000 surveys, recruitment of juveniles was observed at the Benchmark 19 mine. During the 2005 survey, we observed breeding in the form of lactation in three adult females captured. However, we did not conduct the survey at a time of year that would allow us to observe recruitment. In fact, the three female pallid bats we captured appeared to be relatively old individuals, based on the wear on their upper canines. We are unsure if this maternity colony has successfully recruited juveniles recently, or if the juveniles observed in 1999/2000 surveys have continued to survive. Bats would have to be captured during an appropriate time period, probably late August or early September, in order to determine if there are any individuals of an age class younger than what we observed inhabiting the mine.

The bat populations of all surveyed, gated mines appeared to be comparable to pre-gating conditions, with the exception of the pallid bat colony at the Benchmark 19. In addition, there was no indication that there had been any major human disturbance or vandalism at the gated mines. We conclude that the gating of the mines has so far been an appropriate and successful management action. Further monitoring of the gated entrances will be important for observing long-term trends in the bat populations inhabiting the mines on MCAGCC.

## **Management Recommendations**

A list of suggested management recommendations follows:

1. Continue to monitor bat populations at gated mines using standardized techniques at regular intervals. We recommend monitoring every 2-3 years so that bats are not being disturbed each year but long periods of time (greater than 3 years) are not passing between monitoring efforts.
2. Conduct mist-netting at Benchmark 19 mine periodically during late August or early September to determine if the pallid bats are successfully recruiting young individuals to their population.
3. Conduct radio telemetry study on pallid bats roosting in Benchmark 19 mine to determine where the bats are primarily foraging, and to what extent they may be utilizing other roosting and foraging habitats found on MCAGCC.
4. Continue conducting bat survey work at other locations on MCAGCC to determine if and where other sensitive bat species, such as Townsend's big-eared bats and California leaf-nosed bats, may be occurring and utilizing habitats including mines on MCAGCC.

## **Acknowledgements**

We are grateful to the Natural Resources and Environmental Affairs Division (NREA) at MCAGCC Twentynine Palms for securing the funding necessary to conduct these surveys and to NREA personnel, including Rhys Evans and Brent Husung for providing advice, technical information, use of the digital camcorder and maps. We also thank Mr. Husung for coordinating access to base training areas where surveys were conducted, and for providing useful information regarding safety, and road and weather conditions. US Geological Survey biologists who assisted in the field included Cheryl

Brehme, Denise Clark, and Zsolt Kahancza. Cheryl Brehme also provided valuable comments for this report. US Geological Survey biologist Stacie Hathaway provided administrative support and helped coordinate this project. A special thanks to Brown and Berry for recommending and initiating the gating process of the mines of MCAGCC as part of their dedication to bat conservation in Southern California.

## Literature Cited

- Ball, L. C. 2002. A strategy for describing and monitoring bat habitat. *Journal of Wildlife Management* 66:1148-1153.
- Bat Conservation International. 1998. Proceedings of the Western Bat Working Group workshop on ecology, conservation, and management of western bat species – species accounts, Mexican free-tailed bat (*Tadarida brasiliensis*). February 9-13, 1998, Reno, Nevada.
- Bell, G. P. 1982. Behavioural and ecological aspects of gleaning by a desert insectivorous bat, *Antrozous pallidus* (Chiroptera: Vespertilionidae). *Behavioural Ecology and Sociobiology*. 10:217-233.
- Bogan, M. A., E. W. Valdez, and K. W. Navo. 1998. Proceedings of the Western Bat Working Group workshop on ecology, conservation, and management of western bat species – species accounts, California myotis (*Myotis californicus*). February 9-13, 1998, Reno, Nevada.
- Brown, P. E. 1998. Proceedings of the Western Bat Working Group workshop on ecology, conservation, and management of western bat species – species accounts, Western pipistrelle (*Pipistrellus hesperus*). February 9-13, 1998, Reno, Nevada.
- Brown, P. E., R. Berry, and C. Brown. 1994. Foraging behavior of Townsend's big-eared bats (*Plecotus townsendii*) on Santa Cruz Island. Pp. 367-369 in Fourth California islands symposium: update on the status of resources (W. L. Halvorson and G. J. Maender, eds.). Santa Barbara Museum of Natural History, Santa Barbara, California.
- Brown, P. E. and R. Berry. 1998. Bat survey at the Marine Corps Air Ground Combat Center, Twentynine Palms, California. Unpublished report prepared for the Natural Resources Management Branch, Southwest Division Naval Facilities Engineering Command, San Diego, California.
- Fellers, G. M. and E. D. Pierson. 2002. Habitat use and foraging behavior of Townsend's big-eared bat (*Corynorhinus townsendii*) in coastal California. *Journal of Mammalogy*, 83:167-177.
- Humphrey, S. R. 1975. Nursery roosts and community diversity of Nearctic bats. *Journal of Mammalogy*, 56:321-346.
- Johnston, D.S., and M.B. Fenton. 2001. Individual and population-level variability in diets of pallid bats (*Antrozous pallidus*). *Journal of Mammalogy*, 82:362-373.

- Kunz, T. H., D. W. Thomas, G.C. Richards, C.R. Tidemann, E.D. Pierson, and P.A. Racey. 1996a. Observational techniques for bats. PP 105-114. In Wilson, D.E., F.R. Cole, J.D. Nichols, R. Rudran, and M.S. Foster. 1996. Measuring and monitoring biological diversity: Standard methods for mammals. Smithsonian Institution Press, Washington and London. 409 pages.
- Kunz, T. H., C. R. Tidemann, and G.C. Richards. 1996b. Capturing mammals: Small Volant mammals. PP 122-146. In Wilson, D.E., F.R. Cole, J.D. Nichols, R. Rudran, and M.S. Foster. 1996. Measuring and monitoring biological diversity: Standard methods for mammals. Smithsonian Institution Press, Washington and London. 409 pages.
- O'Farrell, M. J., B. W. Miller, and W. L. Gannon. 1999. Qualitative identification of free-flying bats using the Anabat detector. *Journal of Mammalogy* 80:11-23.
- Orr, R. T. 1954. Natural history of the pallid bat (*Antrozous pallidus*). *Proceedings of the California Academy of Sciences*. 28:165-246.
- Pierson, E. D. 1993. Survey protocols for California bats. Wildlife Society, Monterey, California. February 26, 1993. Presentation.
- Pierson, E. D. 1998. Tall trees, deep holes, and scarred landscapes: conservation biology of North American bats. PP 309-325. In: Kunz, T.H.; Racey, P.A. eds. *Bat biology and conservation*. Washington D.C.: Smithsonian Institution Press; 365 Pages.
- Pierson, E. D., and W. E. Rainey. 1996. The distribution, status and management of Townsend's big-eared bat (*Corynorhinus townsendii*) in California. California Department of Fish and Game, Bird and Mammal Conservation Program Report 96-7:1-49.
- Sherwin, R. E. 1998a. Proceedings of the Western Bat Working Group workshop on ecology, conservation, and management of western bat species – species accounts, pallid bat (*Corynorhinus townsendii*). February 9-13, 1998, Reno, Nevada.
- Sherwin, R. E. 1998b. Proceedings of the Western Bat Working Group workshop on ecology, conservation, and management of western bat species – species accounts, pallid bat (*Antrozous pallidus*). February 9-13, 1998, Reno, Nevada.
- Sherwin R. E., D. Stricklan, and D. S. Rogers. 2000. Roosting affinities of Townsend's big-eared bat (*Corynorhinus townsendii*) in northern Utah. *Journal of Mammalogy* 81:939-947.
- Tierra Data Systems, 2001. Monitoring and Surveys for Bats at "Benchmark 19 Mine," Marine Corps Air Ground Combat Center, Twentynine Palms, California, Final

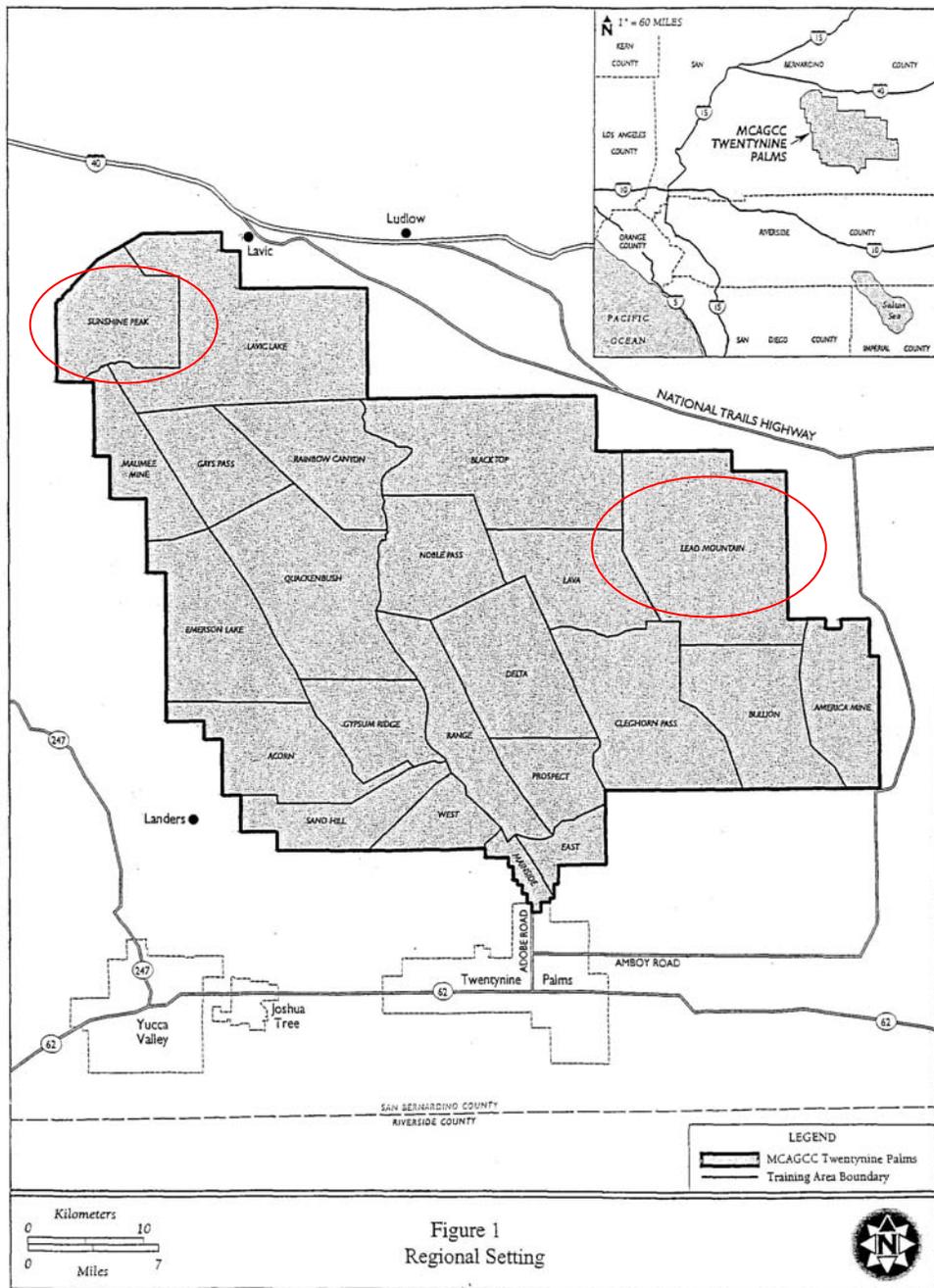
Report. Unpublished report. United States Department of the Navy contract # N68711-97-M-5761. 22 pages.

**Table 1.** Mine-specific Methods. This table includes the mines surveyed, survey dates, the method(s) used to record weather data, and the start and end times of the four survey techniques used during the mine surveys (exit count, anabat, mist-netting, and video recording).

<b>Mine</b>	<b>Date</b>	<b>Weather</b>	<b>Exit Count</b>	<b>Anabat</b>	<b>Mist-net</b>	<b>Video Recording</b>
		(Method)	(Start, End)	(Start, End)	(Start, End)	(Start, End)
<b>Pat Maloy</b>	3/10/2004	Kestrel	1800-2000 hrs	1740-2115 hrs	2010-2210 hrs	1800-2000 hrs
	5/17-18/2004	Kestrel	2000-2200 hrs	2000-2300 hrs	2215-0015 hrs	2000-2200 hrs
<b>Imperial Lode</b>						
<i>Duck-walk</i>	3/11/2004	Kestrel	1800-2000 hrs	1745-2145 hrs	none	none
<i>Wooden Door</i>	3/11/2004	none	1800-2000 hrs	none	2010-2210 hrs	1800-2000 hrs
<i>Duck-walk</i>	5/18/2004	Kestrel	2000-2200 hrs	2000-2330 hrs	2215-2345 hrs	none
<i>Wooden Door</i>	5/18/2004	none	2000-2200 hrs	none	2215-2345 hrs	2000-2200 hrs
<b>Benchmark 19</b>	5/10/2005	Thermometer	1930-2130 hrs	1930-2230 hrs	none	1930-2130 hrs
	5/11/2005	Thermometer	1930-2130 hrs	1930-2230 hrs	2145-2215 hrs	1930-2130 hrs

**Table 2.** Results Summary Table. This table includes the summarized results of surveys conducted at the study mines dating back to 1994. Acronyms used for the bat species in this table are: ANPA *Antrozous pallidus* (Pallid Bat), COTO *Corynorhinus townsendii* (Townsend’s Big-eared Bat), MYCA *Myotis californicus* (California Myotis), PIHE *Pipistrellus hesperus* (Western Pipistrelle), and TABR *Tadarida brasiliensis* (Mexican Free-tailed Bat).

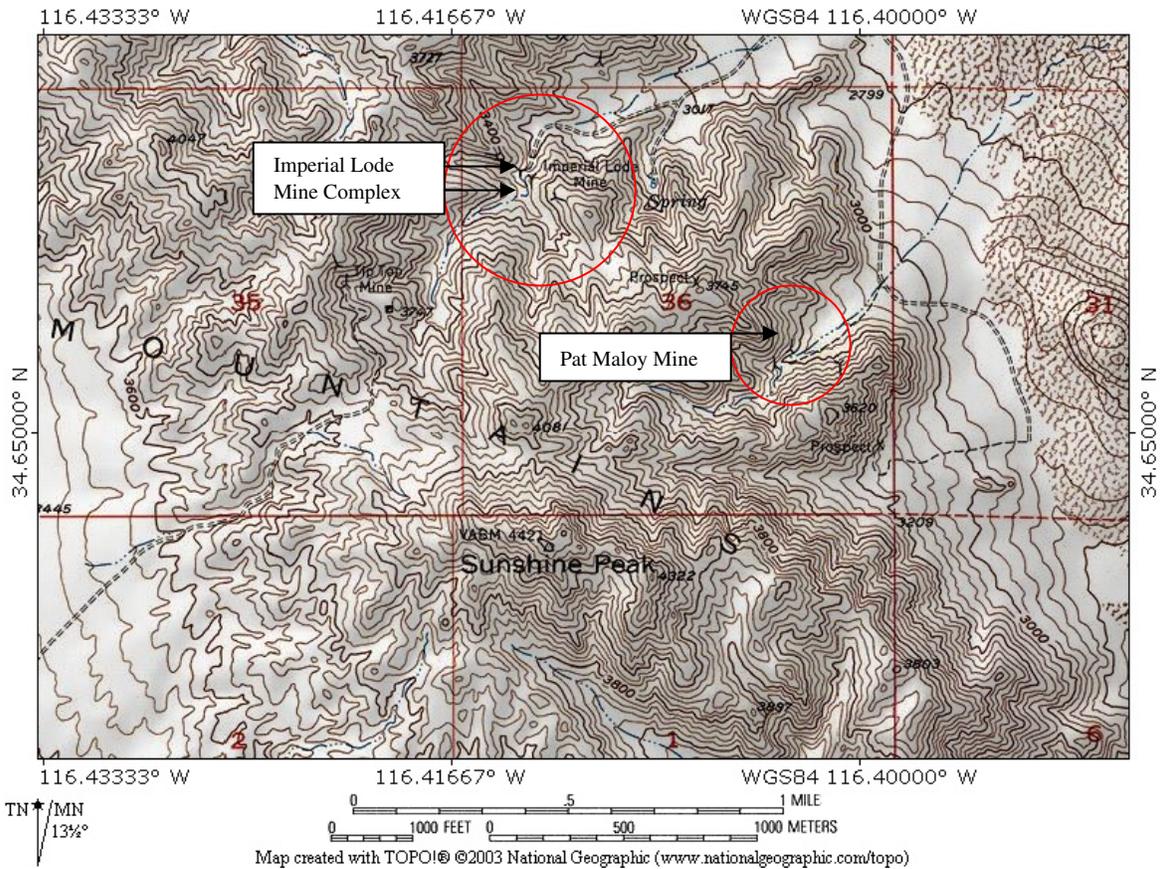
<b>Bat Population Status</b>			
<b>Mine</b>	<i>(Brown and Berry 1994-1998)</i>	<i>(Tierra Data Systems 1999-2000)</i>	<i>(USGS 2004-2005)</i>
<b>Pat Maloy</b>	<u>Pre-gating</u> 1. Hibernation site for 40+ MYCAs 2. Summer day roost for a few MYCAs and COTOs 3. Very active summer drinking/foraging site and night roost for MYCAs, COTOs, ANPAs, and PIHEs	Not surveyed	<u>Post-gating</u> 1. No winter surveys 2. Summer day roost for a few MYCAs and COTOs 3. Very active summer drinking/foraging site and night roost for MYCAs, COTOs, ANPAs, and PIHEs
<b>Imperial Lode</b>	<u>Pre-gating</u> 1. Myotis spp and COTO guano found in mines 2. A few small bats observed exiting and entering mines 3. MYCA, ANPA, PIHE calls recorded	Not surveyed	<u>Post-gating</u> 1. No internal surveys 2. A few small bats observed exiting and entering mines 3. MYCA, ANPA, COTO, TABR, PIHE calls recorded
<b>Benchmark 19</b>	<u>Pre- and post-gating</u> 1. 50 ANPAs estimated using mine prior to and just after gate installation 2. Juvenile ANPAs observed	<u>Post-gating</u> 1. 18 ANPAs estimated using mine 2. Juvenile ANPAs observed	<u>Post-gating</u> 1. 17 ANPAs estimated using mine 2. Lactating female ANPAs observed



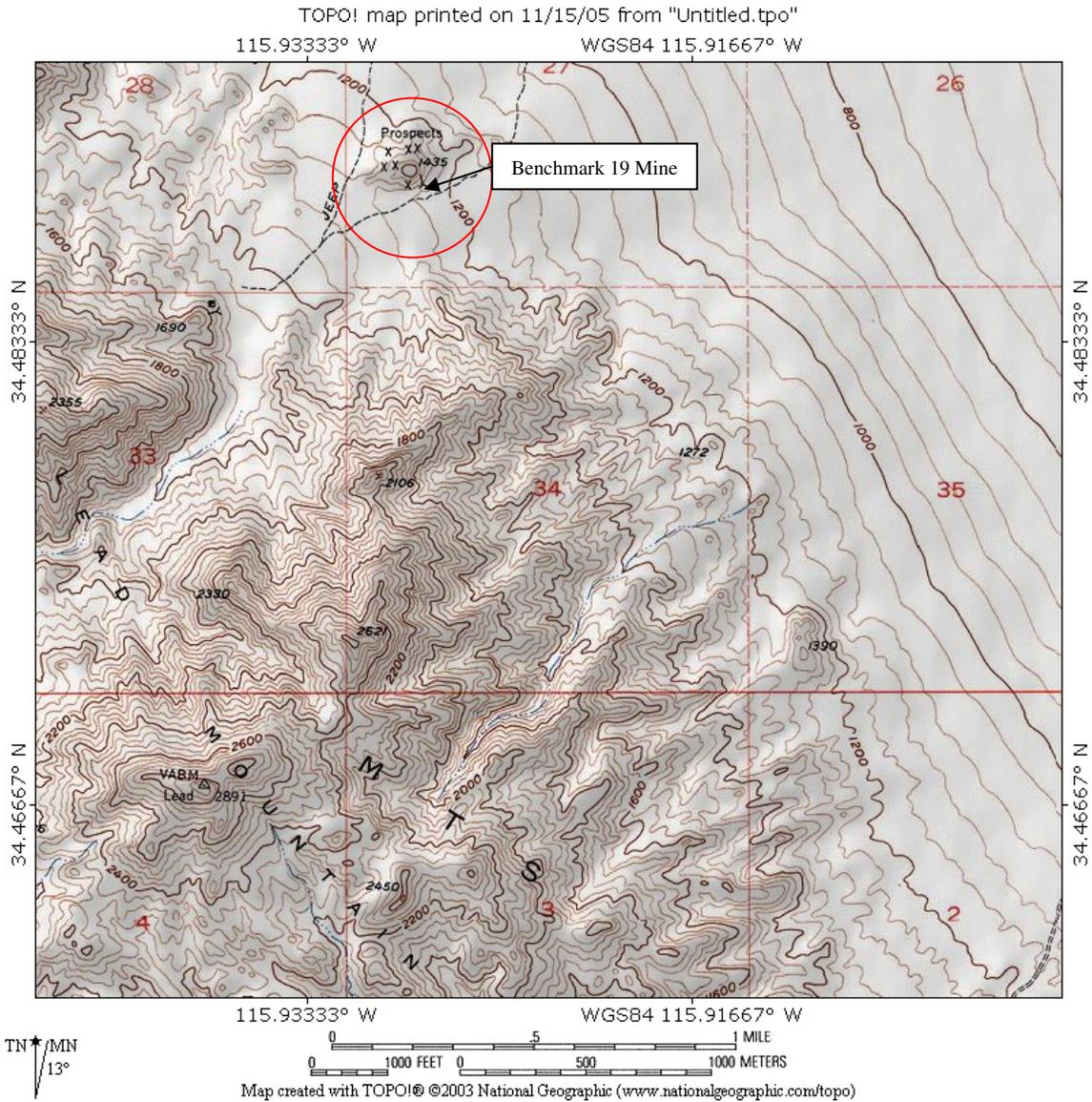
**Figure 1.** Map of Marine Corps Air Ground Combat Center, Twentynine Palms, CA. Map showing regional context of MCAGCC Twentynine Palms in San Bernardino County, southern California. Map includes base training ranges: the Sunshine Peak range is located in the northwest portion of base; the Lead Mountain range in the northeast portion (both ranges highlighted by ellipses).



TOPO! map printed on 11/15/05 from "Untitled.tpo"



**Figure 2.** Map of Imperial Lode and Pat Maloy mines. Detailed topographic map of Sunshine Peak range mines. The two gated Imperial Lode mines are circled at top of map ('Wooden Door' at left of circle center, 'Duck-walk' centered). The gated Pat Maloy mine is circled to right of topo map center.



**Figure 3.** Map of benchmark 19 mine. Detailed topographic map of Lead Mountain range where the Benchmark 19 mine is located. The Benchmark 19 mine is circled in red.



**Figures 4 and 5.** Top: Digital image of outside view of Pat Maloy mine entrance. Bottom: Digital image of gated entrance of Pat Maloy mine entrance.



**Figures 6 and 7.** Top: Digital image of outside view of Imperial Lode 'Duck-walk' mine. Notice dummy ordnance in foreground. Bottom: Digital image of gated entrance of Imperial Lode 'Duck-walk' mine.



**Figures 8 and 9.** Top: Digital image of outside view of Imperial Lode 'Wooden Door' mine entrance. Bottom: Digital image of gated entrance of Imperial Lode 'Wooden Door' mine entrance.



**Figure 10.** Digital image of gated entrance of Benchmark 19 mine.



**Figure 11.** Digital image of captured California myotis (*Myotis californicus*). Bat was captured in mist-net in front of gated Pat Maloy mine entrance.



**Figure 12.** Digital image of captured Pallid bat (*Antrozous pallidus*). Bat was captured in mist-net in front of gated Pat Maloy mine entrance.

Weather Data									
	Temperature (°C)		Cloud Cover		Wind Speed (mph)		Humidity (%)		
	Start	End	Start	End	Start	End	Start	End	
<i>Pat Maloy mine</i>									
10-Mar-04	15.8	17.1	Clear	Clear	4.2	3.1	32	32	
17-May-04	24.3	18.3	Clear	Clear	0	0	35	57	
<i>Imperial Lode mine</i>									
11-Mar-04	17.2	15.8	Clear	Clear	0.8	0.9	27	36	
18-May-04	22.6	18.5	Clear	Clear	3.3	0	24	36	
<i>Benchmark 19 mine</i>									
10-May-05	22	18	Clear	Clear	gusty, 0-20	gusty, 0-20	n/a	n/a	
11-May-05	22	20	Clear	Clear	gusty, 0-5	gusty, 0-5	n/a	n/a	

**Appendix I.** Weather Data. A Kestrel 3000 brand pocket weather station was used to record weather data at the Pat Maloy and Imperial Lode mines. A standard thermometer was used at the Benchmark 19 mine; wind speed was estimated.

<b>Pat Maloy Mine Exit Count Data</b>				
<i>10-Mar-04</i>				
<u>Time:</u>	<u>Bats In Count:</u>	<u>Bats Out Count:</u>	<u>Net Difference:</u>	<u>Time 1st Bat Observed:</u>
1800	0	0	0	
1830	4	4	0	1st Bat Out at 1815
1900	19	18	1 Bat In	
1930	30	29	1 Bat In	
2000	32	32	0	
<i>17-May-04</i>				
<u>Time:</u>	<u>Bats In Count:</u>	<u>Bats Out Count:</u>	<u>Net Difference:</u>	<u>Time 1st Bat Observed:</u>
2000	0	0	0	
2030	39	45	6 Bats Out	1st Bat Out at 2002
2100	71	69	2 Bats In	
2130	98	103	5 Bats Out	
2200	109	116	6 Bats Out	

**Appendix II.** Exit Count Data. Tabular results of exit count survey at the Pat Maloy mine.

<b>Imperial Lode 'Wooden Door' Mine Exit Count Data</b>				
<i>11-Mar-04</i>				
<u>Time:</u>	<u>Bats In Count:</u>	<u>Bats Out Count:</u>	<u>Net Difference:</u>	<u>Time 1st Bat Observed:</u>
1800	0	0	0	
1830	1	0	1 Bat In	1st Bat In at 1810
1900	1	0	1 Bat In	
1930	1	0	1 Bat In	
2000	1	0	1 Bat In	
<i>18-May-04</i>				
<u>Time:</u>	<u>Bats In Count:</u>	<u>Bats Out Count:</u>	<u>Net Difference:</u>	<u>Time 1st Bat Observed:</u>
2000	0	0	0	
2030	1	4	3 Bats Out	1st Bat In at 2002
2100	3	6	3 Bats Out	
2130	4	7	3 Bats Out	
2200	5	10	5 Bats Out	

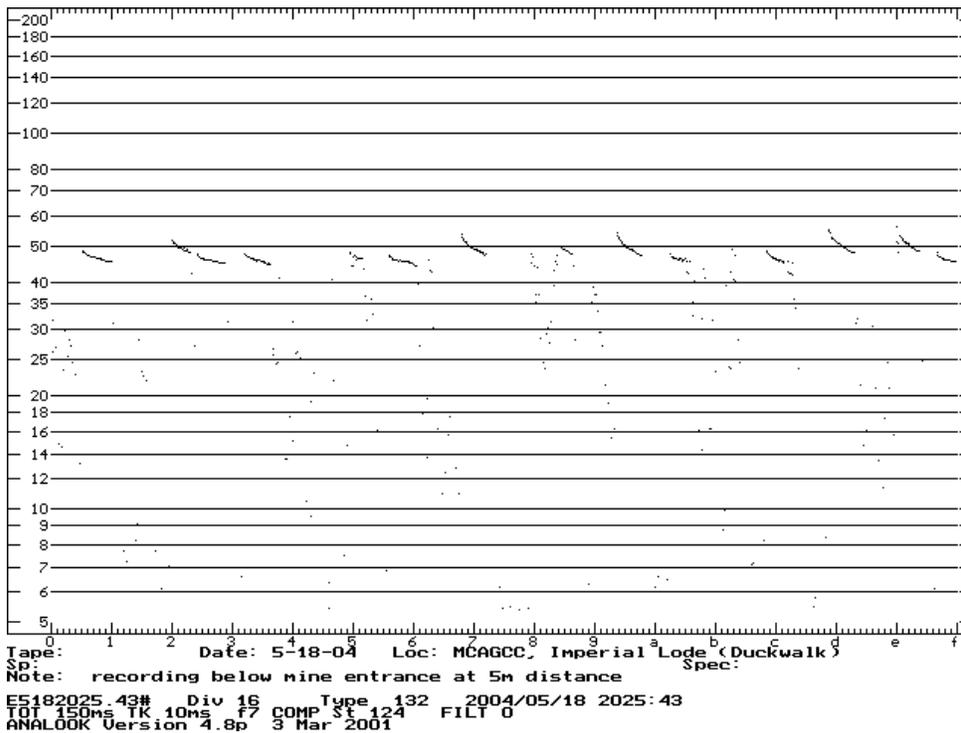
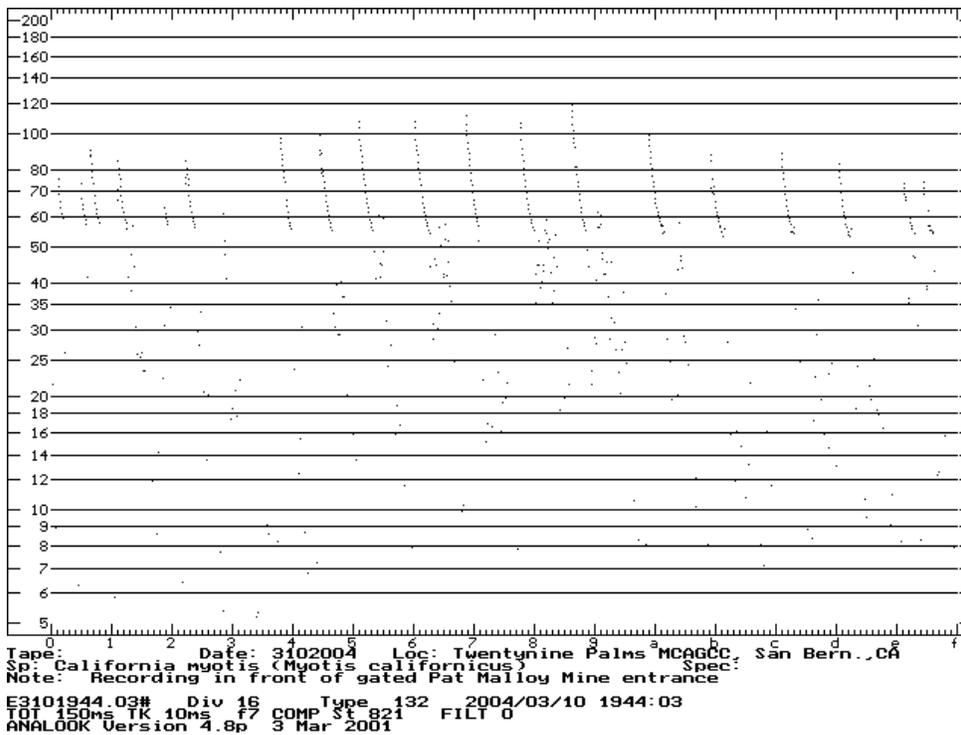
**Appendix II.** Exit Count Data (cont.). Tabular results of exit count surveys at the Imperial Lode 'Wooden Door' mine.

<b>Imperial Lode 'Duck-walk' Mine Exit Count Data</b>				
<i>11-Mar-04</i>				
<u>Time:</u>	<u>Bats In Count:</u>	<u>Bats Out Count:</u>	<u>Net Difference:</u>	<u>Time 1st Bat Observed:</u>
1800	0	0	0	
1830	4	4	0	1st Bat Out at 1803
1900	5	5	0	
1930	5	5	0	
2000	12	11	1 Bat In	
<i>18-May-04</i>				
<u>Time:</u>	<u>Bats In Count:</u>	<u>Bats Out Count:</u>	<u>Net Difference:</u>	<u>Time 1st Bat Observed:</u>
2000	1	0	1 Bat In	1st Bat In at 1955
2030	4	2	2 Bats In	
2100	6	4	2 Bats In	
2130	7	4	3 Bats In	
2200	10	9	1 Bat In	

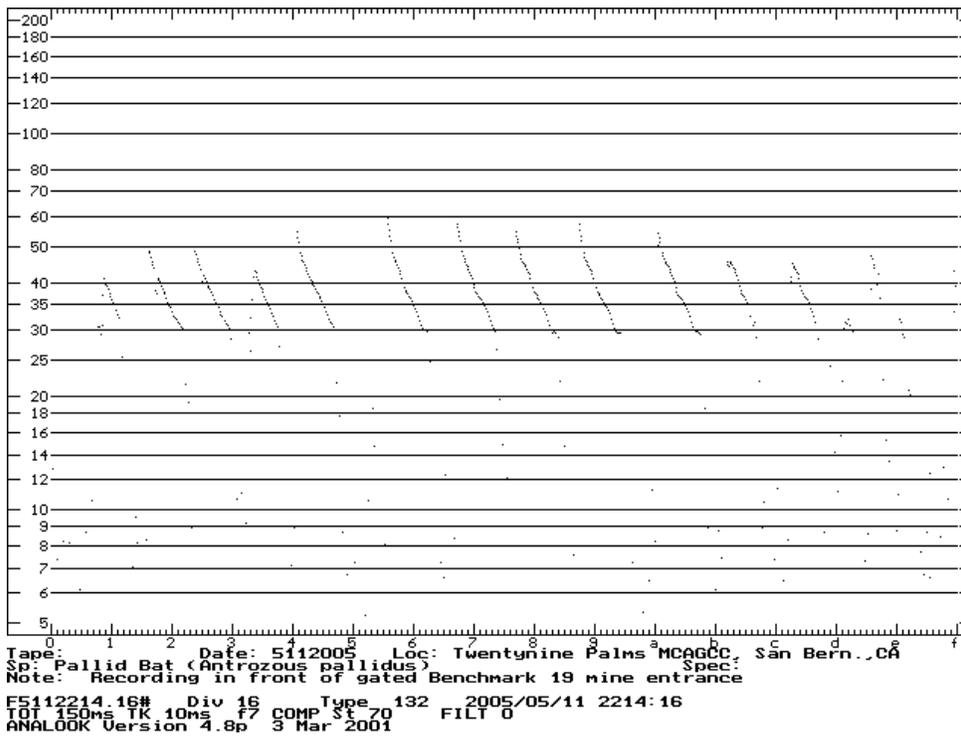
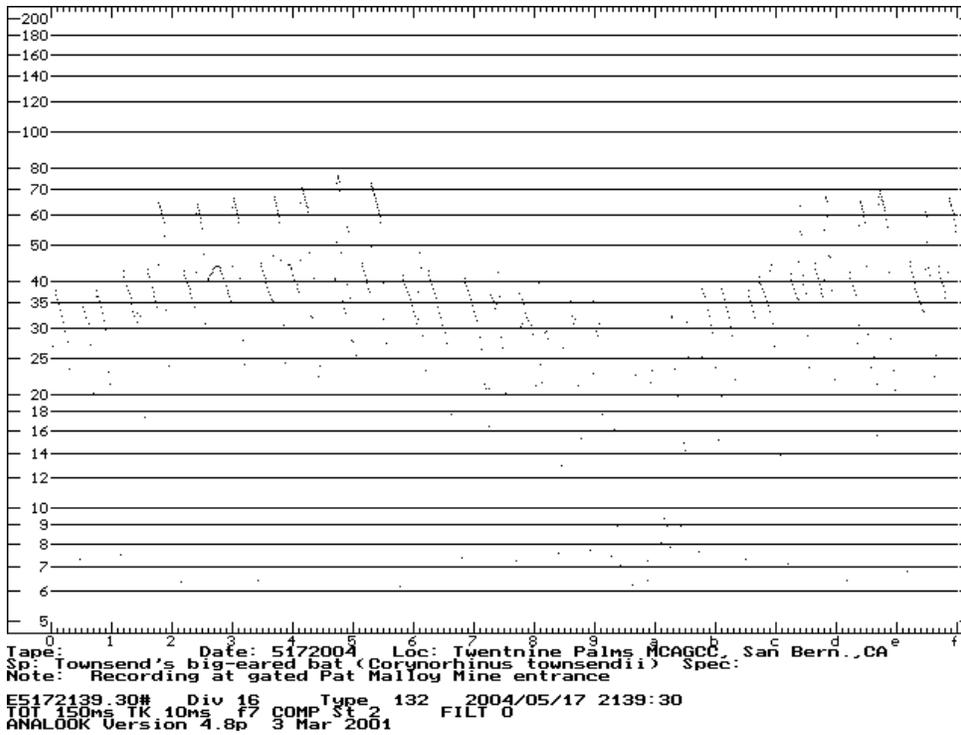
**Appendix II.** Exit Count Data (cont.). Tabular results of exit count surveys at the Imperial Lode 'Duck-walk' mine.

<b>Benchmark 19 Mine Exit Count Data</b>				
<i>10-May-05</i>				
<u>Time:</u>	<u>Bats In Count:</u>	<u>Bats Out Count:</u>	<u>Net Difference:</u>	<u>Time 1st Bat Observed:</u>
1930	0	0	0	
2000	1	1	0	1st Bat In at 1945
2030	7	6	1 Bat In	
2100	10	14	4 Bats Out	
2130	18	20	2 bats Out	
<i>11-May-05</i>				
<u>Time:</u>	<u>Bats In Count:</u>	<u>Bats Out Count:</u>	<u>Net Difference:</u>	<u>Time 1st Bat Observed:</u>
1930	0	0	0	
2000	0	1	1 Bat Out	1st Bat Out at 1955
2030	7	24	17 Bats Out	
2100	7	24	17 Bats Out	
2130	7	24	17 Bats Out	

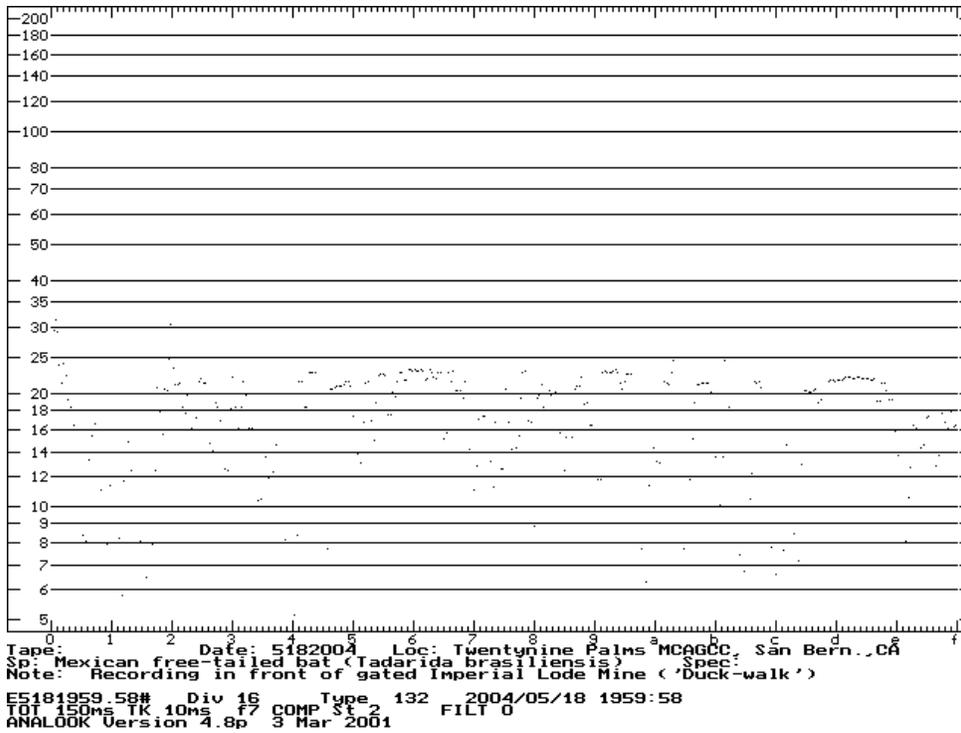
**Appendix II.** Exit Count Data (cont.). Tabular results of exit count surveys at the Benchmark 19 mine.



**Appendix III. Representative Bat Vocalizations.** Screenshots taken from Analoook version 4.8p. A (top): California myotis (*Myotis californicus*) recorded outside of the Pat Maloy mine. B (bottom): Multiple western pipistrelles (*Pipistrellus hesperus*) recorded outside of the Imperial Lode mine ('Duck-walk').



C (top): Townsend's big-eared bat (*Corynorhinus townsendii*) recorded outside of the Pat Maloy mine. D (bottom): Pallid bat (*Antrozous pallidus*) recorded outside of the Benchmark 19 mine.



E (top): Suspected Mexican free-tailed bat (*Tadarida brasiliensis*) recorded outside of the Imperial Lode mine ('Duck-walk'). This recording was low quality but only representative vocalization sequence of this species obtained during surveys.

Mist-net Captures					
Mine	Date	Species	Age	Sex	Reproductive Status
<u>Pat Maloy</u>					
	March 10 2004	<i>Myotis californicus</i>	Adult	Male	Testes Abdominal
		<i>Myotis californicus</i>	Adult	Female	Scarred Teats
	May 17 2004	<i>Antrozous pallidus</i>	Adult	Male	Testes Abdominal
<u>Imperial Lode 'Wooden Door'</u>					
	March 11 2004	<i>Myotis californicus</i>	Adult	Male	Testes Abdominal
<u>Benchmark 19</u>					
	May 11 2005	<i>Antrozous pallidus</i>	Adult	Female	Lactating
		<i>Antrozous pallidus</i>	Adult	Female	Lactating
		<i>Antrozous pallidus</i>	Adult	Female	Lactating

**Appendix IV.** Mist-net Capture Data. Tabular results of mist-netting data.