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Development and utilization of a landscape scale GIS model to identify potential bat habitat features in the Desert Southwest: Identification and Status of Sensitive Bat Habitat Resources – Final Report

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DEVELOPMENT AND UTILIZATION OF A LANDSCAPE SCALE GIS MODEL TO IDENTIFY POTENTIAL BAT HABITAT FEATURES IN THE DESERT SOUTHWEST: IDENTIFICATION AND STATUS OF SENSITIVE BAT HABITAT RESOURCES

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EXECUTIVE SUMMARY

The goal of the Department of Defense's (DoD) Natural Resources Conservation Program is to ensure continued access to realistic habitat conditions to support the military's combat readiness mission, while simultaneously working to ensure the long term sustainability of our country's natural resources. In 2006 (and extended in 2011), the DoD and Bat Conservation International initiated actions to increase bat productivity and habitat enhancements through a Memorandum of Understanding (MOU). This agreement established a policy of cooperation and coordination to identify, document and maintain bat populations and their habitats on DoD installations. In addition an MOU between the DoD and the International Association of Fish and Wildlife Agencies directs the management of natural resources on military installations under provisions of the Sikes Act. There is an increase in the amount of military activities and munitions' testing around mines and caves (*i.e.*, potential bat roosts) on three military installations in southwestern Arizona (Barry M. Goldwater Range East [BMGR East], Barry M. Goldwater Range West [BMGR West], and Yuma Proving Ground [YPG]). Disturbances to hibernating bats and maternity colonies within these mines and caves are especially destructive to bat populations whether from military activities or public use. It is therefore imperative that roost site locations be identified to avoid conflicts between sensitive bat species and military missions. Moreover, many bat species in southwestern Arizona are species of concern, that although not officially protected under the Endangered Species Act (ESA), they represent species that could affect DoD actions and military training activities in the future. Finally, there are safety issues that must be considered when deploying personnel in training scenarios where they may encounter abandoned mines or caves. Having detailed maps of mine and cave locations within BMGR East, BMGR West and YPG could be vital to mission implementation and safety.

By combining the efforts of Year 1 of this project (Legacy project 10-143) with a systematic sampling design to collect new data and the efforts of previous work within our study area, we are able to present data on features and potential bat roosts across this landscape. Additionally, we have implemented a sampling design that can be used for future work in these areas and potentially applied across military installations throughout the Desert Southwest. The projects objectives were to: 1) identify, map and describe potential bat roost structures (caves and mines) and characteristics on the BMGR East, BMGR West and YPG; 2) document all potential bat species present within identified bat roosts during the breeding season; and, 3) propose management and population sampling recommendations that can be used to monitor sensitive bat species while maintaining mission critical activities.

We were able to identify 153 potential bat roosts across the study area. From these data we prioritized and revisited 46 bat features to determine species specific occupancy and type of roost (*e.g.*, day or maternity). Most common across this landscape are *myotis* species (*e.g.*, California, cave and Yuma myotis), California leaf-nosed bat (*Macrotus californicus*), and evidence of Townsend's big-eared bat (*Corynorhinus townsendii*). There are areas that may support lesser long-nosed bats (*Leptonycteris curasoae*) as well. Based on this dataset, we developed and refined a predictive model to identify high probability areas across this landscape that may harbor bat species. This model can be used to inform resource managers on areas with a high likelihood of features in areas not previously surveyed. This will help prioritize high potential bat-roost areas and streamline future survey efforts when management resources are limited.

INTRODUCTION

The United States (U.S.) Marine Corps, U.S Air Force and U.S. Army are responsible for the management and environmental compliance of the BMGR West, BMGR East and YPG respectively (Fig. 1). Continued and future activities on installations require the three branches of the Department of Defense (DoD) minimize operational impacts on any federal or state sensitive species, as declines in these species have a potential to prompt listing or delay de-listing under the Endangered Species Act (ESA). Determining the magnitude of use as well as temporal and spatial distribution of bat species on DoD lands will help develop more cost-effective solutions for wide-scale management and enhance or uphold military training exercises while maintaining unrestricted access to training and test areas.

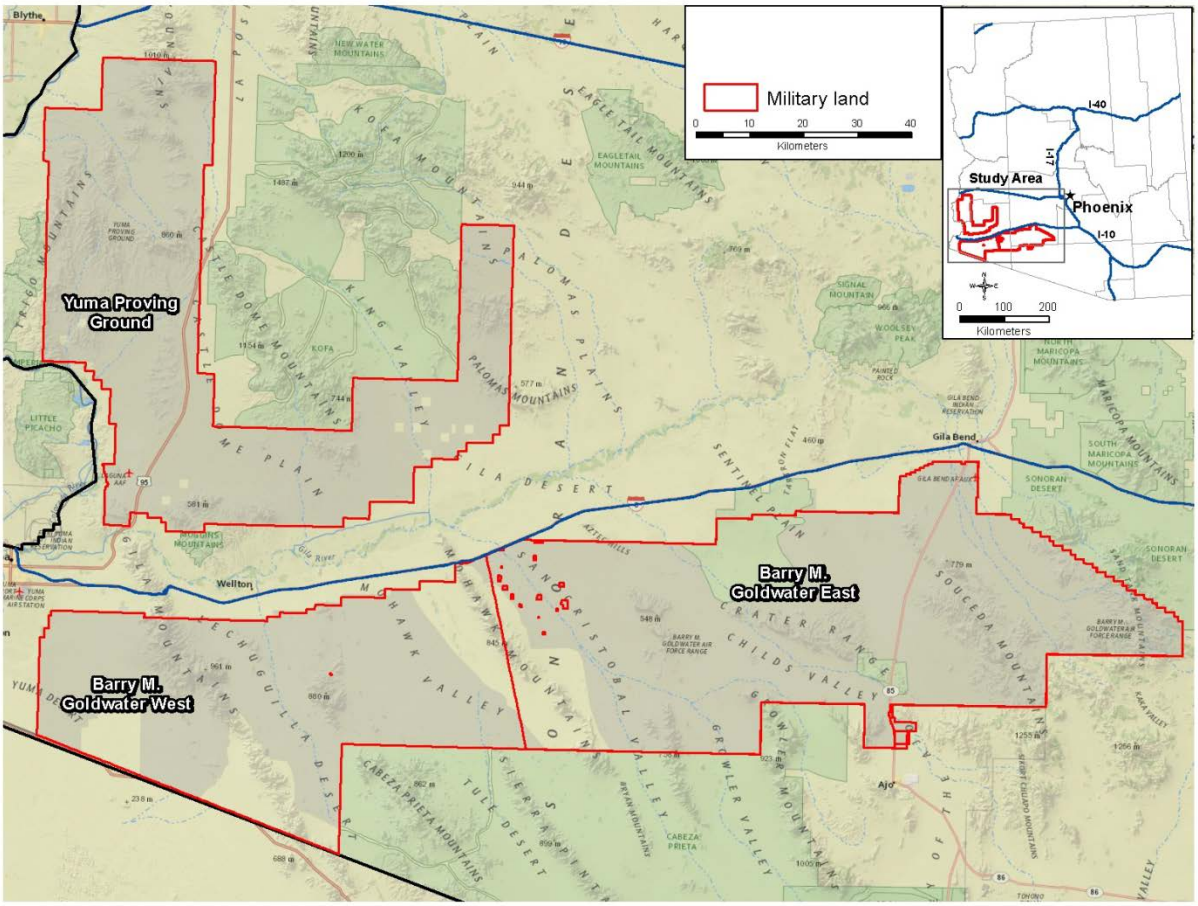


FIGURE 1. Study area of Yuma Proving Ground and Barry M. Goldwater Range East and West in southwestern Arizona 2014.

The importance of abandoned mines and caves for bats lies in their potential to provide a variety of roosting sites including maternity, hibernacula, day, night, and interim roosts (Sherwin et al. 2000). Maternity roosts provide a secure location for females to give birth and rear their young throughout the summer season (Humphrey 1975). Hibernacula provide a winter refuge for non-migratory bats (Johnson et al. 1998, Kuenzi et al. 1999, Raesly and Gates 1986). Day roosts are used by non-reproductive individuals of both sexes while night roosts are utilized by all bats,

regardless of reproductive status, as a place to rest and to digest their prey between foraging bouts (Lacki et al. 1994, Kerth et al. 2001). Night roosts are generally in different locations than day roosts and are used primarily at dawn and dusk (Anthony et al. 1981). Day roosts are substantial roosts that harbor bats during the daytime hours. Interim roosts are used in the spring before the young are born and again in the fall before retreating to the hibernation or winter roost (Dobkin et al. 1995, Twente 1955). Abandoned mines and natural caves may serve all of the above functions, thus accurate surveys of bat activity types are essential in identifying and preserving these bat roosts.

The Sikes Act provides that Integrated Natural Resource Management Plans (INRMPs) must support sustainable multipurpose public use of natural resources to the extent that such use is consistent with the use of military installations to ensure the preparedness of the Armed Forces. Military readiness includes mission activities utilizing caves and mines for training. Therefore, it is important to minimize the impact of these training activities on bat communities within these sites. There are many potential bat species of special concern listed by the Arizona Game and Fish Department (AZGFD) and the Department of the Interior. These species were the focus of a DoD Species at Risk assessment in Arizona and New Mexico as part of a DoD funded legacy project. Military activities on these installations have the potential to impact the federally listed lesser longed-nosed bat (*Leptonycteris curasoae*; Shull 1988). Military activities may additionally affect the pallid bat (*Antrozous pallidus*), California myotis (*Myotis californicus*), cave myotis (*Myotis velifer*), Yuma myotis (*Myotis yumanensis*), Mexican free-tailed bat (*Tadarida brasiliensis*), Townsend's big-eared bat (*Corynorhinus townsendii*) and California leaf-nosed bat (*Macrotus californicus*). The lesser long-nosed bat has been observed foraging on BMGR East and roosting in areas on adjacent federal lands (Lowery and Ingraldi 2006). We recognize that the first step in preventing any potential wildlife and military activity conflicts is to specifically identify where these conflicts may exist. These species roost colonially and depend on mines, caves and crevices to provide suitable habitat. While these species all utilize mines and caves, they prefer different habitat characteristics such as varying structure and climatic conditions within the feature.

The lesser long-nosed bat is seasonally present within southern Arizona from April through October. Plant communities distributed throughout the landscape that produce high-energy foods dictate the western range of their seasonal distribution within Arizona. Lesser long-nosed bats utilize chiropetphillic plants that provide erect light-colored flowers with strong floral odor, nocturnal pollen dehiscence and high protein with relatively low levels of nectar sugar concentrations (Slauson 1996; USFWS 1995). Columnar cacti represent this food resource, specifically saguaro (*Carnegia gigantean*) and organ pipe cactus (*Stenocereus thurberi*) within the BMGR East (Lowery and Ingraldi 2006). The known lesser long-nosed bat roosts within western Arizona are maternity roosts which provide the habitat requirements for parturition and neonate development. These maternity roosts can harbor 10,000 or more individuals. The distance of three known lesser long-nosed bat maternity roost sites are an average of 38 km (24 mi) south and east of the BMGR East management boundary (Sidner and Davis 1988). This distance is not beyond the abilities of the lesser long-nosed bat, as their foraging radius is on the magnitude of 50-100 km (31-62 mi) from utilized roosts USFWS (1994).

The pallid bat is a colonial species, roosting in small groups of 20 or more individuals in rock crevices and caves, mines, rock piles and tree cavities. They prefer areas with rock outcrops. In the Southwest, the pallid bat is among the most common bat species found at lower elevations. In Arizona they frequent desert scrub habitats, and are less often observed in forested oak and pine regions. Pallid bats have been observed at several locations on the YPG and the BMGR. Known roost sites occur on both BMGR West and BMGR East.

The California myotis is found throughout Arizona and feeds over desert scrub to the oak woodlands and along the edge of conifers. Roosts are located in rock crevices, hollow trees, under loose bark and in buildings. Caves and mines are used as hibernacula. The sexes are segregated throughout the summer but can be found roosting together in September and March. Females may form small maternity colonies during pregnancy, birth and lactation (Adams 2003). California myotis have been captured at several wildlife waters located on the BMGR East.

The canyon bat occurs throughout Arizona and is primarily associated with rocky canyons, cliffs and outcroppings to creosote bush flats. They prefer rock crevices as day roosts but will also roost under rocks, in burrows made by other animals, in mines, and in buildings. Colony sizes are small with the largest known colony housing only twelve individuals. The canyon bat is common throughout its range and has been documented on BMGR East, BMGR West and YPG.

The cave myotis is colonial and roosts in clusters, usually near the entrance of a cave or mine. This species is predominantly found in Sonoran desert scrub with creosote bush (*Larrea tridentata*), brittlebush (*Encelia farinosa*), paloverde (*Parkinsonia spp.*) and cacti, but sometimes up to pine-oak communities. Cave myotis roost in caves, tunnels, mine shafts, under bridges, and sometimes in buildings within a few miles of water. Although known from as far southwest as the Harquahala Mountains, Gila Bend, Organ Pipe Cactus National Monument and about 32 km (20 mi) north of Yuma near the Colorado River, it has not been recorded in the extreme southwestern part of the state (Hinman and Snow 2003). The cave myotis has been observed at only one location in the western section of YPG.

The Yuma myotis is a colonial species, hanging in closely grouped clumps. This species rarely roosts in caves or mine shafts, preferring to inhabit cliffs and rocky walls, buildings, and abandoned cliff swallow mud nests. The Yuma myotis has been found throughout most of Arizona, but not in the northeastern or southeastern corners of the state. This species is regularly found in Gila, Graham, La Paz, Maricopa, Mohave, Pinal, and Yuma Counties. It is found in juniper-pinyon associations, but is probably absent in higher, boreal areas. Its winter range is along the Lower Colorado River. The Yuma myotis has been observed at several locations on YPG, and in the Copper and Gila Mountains on BMGR West. Roost locations occur on both YPG and BMGR West.

The Mexican free-tailed bat is colonial and forms enormous maternity colonies. The largest of which is located near San Antonio, Texas in Bracken Cave and is estimated at twenty million adults (Adams 2003). The Mexican free-tailed bat has been found roosting in caves, mine tunnels, and crevices in bridges, parking garages, and buildings. Some of these roosts are used only in the spring and autumn by bats as transient or resting roosts on their annual migrations

north and south. The Mexican free-tailed bat is found throughout Arizona in the summer. In the winter, this species is found in fewer numbers and only in the southern half of the state. Associated plant communities include desert scrub and coniferous forest (Hinman and Snow 2003, AZGFD 2006). Despite being widely distributed in Arizona, Mexican free-tailed bats have been observed at only one location in the southwestern portion of YPG.

Townsend's big-eared bat is a colonial species and is widespread in Arizona, although it is not considered common anywhere. It is least common in northeastern grasslands and southwestern desert areas. In Arizona, summer day roosts are found in caves and mines from desert scrub up to oak woodlands, and oak/pine, pinyon/juniper, and coniferous forests. At day roosts, Townsend's big-eared bat may be suspected when guano is found in circular patches in open areas. Night roosts may often be in abandoned buildings. In winter, they hibernate in cold caves, lava tubes and mines mostly in uplands and mountains from the vicinity of the Grand Canyon to the southeastern part of the state. Winter roosts generally contain fewer individuals (usually singles or small groups and in Arizona occasionally as many as 50) than summer roosts. For hibernation they prefer roost sites with temperatures between 0°-12 °C (32°-54 °F respectively). These preferred sites may be located near entrances and in well-ventilated areas of the roost. The bats may arouse and move to other spots in the roost during the winter so as to be in areas of more stable cold temperatures. Males and females congregate separately in summer. Although the males are thought to be mostly solitary, the females form maternity colonies of 12 to about 200 individuals in the western United States. In Arizona, 5 to 7 maternity colonies have been found with numbers ranging from 100 to several hundreds. Despite being widely distributed, Arizona's Heritage Data Management System (HDMS) does not report any observations of Townsend's big-eared bat on YPG or BMGR.

California leaf-nosed bats are a colonial species and remain active year-round. This species may be suspected if the guano is found at the edges of open areas (*i.e.*, near the base of the sides or walls of a mine or other roost). They are not known to hibernate or migrate, though they may not occupy the same roost year round. They primarily roost in mines, caves, and rock shelters. Day roosts in mines are usually within about 24 m (79 ft) of the entrance. They prefer roost sites with large areas of ceiling and flying space. In colder parts of their range, during winter, they are found in mines where temperatures are well above external ambient temperatures. During this time they are found in roosts with temperatures near 27 ºC (75 ºF) and are usually found 30 m (98 ft) or more back from the entrance. California leaf-nosed bats commonly use night roosts in places that provide overhead protection and an adequate flight approach. Such places include a variety of manmade structures, rock shelters and mines. Nursery colonies are in roost sites with temperatures of about 32º-35 ºC (90º-95 ºF) and located near the entrance to the roost. Some nursery colony sites are occupied year round. During spring and summer, males roost separately then join the females in late summer and early autumn. Males and females are found together during the winter. In Arizona, California leaf-nosed bats are primarily found south of the Mogollon Plateau in Sonoran and Mohave desert scrub, and occasionally in Chihuahuan and Great Basin desert scrub. They are also known from southeastern and, in summer, extreme northwestern Mohave County. California leaf-nosed bats have been observed at several locations on YPG and BMGR with known roost sites identified.

Study Objectives
The objectives of this project are to:
1) Identify, map and describe potential bat roost structures (*e.g.*, caves and mines) and characteristics on throughout the BMGR and YPG;
2) Document bat species present within identified bat roosts during the breeding season; and,
3) Provide proposed management and population sampling recommendations that can be used to monitor sensitive bat species while maintaining military mission activities.

This project evolved through discussions among members of the Sonoran Desert Conservation Partnership Team (a joint DoD, State and Federal natural resource management agencies partnership) and those at the DoD southwest regional workshop. The Sonoran Conservation Partnership Team has recognized the need to protect current military readiness and provide increased flexibility to respond to new missions while minimizing any potential impacts to wildlife. For bats, this first step is to identify all potential roosting structures in order to provide effective recommendations to military personnel that will best minimize any negative impacts to natural resources.

METHODS

Study Area (*see* Fig. 1)
Diurnal bat roost surveys were conducted throughout the BMGR (encompassing BMGR East and BMGR West) and YPG in southwestern Arizona. Each range installation is divided into sections for aerial systems training, live – fire training and ground maneuvers. The ranges together cover approximately 12,690 km^2 (3,700 mi^2) of the Sonoran Desert's Lower Colorado River Subdivision. Steep mountain ranges are surrounded by expansive, sparsely vegetated valleys and wide, shallow washes. The elevation ranges from approximately 61-1,125 m (200-3,700 ft). Average rainfall is often less than 8 cm (3.15 in) and summer temperatures can exceed 44°C (111°F). Dominant vegetation includes creosotebush, white bursage (*Ambrosia dumosa*), palo verde, mesquite (*Prosopis* spp.), ironwood (*Olneya tesota*) and various cactus species. Survey efforts were focused within the Mohawk and Granite Mountains, Crater Range and White Hills on BMGR East; Mohawk, Gila, Copper and Tinajas Altas Mountains and the Wellton Hills on BMGR West; the Trigo, Tank and Muggins Mountains on YPG.

Barry M. Goldwater Range – BMGR East and BMGR West
The BMGR is located in southwestern Arizona in portions of Yuma, Maricopa, and Pima counties. BMGR West is located entirely in Yuma County; portions of BMGR East are located in each of the three counties. Of the BMGR's 7,017 km^2 (1,733,921 ac), about 60 percent is in BMGR East and about 40 percent is in BMGR West. The range is about 214km (133 mi) across on its longest, east-west axis. The BMGR's north-south axes vary in width; at the western end, the north-south axis is about 24 km (15 mi) wide, is generally 29 to 45 km (18 to 28 mi) wide through much of the length of the range, and then narrows to about 6 km (4 mi) at its eastern end. (BMGR INRMP 2012). The Range is bounded to the south by Mexico and Cabeza Prieta National Wildlife Refuge, to the north by Interstate 8 and a mix of private and public properties, and to the east by the Tohono O'odham Nation and Bureau of Land Management lands. Elevations range from below 61 m (200 ft) on western portions of the range to 1,128 m (3,700 ft) in the Sand Tank Mountains (BMGR INRMP 2012). Temperatures on BMGR can range rarely

from below 0 °C (32 °F) to 49 °C (120 °F), with a range-wide average annual rainfall of approximately 5 in [12.7 cm (BMGR INRMP 2012)]. The Lower Colorado River Subdivision of the Sonoran Desert is the predominating vegetative community and is characterized by extremely drought-tolerant plant species such as creosote bush, bursage (*Ambrosia spp.*), paloverde (*Parkinsonia spp*.) and cacti (*e.g.*, chollas [*Cylindropuntia spp*]. and saguaros [*Carnegiea gigantean*]) (Brown 1994, Marshall et al. 2000). The broad, flat and sparsely vegetated desert plains of BMGR are dissected by numerous incised washes that harbor ironwood, smoketree (*Psorothamnus spinosa*), acacia (*Acacia greggii*), mesquite, ocotillo (*Fouquieria splendens*) and numerous shrub species.

Yuma Proving Ground - YPG

YPG lies within La Paz and Yuma counties near Yuma, Arizona and totals approximately 3,450 km² (852,514 ac) (Fig. 1). Kofa National Wildlife Refuge is adjacent to YPG for 93 km (58 mi; U.S. Army Garrison Yuma Proving Grounds 2012). Lower Colorado River subdivision of the Sonoran Desert is the predominating vegetative community within YPG (Fig. 2). This vegetative community is the largest and most arid component within the Sonoran Desert and characterized by extremely drought-tolerant plant species such as creosote bush, bursage, palo verde and cacti (*e.g*., paddle cacti [*Opuntia spp.*] and saguaro) (Brown 1994, Olson and Dinerstein 2002). The broad, flat and sparsely vegetated desert plains of YPG are dissected by numerous incised washes that harbor ironwood, smoketree, acacia, mesquite and numerous shrub species. More elevated hills and mountain slopes contain vegetation consisting of Arizona Upland Subdivision of the Sonoran Desert with beargrass, cacti and agave species. The range of elevation is between sea level to 878 m (2,881 ft; U.S. Army Garrison Yuma Proving Grounds 2012). The average temperatures on YPG are between 16 °C [61 °F (December)] and 30 °C [86 °F (July)] (Atmospheric Sciences Laboratory, YPG Central Meteorological Observatory), with average annual rainfall of approximately 8.8 cm (3.46 in; U.S. Army Garrison Yuma Proving Grounds 2012).

Sampling Framework

In order to systematically survey this study area (Fig. 1), we developed a Geographic Information System (GIS) based modeling framework to collect, record, and prepare data to identify potential feature and bat roost locations throughout the study area. We structured the framework around known features (n = 144) within this landscape (Lowery et al. 2012; Dalton and Dalton 1994). We imported the geographic coordinates of these features into ArcGIS (version 10.1; Environmental Systems Research Institute, Redlands, California, USA) and related them to datasets describing terrain and landform characteristics (e.g., landform, vegetation, and geological formation; Table 1). We calculated descriptive statistics for terrain (including *mean*, *variance*, *standard deviation* and *standard deviation range*) as they related to each feature and identified which covariates contributed to the likelihood of a feature and or bat presence. We tested several regression models using the R statistical software program (version 2.15.1; R Development Core Team 2012) from these data using Generalized Linear Models (GLM) to determine the best-fit model using the Chi-squared statistic. These results contributed to a weighted probability dataset from which to systematically sample across our study area described in Fig. 2 (for more information see Technical Analysis; Piorkowski et al. 2014)

TABLE 1. Datasets related to feature and bat roost locations on military lands in southwestern Arizona, 2014.

DATASET	DATA TYPE	DESCRIPTION
Terrain	Elevation, Slope, Aspect	Elevation, slope, aspect 30 meter raster data layers; (USGS NGAP 2004)
Landform	Categorical	USGS Southwest ReGAP (Prior-Magee et al. 2007)
Vegetation	Categorical	USGS Southwest ReGAP (Prior-Magee et al. 2007)
Geological Formation	Categorical	Arizona Geological Survey Geological Characteristics dataset

Additional landform, vegetation and geological formation covariates were reclassified and combined in a weighted overlay (based on bat presence at a given feature) across the study area. Each covariate's influential weight was normalized and weighted by each given proportion. We then calculated zonal mean values (Spatial Analyst extension; "zonal statistics") at a 1-km resolution using each of the 30-m pixels contained within each 1-km grid cell. The mean values were recalculated (Spatial Analyst extension; "raster calculator") to create a new raster dataset reflecting mean probabilities between 0 and 1 (actual probability range: 0.008 to 0.945) of likely feature locations (Fig. 2). Sandy washes creosote flats, and developed areas that do not support features and were excluded (< 0.008 probability) from sampling efforts.

We used the resulting raster dataset as a weighted matrix and identified 1,000 spatially balanced points (Geostatistical Analyst Extension; "Create Spatially Balanced Point"), that identified 1-km grid cells for field surveys (hereafter survey plots). In essence, survey plots are evenly distributed across the landscape but weighted by the probability of a feature to be identified (Fig. 3). We selected the first 401 grid cells in selection order for field surveys to maintain the sampling design's spatial balance. By using this methodology we can assess the model's prediction power through validation.

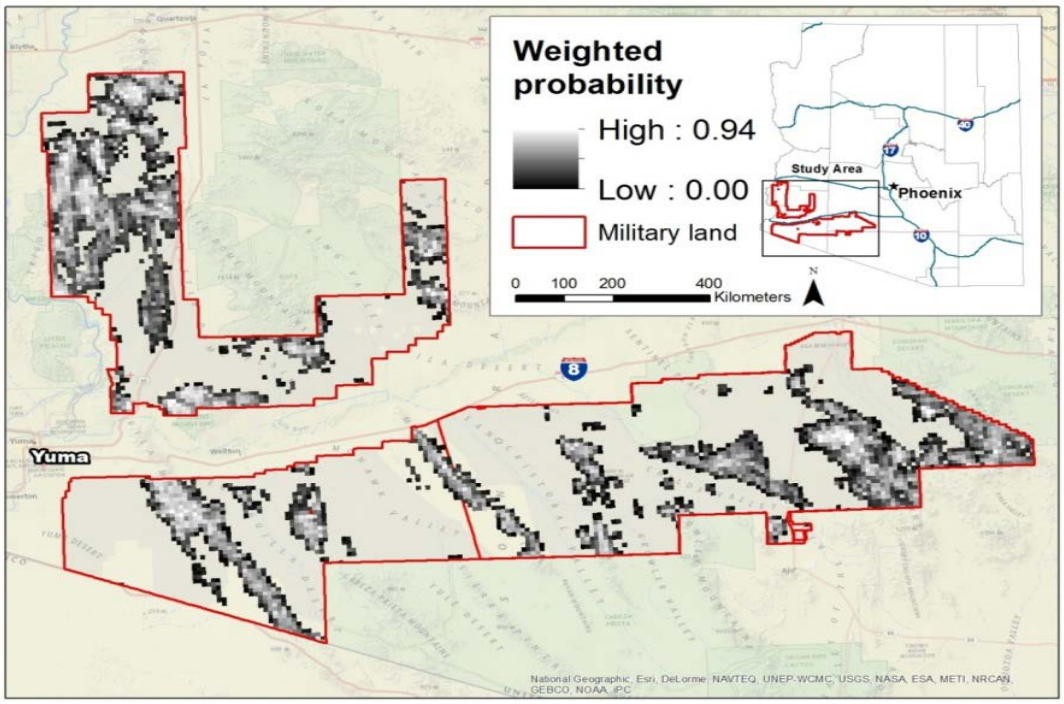


FIGURE 2. Mean weighted model based on probability of mine or cave locations on a 1-km grid-scale, 2014.

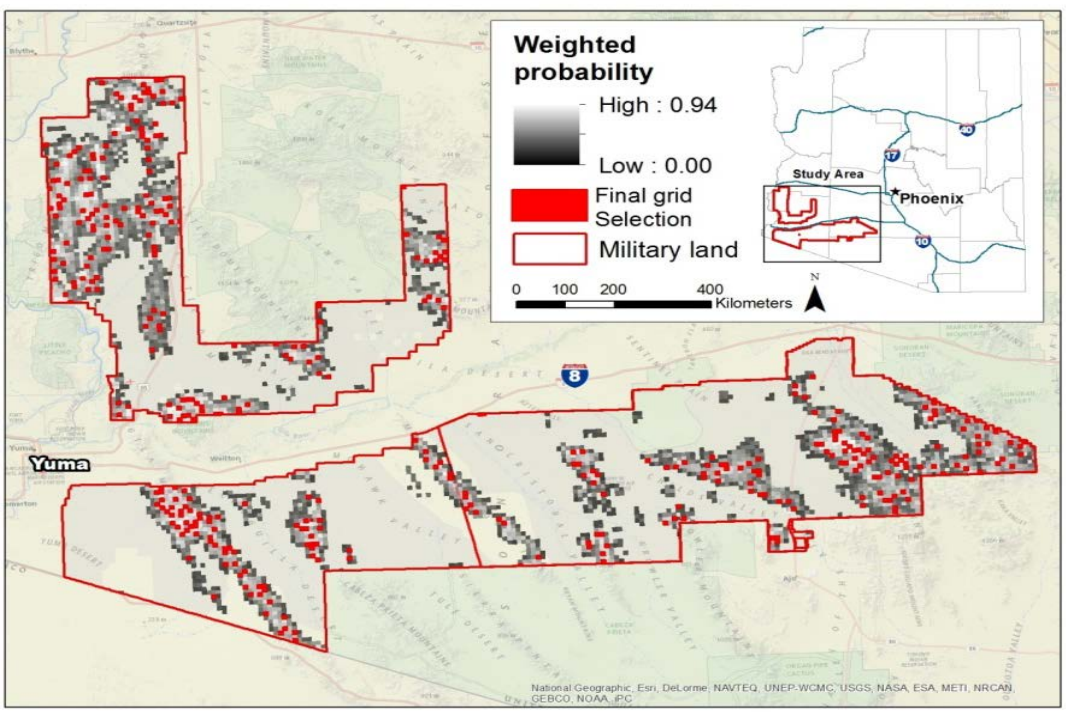


FIGURE 3. Sampling framework of 1km^2 survey plots (n =401; red) across military lands in southwestern Arizona based on a spatially-balanced sampling design with weighted input, 2014.

Field Surveys
To conduct a survey, plot centroids' were marked and distances of 500 m (1,640 ft) in each cardinal direction (*i.e.*, North, South, East and West) determined the outer boundaries of the survey. This allowed delineation of a 1 km^2 survey plot on the ground. A preliminary scan of the site by a group of 2-3 surveyors was completed using 10 X 42 mm Vortex™ binoculars to determine if obvious features existed (in a few cases the topography was such that there were no features on the site and further investigation was not needed). Once the preliminary scan was completed, transects surveys were conducted and any potential features within the plot that may harbor roosting structure for bats were recorded with a Global Positioning Unit (GPS). At each plot we completed a "plot survey form" regardless of whether or not any features were discovered. If a feature was identified on the plot, we completed a separate feature section for each identified feature in the plot. Upon finding a potential feature within a survey plot we classified each as a cave (i.e., natural formation), mine (i.e., anthropogenic formation) or crevice (i.e., natural formation). In addition, each feature was subsequently described as an adit (horizontal opening) or shaft (vertical opening) and the following measurements were recorded: GPS location, portal/collar temperature, internal temperature, portal height and width, and length/depth, bat presence/absence, bat guano present/absent in high, medium or low quantities, general description and photo number(s). Upon completion of data collection, any markers (flagging) used to visualize the plot were removed and the area was left in the same condition as it was found. Then we would relocate to the next plot centroid and resume the same methodology as described above.

Revisit Surveys
During the field season, we revisited sites that were difficult to fully assess potential bat features. In early 2014, we identified features to revisit. These features were selected for a revisit for one of three reasons: 1) potentially high use, 2) inconclusive evidence of potential bat species utilizing the feature, and 3) document the roost type (*e.g.*, day, night, maternity, etc.). Revisits were completed using the previously identified coordinate of the feature location and two observers. At least one observer was skilled at species identification of guano while the second observer assisted in precise data collection/measurements and more detailed description of the feature than previously collected.

Predictive Model – Potential likelihood of bat features across the study area
We combined feature detections from the field validation, historic feature use and bat roost observations to develop a model that identifies the likelihood of bat roosts in areas not sampled. The initial sampling grid dataset (Fig. 2) was included as a refinement mask for model consistency. We imported known feature locations and bat roosts from the field surveys along with historic survey efforts (Lowery and Ingraldi 2006; Dames and Moore 1996; Dalton and Dalton 1994) and spatially joined them to the sample grid dataset. The resulting grid data set was then related to a list of variables describing terrain and physical habitat variables along with categories of remotely sensed climate data (Table 2). We modeled derivatives of elevation, including aspect, hillshade, and slope using the spatial analyst extension in ArcGIS and likewise included in our descriptive variables (Gesch et al. 2002). We summarized and spatially joined continuous datasets with zonal statistics (*i.e.*, minimum, mean, and maximum values) describing

each grid cell using Geospatial Modeling Environment (GME, version 0.7.2.0 RC2; isectpolyrst). Categorical datasets were also summarized with GME (isectpolyrstr), describing the total area of each class. We summarized a roads and perennial water layer dataset (Tiger Products 2013; ASLD 1993), describing the total length in each grid cell. The resulting comprehensive dataset was exported as a table for analysis.

TABLE 2. Spatial covariates used for bat roost feature likelihood predictive model across Barry M. Goldwater Range and Yuma Proving Ground.

Name	Resolution/Type	Description/Units	Source
Elevation	30m	meters	Landfire (LANDFIRE 2007)
Hillshade	30m		Elevation derivative
Aspect	30m	minimum, mean, and maximum	Elevation derivative
Slope	30m		Elevation derivative
Landcover	30m	Southwest reGAP	Landfire
Landform	30m	Southwest reGAP	Landfire
Road distance	30m	Tiger roads	US Census Bureau, (Tiger Products 2013)
Stream distance	30m	Euclidian distance	Arizona State Land Department
Stream length	Vector data	Combined length of perennial washes	Calculated: GME
Disturbance distance	30m	Distance from nearest military training site	Department of Defense
Average temperature across plot	1000m	Minimum, mean, and maximum	WorldClim
Isothermality	1000m	Minimum, mean, and maximum	WorldClim
Terrain ruggedness	30m	Vector ruggedness measure: minimum, mean, and maximum	Calculated: Sappington et al. 2007
Rock type	Vector data		Arizona State Land Department
Soil type	Vector data	Soil association	Arizona State Land Department
Annual Precipitation	1000m	Minimum, mean, and maximum	WorldClim

Using the Statistical Analysis Software version 5.0 (SAS Institute, Cary, North Carolina), we ran logistic regression analyses with a best-fit model parameter (Hosmer and Lemeshow 2000) and to determined which covariates contributed to the likelihood of a feature and/or bat roost. Prior to analysis, we examined the dataset for collinearity and removed variables that demonstrated ≥0.5 correlations with others. We ranked the resulting models by Akaike's Information Criterion (AIC; Hosmer and Lemeshow 1989) and selected the top ranking model. For graphical

interpretation, we imported the model into ArcGIS where we transformed the resulting logit function to the natural log of odds (probability) using raster math [ArcGIS (Spatial Analyst Extension; Map Algebra)]. Spatial resolution reflecting the most appropriate fit for use during analysis was selected as each covariate was converted to a 30-m pixel dataset (Fisher and Tate 2006). Using the Jenks optimization method (Jenks 1967), we defined the color ramp.

RESULTS

We completed 83 spatially balanced 1 km^2 survey plots for field validation of feature and/or bat roost presence. These survey plots were visited between 7 December 2012 and 19 February 2013. By combining the first year's data (Legacy 10-143), we identified 153 features containing evidence of bat use (Fig. 4). We intensively revisited 46 of these features during the Spring of 2014 to determine the level of use and identify specific species utilizing these roosts with experts knowledgeable in both guano and visual identification.

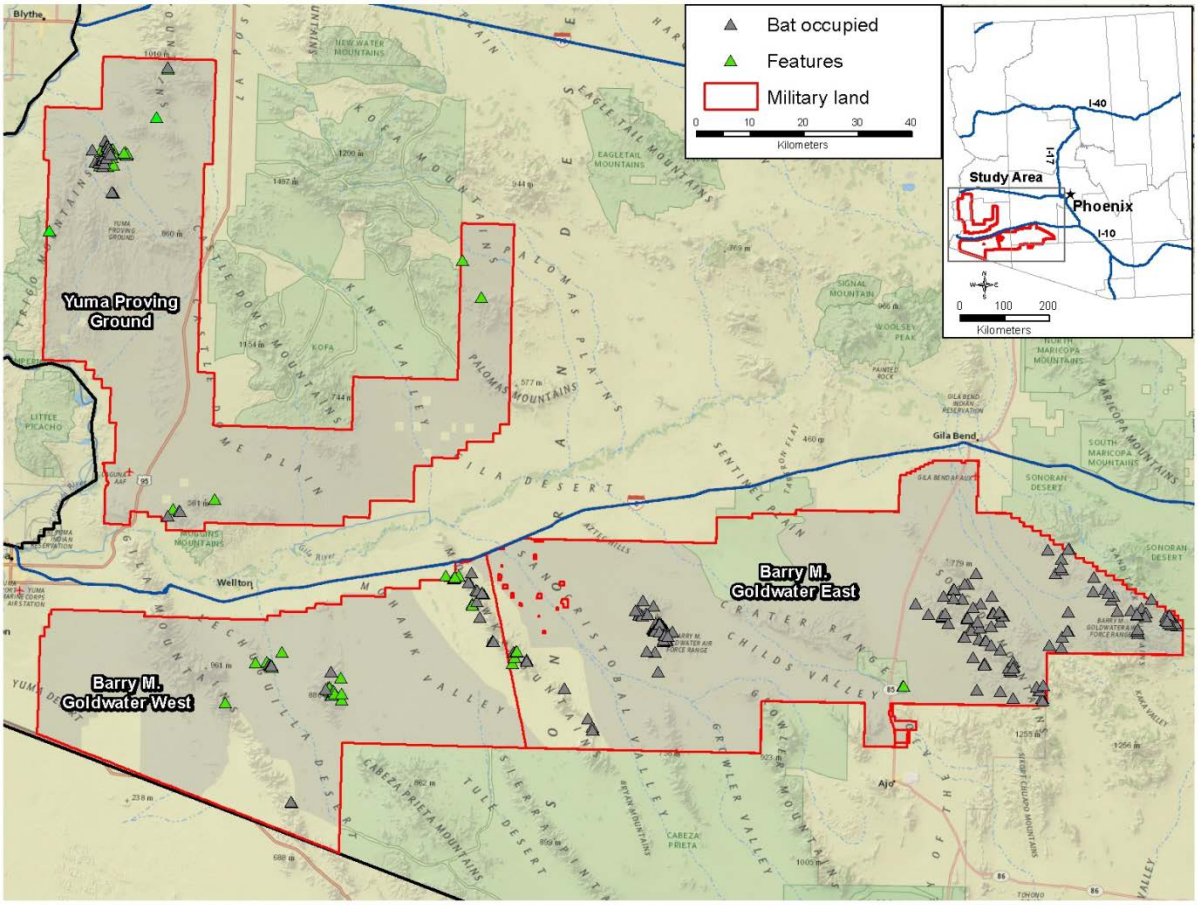


FIGURE 4. Locations of features (green triangles) and bat occupied features (gray triangles) across our study area from 2010-2014.

We identified the features listed in Table 3 while conducting surveys for this project. The only species we positively observed during surveys were California leaf-nosed bats, although guano evidence for Myotis spp. and Townsend's big-eared bat were also detected in several features.

We also detected three bats using a rock crevice that could not be positively identified due to the nature of the structure. These bats were most likely a Myotis spp. or big brown bats (*Eptesicus fuscus*). We detected a total of 153 features with evidence of bat use throughout the length of the project with 46 revisits at potential bat roost features during the 2014 field season. We located six features being utilized as a day roost for California leaf-nosed bats and rock crevices being utilized as a day roost for either a Myotis spp. or big brown bats. Several features showed high intensity use (day and night roost) based on guano and culled arthropod evidence.

TABLE 3. Survey results for features with bat evidence detected between 2010 and 2014 across Barry M. Goldwater Range and Yuma Proving Ground. Detailed descriptions of location and survey summaries follow this table.

Site Name	Depth (m)	Arthropod Parts	Guano Observed	Species (Individuals Observed)[a]	Feature Type[b]	Roost Type[c]
Mohawk 1	33+	X	Moderate	N	M	Night
Mohawk 2	88	X	Moderate	MACA (12)	M	Day
Mohawk 3	55+		Moderate	N	M	Day
Mohawk 4	9		Low	N	M	
Mohawk 5	33		Low	N	M	
Mohawk 6	5		Low	N	M	
Mohawk 7	6		Low	N	M	
Mohawk 8	30		Low	N	M	
Mohawk 9	18	X	Moderate	N	M	Night
Mohawk 10	10		Low	N	M	
Mohawk 11	135		Moderate	N	M	Day
Mohawk 12	Unk		Moderate	N	M	Gated
Mohawk 13	Unk		Low	N	M	Gated
Mohawk 14	10		Low	N	M	
Mohawk 15	1		Low	N	M	
Mohawk 16	12		Low	N	M	
Mohawk 17	10		Low	N	M	
Mohawk 18	Unk		Moderate	N	M	Gated
Mohawk 19	15		Low	N	M	
Mohawk 20	3		Low	N	M	
Mohawk 21	4		Low	N	Ca	
Mohawk 22	2		Moderate	N	Ca	
Mohawk 23	2		Low	N	Ca	
Mohawk 24	1.5		Low	N	Ca	
Mohawk 25	3		Low	N	Ca	
Mohawk 26	2		Low	N	Cr	
Mohawk 27	4		Low	N	Ca	
Mohawk 28	6.1		Moderate	N	Ca	

Site Name	Depth (m)	Arthropod Parts	Guano Observed	Species (Individuals Observed)[a]	Feature Type[b]	Roost Type[c]
Mohawk 29	5		Low	N	Ca	
Mohawk 30	18		Low	N	M	
Mohawk 31	3		Moderate	N	Ca	
Mohawk 32	93+	X	High	MACA (20 and 50+)	M	Day/Night
Mohawk 33	11.4	X	High	MACA (1 dead)	M	Night
Mohawk 34	5		Low	N	Ca	
Mohawk 35	5.8	X	Moderate	MACA (2)	Ca	Day/Night
Mohawk 36	~14	X	High (MACA)	N	M	Night
Mohawk 37	5		Low	N	Ca	
Mohawk 38	10		Low	N	Cr	
Mohawk 39	5.3	X	Moderate (MACA)	N	Ca	Night
Mohawk 40	5		Low	N	Cr	
Mohawk 41	10		Moderate	N	Ca	
Mohawk 42	15		Low	N	Ca	
Mohawk 43	20		Moderate	N	Ca	
Mohawk 44	3.7	X	Low	N	Ca	Night
Mohawk 45	25	X	Moderate (MACA and COTO)	MACA (30 and 30)	M	Day/Night
Mohawk 46	160	X	Moderate	MACA (40+ and 1)	M	Day/Night
Mohawk 47	3.7	X	Moderate (MACA)	N	M	Night
Crater Range 1	5		Low	N	Cr	
Crater Range 2	1.5		Low	N	Cr	
Tank 1	3		Low	N	Ca	
Tank 2	10		Moderate	N	Ca	
Trigo 1	1.4		Low	N	Ca	
Trigo 2	2.5	X	Moderate	N	Ca	Night
Trigo 3	0.7		Low	N	Ca	
Trigo 4	1.4		None	N	Ca	
Trigo 5	2.5		Low	N	Ca	
Trigo 6	1		Low	N	Ca	
Trigo 7	25		Low	N	Ca	

Site Name	Depth (m)	Arthropod Parts	Guano Observed	Species (Individuals Observed)[a]	Feature Type[b]	Roost Type[c]
Trigo 8	1.8		Low	N	Ca	
Trigo 9	1.5		Low	N	Cr	
Trigo 10	2		Low	N	Ca	
Trigo 11	2		Low	N	Ca	
Trigo 12	3.2		Low (Myotis spp.)	N	Ca	
Trigo 13	2		None	N	Ca	
Trigo 14	3		Moderate	N	Cr	
Trigo 15	1.5		Low	N	Ca	
Trigo 16	3		Low	N	Ca	
Trigo 17	3.5		None	N	Cr	
Trigo 18	1.1		Low	N	Ca	
Trigo 19	1.6		Low	N	Ca	
Trigo 20	6.3	X	Moderate (MACA)	N	Ca	Night
Trigo 21	2.7		Low	N	M	
Trigo 22	3		Moderate	Unknown, Myotis spp. or Big Brown (3)	Ca	Day
Trigo 23	1.3		None	N	Ca	
Trigo 24	3		Low	N	Ca	
Trigo 25	2		Low	N	Ca	
Trigo 26	2		Low	N	Cr	
Trigo 27	4		Low	N	Cr	
Trigo 28	3		Low	N	Ca	
Trigo 29	1.3		Low	N	Ca	
Trigo 30	1.5		Low	N	Cr	
Trigo 31	1.2		None	N	Ca	
Trigo 32	2.6		Low	N	Ca	
Trigo 33	2.3		None	N	Ca	
Trigo 34	3.5	X	Low	N	Ca	Night
Trigo 35	2		Low	N	Ca	
Trigo 36	6		Moderate	N	Ca	
Trigo 37	2		Low	N	Cr	
Trigo 38	6		Low	N	Ca	
Trigo 39	0.2	X	Low	N	Cr	Night
Trigo 40	0.3		Low	N	Cr	
Trigo 41	1		None	N	Ca	
Trigo 42	2.1		None	N	Ca	

Site Name	Depth (m)	Arthropod Parts	Guano Observed	Species (Individuals Observed)[a]	Feature Type[b]	Roost Type[c]
Trigo 43	1	X	Low	N	Ca	Night
Trigo 44	1.5	X	Low	N	Ca	Night
Trigo 45	2		Low	N	Cr	
Trigo 46	2		Low	N	Ca	
Trigo 47	1.3		Low	N	Ca	
Trigo 48	10		Low	N	Ca	
Trigo 49	0.7		Low	N	Ca	
Trigo 50	10		Moderate	N	Cr	
Trigo 51	1		Low	N	Ca	
Trigo 52	2		Low	N	Ca	
Trigo 53	2.8		Low	N	Ca	
Trigo 54	2		Low	N	Ca	
Trigo 55	0.6		Low	N	Ca	
Trigo 56	1.7		Low	N	Ca	
Trigo 57	1		Low	N	Ca	
Trigo 58	1		Low	N	Ca	
Trigo 59	1		Low	N	Ca	
Trigo 60	2	X	Low	N	Ca	Night
Trigo 61	1.3		Low	N	Ca	
Trigo 62	2	X	Low	N	Ca	Night
Trigo 63	2		Low	N	Ca	
Trigo 64	3.4		None	N	Ca	
Trigo 65	2		Moderate	N	Ca	
Trigo 66	2		Low	N	Ca	
Trigo 67	0.5		Moderate	N	Ca	
Trigo 68	2.5		Low	N	Ca	
Trigo 69	2		Low	N	Cr	
Trigo 70	3		Low	N	Ca	
Trigo 71	3		Low	N	Ca	
Trigo 72	1.5		Low	N	Ca	
Trigo 73	2.5		Low	N	Ca	
Trigo 74	5		Moderate	N	Cr	
Trigo 75	2		Low	N	Ca	
Trigo 76	2.6		Low	N	Ca	
Trigo 77	1		Low	N	Ca	
Trigo 78	1		Low	N	Ca	
Trigo 79	1.6		Low	N	Ca	
Trigo 80	4.5	X	Low (MACA)	N	M	Night

Site Name	Depth (m)	Arthropod Parts	Guano Observed	Species (Individuals Observed)[a]	Feature Type[b]	Roost Type[c]
Trigo 81	2.5		Low	N	Ca	
Trigo 82	6.8		Low	N	Ca	
Muggins 1	4	X	Low (MACA)	N	M	Night
Muggins 2	3		Low	N	Ca	
Muggins 3	4	X	Low (Myotis spp.)	N	Ca	Night
Muggins 4	20	X	High	MACA (2 and 20)	M	Day/Night
Muggins 5	3		Low	N	Ca	
Gila 1	3		Low	N	Ca	
Tinajas 1	23		Moderate	N	Ca	
Wellton 1	Unk		Low	N	M	Gated
Wellton 2	15		Low	N	M	
Wellton 3	42	X	Moderate (MACA)	N	M	Night
Wellton 4	18	X	Low (MACA)	N	M	Night
Wellton 5	13	X	Moderate	N	M	Night
Wellton 6	17	X	Moderate	N	M	Night
Wellton 7	7.5	X	Low	N	M	Night
Wellton 8	14	X	Moderate	N	M	Night
Wellton 9	30		Low	N	M	
Wellton 10	30		Moderate	N	M	
Wellton 11	30	X	Moderate	N	M	Night
Wellton 12	17	X	Moderate	N	M	Night
Wellton 13	23	X	Moderate	N	M	Night

[a] Species abbreviations include MACA (*Macrotus californicus;* California leaf-nosed bat) COTO (*Corynorhinus townsendii;* Townsend's big-eared bat).

[b] Feature type abbreviations include Ca (Cave), Cr (Crevice) and M (Mine). Caves and crevices are natural formations while mines are anthropogenic formations.

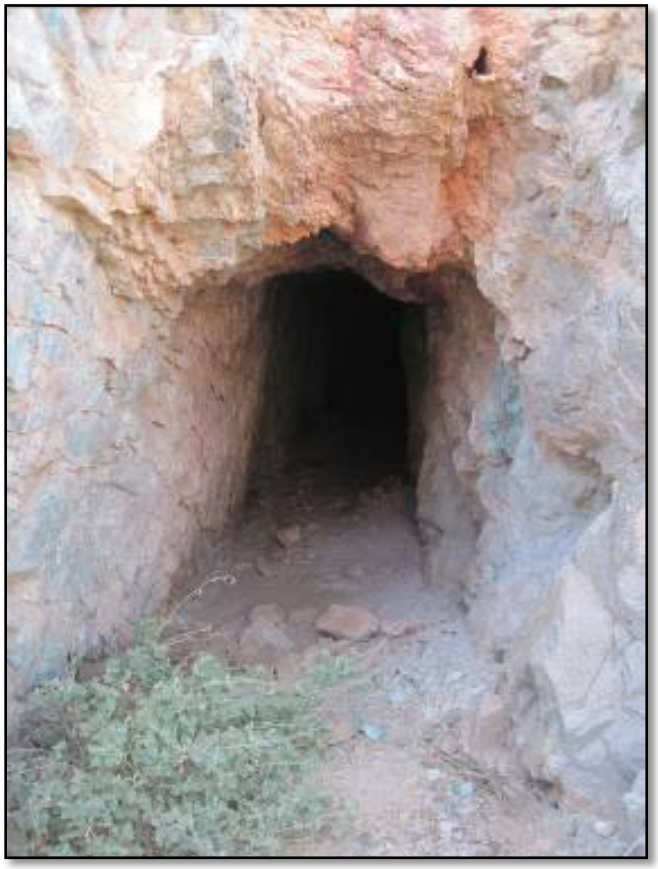
[c] Roost type consists of most probably description of the roost when bat evidence is present. "Gated" designates those features with exclusions designed to deter human disturbance within the feature (see Wellton 1 for an example).

Bat Feature Identification and Descriptions (all measurements are in metric units)

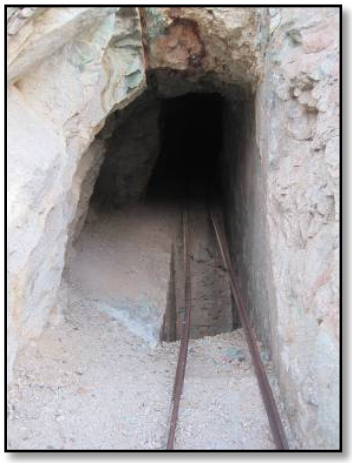
Definitions: These definitions can be applied to both caves and mine features on the landscape.
adit – an entrance to an underground mine that is horizontal or nearly horizontal.
shaft – long, narrow, vertical hole into an underground mine.
winze – an opening in an underground mine that is sunk downwards.

Roost Site: Mohawk 1 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 218583 mE, 3600730 mN
Dates Observed: 1/25/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: Guano, no bats observed
Many scattered pieces of guano throughout mine feature. Feature is a 25 m adit with 15 m winze at rear of feature.

Revisit: 2/7/2014
Observers: N. Foley and E. Scobie
Evidence: Air flow detected. Mine is most likely connected to Mohawk 2. Part of Betty Lee Mine Complex. No bats observed but moderate amount of guano and moth wings are present suggesting this feature is at least utilized as a night roost. This feature is a popular spot for recreationist with a lot of human traffic observed. This adit is a candidate for a future gate to protect bat populations and ensure human safety.



Roost Site: Mohawk 2 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 218648 mE, 3600693 mN
Dates Observed: 1/25/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: scattered guano
Located mine adit with winze at entrance, unable to search entire feature.

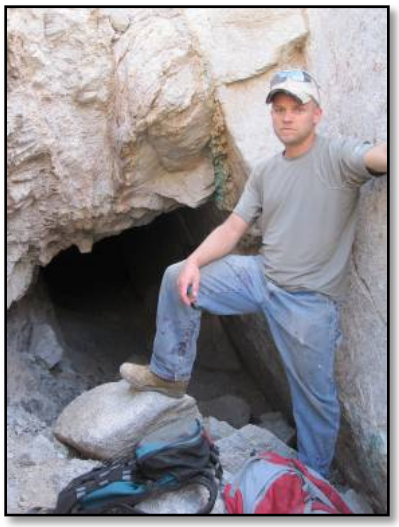


Revisit: 2/7/2014
Observers: N. Foley and E Scobie
Evidence: This feature is a part of the Betty Lee Mine complex. Twelve California leaf-nosed bats were observed utilizing this mine as a day roost. Guano and moth wings observed within feature. This feature is a popular spot for recreationist with a lot of human traffic observed (Group of 8 people visited this mine immediately before internal survey was conducted). This adit is a candidate for a future gate to protect bat populations and ensure human safety. Winze with unsupported rail track crossing can be seen in picture below.

Roost Site: Mohawk 3 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 218651mE, 3600672 mN
Dates Observed: 1/17/2011
Observers: C. Bertrand
Feature Type; Mine
Evidence: Scattered guano, no bats observed
Mine adit approximately 100 m deep with scattered guano.

Revisit: 2/7/2014
Observers: N. Foley and E. Scobie
Evidence: Internal survey conducted to 18 m deep with scattered guano detected. A winze at 18 m prohibits a complete survey of the entire feature which is measured to at least 55 m in depth. The feature may go deeper as it appears a slight bend in the tunnel prohibits a full measurement. This feature is most likely connected to Mohawk 1. Guano detected within this feature. This feature is a popular spot for recreationist with a lot of human traffic observed. This adit is a candidate for a future gate to protect bat populations and ensure human safety.

Roost Site: Mohawk 4 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 219054 mE, 3600960 mN
Dates Observed: 1/25/2011
Observers: W. Carroll
Feature Type: Mine
Evidence: scattered guano
Mine adit approximately 9 m deep with scattered guano, NW facing.



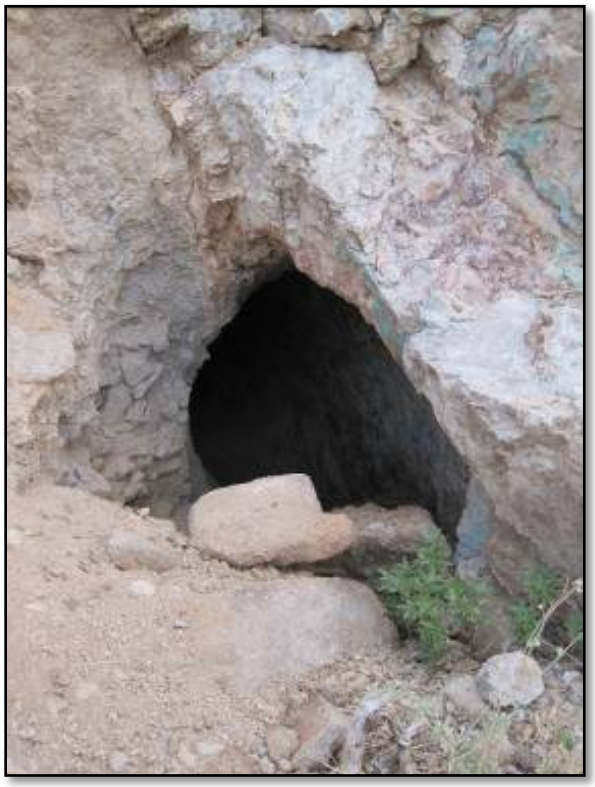
Roost Site: Mohawk 5 BMGRW

Quad: Mohawk SW
UTMs (WGS 84): 219157 mE, 3600401 mN
Dates Observed: 1/27/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: scattered guano
Mine approximately 33 m deep with scattered guano, SE facing.
No photo

Roost Site: Mohawk 6 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 219270 mE, 3600655 mN
Dates Observed: 1/25/2011
Observers: W. Carroll
Feature Type: Mine
Evidence: scattered guano
Mine adit approximately 5 m deep with scattered guano, N facing.
No photo

Roost Site: Mohawk 7 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 219275 mE, 3601107 mN
Dates Observed: 1/25/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: scattered guano
Mine approximately 6 m deep with scattered guano, SE facing.
No photo

Roost Site: Mohawk 8 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 219319 mE, 3600883 mN
Dates Observed: 1/25/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: scattered guano
Mine adit approximately 30 m deep with scattered guano, NW facing.



Roost Site: Mohawk 9 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 219549 mE, 3603914 mN
Dates Observed: 1/17/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: piled guano, insect parts
Mine adit splits into 3 separate drifts at approximately 12 m; 3 piles of guano, SW facing.

Revisit: 2/13/2014
Observers: N. Foley and E. Scobie
Evidence: Mine contains 18 m of total drift. No bats observed. A moderate amount of guano with moth and beetle wings observed suggesting this is most likely a night roost.

Roost Site: Mohawk 10 BMGRW
Quad: Buck Peak
UTMs (WGS 84): 219561 mE, 3599558 mN
Dates Observed: 1/26/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: scattered guano
Mine adit approximately 10 m deep with 3 drifts and 1 shaft; scattered guano, SE facing.
No photo

Roost Site: Mohawk 11 BMGRW

Quad: Buck Peak
UTMs (WGS 84): 219653 mE, 3599579 mN
Dates Observed: 1/26/2011
Observers: Unknown
Feature Type: Mine
Evidence: piled guano
Mine adit approximately 135 m deep with 15 piles of guano, NE facing. Shaft at back of feature at least 20 m deep, 3 drifts.

Roost Site: Mohawk 12 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 220006 mE, 3600393 mN
Dates Observed: 1/27/2011
Observers: W. Carroll
Feature Type: Mine
Evidence: piled guano
Mine shaft, gated; depth unknown; 5 piles of guano, S facing.
No photo

Roost Site: Mohawk 13 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 220021 mE, 3600436 mN
Dates Observed: 1/27/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: scattered guano
Mine, gated; depth unknown; scattered guano, SE facing.
No photo

Roost Site: Mohawk 14 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 220074 mE, 3600154 mN
Dates Observed: 1/27/2011
Observers: W. Carroll
Feature Type: Mine
Evidence: scattered guano
Mine adit approximately 10 m deep with scattered guano, SE facing.
No photo

Roost Site: Mohawk 15 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 220134 mE, 3600258 mN
Dates Observed: 1/27/2011
Observers: W. Carroll
Feature Type: Mine
Evidence: scattered guano
Mine adit approximately 1 m deep with scattered guano, NE facing.
No photo

Roost Site: Mohawk 16 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 220290 mE, 3599837 mN
Dates Observed: 1/26/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: scattered guano
Mine adit approximately 12 m deep with scattered guano, NW facing. Adjacent to Betty Lee Tank.

Roost Site: Mohawk 17 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 221345 mE, 3602749 mN
Dates Observed: 1/27/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: scattered guano
Mine adit approximately 10 m deep with scattered guano, S facing.
No photo

Roost Site: Mohawk 18 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 221354 mE, 3602721 mN
Dates Observed: 1/27/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: piled guano
Mine adit, gated; depth unknown; 1 pile of guano, S facing.
No photo

Roost Site: Mohawk 19 BMGRW
Quad: Buck Peak
UTMs (WGS 84): 221480 mE, 3598706 mN
Dates Observed: 1/17/2011
Observers: W. Carroll
Feature Type: Mine
Evidence: scattered guano
Mine approximately 15 m deep, scattered guano, N facing.
No photo

Roost Site: Mohawk 20 BMGRW
Quad: Mohawk SW
UTMs (WGS 84): 221485 mE, 3599839 mN
Dates Observed: 1/26/2011
Observers: W. Carroll
Feature Type: Mine
Evidence: scattered guano
Mine adit approximately 3 m deep, scattered guano, N facing.
No photo

Roost Site: Mohawk 21 BMGRW
Quad: Mohawk
UTMs (WGS 84): 240844 mE, 3621683 mN
Dates Observed: 4/5/2011
Observers: J. Miller
Feature Type: Cave
Evidence: scattered guano
Cave approximately 4 m deep, scattered guano, NW facing. Cave inclined.
No photo

Roost Site: Mohawk 22 BMGRW
Quad: Mohawk
UTMs (WGS 84): 240855 mE, 3621676 mN
Dates Observed: 4/5/2011
Observers: J. Miller
Feature Type: Cave
Evidence: piled guano
Cave approximately 2 m deep, 1 pile of guano, NW facing. Cave inclined.
No photo

Roost Site: Mohawk 23 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 242279 mE, 3621140 mN
Dates Observed: 4/5/2011
Observers: H. Hoffman
Feature Type: Cave
Evidence: scattered guano
Cave approximately 2 m deep and 10 m wide, scattered guano, E facing.

Roost Site: Mohawk 24 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 242336 mE, 3621291 mN
Dates Observed: 4/5/2011
Observers: C. Bertrand
Feature Type: Cave
Evidence: scattered guano
Cave approximately 1.5 m deep, scattered guano, NW facing.
No photo

Roost Site: Mohawk 25 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 242515 mE, 3621393 mN
Dates Observed: 4/5/2011
Observers: W. Carroll
Feature Type: Cave
Evidence: scattered guano
Cave approximately 3 m deep, scattered guano, NE facing.
No photo

Roost Site: Mohawk 26 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 242533 mE, 3621378 mN
Dates Observed: 4/5/2011
Observers: W. Carroll
Feature Type: Crevice
Evidence: scattered guano
Crevice approximately 2 m deep, scattered guano, N facing.
No photo

Roost Site: Mohawk 27 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 243174 mE, 3621714 mN
Dates Observed: 4/6/2011
Observers: H. Hoffman
Feature Type: Cave
Evidence: scattered guano
Cave approximately 4 m deep, scattered guano, W facing.

Roost Site: Mohawk 28 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 245120 mE, 3620405 mN
Dates Observed: 2/12/2011
Observers: W. Carroll
Feature Type: Cave
Evidence: scattered guano
Cave approximately 5 m deep, scattered guano, NW facing. Small cave at rear, unable to fully evaluate, scattered guano.
No photo

Revisited: 3/14/2014
Observers: N. Foley and E. Scobie
Evidence: Tall narrow cave (6 m deep) set into cliff-face at the top of a steep mountain. Another cave is located approximately 5 m away and is also 6 m deep. Both caves contain a moderate amount of guano and significant staining but no bats detected. No culled arthropod parts were detected in either. A prairie falcon nesting site is located within 50 m of this cave.

Roost Site: Mohawk 29 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 245128 mE, 3620406 mN
Dates Observed: 2/12/2011
Observers: W. Carroll
Feature Type: Cave
Evidence: scattered guano
Cave approximately 5 m deep, scattered guano, NW facing.
No photo

Roost Site: Mohawk 30 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 245703 mE, 3616566 mN
Dates Observed: 4/7/2011
Observers: W. Carroll
Feature Type: Mine
Evidence: scattered guano
Mine adit approximately 18 m deep, scattered guano, W facing. Deer bones present.
No photo

Roost Site: Mohawk 31 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 245745 mE, 3616260 mN
Dates Observed: 4/7/2011
Observers: J. Ernst
Feature Type: Cave
Evidence: scattered guano
Cave approximately 3 m deep, 1 pile of guano, NW facing.
No photo

Roost Site: Mohawk 32 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 246552 mE, 3616898 mN
Dates Observed: 4/8/2011
Observers: C. Bertrand
Feature Type: Mine
Evidence: piled guano
Mine adit approximately 140 m deep, 1 pile of guano, NW facing. Shaft 80 m from entrance, depth unknown. Approximately 20 *M. californicus* present.
No photo

Revisit: 2/6/2014
Observers: N. Foley and E. Scobie
Evidence: Adit, with at least 93 m of drift. Surveyed to the second winze and measured from there. This may or may not be the working face. A high amount of guano located inside and scattered throughout ranging from high to extremely high in density. Moth wings scattered throughout as well in similar densities. At least 50 *M. californicus* observed inside. Bats observed roosting in the first winze, under the tiered timbered platforms. More bats observed further in, but highest density seemed to be at first winze and slightly beyond.

Roost Site: Mohawk 33 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 246677 mE, 3618894 mN
Dates Observed: 2/11/2011
Observers: C. Bertrand
Feature Type: Mine
Evidence: piled guano, insect parts
Mine adit approximately 12 m deep, 5 piles of guano, E facing.

No photo

Revisit: 3/14/2014
Observers: N. Foley and E. Scobie
Evidence: 11.4 m adit. Portal begins after about 8 m trench cut. Mine is located behind a small hill complex and at the foothills of the Mohawk Mountains. The mine contains high amounts of guano, moth wings, dragonfly wings, and some other arthropod parts (beetle, centipede). One dead *M. californicus* observed inside. No live bats.

Roost Site: Mohawk 34 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 247139 mE, 3614009 mN
Dates Observed: 4/8/2011
Observers: W. Carroll
Feature Type: Cave
Evidence: scattered guano
Cave approximately 5 m deep, scattered guano, NW facing. May be exit for Mohawk 35.
No photo

Roost Site: Mohawk 35 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 247163 mE, 3614012 mN
Dates Observed: 4/8/2011
Observers: J. Miller
Feature Type: Cave
Evidence: piled guano
Cave at least 7 m deep, steep incline at back to adjoining, inaccessible cave; 3 piles of guano, SW facing. At least 2 *M. californicus* present.

Revisit: 2/5/2014
Observers: N Foley and E. Scobie
Evidence: Natural cave, relatively small in size. Guano and what appears to be a large amount of sheep droppings, possibly collected by a rodent inside. Strong "bat" odor. Detected staining on roof of cave in spots. No bats detected.

Roost Site: Mohawk 36 BMGRW
Quad: Mohawk Mtns NW
UTMs (WGS 84): 247604 mE, 3618460 mN
Dates Observed: 2/11/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: piled guano
Mine adit 12 m deep, 1 pile of guano covering mine floor, E facing.
No photo

Revisit: 3/13/2014
Observers: N. Foley and E. Scobie
Evidence: Mine is located at end of worn track along with 5 shafts, 3 of which are mostly collapsed. This mine drops from ground level into an incline and extends 6.4 m. A horizontal adit branches from above the incline and extends 10 m. Giving about 14 m max underground depth. The working-face itself extends a few meters beyond the horizontal's portal, but this few

meters consists of the shallow vertical opening to the surface. This vertical portion is heavily timbered. Timbers are well worn and the structure is about 40% collapsed. Inside, the mine consists of an upper adit accessed from a 1.5 m ledge, and a 6.3 m deep incline below. Heavy *M. californicus* evidence exists in the upper adit. High amounts of guano, moth, dragonfly and beetle wings as well. No bats observed on this visit.

Roost Site: Mohawk 37 BMGRW
Quad: Mohawk Mtns SW
UTMs (WGS 84): 249492 mE, 3609611 mN
Dates Observed: 4/8/2011
Observers: C. Bertrand
Feature Type: Cave
Evidence: scattered guano
Cave 5 m deep, scattered guano, SW facing.
No photo

Roost Site: Mohawk 38 BMGRW
Quad: Mohawk Mtns SW
UTMs (WGS 84): 249497 mE, 3609551 mN
Dates Observed: 4/8/2011
Observers: C. Bertrand
Feature Type: Crevice
Evidence: scattered guano
Crevice 10 m deep, scattered guano, W facing.
No photo

Roost Site: Mohawk 39 BMGRW
Quad: Mohawk Mtns SW
UTMs (WGS 84): 249639 mE, 3609451 mN
Dates Observed: 4/8/2011
Observers: C. Bertrand
Feature Type: Cave
Evidence: piled guano
Cave 10 m deep, 1 pile of guano, W facing.
No photo

Revisit: 2/6/2014
Observers: N. Foley and E. Scobie
Evidence: Natural cave with wide opening, relatively shallow ~5 m deep. No absolute dark areas. Some rodent and bird evidence - droppings, and a midden. A large portion of urine stains observed ~18 m deep. Some crystallization of urine observed there too. Guano pile underneath. Beetle and dragonfly wings observed. Possibly *M. californicus*. Most wings further in ~4 m with some guano. No bats observed.

Roost Site: Mohawk 40 BMGRW
Quad: Mohawk Mtns SW
UTMs (WGS 84): 253138 mE, 3605501 mN
Dates Observed: 1/28/2011
Observers: C. Bertrand
Feature Type: Crevice
Evidence: scattered guano
Crevice 5 m deep, scattered guano, SW facing. Great-horned owl roost at entrance.
No photo

Roost Site: Mohawk 41 BMGRW
Quad: Mohawk Mtns SE
UTMs (WGS 84): 253642 mE, 3606531 mN
Dates Observed: 4/9/2011
Observers: W. Carroll
Feature Type: Cave
Evidence: piled guano
Cave 10 m deep, 4 piles of guano, SE facing. Opening to large chamber at rear of cave.
No photo

Roost Site: Mohawk 42 BMGRE
Quad: Mohawk Mtns SE
UTMs (WGS 84): 253959 mE, 3607603 mN
Dates Observed: 5/8/2011
Observers: C. Bertrand
Feature Type: Cave
Evidence: scattered guano
Cave 15 m deep, scattered guano, SE facing. Pack rat midden covering cave floor.
No photo

Roost Site: Mohawk 43 BMGRE
Quad: Mohawk Mtns SE
UTMs (WGS 84): 254060 mE, 3607708 mN
Dates Observed: 5/8/2011
Observers: W. Carroll
Feature Type: Cave
Evidence: piled guano
Cave 20 m deep, 1 pile of guano, S facing.
No photo

Roost Site: Mohawk 44 BMGRE
Quad: Mohawk Mtns SE
UTMs (WGS 84): 262913 mE, 3600764 mN
Dates Observed: 3/8/2011
Observers: H. Hoffman
Feature Type: Cave
Evidence: scattered guano
Cave 4 m deep, scattered guano, NE facing. Whitewash.

Revisit: 2/12/2014
Observers: N. Foley and E. Scobie
Evidence: Natural cave, remote, located on the SW side of Mohawk Mountains. Whitewash and many small bones indicate owl presence. Some staining by bats. Low amount of guano, but a moderate amount of arthropod parts present. Cave is on the North facing slope about 100 m above the desert floor. No bats observed.

Roost Site: Mohawk 45 BMGRE
Quad: Monreal Well
UTMs (WGS 84): 268090 mE, 3593043 mN
Dates Observed: 3/9/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: piled guano
Mine adit 40 m deep, 4 piles of guano, W facing. At least 30 *M. californicus* and adit drops at 12 m.

Revisit: 2/12/2014
Observers: N. Foley and E. Scobie
Evidence: Adit, declining in stages, ~25 m depth. Internally relatively spacious ~2.5x2.5 m (variable). ~30 *M. californicus* inside, concentrated guano suggest the majority are roosting near

the working face. Guano throughout, along with green splat (?), moth wings, beetle, and grasshopper parts. Staining on the spine 1/4 to 1/3 of the way in.

Revisit: 4/28/2014
Observers: R. Mixan, J. Diamond and A. Alvidrez
Evidence: No bats detected at this time. Guano evidence suggests heavy *M. californicus* use as well as *C. townsendii.* Most likely a transitory roost (interim roost) for *C. townsendii*.

Roost Site: Mohawk 46 BMGRE
Quad: Mohawk Mtns SE
UTMs (WGS 84): 219654mE, 3599578mN
Dates Observed: 2/07/14
Revisit: 2/13/14
Observers: N. Foley and E. Scobie
Feature Type: Mine
Evidence: Adit, ~115 m main drift, 43 m side drift, terminating at winze of ~14 m depth. Unknown if adits extend at bottom of winze. Internally very stable, almost solid granite, few loose rocks on floor. Significant *M. californicus* evidence, guano, moth, dragonfly, beetle wings

throughout, evenly distributed. Other human footprints inside. First visit 40+ *M. californicus*, second visit only 1. This area seems to be popular with Elderly Seasonal Recreationists. This feature is a candidate for a gate to protect the bat population and ensure human safety. Dangerous winze seen in pictures below.

Roost Site: Mohawk 47 BMGRE
Quad: Mohawk Mtns SE
UTMs (WGS 84): 247634mE, 3618597mN
Date Observed: 3/13/2014
Observers: N. Foley and E. Scobie
Feature Type: Mine
Evidence: Adit located in wash alongside road leading to mine workings site with six openings. This seems to have been some sort of storage room built into the wall of the wash. The floor is covered in midden material, pack rat droppings, moderate guano, and dragonfly, moth, and beetle parts. High *M. californicus* Evidence was found at the mine site nearby. Evidence in this small adit is consistent with *M. californicus* as well.

Roost Site: Crater Range 1 BMGRE
Quad: Deadman Gap
UTMs (WGS 84): 325656 mE, 3601289 mN
Dates Observed: 3/9/2011
Observers: C. Bertrand
Feature Type: Crevice
Evidence: scattered guano
Crevice 5 m deep, scattered guano, NW facing. Owl roost with bones and pellets.
No photo

Roost Site: Crater Range 2 BMGRE
Quad: Deadman Gap
UTMs (WGS 84): 325756 mE, 3601186 mN
Dates Observed: 3/9/2011
Observers: C. Bertrand
Feature Type: Crevice
Evidence: scattered guano
Crevice 1.5 m deep, scattered guano, SE facing.
No photo

Roost Site: Tank 1 YPG
Quad: Palomas Mtns NW
UTMs (WGS 84): 243876 mE, 3680124 mN
Dates Observed: 4/10/2011
Observers: W. Carroll
Feature Type: Cave
Evidence: scattered guano
Cave approximately 3 m deep, scattered guano, E facing.
No photo

Roost Site: Tank 2 YPG
Quad: Palomas Mtns NW
UTMs (WGS 84): 247489 mE, 3673193 mN
Dates Observed: 4/10/2011
Observers: C. Bertrand
Feature Type: Cave
Evidence: piled guano
Cave approximately 10 m deep, 2 piles of guano, W facing. Incline at rear.
No photo

Roost Site: Trigo 1 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 733326 mE, 3697925 mN
Dates Observed: 12/6/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: scattered guano
Cave 1 m deep, scattered guano, NE facing. 1 m off wash floor.

Revisit: 3/5/2014
Observers: N. Foley and E. Scobie
Evidence: Small cave located in side wall of wash bed, close to ground level. Small amount of guano observed inside. Guano itself is also small.

Roost Site: Trigo 2 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 734111 mE, 3695709 mN
Dates Observed: 12/6/2010
Observers: C. Bertrand
Feature Type: Cave
Evidence: piled guano, insects
Cave 3 m deep, 1 pile of guano, SW facing. 5 m off wash floor, pool present.

Revisit: 3/15/2014
Observers: N. Foley and E. Scobie
Evidence: Cave located in narrow canyon near top of wall a few meters above the wash bed. Dragonfly and moth wings, as well as low to moderate amount of guano inside. Dragonfly and moth wings were low in density. No bats detected.

Roost Site: Trigo 3 YPG
Quad: Mohave Peak
UTMs (WGS 84): 734738 mE, 3695570 mN
Dates Observed: 12/6/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: scattered guano
Cave 1 m deep, scattered guano, SW facing.

Roost Site: Trigo 4 YPG
Quad: Mohave Peak
UTMs (WGS 84): 734758 mE, 3695625 mN
Dates Observed: 12/6/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: scattered guano
Cave 1.5 m deep, 4 pieces scattered guano, SW facing.

Date Observed: 3/15/2014
Observers: N. Foley and E. Scobie
Evidence: It is unclear form GPS coordinates which of two caves is the detection site. The most likely candidate is written up here, while the other is fairly similar in dimensions No animal activity of any kind detected in either cave. Located along ridge with a steep slope on either side, and is south facing and shallow.

Roost Site: Trigo 5 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 734876 mE, 3696117 mN
Dates Observed: 12/18/2010
Observers: C. Bertrand
Feature Type: Cave
Evidence: scattered guano
Cave 2 m deep, scattered guano, SW facing. Sheep scat and whitewash present.

Revisit: 3/15/2014
Observers: N. Foley and E. Scobie
Evidence: Cave located about 20 m above wash bed in cliff face. Contains low amount of guano, some staining, but no arthropod parts or live bats.

Roost Site: Trigo 6 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 734882 mE, 3696129 mN
Dates Observed: 12/18/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: scattered guano
Cave 1 m deep, scattered guano, NW facing.
No photo

Roost Site: Trigo 7 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 734922 mE, 3697714 mN
Dates Observed: 12/5/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: scattered guano
Cave 25 m deep, scattered guano, E facing. Midden found.

Roost Site: Trigo 8 YPG
Quad: Mohave Peak
UTMs (WGS 84): 734923 mE, 3695037 mN
Dates Observed: 12/19/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: scattered guano
Cave 2 m deep, scattered guano, SW facing.

Roost Site: Trigo 9 YPG
Quad: Mohave Peak
UTMs (WGS 84): 735002 mE, 3695606 mN
Dates Observed: 12/17/2010
Observers: H. Hoffman
Feature Type: Crevice
Evidence: scattered guano
Crevice 1.5 m deep, scattered guano, S facing.

Roost Site: Trigo 10 YPG
Quad: Mohave Peak
UTMs (WGS 84): 735131 mE, 3695510 mN
Dates Observed: 12/17/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: scattered guano
Cave 2 m deep, scattered guano, NE facing.
No photo

Roost Site: Trigo 11 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735166 mE, 3696728 mN
Dates Observed: 12/18/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: scattered guano
Cave 2 m deep, scattered guano, NE facing.
No photo

Roost Site: Trigo 12 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735233 mE, 3696407 mN
Dates Observed: 12/18/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: piled guano
Cave 3 m deep, 1 pile of guano, 150 pieces; N facing.

Revisit: 3/15/2014
Observers: N. Foley and E. Scobie
Evidence: Cave located about halfway up steep drainage. Low to moderate amount of guano (*myotis* spp.) and no arthropod parts. North facing slope. No bats observed.

Roost Site: Trigo 13 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735313 mE, 3696294 mN
Dates Observed: 12/18/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Scattered guano
Cave 2 m deep, scattered guano, 15-20 pieces; N facing.

Revisit: 3/15/2014
Observers: N. Foley and E. Scobie
Evidence: Cave located about ¾ uphill from drainage, on North-facing slope. No sign of bat activity.

Roost Site: Trigo 14 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735361 mE, 3696180 mN
Dates Observed: 12/18/2010
Observers: H. Hoffman
Feature Type: Crevice
Evidence: piled guano
Crevice 3 m deep, 2 large piles of guano, SW facing. 3m above ground crevice runs horizontally, depth unknown. Ledge covered in guano > 0.3m deep.

Revisit: 3/15/2014
Observers: N. Foley and E. Scobie
Evidence: One crevice on the underside of an overhang, 6.6 m from ground level. Portal has significant staining and moderate amount of old-looking guano beneath it. Due to its location accurate measurements could not be made of the crevice, but it is approximately 0.1x1.0 m at its portal and extends for an unknown depth. A second crevice is similarly located about 0.5m away and measures about 2.0x0.5 m at its portal (Possible staining seen here as well). This area is located near a peak on a steep slope. No bats observed.

Roost Site: Trigo 15 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735421 mE, 3695892 mN
Dates Observed: 12/17/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: scattered guano
Cave 1.5 m deep, scattered guano, N facing.
No photo

Roost Site: Trigo 16 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735442 mE, 3696115 mN
Dates Observed: 12/17/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: scattered guano
Cave 3 m deep, scattered guano, SW facing.
No photo

Roost Site: Trigo 17 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735461 mE, 3696275 mN
Dates Observed: 12/5/2010
Observers: H. Hoffman
Feature Type: Crevice
Evidence: scattered guano
Crevice 3 m deep, scattered guano, W facing. Roost over midden.

Revisit: 3/15/2014
Observers: N. Foley and E. Scobie
Evidence: Wide crevice located near peak of mountain. No sign of bat activity but a pack rat midden and droppings are inside. West-facing. Crevice narrows into mountainside.

Roost Site: Trigo 18 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735524 mE, 3696537 mN
Dates Observed: 12/18/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: scattered guano
Cave 1 m deep, scattered guano, NW facing.

Roost Site: Trigo 19 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735544 mE, 3696528 mN
Dates Observed: 12/18/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: scattered guano
Cave 1.5 m deep, scattered guano, NE facing.

Roost Site: Trigo 20 YPG
Quad: Mohave Peak
UTMs (WGS 84): 735544 mE, 3694980 mN
Dates Observed: 12/19/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: scattered guano
Cave 15 m deep, scattered guano, NE facing. Whitewash.

Date Observed: 3/12/2014
Observers: N. Foley and E. Scobie
Evidence: Cave about 6.3 m deep and located on steep cliff face, difficult to reach. Very remote area. Low to moderate amounts of guano, most of which seems old. Two moth wings suggestive of *M. californicus*. Rodent evidence inside also. Whitewash outside of portal. No bats observed.

Roost Site: Trigo 21 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735713 mE, 3699740 mN
Dates Observed: 12/2/2010
Observers: J. Ernst
Feature Type: Mine
Evidence: insect parts
Mine adit 3 m deep, insect parts only, E facing.

Date Observed: 3/5/2014
Observers: N. Foley and E. Scobie
Evidence: Short adit (2.7 m deep) with low amount of guano within. Several small caves are in the immediate vicinity with no sign of bat activity, as well as an overhang in a cliff face with some staining and a few pieces of guano beneath. Bats observed flying as we approached (dusk).

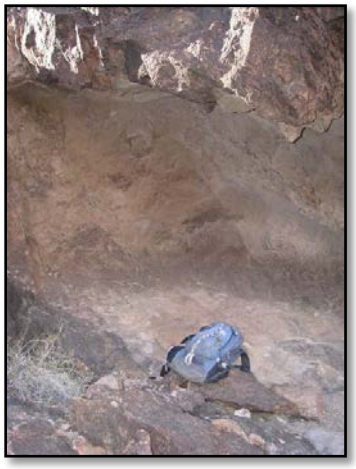
Roost Site: Trigo 22 YPG
Quad: North Trigo Peaks, AZ
UTMs (WGS 84): 735722mE, 3697006mN
Dates Observed: 12/5/2010
Observers: H. Hoffman
Feature Type; Cave
Evidence: Scattered guano, no bats observed
Feature is a 3 m deep cave with 2 m^2 of scattered guano.

Date Observed: 3/16/2014
Observers: N. Foley and E. Scobie
Evidence: Crevice (listed as cave on previous data) on underside of overhang, about halfway up slope along drainage, 4.8 m from ground level. Significant staining all along outside of crevice. At least three bats seen inside crevice. Identification was difficult due to position of crevice high above ground but possibly *Mytois spp*. or *E. fuscus*. A second crevice is located 5 m away under the same overhang and with similar staining, but no bats. Both crevices have amounts of guano beneath them but only the one containing bats has fresh-looking guano.

Roost Site: Trigo 23 YPG
Quad: Mohave Peak,
UTMs (WGS 84): 735758mE, 3695546mN
Dates Observed: 12/17/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Around 50 pieces of guano were scattered around the feature. A 0.3x0.3 m recess was found in cave.

Revisit: 3/12/2014
Observers: N. Foley and E. Scobie
Evidence: This site represents the most likely roost location that was < 5 m from the point on the GPS. It is a small cave-like outcropping at the top of a cliff face. No guano present. Some rodent droppings. Shallow, not very tall.

Roost Site: Trigo 24 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735807mE, 3696823mN
Dates Observed: 12/5/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Scattered guano found throughout 3 m deep cave.



Roost Site: Trigo 25 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735816mE, 3696827mN
Dates Observed: 12/5/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 2 m deep cave found with scattered guano.

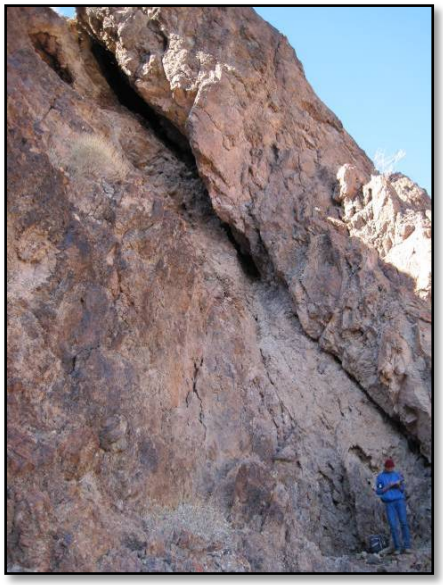
Roost Site: Trigo 26 YPG
Quad: Mohave Peak
UTMs (WGS 84): 735895mE, 3695294mN
Dates Observed: 1/5/2011
Observers: H. Hoffman
Feature Type: Crevice
Evidence: Scattered guano, no bats observed
2 m deep crevice with scattered guano.

Roost Site: Trigo 27 YPG
Quad: Mohave Peak
UTMs (WGS 84): 735904mE, 3695297mN
Dates Observed: 1/5/2011
Observers: H. Hoffman
Feature Type: Crevice
Evidence: Scattered guano, no bats observed
4 m deep feature with scattered guano.

Roost Site: Trigo 28 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735922mE, 3696467mN
Dates Observed: 12/16/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Cave had scattered guano and two additional crevices.

Roost Site: Trigo 29 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 735997mE, 3696564mN
Dates Observed: 12/16/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Scattered guano, no bats observed.
Feature is a small cave 1.3m deep with signs of white wash.

Roost Site: Trigo 30 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736001mE, 3696516mN
Dates Observed: 12/16/2010
Observers: J. Ernst
Feature Type: Crevice
Evidence: Scattered guano, no bats observed.
Crevice 1.5 m deep turns into large overhang. Staining on wall observed.



Roost Site: Trigo 31 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736043mE, 3699017mN
Dates Observed: 12/3/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Insect parts, no bats observed
Feature is a 3.5 m deep cave with scattered insect parts.

Revisit: 3/7/2014
Observers: N. Foley and E. Scobie
Evidence: Some whitewash and low amount of pellet evidence, indicating owl use. No sign of bat activity. Located high on mountain side.

Roost Site: Trigo 32 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736050mE, 3696567mN
Dates Observed: 12/16/2010
Observers: C. Bertrand
Feature Type: Cave
Evidence: Scattered guano, no bats observed.
Guano was found under cave lip. Feature is 3 m deep.

Date Observed: 3/16/2014
Observers: N. Foley and E. Scobie
Evidence: This cave is the only feature nearby with any bat sign. Low amount of guano and no arthropod parts or live bats. Located about 2/3 uphill of steep drainage, facing East.

Roost Site: Trigo 33 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736067mE, 3698887mN
Dates Observed: 12/3/2010
Observers: J Ernst
Feature Type: Cave
Evidence: Insect parts, no bats observed
Feature is a 2 m deep cave with scattered insect parts found throughout.

Date Observed: 3/7/2014
Observers: N. Foley and E. Scobie
Evidence: Above UTMs indicate a small crevice in a cliff-face, high on a mountainside. 15 m away is a large, open cave containing a significant amount of owl pellets, whitewash, and rodent bones littering the floor. A couple pieces of guano were found inside. No bat activity observed in crevice.

Roost Site: Trigo 34 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736090mE, 3698891mN
Dates Observed: 12/3/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Insect parts, no bats observed
Feature is 3.5m deep with stains found on walls. Insect parts were found inside cave but no bats were observed.

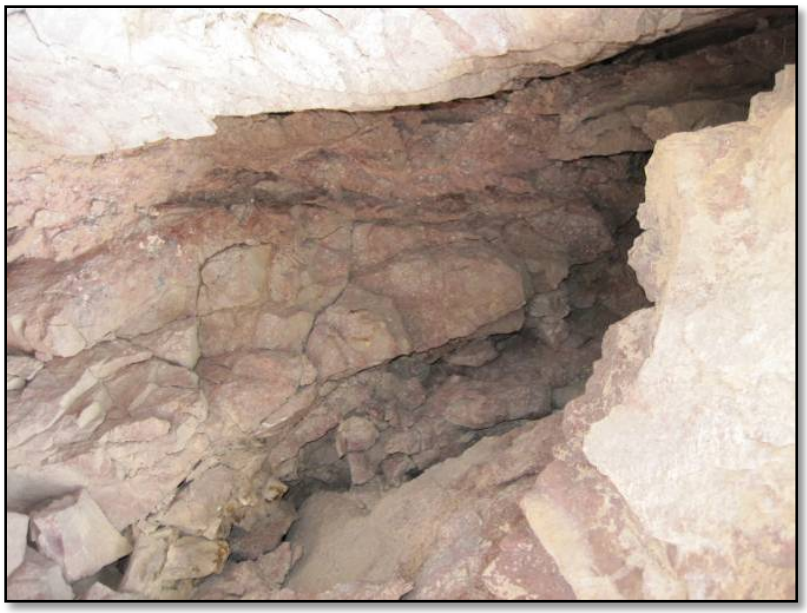
Roost Site: Trigo 35 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736109mE, 3698732mN
Dates Observed: 12/3/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a small overhang 0.5 m deep with stains on the wall.

Revisit: 3/7/2014
Observers: N. Foley and E. Scobie
Evidence: Small cave near peak of mountain. A few small pieces of guano observed inside. Active beehive 3 m away.

Roost Site: Trigo 36 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736115mE, 3696769mN
Dates Observed: 12/16/2010
Observers: C. Bertrand
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 6 m deep cave with one pile of guano found. Sheep scat was all present at the feature.
No Photo

Roost Site: Trigo 37 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736137mE, 3698041mN
Dates Observed: 12/4/2010
Observers: H. Hoffman
Feature Type: Crevice
Evidence: Scattered guano, no bats observed
Feature 2 m deep with only one piece of guano found.

Roost Site: Trigo 38 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736210mE, 3697188mN
Dates Observed: 12/16/2010
Observers: C. Bertrand
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is 6 m deep with scattered guano.



Roost Site: Trigo 39 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736221mE, 3696615mN
Dates Observed: 12/16/2010
Observers: J. Ernst
Feature Type: Crevice
Evidence: Scattered guano, no bats observed
Feature is a small crevice 0.2 m deep with scattered insect parts.

Roost Site: Trigo 40 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736223mE, 3696607mN
Dates Observed: 12/16/2010
Observers: J. Ernst
Feature Type: Crevice
Evidence: Scattered guano, no bats observed.
Feature is 0.3m deep found along a tall rock face.

Roost Site: Trigo 41 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736265mE, 3698112mN
Dates Observed: 12/4/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is 2m deep with only one piece of guano found.
No Photo

Date Observed: 3/7/2014
Observers: N. Foley and E. Scobie
Evidence: Large pocket in mountainside, only 1.0 m deep. No sign of bat activity.

Roost Site: Trigo 42 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736278mE, 3697771mN
Dates Observed: 12/4/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Guano, no bats observed
1.0 m deep cave with a 2x2 m wall stain below crevice. One pile of guano was found but no bats were observed.

Date Observed: 3/6/2014
Observers: N. Foley and E. Scobie
Evidence: Natural cave/crevice. No bat sign. A few rodent droppings on the floor, some whitewash. Squeeze test done on one of the questionable droppings and it remained intact characteristic of rodent droppings. Feature is small and located on a rocky steep slope and small canyon. Remote location.

Roost Site: Trigo 43 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736281mE, 3697789mN
Dates Observed: 12/4/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Insect parts, no bats observed
Feature is a shallow 1m cave, with scattered insect parts found throughout.

Roost Site: Trigo 44 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736285mE, 3698160mN
Dates Observed: 12/4/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Insect parts, no bats observed
Feature is a 1.5 m cave with scattered insect parts.

Roost Site: Trigo 45 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736292mE, 3698131mN
Dates Observed: 12/4/2010
Observers: H. Hoffman
Feature Type: Crevice
Evidence: Scattered guano, no bats observed
No Photo

Roost Site: Trigo 46 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736304mE, 3698114mN
Dates Observed: 12/4/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed.
Feature is 2 m deep with scattered guano.

Roost Site: Trigo 47 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736312mE, 3698023mN
Dates Observed: 12/4/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 1.3 m deep cave found with scattered guano.

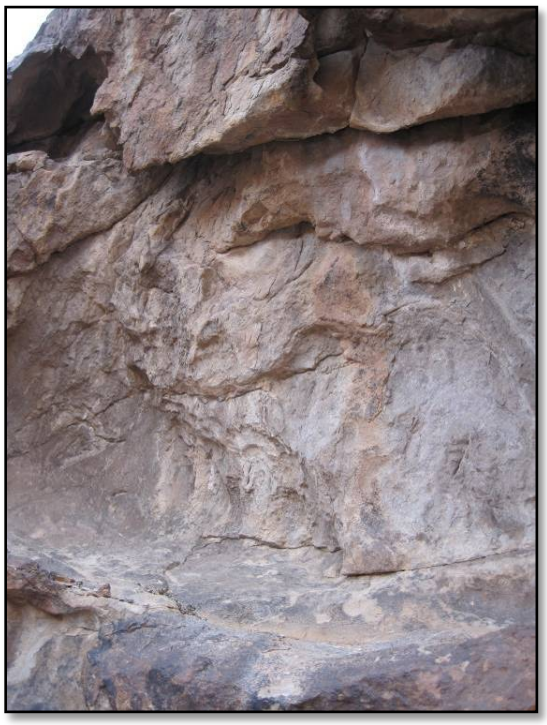
Roost Site: Trigo 48 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736335mE, 3697910mN
Dates Observed: 12/4/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Scattered guano, no bats observed
10 m deep cave with scattered guano. Only able to explore 1/3 of cave.

Roost Site: Trigo 49 YPG
Quad: North Trigo Peaks,
UTMs (WGS 84): 736342mE, 3698167mN
Dates Observed: 12/4/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Shallow 0.7 m deep cave found with scattered guano.

Roost Site: Trigo 50 YPG
Quad: Mohave Peak
UTMs (WGS 84): 736404mE, 3695092mN
Dates Observed: 1/5/2011
Observers: C. Bertrand
Feature Type: Crevice
Evidence: Guano, no bats observed
Feature is 12-14 m long and is 8-10 m off the ground. Pack rat midden found. Three piles of guano found with a total area of 1.6 m^2.
No photo

Roost Site: Trigo 51 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736410mE, 3698297mN
Dates Observed: 12/3/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a shallow 1m deep cave with scattered guano.

Roost Site: Trigo 52 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736413mE, 3698303mN
Dates Observed: 12/3/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 2 m deep cave with scattered guano.



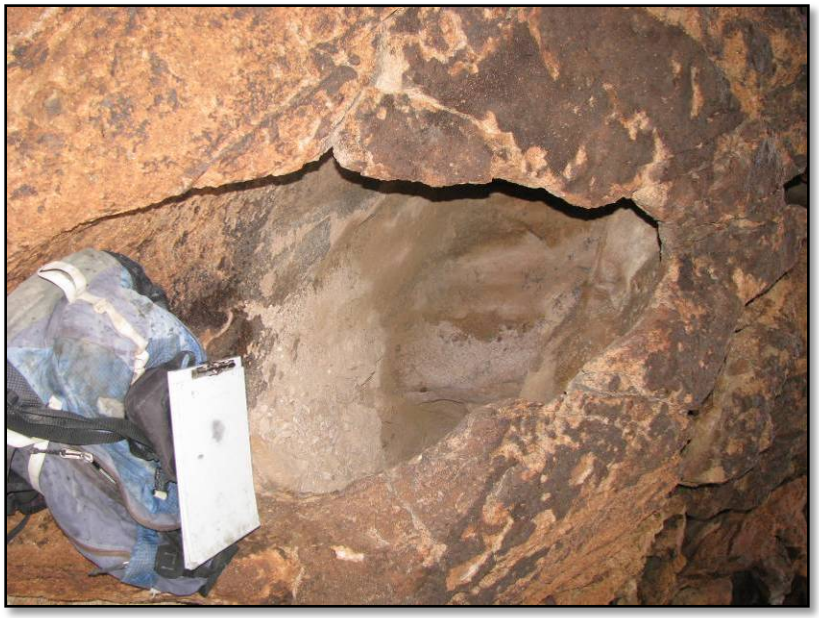
Roost Site: Trigo 53 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736415mE, 3698402mN
Dates Observed: 12/3/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Scattered guano, no bats observed
3 m deep cave with wall stains and scattered guano.

Revisit: 3/7/2014
Observers: N. Foley and E. Scobie
Evidence: Feature is tall and wide, relatively shallow, with some areas of greater depth near the top. Some guano and corresponding staining on roof towards the northern edge of the feature. Some whitewash and sheep droppings. Located about 1/3 way up a finger-ridge dividing the canyon.

Roost Site: Trigo 54 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736415mE, 3698405mN
Dates Observed: 12/3/2010
Observers: J. Ernest
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature was a 2 m deep cave with scattered guano found within. Sheep scat found at site.

Roost Site: Trigo 55 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736440mE, 3698059mN
Dates Observed: 12/3/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: 2 m deep cave
Feature is a shallow 0.6 m deep cave with scattered guano.

Roost Site: Trigos 56 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736486mE, 3697633mN
Dates Observed: 12/16/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed.
Feature is a cave that is 1.7 m deep with scattered guano.



Roost Site: Trigo 57 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736490mE, 3697765mN
Dates Observed: 12/4/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: 2 m deep cave
Feature is a shallow cave with scattered guano.

Roost Site: Trigo 58 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736523mE, 3698046mN
Dates Observed: 12/4/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is 1 m deep found with scattered guano.

Roost Site: Trigo 59 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736528mE, 3698050mN
Dates Observed: 12/4/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a shallow cave 1 m deep with scattered guano.

Roost Site: Trigo 60 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736545mE, 3697688mN
Dates Observed: 12/4/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Insect parts, no bats observed
Feature is a 2 m deep cave with an additional crevice found inside. Insect parts, whitewash and pellets were found inside feature as well.

Date Observed: 3/6/2014
Observers: N. Foley and E. Scobie
Evidence: Cave located in cliff face along drainage. Owl use evidenced by pellets and rodent bones. One moth wing and possibly one piece of guano. At most this is a very infrequent night roost.

Roost Site: Trigos 61 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736558mE, 3697647mN
Dates Observed: 12/4/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 1.3 m deep cave which had scattered guano

Roost Site: Trigo 62 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736561mE, 3697647mN
Dates Observed: 12/4/2010
Observers: J. Ernst
Feature Type: Cave
Evidence: Insect parts, no bats observed
Feature is a 2 m deep cave found with scattered insect parts.

Roost Site: Trigos 63 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736644mE, 3698004mN
Dates Observed: 12/3/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 2 m deep cave found with both scattered guano and sheep sign.

Roost Site: Trigo 64 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736756mE, 3697293mN
Dates Observed: 12/28/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 3 m deep cave with scattered guano and whitewash.
No photo

Date Observed: 3/6/2014
Observers: N. Foley and E. Scobie
Evidence: Cave located near peak of mountain, along steep drainage. No evidence of bat activity. Significant amount of whitewash, as well as owl pellets.

Roost Site: Trigo 65 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 736957mE, 3698122mN
Dates Observed: 12/28/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Guano, no bats observed
Feature is a 2 m deep cave with one pile of guano 0.1 m^2 found.

Roost Site: Trigo 66 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 737028mE, 3696724mN
Dates Observed: 12/29/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a cave 2 m deep found with scattered guano

Roost Site: Trigo 67 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 737077mE, 3697599mN
Dates Observed: 12/28/2010
Observers: C. Bertrand
Feature Type: Cave
Evidence: Guano, no bats observed
Feature is 0.5 m deep with a pile of guano 0.05 m^2. Sheep scat was present at feature.

Roost Site: Trigo 68 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 737098mE, 3698225mN
Dates Observed: 12/28/2010
Observers: C. Bertrand
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Cave is 2.5 m deep found with scattered guano and sheep scat.
No photo

Roost Site: Trigo 69 YPG
Quad: Mohave Peak
UTMs (WGS 84): 737191mE, 3695625mN
Dates Observed: 1/3/2011
Observers: H. Hoffman
Feature Type: Crevice
Evidence: Scattered guano, no bats observed
Feature is a 2 m deep crevice with scattered guano.
No photo

Roost Site: Trigos 70 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 737212mE, 3697582mN
Dates Observed: 12/28/2010
Observers: C. Bertrand
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 3 m deep cave with scattered guano and sheep scat.

Roost Site: Trigo 71 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 737249mE, 3697462mN
Dates Observed: 12/28/2010
Observers: C. Bertrand
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 3 m deep cave found with scattered guano and sheep scat.

Roost Site: Trigo 72 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 737254mE, 3697523mN
Dates Observed: 12/28/2010
Observers:
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 1.5 m deep cave found with scattered guano.
No photo

Roost Site: Trigo 73 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 737267mE, 3697496mN
Dates Observed: 12/28/2010
Observers: C. Bertrand
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Cave is 2.5 m in length found with scattered guano

Roost Site: Trigo 74 YPG
Quad: Mohave Peak
UTMs (WGS 84): 737482mE, 3695320mN
Dates Observed: 1/3/2011
Observers: H. Hoffman
Feature Type: Crevice
Evidence: Guano, no bats observed
Feature is a 5 m deep crevice found with a pile of guano 0.2 m^2 wide.

Roost Site: Trigo 75 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 739292mE, 3697650mN
Dates Observed: 12/27/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 2 m deep cave found with scattered guano and sheep sign.
No photo

Roost Site: Trigo 76 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 739596mE, 3697827mN
Dates Observed: 12/27/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is 2.6 m deep, found with scattered guano and sheep sign.

Roost Site: Trigo 77 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 739741mE, 3697398mN
Dates Observed: 12/27/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a shallow 1 m deep cave with scattered guano and sheep sign
No photo

Roost Site: Trigo 78 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 739750mE, 3697373mN
Dates Observed: 12/27/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is 1 m deep found with scattered guano
No photo

Roost Site: Trigos 79 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 739824mE, 3697568mN
Dates Observed: 12/27/2010
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Cave is 1.6 m deep found with scattered guano

Roost Site: Trigos 80 YPG
Quad: North Trigo Peaks
UTMs (WGS 84): 746435mE, 3714039mN
Date Observed: 2/21/2014
Observers: N. Foley and E. Scobie
Feature Type: Mine

Evidence: Mine located alone on the side of drainage. 4.5 m deep and forms a zigzag pattern of down, east, down, west. Low amount of guano and some moth wings but no bats observed.

Roost Site: Trigos 81 YPG
Quad: North Trigo Peaks
UTM's (WGS 84): 737561mE, 3690323mN
Date Observed: 3/5/2014
Observers: N. Foley and E. Scobie
Feature Type: Cave
Evidence: Wide, shallow cave (more like rocky overhang) located on steep slope along drainage. Several other small crevices (< 1.0 m^2) located in the immediate vicinity. One piece of guano observed within.

Roost Site: Trigos 82 YPG
Quad: North Trigo Peaks
UTM's (WGS 84): 737463mE, 3690333mN
Date Observed: 3/5/2014
Observers: N. Foley and E. Scobie
Feature Type: Cave
Evidence: Cave 6.8 m deep that inclines upwards, located on steep slope along drainage. Several other crevices (< 1.0 m^2) located in the immediate vicinity. Low amounts of guano observed within. No bats observed.

Roost Site: Muggins 1 YPG
Quad: Dome
UTMs (WGS 84): 751190mE, 3631106mN
Dates Observed: 4/19/2011
Observers: J. Ernst
Feature Type: Mine, adit
Evidence: Scattered guano, no bats observed
Feature is a 4 m deep adit found with scattered guano.
Location has multiple shallow adits with only one with guano. Coyote skeleton found on site.

Revisit: 3/8/2014
Observer: R. Mixan
Evidence: Two shallow prospects located next to each other. Scattered guano and small amount of moth wings. Guano evidence consistent with *M. californicus*. This feature is a low activity night roost.

Roost Site: Muggins 2 YPG
Quad: Dome
UTMs (WGS 84): 752140mE, 3632357mN
Dates Observed: 4/23/2011
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is 3 m deep and is found at the bottom of a wash

Roost Site: Muggins 3 YPG
Quad: Dome
UTMs (WGS 84): 753308mE, 3632116mN
Dates Observed: 4/23/2011
Observers: J. Ernst
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is 4 m deep and was found with around 100 scattered pieces of guano.

Date Observed: 3/08/14
Observer: R. Mixan
Evidence: Some scattered guano and *Lepidoptera* spp wings observed. This feature is open to the elements and evidence is consistent with a low activity night roost. Guano is consistent with *Myotis* spp.

Roost Site: Muggins 4 YPG
Quad: Dome
UTMs (WGS 84): 753371mE, 3632098mN
Dates Observed: 4/23/2011
Observers: J. Ernst
Feature Type: Mine, adit
Evidence: Guano, bats observed
Feature is a 15 m deep adit with four piles of guano 0.6 m^2 combined. *M. californicus* were observed at this location. A ram skull, horns and bones were found inside adit.

Date Observed: 3/08/14
Observer: R. Mixan
Evidence: Approximately 20 m *M. californicus* observed utilizes this mine as a day roost. Adit is 20 m in depth with 2 large stopes. The first stope is located halfway through and only 2 bats were observed using this section. The remaining bats were observed utilizing the second stope at the working face. Heavy guano deposits were observed beneath the stopes as well as *Lepidoptera* wings. Guano evidence is consistent with *M. californicus, C. townsendii and Myotis spp*. This mine is located in an area used by the DoD as a training course for military vehicles. This mine is fairly stable and access to the general public is restricted. Therefore, a gate is most likely not necessary at this time.

Roost Site: Muggins 5 YPG
Quad: Red Bluff Mountain West
UTMs (WGS 84): 759715mE, 3634591mN
Dates Observed: 4/24/2011
Observers: C. Bertrand
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature has 2 shallow adits nearby.
No photo

Roost Site: Gila 1 BMGRW
Quad: Cipriano Pass
UTMs (WGS 84): 763772mE, 3597175mN
Dates Observed: 2/9/2011
Observers: H. Hoffman
Feature Type: Cave
Evidence: Scattered guano, no bats observed
Feature is a 3 m deep cave found with scattered guano
No photo

Roost Site: Tinajas 1 BMGRW
Quad: Cipriano Pass
UTMs (WGS 84): 77696mE, 357954mN
Dates Observed: 2/9/2011
Observers: J. Miller
Feature Type: Cave
Evidence: Moderate amounts of guano within the 15 m surveyed, no bats observed
Features is a moderately complex feature with 2 opening and at least 3 levels.
No photo

Roost Site: Wellton 1 BMGRW
Quad: Wellton Hills
UTMs (WGS 84): 768993mE, 3604891mN
Dates Observed: 1/15/2011
Observers: WC
Feature Type: Mine
Evidence: Scattered guano
Feature was gated. Unable to determine usage.

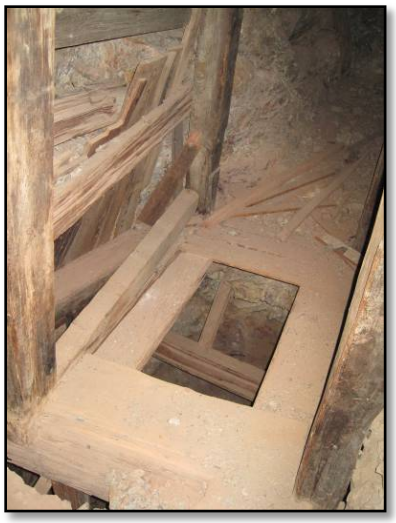
Roost Site: Wellton 2 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 771101mE, 3605109mN
Dates Observed: 1/13/2011
Observers: H. Hoffman
Feature Type: Mine, adit
Evidence: Scattered guano, no bats observed
Feature is a 15m deep adit with scattered guano.

Roost Site: Wellton 3 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 771507mE, 3604761mN
Dates Observed: 1/13/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: Guano, no bats observed
Feature is a 35 m deep mine with a pile of guano 0.2 m^2.

Revisit: 2/11/2014
Observers: N. Foley and E. Scobie
Evidence: Adit with 42 m main drift, one side drift measured ~12 m. Guano scattered throughout, with piles dispersed through the mine. Moth wings and beetle parts, along with grasshopper legs. No bats observed, but evidence strongly suggests *M. californicus*. This mine is located in the Wellton Hills. There were *canid* spp tracks in the mine, as well as a few human footprints. This is a possible candidate for a gate to protect bat population and ensure human safety.

Roost Site: Wellton 4 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 771587mE, 3604723mN
Dates Observed: 1/13/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: Scattered guano, no bats observed
Feature is 15 m deep with a shaft of unknown depth. Great horned owl wing, feathers and pellets found.

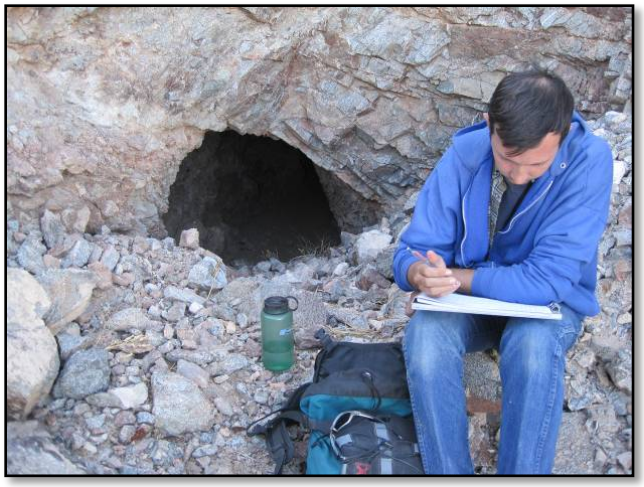
Revisit: 2/11/2014
Observers: N. Foley and E. Scobie
Evidence: 18m adit. After ~14 m, the adit drops into a winze, of at least 8 m depth, but most likely more given the size of the dump and relatively short length of the adit. Timberings, the angle of descent of the winze, and safety concerns prohibited further measurement of the winze depth. The adit continues ~3m beyond the terminal edge of the winze. At the portal, there is a partial collapse of the original portal, boulders have come down and partially crushed the portal's deteriorated timbers. Access is possible through the collapsed portion as well as over it. Going over the collapse is the safer route. One set of human footprints observed inside. Moth, dragonfly, and beetle wings observed inside, however guano was relatively low, suggesting roosting further in the mine via the winze, or the use of the mine as a night roost. This mine is located in the same vicinity of a confirmed detection location, sharing strong evidence of *M. californicus* use. This feature is a possible candidate for a gate to protect bat population and ensure human safety.



Roost Site: Wellton 5 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 771774mE, 3604531mN
Dates Observed: 1/13/2011
Observers: J. Ernst
Feature Type: Mine
Evidence: Scattered guano, no bats observed
Feature is a mine 15 m deep with scattered guano.

Revisit: 2/13/2014
Observers: N. Foley and E. Scobie
Evidence: 13 m long adit. Several other features in the vicinity. Small room ~2.5x3.0 m at the working face. Guano, moth, beetle, dragonfly wings most heavily concentrated in the "room". Evidence scattered along the drift. No animals observed.

Roost Site: Wellton 6 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 771834mE, 3604480mN
Dates Observed: 1/13/2011
Observers: J. Ernst
Feature Type: Mine, adit
Evidence: Guano, no bats observed
Feature splits into two different adits further inside. Five different piles of guano found with a total combined area of 0.75 m^2. Owl pellets also found onsite.



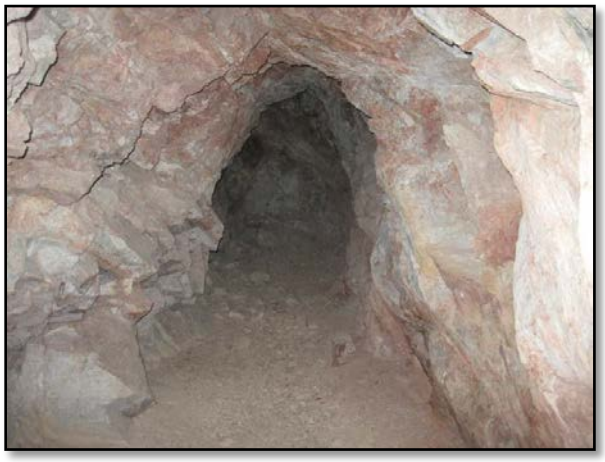
Date Observed: 2/14/2014
Observers: N. Foley and E. Scobie
Evidence: Adit with ~17 m maximum depth. Moderate guano, mostly in the left fork. Moth, beetle, dragonfly wings throughout. Located in an area with several other features which also contain similar bat evidence. No animals detected on this visit.

Roost Site: Wellton 7 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 771921mE, 3604496mN
Dates Observed: 1/13/2011
Observers: J. Ernst
Feature Type: Mine, adit
Evidence: Scattered guano, no bats observed
Feature is 8 m deep with scattered guano. Mine also found with owl pellets, feathers and whitewash.

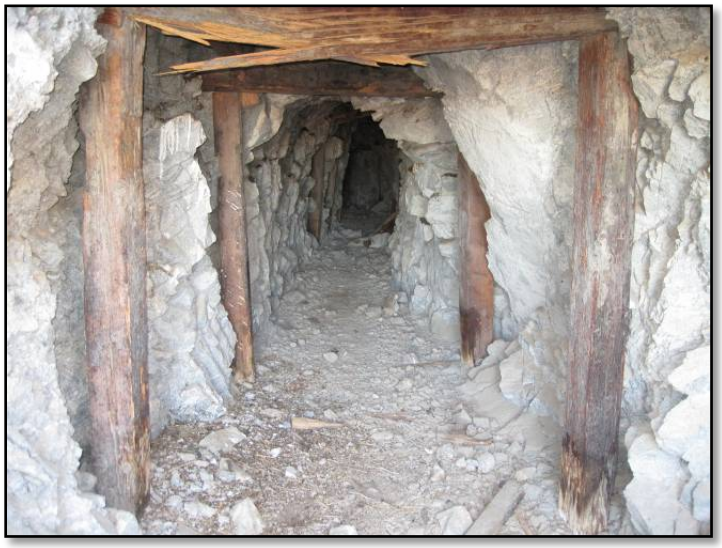
Revisit: 2/14/2014
Observers: N. Foley and E. Scobie
Evidence: 7.5 m long adit. Low guano, moth wings throughout. Located in an area with several other features containing similar bat evidence. No animals. Possibly night roost.

Roost Site: Wellton 8 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 771941mE, 3604600mN
Dates Observed: 1/13/2011
Observers: H. Hoffman
Feature Type: Mine, adit
Evidence: Scattered guano, no bats observed
Feature is 15 m deep with scattered guano found throughout.

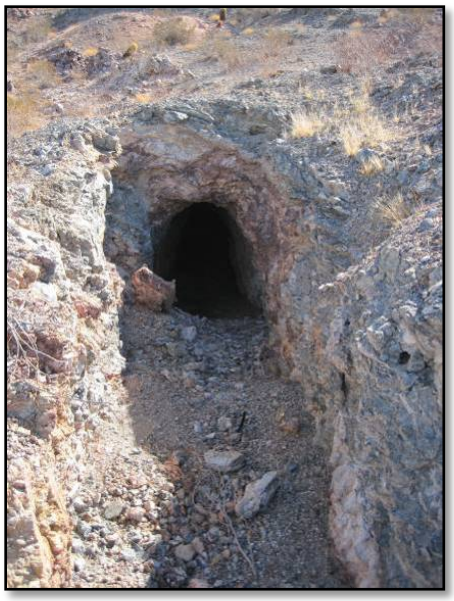
Revisit: 2/14/2014
Observers: N. Foley and E. Scobie
Evidence: 14 m long adit. Moderate to low guano. Moth, beetle wings scattered throughout in moderate to low density. In an area with several other features with similar bat evidence.



Roost Site: Wellton 9 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 772041mE, 3604200mN
Dates Observed: 1/13/2011
Observers: H. Hoffman
Feature Type: Mine, adit
Evidence: Scattered guano, no bats observed
Feature is 30 m deep found with scattered guano.



Roost Site: Wellton 10 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 773793mE, 3607163mN
Dates Observed: 1/15/2011
Observers: WC
Feature Type: Mine
Evidence: Scattered guano, no bats observed
Feature is 30 m deep with very large pile of guano 11.1 m^2.



Roost Site: Wellton 11 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 772045mE, 3604423mN
Date Observed: 2/14/2014
Observers: N. Foley and E. Scobie
Feature Type: Mine
Evidence: Adit with ~30 m max drift length. First ~20 m is timbered and stability appears moderate to low. Some collapse and fallen timbers from portal to ~4 m back. At about 20 m, the adit curves left and narrows slightly. This portion is not timbered and seems more stable. The majority of the guano was found here. Moth and beetle wings could be found through the length of the mine. Located in an area with several other features exhibiting similar bat evidence. No animals detected. Shaft located nearby (772004/3604406 UTMs) but was not able to be surveyed.

Roost Site: Wellton 12 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 771796mE, 3604530mN
Date Observed: 2/13/2014
Observers: N. Foley and E. Scobie
Feature Type: Mine
Evidence: Adit with ~17 m drift length. Moth, dragonfly, and beetle wings along with guano dispersed more or less evenly throughout the mine. A somewhat higher concentration of moth wings near portal. No animals observed. The mine is in the vicinity of several other workings. Basically this mine has the same amount and type of bat evidence as Wellton 5 - a known point, which is just upslope from this mine. It does not appear that this mine is a site, neither occupied of unoccupied.

Roost Site: Wellton 13 BMGRW
Quad: Wellton SE
UTMs (WGS 84): 771841mE, 3604465mN
Date Observed: 2/13/2014
Observers: N. Foley and E. Scobie
Feature Type: Mine
Evidence: Adit. 23 m maximum drift length. Irregularly dimensioned inside. Guano, moth, beetle, dragonfly wings present. Raptor skeleton. UDA garbage near working face. No animals observed. In the vicinity of several other workings. Guano and wings throughout, with a slightly higher concentration of wings near the portal.

Survey results

From all surveys completed, we surveyed 1,345 survey plots. Of these, 158 survey plots contained features and 149 survey plots contained bat features [*see* Figs. 5 (BMGR East), 6 (BMGR West) and 7 (YPG)]. Our top model selected 4 predictive covariates (*i.e.*, landform, road distance, slope and soil types) from a set of 16 (Table 2). The probability of feature likelihood increased with proximity to roads, rocky soil associations and level plateaus or terraces. Feature likelihood decreased with close proximity to moderately steep slopes. Figure 8 graphically displays the results of these analyses across our study area. Based on this model output, less than 5% of the total study area has the highest category likelihood of bat features (YPG = 3.57%, BMGR = 4.84%; Table 4).

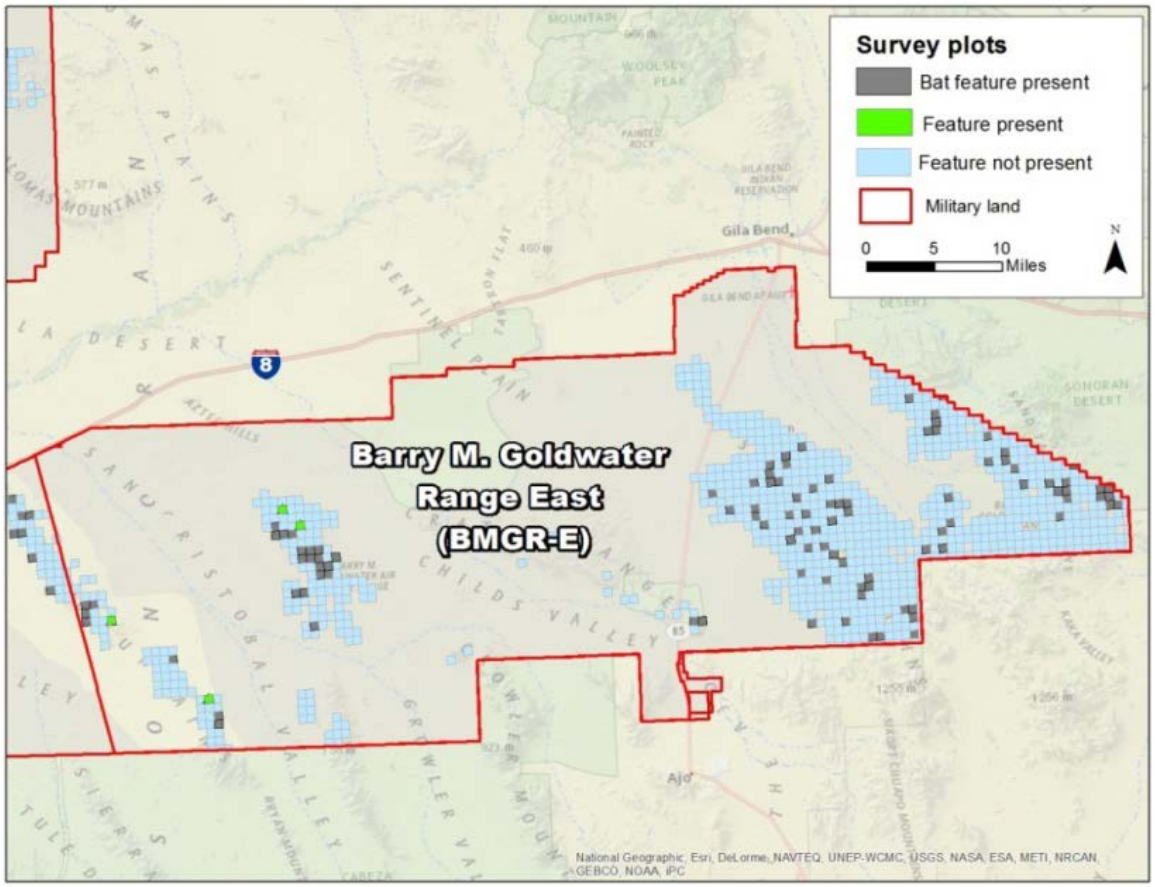


FIGURE 5. Surveyed 1-km sampling framework (blue, gray and green blocks) used to develop predictive bat feature likelihood model with bat features (gray blocks) and additional non-bat features (green blocks) across BMGR East, 2014.

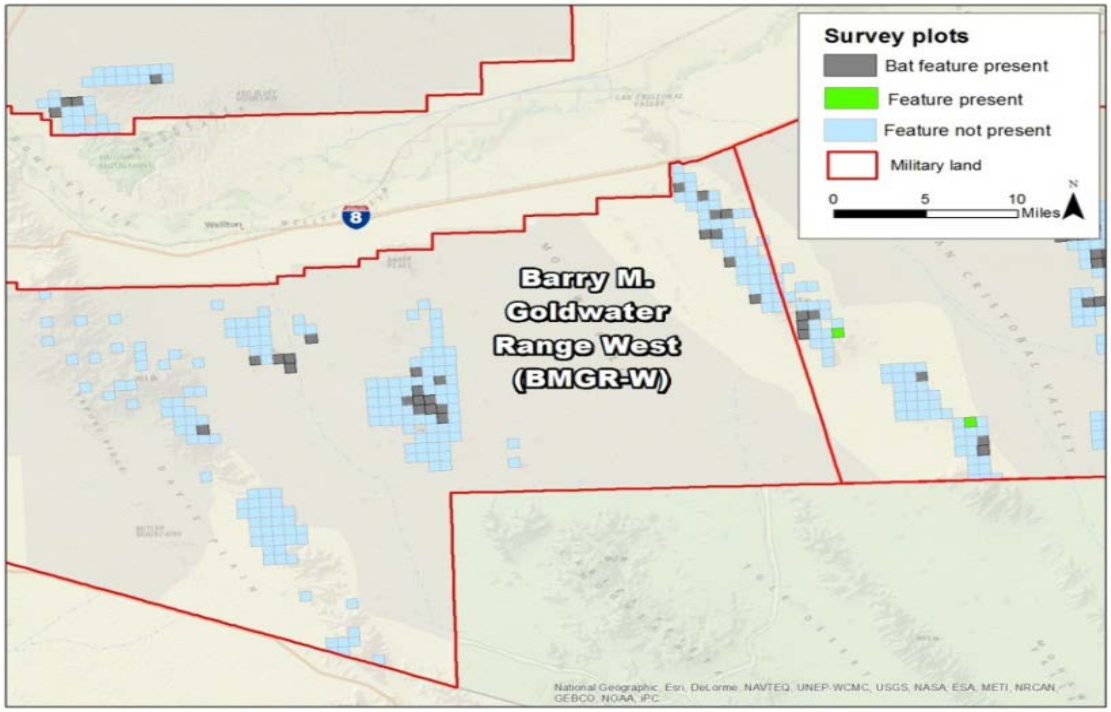


FIGURE 6. Surveyed 1-km sampling framework (blue, gray and green blocks) used to develop predictive bat feature likelihood model with bat features (gray blocks) and additional non-bat features (green blocks) across BMGR West, 2014.

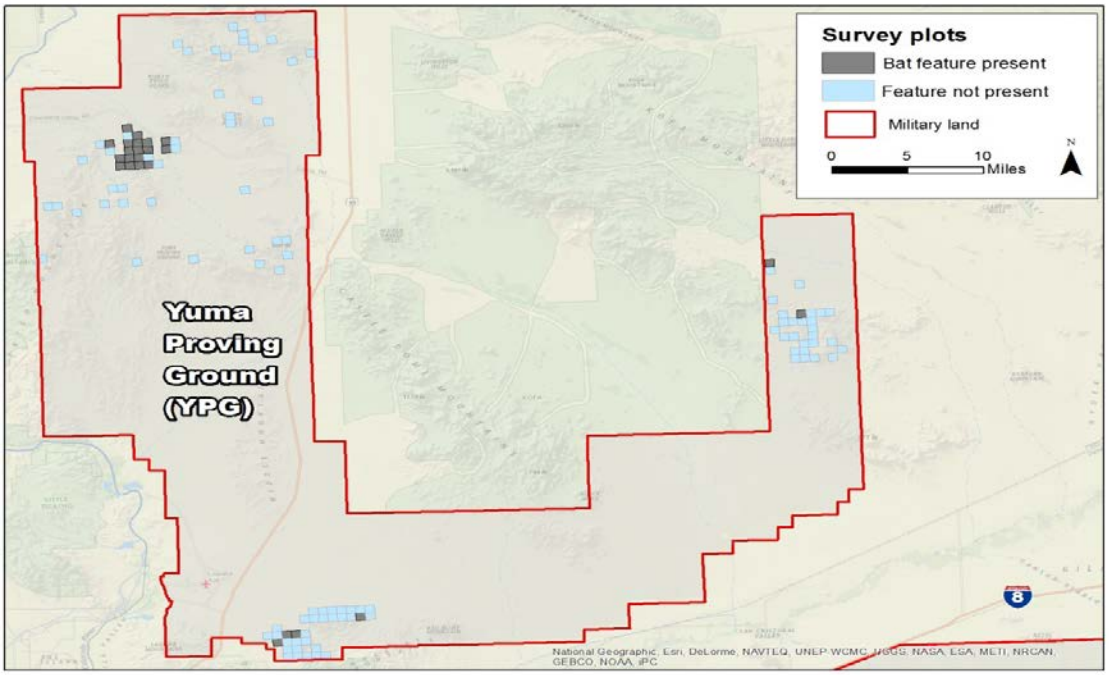


FIGURE 7. Surveyed 1-km sampling framework (blue, gray and green blocks) used to develop predictive bat feature likelihood model with bat features (gray blocks) and additional non-bat features (green blocks) across the YPG, 2014.

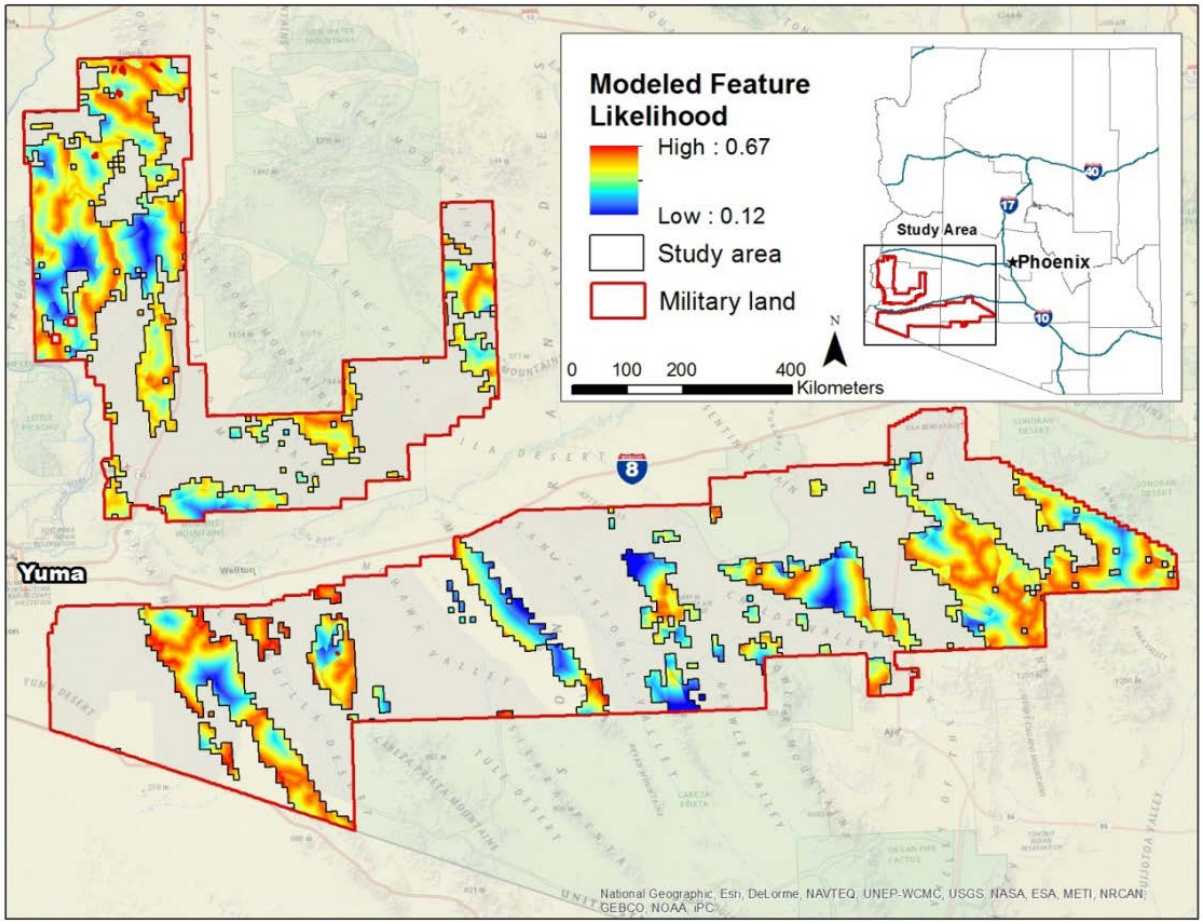


FIGURE 8. Modeled GIS output of significant covariates describing the likelihood of potential bat features across the Barry M. Goldwater Range and Yuma Proving Ground on a color ramp from high likelihood (red) to low likelihood (blue) from data collected by the combined efforts of 2010 through 2014.

TABLE 4. Likelihood of bat features for Barry M. Goldwater Range (BMGR) and Yuma Proving Ground (YPG) determined from field surveys and regression modeling, 2014.

	FEATURE LIKELIHOOD (*p*)		
Location	*48-66%*	*26-48%*	*11-26%*
YPG (335,985 ha)	12,000 ha	577,504 ha	95,517 ha
BMGR (707,200 ha)	34,248 ha	781,209 ha	122,124 ha

DISCUSSION

Mines and caves are important habitat for many bat species that occupy DoD lands in southern Arizona. Twenty-seven of the 45 bat species in the United States are known to roost in mines,

and for several of these species, mines may represent critical habitat (Tuttle and Taylor 1998). The lesser long-nosed bat, Arizona's only endangered bat species, appears to be heavily dependent on abandoned mines for roosting sites. Other species that rely heavily on mines are: California myotis, cave myotis, Yuma myotis, pallid bats, Townsend's big-eared bats, Allen's lappet-browed bats (*Idionycteris phyllotis*), Mexican long-tongued bats (*Choeronycteris mexicana*), Mexican free-tailed bats, and California leaf-nosed bats. With the loss of traditional roosts (*e.g*., caves) due to disturbance, habitat modification and other factors, mines may become more important habitat features for roosting bats. These survey efforts highlighted the distribution of roost sites for bats across these ranges and the importance of historic mine sites for bats.

Mines share several characteristics with caves (Tuttle and Taylor 1998) that make them high-quality bat habitat, including stable temperature and humidity, low light levels, and protection from predators. As with caves, certain mine structures may create cold or warm air traps providing appropriate microclimate for roosting bats. Multiple mine entrances may create air flow, which may also affect the variety of microclimates available. Similar to caves, mines may be used as day roosts (*i.e.*, maternity, bachelor, or transitory [*e.g.*, Mohawk 45]), night roosts, courtship sites, and hibernacula. However, mines may also be susceptible to greater disturbance than caves due to proximity to roads and increased human activities (Kunz 1982)

Because of low fecundity, high juvenile mortality, and long generational turnover, many bat populations may be vulnerable to human-induced pressures. Entering roosts at sensitive times of the year , camping in or near caves and mines, releasing environmental toxins (O'Shea et al. 2001), and destroying roost sites are all human-induced pressures known to be threats to bats. The threat of human disturbance to bats living in mines is similar to the threat of disturbance to cave-roosting bats. Human visitors can intentionally or unintentionally disturb and even cause mortality to roosting bats. Mineral and artifact collectors are entering mines in increasing numbers. Mines are inherently unstable, providing threats to humans and roosting bats alike. Collapsing mine workings may cause injuries for fatalities to bats, humans and other wildlife. In addition, human disturbances can alter or block entrances that have the potential to change the internal micro-climate of the mine. Finally, programs that result in closures intended to safeguard humans but can be incompatible with mine-roosting bats should be carefully considered.

There are an estimated 80,000 to 100,000 mines in Arizona, but not all mines are equally suitable for bats. Of the Arizona mines surveyed by the AZGFD Bat Project, about one-third showed evidence of bat use, and approximately 10% appeared to be significant roosts (*pers. comm*., T. Snow). However, most surveys for this project involved one-time visits to the roosts and may not reflect actual mine usage. P. Brown (Brown-Berry Biological Consulting) has found 75-80% bat use (*i.e*., bats or guano) in Arizona mines with 10% showing "significant" usage. Knowledge of which factors characterize appropriate roosting habitat is sorely lacking. It is quite possible that many mines that are not currently used by bats could become appropriate roosts if protected from disturbance (Arizona Game and Fish Department 2006). Thus, effective prediction models are especially valuable if validated with site visits that determine bat use.

The amount of training and public recreation on the BMGR and YPG has increased in recent years, especially regarding the use of mines and caves (*i.e*., potential bat roosts) in military

exercises and munitions testing. It is therefore imperative that roost site locations be identified to avoid conflicts between sensitive bat species and military missions and/or public health and safety. Finally, there are safety issues that must be considered when deploying personnel in training scenarios where they may encounter abandoned mines or caves. Having detailed maps of mine and cave locations within the BMGR and YPG could be vital in mission implementation and safety.

Management Recommendations

During surveys for features, the following identified features should be considered for the installation of protective gate options for mitigation primarily due to public safety concerns. Appropriate gates (*see* White and Seginak 1987; Pugh and Altringham 2005) can create a barrier between human activities and the bat roost sites that is beneficial to the military installations liability while protecting the bats utilizing these features. We also recommend that long-term monitoring methodologies be developed and implemented to assure that the bat activity in these features be retained. Specifically we recommend yearly surveys of these features and a development of remote monitoring strategies. These remote monitoring strategies should focus on methods such as motion detectors or acoustic roost loggers. These devices will provide a year-long pattern of bat use types and magnitudes. These bat use types and magnitudes can then be compared across years to determine if bat use declines or increases. These declines or increases in bat activity can then be used to ascertain the status of bat habitat on these DoD installation prior to total bat population collapse.

Mohawk 1:	Gate. Lots of human traffic. Most likely connected to Mohawk 2 airflow.
Mohawk 2:	Gate. Lots of human traffic. Deep mine and unable to complete survey because of winze at 18m. A dangerous mine. Airflow, most likely connected to Mohawk 1.
Mohawk 3:	Gate. Lots of human traffic: Approximately 12 *M. californicus* using as a day roost. Very dangerous mine, rail tracks run over an unsupported winze.
Mohawk 11:	No revisit but possible gate due to the depth and complexity of this mine feature and high likelihood of bat use from both *M. californicus* and *myotis* spp.
Mohawk 32:	50 + *M. californicus* using as a day roost.
Mohawk 45:	Approximately 30 *M. californicus* using as a day roost. *C. townsendii* guano and *myotis* spp. Guano also detected.
Mohawk 46:	Gate. Lots of human traffic. 40+ *M. californicus* using as a day roost.
Muggins 4:	Approximately 20 *M. californicus* using as a day roost.
Wellton 4:	Unable to be fully surveyed but strong evidence bats may be roosting deeper in the winze. Possible gate recommendation, human footprints detected inside.

This report expands upon previous efforts to collect and compile a comprehensive list of features throughout these three military installations (Table 3). Moreover, a predictive GIS model has been developed to focus future resources for monitoring and additional survey efforts across this landscape (Fig. 8). We suggest for monitoring purposes that a cost-effective combination of acoustic stations and bat mist-netting be implemented throughout this landscape to monitor trends in species presence and general behavior throughout this landscape. We also recommend further investigative surveys of polygons predicted as high potential areas for bat use. As the

study area in this effort was vast we were unable to thoroughly survey all 1-km^2 survey plots. Our modeling efforts derived from the sampled cells indicate that several un-surveyed polygons have a high potential to contain bat habitat. These polygons should be managed as occupied areas until a thorough investigation of the polygons can be conducted. The data collected and the models created through this survey effort should be utilized to proactively manage bat roosting habitats on these DoD installations. This study will allow land managers to assess trends associated with new or expanded military activities and maintain compliance with the DoD and BCI MOU, Sikes Act, ESA, and Integrated Natural Resources Management Plans.

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