

Assessment of Abandoned Mines for Bat Use on Bureau of Land Management Lands in Southwestern Montana: 1997-1998

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ABSTRACT

One hundred and seventy-three abandoned mine workings (77 adits, 96 “shafts” and pits) at 88 mine sites in southwestern Montana (Beaverhead, Madison, and Silver Bow counties) were investigated for evidence of use by bats during 1997-1998. Of the mine workings, 40 (23.1%) were partly or completely collapsed. Evidence of bat use was collected from 66 workings at 49 mine sites. Bat activity was detected with ultrasonic bat detectors or trapping at 61 workings of 45 mine sites. Bat guano (usually only one or a few droppings) was present at 5 additional mine workings at 4 mine sites where there was no other evidence of bat use. No maternity sites were found (although single lactating females were captured twice at one mine); the majority of used workings were probably night roosts. Only one working was confirmed as a hibernaculum, but several others may be so used.

Sixty-four individuals represented by Western Small-footed Myotis (*Myotis ciliolabrum*), Western Long-eared Myotis (*M. evotis*), Big Brown Bat (*Eptesicus fuscus*), and Townsend’s Big-eared Bat (*Corynorhinus townsendii*), were captured or observed at 17, 5, 2, and 3 mine workings, respectively. Sex ratio of captured bats was extremely male biased. Most bat detector results (at 47 of 50 workings with detections) were identified as unknown bat or unknown *Myotis*, but species identifications were tentatively assigned to *M. evotis* at 10 workings, *E. fuscus* at 12 workings, *C. townsendii* at 6 workings, and *Lasiurus noctivagans/Lasiurus cinereus* at 4 workings.

Monitored mines at higher elevations were used less often than mines below 6000'. Unobstructed mine workings were used more often than workings with partial obstructions, and adits in both categories were used more often by bats than were shafts. The elevation distributions of monitored adits and shafts were similar, and therefore not a factor confounding the general elevation pattern of use. Dominant vegetation at most (87%) of the monitored workings was sagebrush shrubland, and was also not a confounding factor in the detected patterns of mine use. Neither portal size nor the number of open portals at a mine site appeared to affect use by bats. Proximity to water could not be accurately determined, but most workings were < 2 km from known surface water, which is probably within the nightly foraging range of most bats.

Twelve mine workings were inspected internally for the presence of bats. Mines chosen for entry were selected based on relative hazard and prior evidence of bat use. Bats (four total) were found in three mines. Data loggers were installed in six mine workings to record over-winter mine air temperature and relative humidity every six hours. Data logger results are not included in this report, but will be provided as an addendum. Climate data taken at the time of entry indicate most sites probably are too cold for maternity colonies.

It is recommended that all open workings be considered as potential habitat for bats in this area. None of the workings where bat activity was confirmed should be closed, although monetary considerations could limit the number of workings modified to protect bats while restricting access to humans. Instead, other protective and bat-friendly measures should be considered, such as the installation of gates. Highest priority sites are those confirmed, or with the potential, to be maternity and/or hibernation roosts. The current method for closing shafts and other “vertical” workings (ground-level grating with 1x3 inch openings) effectively prohibits access by bats. Replacement of fine-meshed grates with an alternative, bat-friendly design might allow bats to use a number of these workings.

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INTRODUCTION

Several species of North American cave-dwelling bats have been adversely affected in recent decades by a variety of human-induced environmental changes to caves, including cave closures, impoundments, and vandalism or other direct human disturbances (see Humphrey 1978, Tuttle 1979, LaVal and LaVal 1980, Sheffield et al. 1992.). These, and landscape changes such as deforestation (including loss of large trees with basal hollows) and agricultural development, have forced many bat species to abandon traditional sites in search of new roosts and hibernacula. As a result of these wide-spread disturbances, some cave-dwelling species in the eastern and Midwestern United States have been listed as threatened or endangered under the U.S. Endangered Species Act. Abandoned mines offer a variety of subterranean microclimates similar to those in natural caves (Tuttle and Stevenson 1978, Tuttle and Taylor 1994) and can provide suitable habitat for roosting and hibernating bats. Abandoned mines now serve as principle roosts and hibernacula for many cave-dwelling species (Tuttle and Taylor 1994), and are important for populations occupying marginal habitats (Gates et al. 1984) in areas where there are continued threats to primary natural roosts. It is widely acknowledged that natural cave environments are the most stable and desirable long-term habitats for bats, but abandoned mines may provide a suitable alternative.

Mine reclamation (including closure to restrict human access) is of interest to wildlife managers because reclamation activities can have significant negative impacts on bat populations (see Sheffield et al. 1992, Richter et al. 1993). Therefore, it is important that closure is done in such a way as to minimize disturbance to bats in the mines affected. Because the majority of bat species in Montana use caves and mines, it is especially important to determine the extent and magnitude of mine use by bats in the state, and identify situations where access by humans to abandoned mines can be restricted while maintaining mine attractiveness to bats.

Increased concern over bat populations nationally, coupled with increased emphasis on the closure of abandoned mines on public lands, has prompted Bureau of Land Management (BLM) biologists in Montana to assess abandoned mines for bat activity prior to mine closure (e.g., Hendricks 1997). A number of abandoned mines on BLM land in southwestern Montana are scheduled for closure in the near future. Some of these mines may provide habitat critical for hibernation, reproduction, and warm-season roosting by bats, including Townsend's Big-eared Bat (*Corynorhinus townsendii*), a designated Special Status species by the BLM in Montana, identified as a high priority species in 1998 by the Western Bat Working Group, and designated as a species of concern (former C-2 candidate for listing) by the U.S. Fish and Wildlife Service.

Primary objectives of the 1997-1998 abandoned mine inventory on BLM lands in southwestern Montana were to 1) identify specific mine workings used by bats, 2) gather external mine attribute data that might aid in identifying the suitability of unsurveyed workings and predicting broader patterns of mine use, 3) gather internal mine attribute data that will provide baseline environmental information on abandoned mines used by bats, with the expectation that these data will be useful in identifying suitable mine workings, even in the absence of bats, and 4) capture and identify bat species using abandoned mines in the project area.

STUDY AREA AND METHODS

The study area is in the Beaverhead Section ecological unit of the U.S. Forest Service Northern Region (Nesser et al. 1997). This section has a cold continental climate characterized by a warm, dry summer and a cold, dry winter; mean annual precipitation ranges from 9-20 inches (23-51 cm), with about 10% falling as snow. Large gravel filled valleys, surrounded by steep fault block mountains of a variety of bedrock types, dominate the topography. Valley elevation ranges from 4700-7600 feet, potential natural vegetation is largely sagebrush-steppe. The majority of mines surveyed were in this Southwest Montana Intermontane Basins and Valleys subsection.

Lists and location of mine sites and workings to be visited were obtained from the Dillon and Headwaters Resource Areas – BLM (= Dillon and Butte Field Offices, respectively), from databases developed by the Montana Bureau of Mines and Geology, and directly from topographic maps. Areas of focus tended to be at and near mines on the BLM lists, and particularly in mining districts (Ermont, Rochester, Tidal Wave) scheduled first for mine reclamation activities. The majority of mine workings surveyed were located in southwestern Montana, in Beaverhead and Madison counties, with a handful of sites in extreme southern Silver Bow County.

Precise location of 52 sites was recorded on a differentially-correctable Trimble Geoxplorer II GPS unit, but some sites were never recorded and some files were inadvertently lost. Thus the record of GPS locations in Table 1 is incomplete because of missing data, and the production of maps from the available data seemed pointless. Nevertheless, all mines surveyed were recorded to quarter-quarter section precision (see Table 1), and photographs, where taken, were filed for future reference with original field data sheets at the Montana Natural Heritage Program Helena office.

Mine workings represent a continuum of types, but were classified into three basic categories: adits (horizontal slender workings), shafts (vertical slender workings), and pits (vertical broad workings). Some workings fell somewhere between adits and shafts, and are more accurately termed “inclines”; inclines usually appear on topographic maps (if portrayed at all) as shafts. Most often, inclined workings were angled $> 30^\circ$, and contained remains of ladders in the main passage to aid movement. In this report inclined workings steep enough for ladders to be helpful are categorized as shafts and those of lesser angle are termed adits, for reasons of simplicity and lack of clear criteria for demarcation between adits, inclines, and shafts.

For each mine site visited, the presence or absence of open portals was the first variable noted. If a mine working had not collapsed, then the dimensions of each opening were measured or estimated, any obstructions (grating, cable netting, fallen timbers or rock, etc.) noted, and if accessible the entrance was inspected for bat spoor (primarily droppings). Temperature of outward air flow, if present, was also measured. Dominant cover-type of the surrounding habitat at mines was classified following a standardized scheme used by Montana Partners-In-Flight for point-count monitoring of birds (Hutto and Young 1999).

A small subset of mine workings was examined internally for bats and to install electronic data loggers (HOBO; Onset Computer Corporation, Bourne, MA). Data loggers were set to record mine air temperature and relative humidity every 6 h, put in the selected mines in September 1998, and left in situ during winter 1998-1999. The underground climate data captured by the data loggers are not available for this report. Underground workings were

crudely mapped as far as they were examined, and carefully inspected for bats and bat guano in sections deemed safe to explore. Twelve workings were thus examined (Table 1), and data loggers were left in six of these.

Bat detectors (ANABAT II, Titley Electronics, Ballina, Australia), mist nets, and/or harp traps were deployed at workings where spoor was present or the mine working otherwise appeared potentially suitable for bats. Detector units (consisting of an ultrasound detector, timer/tape-driver, and a voice-activated cassette tape recorder) were set before dusk facing portals or aimed across shafts, and left in place overnight. Recorded calls were analyzed on an IBM compatible PC using ANABAT II zero-crossings analysis interface module (ZCAIM) and software.

Assignment of vocalizations to a particular species of bat was achieved by matching time-frequency structure of field recordings with a reference set of calls obtained from captured individuals and published descriptions of vocalizations (e.g., Fenton et al. 1983, O'Farrell 1997). However, bat species can show significant variation in call structure (Betts 1998, Barclay 1999), and we did not actively track and record flying bats (O'Farrell et al. 1999) to maximize quality and quantity of diagnostic sequences. Furthermore, units recorded bats exiting roosts or flying near potential roosts. Roost-exit calls and calls in high clutter tend to be fragmentary, lacking diagnostic features necessary for species identification (O'Farrell 1999). Therefore, all species-level identifications based on recorded vocalizations, where made in this study, are considered tentative.

Myotis designations (as a group) were assigned to recordings with vocalizations of short duration (< 3 msec) with a relatively linear, perpendicular call pattern. In some cases, *Myotis* call sequences were assigned to *M. evotis* if sweep pattern ranged from a maximum 90 kHz to a minimum 35-40 kHz, otherwise all were classified *Myotis* species. Calls with a bilinear (extreme curvilinear) pattern were tentatively assigned to a non-*Myotis* species or classified as unknown bat. Passes with call fragments were also designated unknown bat if no associated calls allowed finer resolution. Most bilinear call sequences were assigned to *Eptesicus fuscus* if a continuous frequency tail ranged from 33-28 kHz. This could result in confusion with *Lasionycteris noctivagans* (Betts 1998), which has a similar call structure, but most of our recordings were made at the mouths of mines where the latter species is unlikely to occur.

Number of "passes" (defined here as a distinct vocalization with at least a 1 sec gap between prior and following vocalizations) was recorded as a measure of relative activity at each site. At five sites with bat activity, equipment malfunctioned prematurely. Therefore, relative activity as presented here is useful primarily as an index with variable degrees of error.

Bats were captured using 50-denier mist nets of various lengths (most often 6 and 9 meter) and set in a variety of arrays across portals, depending on site morphology. Nets typically were operated for at least three hours (usually until midnight or 01:00 MDT). Less frequently a harp trap was set in the portal of an adit and left overnight. Captured bats were identified with aid of keys in van Zyll de Jong (1985) or Nagorsen and Brigham (1993). Individuals were sexed, aged, measured (forearm, weight), reproductive status noted, then released.

Where data are analyzed statistically, standard procedures and tests were followed as described by Sokal and Rohlf (1981). G-tests were used to examine the null hypothesis of equal proportions in frequency distributions, the null hypothesis of equal means in normally-distributed data sets was examined using t-tests. No particular probability level was assumed as representing statistical significance, other than to consider a *P*-value of 0.05 or less to fall within

that nebulous category. Some tests were run using STATISTIX version 2.0 (Analytical Software, Tallahassee, Florida).

RESULTS

General Summary of External Surveys

External inspections of 173 workings at 88 abandoned mine sites were documented in 1997-1998 during this survey (Table 1). Of these workings, 77 were adits, 90 were "shafts" (see Methods), and 6 were pits. Ninety-two workings were monitored for bat activity at least one night: 78 with bat detectors and 39 (14 exclusively) with mist nets and/or a harp trap. Some workings were monitored more than once using more than one method (Table 1). Elevation of mine workings ranged from 4970' to 8700'. Monitored adits (46) and shafts/pits (46) were distributed similarly by elevation (Fig. 1; $G = 1.780$, $df = 2$, $P > 0.4$). Dominant vegetation (cover type) was recorded at 87 (94.6%) of the monitored mine workings, of which 76 (87.4%) were in sagebrush steppe. Remaining cover types at mine workings included grassland (1), Douglas-fir (5), mixed conifer (1), spruce/fir (3), and whitebark/limber pine (1).

Evidence of bat use was gathered at 66 workings of 49 mine sites, ranging in elevation from 4970' to 7640', while elevation range of unused mine workings was 5150' to 8700'. Of these, in-hand identification of bats was made at 20 workings of 16 mine sites (Table 2). Bat activity was recorded by bat detectors at 50 workings of 40 mine sites (Table 3); of these, 41 workings at 30 mine sites were at locations where bats were not visually identified. Bat use based only on the presence of guano (usually only one or a few pellets) was recorded at 5 workings of 4 mine sites. Bat activity was recorded at 48 (63.2%) of the workings in sagebrush habitat, 4 (80%) in Douglas-fir habitat, each single working in the grassland, mixed conifer, and whitebark/limber pine habitats, and none of the workings in spruce/fir habitat.

Bat Species Captured or Observed

During 1997-1998, 64 bats representing four species were captured or observed at 20 different workings of 16 mine sites (Table 2). Six individuals of two species may have been sampled twice < two weeks apart at the unnamed adit T4SR8WS18SENW, as the sexes and numbers of each species in each sample were identical. However, forearm measurements and scars did not closely match, so here I assume that 12 different individuals were captured. The Western Small-footed Myotis (*Myotis ciliolabrum*) represented 78.1% of the total ($n = 44$ m, 5 f, 1 ?), Western Long-eared Myotis (*M. evotis*) 14.1% ($n = 7$ m, 2 f), Townsend's Big-eared Bat (*Corynorhinus townsendii*) 4.7% ($n = 2$ m, 1 ?), and Big Brown Bat (*Eptesicus fuscus*) 3.1% ($n = 1$ m, 1 ?). These species were captured or observed at 17, 5, 3, and 2 workings, respectively. Maximum number of captures during nights when bats were captured ($n = 17$) was 9 bats, the mean was 3.12 ± 2.29 /night. Successful trapping occurred between 11 June and 21 August.

Sex ratio of the 61 bats assigned to sex was extremely male-biased (7.71 males for every female). Sex ratio for the two *Myotis* species combined was 7.29 males:1 female ($G = 37.683$, $P < 0.001$). Sex ratio of each species was *M. ciliolabrum* = 8.8 males:1 female ($G = 17.817$, $P < 0.001$), and *M. evotis* = 3.5 males:1 female.

Evidence of reproductive activity was scant. A lactating female *M. evotis* was captured on 6 August 1998 at the unnamed adit T4SR8WS18SENW, a second lactating female *M. evotis* was captured on 17 August 1998 at the same adit. Three female *M. ciliolabrum* with evident teats (non-nursing) were captured on 11 June 1998 at the unnamed adit T3SR7WS8SESE. Three

captured males were classified as scrotal: one *E. fuscus* at the Kent/Bluewing E on 24 July 1998, one *M. ciliolabrum* at the Kent/Bluewing F also on 24 July 1998, and one *M. evotis* at the Huron/Cottontail C on 20 August 1997.

Ultrasonic Monitoring

Ultrasonic bat detectors were placed at 78 different workings (Table 1). Bat activity was detected on at least one night at 51 (65.4%) of the workings (Table 3). Most detections (at 47 of 50 workings) were classified as unknown bat or *Myotis* species; for 992 recorded passes during the survey, 793 (79.9%) were classified in these two groupings. Western Long-eared Myotis (*Myotis evotis*) was tentatively determined at 10 workings, Big Brown Bat (*Eptesicus fuscus*) at 12 workings, Townsend's Big-eared Bat (*Corynorhinus townsendii*) at 6 workings, and Silver-haired Bat (*Lasionycteris noctivagans*)/Hoary Bat (*Lasiurus cinereus*) at 4 workings, 3 of which were shafts. Shafts probably are the kind of mine working where these non-mine inhabiting species are most likely to be detected, as they forage over the mine area.

Activity at most sites was relatively low, based on the number of passes detected. For 54 nights of monitoring at 50 workings (number of passes were not recorded at one site), the mean number of passes (\pm SD) was 18.4 ± 38.2 . The large standard deviation indicated the wide range of activity at individual sites where bats were detected (from 1 to 187 passes/detector night). Only 16 (31.4%) of the samples included > 10 passes/detector night, and eight of these were < 30 passes. For workings with < 30 passes/detector night ($n = 47$), the mean number of passes was 6.3 ± 5.2 . Sites with more than 100 passes/detector night included the Ermont #19 pit + shaft (145 passes on 18 August 1997), Hendricks gated adit (154 passes on 21 August 1997), and the unnamed shaft T3SR7WS33NESW (187 passes on 29 June 1998). Of course, there was no way of determining how many individual bats were active at any of the workings based only on the recorded vocalizations. Also, weather and battery failure interfered with some all-night recordings, limiting their reliability as a measure of relative activity.

Patterns of Mine Use

Bats used all three categories of mine workings (adits, "shafts", pits) across a wide range of elevations and habitat types, from 9 June to 15 October (nearly the extreme dates for external surveys). However, some patterns of mine use were evident upon closer examination of the data. The analyses that follow are necessarily crude, because several variables that were not sampled adequately may also influence patterns. These will be addressed at greater length in the Discussion.

Mine sites with evidence of bat use tended to be at lower elevations (Fig. 2; $G = 6.680$, $df = 2$, $P < 0.05$). Over 86% of monitored sites $< 6000'$ showed evidence of bat use, while the respective values for 6000-6999' and $> 7000'$ were 57.6% and 62.5%.

The proportion of mine sites with solitary workings that were used by bats (78.8% of 33 sites) was similar ($G = 0.256$, $P > 0.5$) to use of mine sites with more than one working (84% of 25 sites). Obviously, the criterion used to define a solitary or isolated working was very arbitrary (whether or not the named or apparent mine site had one or multiple significant and open workings). Using a larger number of categories to define the number of portals per mine site may result in a different conclusion. Such was not possible in this inventory because of relatively small samples of monitored mine sites with different numbers of workings.

A rough measure of portal size could be calculated for 50 of the monitored workings. Mean area (\pm SD) of used workings ($2.80 \pm 5.35 \text{ m}^2$, $n = 33$) was slightly smaller than for non-

used workings ($3.44 \pm 4.18 \text{ m}^2$, $n = 17$), but the difference was not statistically significant ($t = 0.43$, $df = 48$, $P = 0.670$). Some used workings were covered with wire netting or gates, and the “mesh size” was used in the above calculation. Using only the portal area itself behind the gate or mesh made the actual mean area of openings at used workings ($3.26 \pm 5.19 \text{ m}^2$) nearly identical with that of non-used workings. The large standard deviations indicate the wide range in portal sizes at used and unused workings.

Each major type of mine working was used by bats, but there was a difference in the frequency of their use (Fig. 3). Adits were used in much greater frequency than shafts (including pits) in 1998 ($G = 8.720$, $df = 1$, $P < 0.005$). This result is not biased by elevation distribution of the different types of sampled workings, as distributions were very similar (Fig. 1). Only 1998 data were used in this analysis, however, as there was slight overlap in the range of survey dates during the two years. External surveys were conducted from 4 August-16 October in 1997 and 9 June-19 August in 1998. Nevertheless, the pattern was similar, albeit weaker, in 1997, when 65.6% of monitored adits were used by bats versus 50% of shafts ($G = 1.242$, $P > 0.1$). Different dates of sampling (as well as different sampling conditions) may account for some of the annual disparity.

Obstructed openings also affected use of mine workings by bats. Bats were detected at 41.7% of unobstructed shafts ($n = 24$) and 65.2% of unobstructed adits ($n = 23$) that were monitored in 1998. Respective values for obstructed workings were 11.1% ($n = 9$) and 63.6% ($n = 11$). For years combined (including mine workings sampled in both years), 60% of unobstructed workings were used versus 42.9% for obstructed workings. Bats were more likely to use unobstructed adits in 1998 than unobstructed shafts ($G = 2.644$, $P = 0.12$). Likewise, bats were more likely to use obstructed adits in 1998 than obstructed shafts ($G = 6.222$, $P < 0.025$). Even though some workings were grated, screened or gated, all sampled workings were considered as possible bat habitat because each provided potential avenues of access to underground workings around the obstruction.

Internal Surveys

Twelve mine workings were inspected internally in 1998 for the presence of bats (Tables 1 and 4). Two of these were steep inclines (“shafts”), the remainder were simple or complex adits. Elevation of these mines ranged from 5640-7380'. Eight were $< 200'$ in length, relatively simple, and completely explored. Mine air temperature in September in this group ranged from 47.5-52.0°F near the drift faces. Another two (Unnamed Gold Deposit #2 and #3) were $> 200'$ but not fully explored (mine air temperature = 48.0°F), and the last two mines (Union #4 and Hendricks) were $> 400'$ and $> 1000'$ in length, respectively, with multiple levels, but not fully explored. Air temperature 323' from the portal of the Union #4 was 55°F. Air temperature in the Hendricks ranged from 41.5°F (400' from the portal) to 54°F (700' from the portal). Most mines were damp or contained standing water, but at least two were completely dry at the time of inspection. Data loggers were placed in six of the mine workings in September and will be retrieved in late August 1999. Each data logger is set to record mine air temperature and relative humidity every 6 hours.

Only the Hendricks Mine had significant quantities of guano scattered throughout the mine workings. Scattered guano in small quantities was present in the other mines. Bats were observed during internal surveys of three mines. One Western Small-footed Myotis (*Myotis ciliolabrum*) was observed in the Hendricks Mine on 13 June. Also in the Hendricks, one Small-footed Myotis and one Big Brown Bat (*Eptesicus fuscus*) were observed hibernating about 320'

from the portal on 4 December (D. Kampwerth, pers. comm.), near one of the temperature and humidity dataloggers. The large amount of guano throughout the passages of this mine suggest greater use by bats than revealed in this study. In other mines, one Townsend's Big-eared Bat (*Corynorhinus townsendii*) was observed in the Plainview B on 11 July, and one fresh dead Western Small-footed Myotis was found in the Unnamed Gold deposit #2 on 3 September.

DISCUSSION

General

The most abundant bat species using the abandoned mines surveyed in the study area (Table 1) is probably the Western Small-footed Myotis (*Myotis ciliolabrum*); 49 (78.1%) of the 64 bats captured or identified by sight were this species (Table 2). This species was captured at 17 workings, over three-fold more than for any other species. The Western Long-eared Myotis (*M. evotis*) appears to be the second most abundant bat using the mines, comprising another 14.1% (n = 9) of the total captured. This species was captured at 5 mine workings and tentatively identified with bat detectors at another 10 (Tables 2 and 3). These two species combined probably also comprised the majority of unknown bat and *Myotis* species determined on the bat detector recordings (Table 3). Both species are widespread in arid-land and forested habitats of the western United States (van Zyll de Jong 1985, Nagorsen and Brigham 1993, Ports and Bradley 1996, Szewczak et al. 1998, Kuenzi et al. 1999).

Townsend's Big-eared Bat (*Corynorhinus townsendii*), a BLM Special Status species in Montana, was captured or sight-identified at 3 workings (Table 2), and tentatively determined at another 3-6 workings using ultrasound detectors (Table 3). These encounters occurred in seven townships, suggesting a broad geographical distribution at a low-level of abundance. This species also is routinely encountered using mines and caves in arid habitats (Humphrey and Kunz 1976, van Zyll de Jong 1985, Nagorsen and Brigham 1993, Ports and Bradley 1996, Szewczak et al. 1998, Kuenzi et al. 1999). The Big Brown Bat (*Eptesicus fuscus*) was the fourth species captured (at 1 working and observed in another), and was tentatively identified with ultrasound detectors at 10 additional workings. This species is widespread over much of North America (van Zyll de Jong 1985, Nagorsen and Brigham 1993). The final two species, Silver-haired Bat (*Lasionycteris noctivagans*) and Hoary Bat (*Lasiurus cinereus*), were tentatively identified only with bat detectors at 4 mine workings. Both species rarely use mines and caves for roosts (van Zyll de Jong 1985, Nagorsen and Brigham 1993), so their presence at mine workings is likely a reflection of their foraging activity near these sites.

Bat activity in the inventory area was widespread during 1997-1998. However, intensity of activity was relatively low at most sites, suggesting that the majority of used abandoned mine workings served as night and/or day roosts. This does not mean that the mines are not important for the bat populations of the survey area. Low population densities of bats could easily account for the relatively low activity at many workings, and sites in which to rest between foraging forays remain important habitat components for bats.

None of the mine workings appeared to serve as a maternity roost, although this conclusion is based on circumstantial evidence. Few female bats were captured (Table 2), and mine air temperatures were likely too cool for maternity sites (see discussion in Betts 1997). Instead, most females raising developing young probably were using natural cavities in trees and rock outcrops, where warmer temperatures occur (e.g., Humphrey and Kunz 1976, Dobkin et al.

1995, Bogan et al. 1996, Vonhof and Barclay 1996, Kalcounis and Brigham 1998, Ormsbee and McComb 1998, Rabe et al. 1998).

The degree to which any of the examined workings are used by bats as hibernacula is largely unknown. It can be very difficult to determine the importance of a mine as a hibernaculum based solely on external surveys unless a visit happens to coincide with bats returning to the site to overwinter. Internal temperature regimes, mean annual surface temperatures, and mine complexity may be good predictors of such use in some areas (e.g., Dwyer 1971, Tuttle and Taylor 1994), and such information could help in judging the necessity for future internal surveys at selected sites. Some aspects of internal temperature and relative humidity regimes of mines in southwestern Montana may be inferred from data obtained through the data loggers in place from September 1998 to August 1999. These records will be supplied in a supplemental report following instrument retrieval and data analysis.

The Hendricks is currently the only mine in the study area that is known to be a hibernaculum; one *M. ciliolabrum* and one *E. fuscus* were found hibernating in the mine on 4 December 1998 (Tables 2 and 4, D. Kampwerth pers. comm.). This mine is on land formerly owned by the BLM but now under jurisdiction of Bannock State Park. It seems probable, however, that several other mine hibernacula are present on BLM lands in the inventory area. The four bat species captured during this study have been documented over-wintering in mines or caves elsewhere in Montana (Swenson 1970, Swenson and Shanks 1979, Hendricks et al. 2000), Idaho (Genter 1986), and Wyoming (Priday and Luce 1997). Two studies where *M. ciliolabrum* and *C. townsendii* co-occur (Genter 1986, Kuenzi et al. 1999) indicate that the former species may occupy slightly colder hibernacula.

Mine Selection

Results of this inventory showed that bat activity at monitored abandoned mines was not uniform across the study area. On a landscape scale, higher-elevation workings (> 6000') were used less frequently than workings at lower elevations (Fig. 2). Why this should be so is not entirely clear, especially given that most used workings appeared to be night roosts. In regional and local studies, reproductive females favor lower elevations, presumably because of the more favorable climate conditions in which to raise young (Thomas 1988, Nagorsen and Brigham 1993, Storz and Williams 1996). Their absence from higher-elevation areas still would not explain why mine workings were visited less frequently by males and non-reproductive females. Perhaps population densities of bats at higher elevations in this region are extremely low for reasons other than the availability of underground roosts.

On a more local scale, unobstructed workings were more likely to be used, although the difference for adits was very slight. More surprisingly, adits, whether obstructed or not, were more likely to be used than shafts (Fig. 3). Why partially obstructed workings might deter bat use is seemingly self-evident, through inhibiting access. The differential use of adits and shafts is less easily explained. I am not aware of other studies showing a preference for one kind of working over another, either within a suite of bat species, or by any particular species of bat. It is possible that horizontal adits may better hold warm air overnight than vertical shafts, and that bats seek warmer places to night roost. In Arizona it has been shown that night roosting by Pallid Bats (*Antrozous pallidus*) in horizontally oriented grottos typically began when external air temperature cooled below that of the warmer internal air (O'Shea and Vaughan 1977). It is also possible that some species of bats prefer to enter horizontal workings. This pattern merits additional study.

There are factors that confound the differential use of adits and shafts, however, making tentative the conclusions drawn from that pattern. First, obstructions at shafts, especially grates, may be more effective barriers to bats, even though there may be a missing door in the grate, or there is some sloughing below the edges that might allow access near ground-level. Obstructions at adits often include gates, cable netting, partially open wooden doors or collapsed headframes, etc. with spaces allowing the passage of bats. Therefore, not all partial obstructions are equal, and those usually associated with shafts appear to be more effective in excluding bats. Second, shafts may be more likely to be obstructed by debris falling from the ground surface and accumulating in passages beyond the portal, as a result of their morphology. Because most workings (many adits as well as all shafts except two inclines) were not explored internally, there is no way of knowing what conditions they offered to bats. This is probably the most important shortcoming in attempting to develop external criteria for predicting mine suitability to bats; surface conditions may be completely unrelated to conditions underground.

Access to water is an important component in the spatial environment of bats that affects where they are active. This could not be realistically measured during this inventory, as there are many unmapped sources of surface water in most areas and at many times during an active season. However, most monitored workings were within 2 km of known surface streams or stock ponds, well within the nightly foraging distance from roosts of some bat species (e.g., Wai-Ping and Fenton 1989, Dobkin et al. 1995). Furthermore, water is sometimes available underground. At least 4 (25%) of the workings explored underground in 1998 had significant pools of standing water within them. Without access to all workings (including those on private land), proximity to water at any mine is speculative but is unlikely to be a significant factor influencing mine use in this study area.

Some potential confounding variables that could influence the detected patterns can be eliminated. The majority (87%) of workings was in sagebrush habitat, so vegetation cover type probably had a minor influence at most on which mine workings were used. Also, the samples of monitored adits and shafts were distributed similarly by elevation (Fig. 1), so their relative distributions across an elevation gradient had little influence on the preference shown for lower-elevation mines, if indeed adits really are favored by bats in this region (see Fig. 3).

Neither portal size nor the number of potentially suitable portals at a mine site affected the pattern of mine use by bats. Results of the portal size analysis could be biased for reasons previously addressed (not all partial obstructions can be equally by-passed by bats), but the distribution of grated shafts was roughly equal in the used and unused groups. However, number of portals at a mine site was classified into only two categories, one and more than one. With a larger sample containing multiple portals per mine, a different pattern may appear. Also, distance between portals needs to be measured metrically, rather than classified by mine name. To do this analysis properly, it is necessary to include mine workings on private lands, unless study areas are kept smaller than that of this inventory, and where access to all mines can be assured.

MANAGEMENT CONSIDERATIONS

Mine use by bats and mine climate

It is desirable to gather long-term climate data, using electronic data loggers, from a variety of mines used by bats as maternity, hibernation, and/or night roosts in Montana. These

baseline data will enhance the accuracy of future determinations of abandoned mine suitability for bats in Montana, especially for sites where no bats were directly observed.

Identifying mines used by bats can be relatively simple. For mines where entry is possible, presence of bat droppings indicates a mine has been used relatively recently. For mines considered too hazardous to enter, or where entry is prohibited or limited due to obstructions, use of electronic bat detectors or some form of capture technique can provide evidence of current use. Yet determining *why* bats are using different mines may be more involved. Reason for use (of interest to bat biologists and animal ecologists) may be immaterial to a management agency, so long as used sites are identified and protected. However, limited monetary resources could restrict the number of used mines that can be protected and maintained for bats. In such cases, highest priority mines are those used as maternity and/or hibernation roosts (Tuttle and Taylor 1994), and it is very desirable to identify these from night roosts, places where bats rest in safety to digest an evening meal.

In the Beaverhead/Madison counties survey area, most mines where bats were recorded appeared to be summer night/day roosts, with only a subset of these known or likely to be hibernacula. Temperatures recorded during internal inspections in June and September (8.5-16.5°C) were near or below lower thresholds recorded at maternity colonies in other areas (e.g., Twente 1955, Tuttle and Stevenson 1978, Pierson et al. 1991, Betts 1997, Williams and Brittingham 1997, Hurst and Lacki 1999). However, our temperature and relative humidity data are of limited use because they were taken usually during a single visit, and do not provide an adequate picture of temporal or spatial climate variation within many of these mines.

The microclimate of a mine, especially temperature and relative humidity, determines whether bats can use it at all and if so, in which season and for what purpose. In Montana, long-term climate data are not available for mines used by bats. Currently, climate measurements taken during internal mine surveys to determine potential suitability for bats throughout their annual cycle are compared with roost data from other regions. However, there is no reason to assume a priori that ranges in climate variables at roosts are invariant across species ranges, and we anticipate that climate in mines used for roosts in Montana may be somewhat cooler than in more southern regions of western North America. Using climate data from elsewhere as the basis for determining the range of suitable sites in Montana might result in exclusion of some usable mines.

Once more is learned from the data logger samples of climate regimes in the abandoned mine workings where they were placed (each of which was used by bats), it may be suitable for the BLM to a) consider sponsoring additional internal hibernacula surveys according to temperature, b) put an emphasis on future searches for maternity colonies in unsurveyed mines at lower elevations, and/or c) assign priorities for protection in a way that also considers likely thermal regimes best suited for bat hibernacula or maternity use.

Importance of abandoned mines in the inventory area

The determination of importance or significance of a mine working for bats is difficult. Almost any mine working in the inventory area still accessible to bats should be considered potentially important for them, especially those at which monitoring was conducted (Table 1), and particularly for workings where significant activity was recorded (e.g., bats captured, more than 10 passes recorded; see Tables 2 and 3). These comments are based on a combination of factors, including inadequate surveying of the entire area (partly due to complex ownership patterns), incomplete monitoring at mines visited (e.g., multi-season visits [see Altenbach 1995])

were largely impractical for logistical and monetary reasons), and localized availability of surface water with inadequate knowledge of how bats use the landscape around roosts. Also, the importance for bats of mines on private lands in the study area is unknown, and long-term security of these for use as bat roosts is also open to question.

Mines with obstructions are, on average, less attractive to bats for roosts, but some of these were used nevertheless. Removal of obstructions should be considered as an option for making mine workings more attractive to bats, especially at some mines where grated shafts predominate (the Emma is an example). Mine workings where bat activity was confirmed should be gated or protected by means other than closure. This assumes that policy dictates they are to be made accessible to bats but not to humans and/or livestock, and that adequate funding exists or can be allocated for such management activity. With limited funding, highest priority for protection should be given to those workings with the greatest amount of documented activity, and sites where Townsend's Big-eared Bat (a BLM Special Status species in Montana) was identified.

Mine closure methods

Bat friendly gates (see Tuttle and Taylor 1994, Dalton and Dalton 1995) should be installed on adit portals not already protected. Gates should be constructed such that they do not restrict air movement or passage of bats, yet prohibit livestock and unauthorized human entry. A bat-friendly gate design has been installed by the Mine Waste Cleanup Bureau, Montana Department of Environmental Quality at four abandoned mine adits elsewhere in Montana that are known to be used as hibernacula and/or maternity roosts by Townsend's Big-eared Bat (*Corynorhinus townsendii*). These adits were still in use in 1999 by this species and at least one species of *Myotis* three years after gate installation. The design uses 13 mm rebar with recommended spacing (5.75 inch vertical, 24 inch horizontal) on a swinging gate, secured by a protected lock (not an exposed chain and/or lock) and secured to the end of a corrugated metal pipe that is inserted into the mine portal. The corrugated pipe is then covered with fill to assure that entry is through the pipe and gate. Cable netting (usually about 8 x 8 inches mesh size) has been used with success in a few situations, but is more easily breached by humans than are properly designed gates. Cable netting is suitable primarily to maintain mine airflow while hindering access by humans and livestock, and is not recommended for protecting portals used by bats.

The current gate design used on many shafts in the study area, where a fine-mesh grate (mesh size of 1 x 3 inches) is placed at ground level over the portal, effectively prevents their use by bats. Many grated shafts have the potential to be used by bats if they were made more bat-friendly. Current grates can be replaced with grates built with angle iron having the proper spacing (5.75 x 24 inches) that will allow passage of bats (Dalton and Dalton 1995). However, use of this design without fencing may fail to prevent livestock from stumbling onto these and being injured. Replacement of the current grate design with a box-type or "cupola" design (e.g., Tuttle and Taylor 1994) on shafts currently protected should be considered. Fencing around shafts, the least obtrusive method to bats for preventing injury to livestock, fails to address the potential hazard for humans

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Table 1 Mine sites surveyed for potential/actual use by bats in southwestern Montana during 1997-1998 Sites with evidence of bat activity are indicated with a "+", mine workings inspected internally are marked with a "**"

Mine Site	Type	Date	Elev (ft)	Lat. (N)	Long. (W)	Legal TRS	Survey Method
+*Ruth & Copper Bottom	adits (3)	9 Jul 98+ 2 Sep 98*	7400	45° 43' 11"	112° 36' 15"	T1SR8WS28NWSW	visual (1 droppings) longest adit
Unnamed (collapsed)	shaft	20 Aug 98	5900			T1SR10WS9NNWNW	visual
Strawberry A	adit	16 Sep 97	6440			T2SR3WS14SENW	Anabat
Strawberry B	adit	14 Aug 98	6800	45° 39' 53"	111° 56' 21"		Anabat
Strawberry C	adit		6800				Anabat
+Strawberry D	shaft	17 Sep 97+	7200				Anabat
+Strawberry E	shaft	14 Aug 98	7280	45° 39' 53"	111° 56' 21"		Anabat
Mountain Cliff A (gated)	adit	17 Sep 97	8160			T2SR3WS15NENW	Anabat
Mountain Cliff B (gated)	adit		8700				Anabat
Mountain Cliff C	shaft		8700				Anabat
+Molhawk A	adit	25 Sep 97+ 19 Aug 98	5960			T2SR6WS10SENW	Anabat
+Molhawk B	shaft	25 Sep 97+					Anabat
Molhawk C (collapsed)	adit						Anabat
+Unnamed adit (gated)	adit	25 Sep 97	6200			T2SR6WS10SWNW	visual
+Gold Rod (mesh netting)	adits (2)	10 Jul 98	5100	45° 39' 16"	112° 19' 19"	T2SR6WS22NENE	Mist net
Short Sheriff (partly covered)	shaft	9 Jul 98	6940	45° 41' 09"	112° 30' 31"	T2SR7WS6SESE	Anabat, Harp trap
+Waiseca	shaft	6 Aug 97	5880	45° 37' 10"	112° 30' 22"	T2SR7WS31SENE	Mist net
+Beacon Light	adit	30 Jun 98	5860			T2SR7WS31SWSE	Anabat
+Champion	shaft	6 Aug 97	5800	45° 36' 55"	112° 30' 30"	T2SR7WS31SENE	Mist net
+Dick & Billy Jane (grated)	shafts (2)	6 Aug 97	5840	45° 36' 59"	112° 31' 03"	T2SR7WS31NESE	Anabat
Gold Nugget #1 (covered)	shaft	27 Jun 98	5900	45° 37' 26"	112° 29' 16"	T2SR7WS31NESW	Anabat
Gold Nugget #2	shaft		6000	45° 37' 18"	112° 29' 06"	T2SR7WS32NENE	Anabat
Gold Nugget #3	shaft		5900	45° 37' 26"	112° 29' 31"		Anabat, Mist net
Horn Silver (collapsed)	shaft	7 Jul 98	6700	45° 41' 09"	112° 37' 04"	T2SR8WS5SWSE	visual
Greylock	shaft	7 Jul 98	6400	45° 41' 15"	112° 37' 54"	T2SR8WS6SESE	Mist net
+Greylock West (collapsed)	adit	7 Jul 98	6400	45° 41' 21"	112° 38' 06"	T2SR8WS6NWSE	visual
+Champ Creek	adit	1 Jul 98	6050	45° 40' 55"	112° 33' 39"	T2SR8WS11NENW	Anabat, Harp trap
Chlorine Gulch (collapsed)	adit, shaft	17 Aug 98	6190	45° 39' 55"	112° 36' 54"	T2SR8WS17SENE	Anabat
+Jackrabbit	shaft, adit+	6 Jul 98	6700	45° 38' 30"	112° 35' 52"	T2SR8WS21NESW	Harp trap, Mist net
Unnamed (open door)	adit	6 Jul 98	6760			T2SR8WS21NWSE	Anabat
Unnamed PIG#3 (partly filled)	shaft	7 Jul 98	6650	45° 37' 19"	112° 35' 17"	T2SR8WS27NWNW	visual

Table 1 (cont.) Mine sites surveyed for potential/actual use by bats in southwestern Montana during 1997-1998. Sites with evidence of bat activity are indicated with a "+", mine workings inspected internally are marked with a "*".

Mine Site	Type	Date	Elev. (ft)	Lat. (N)	Long. (W)	Legal TRS	Survey Method
Union Prospect	adit	7 Jul 98	6600			T2SR8WS28NENE	visual
Unnamed Prospects	adit	7 Jul 98	6000	45° 37' 59"	112° 36' 43"	T2SR8WS29NWNW	visual
+Maiden Rock	adit	5 Aug 97	5400	45° 41' 46"	112° 44' 13"	T2SR9WS5NENE	Anabat
+Unnamed (N of Helene) (2 collapsed)	shafts (4)	8 Aug 98	5050			T3SR1ES19NENW	Anabat, Mist net
+Helene (collapsed)	adits (2)	8 Aug 98	4970			T3SR1ES19NENW	Anabat, visual
Florence (collapsed)	adits (3)	8 Aug 98	5250			T3SR1ES19NWE	visual
+Plainview A (grated culvert)	adit	23 Sep 97 11 Jul 98+	5680			T3SR5WS28NWNW	Anabat
+*Plainview B	adit	11 Jul 98					visual
+Tidal Wave A	adit	23 Sep 97+	5960	45° 32' 59"	112° 13' 43"	T3SR5WS28NENW	Anabat
+Tidal Wave B (grated)	shaft	10 Jul 98+	6000	45° 32' 59"	112° 13' 30"		Anabat, Mist net
Tidal Wave C (collapsed)	adit		5900				visual
Tidal Wave D (grated culvert)	adit		5900				visual
Pearson Prospect (adit collapsed)	shaft, adit	24 Sep 97 22 Jul 98	6080			T3SR5WS34SENW	Anabat
+Falcon Prospect (partially collapsed)	shaft	24 Sep 97+	5960	45° 31' 49"	112° 12' 34"	T3SR5WS34NESW	Mist net
Walker adits (grated or collapsed)	adits (3)	24 Sep 97+	5920			T3SR5WS34NWSW	Anabat
+Walker shaft (collapsed 1998)	shaft	10 Jun 98		45° 31' 51"	112° 12' 44"		visual
+Black Ace #1 (partially collapsed)	adit	24 Sep 97+	6400			T3SR5WS34NWNNE	Anabat, visual
+Black Ace #2	adit	22 Jul 98+					Anabat
Black Ace shaft	shaft	22 Jul 98					Anabat
Germania 1	shaft	24 Sep 97					visual
+Germania 2	adits (2)	28 Jun 98	5980	45° 36' 08"	112° 27' 40"	T3SR7WS3NWSW	visual
Germania 3	adit			45° 36' 09"	112° 27' 44"		Anabat
+Germania 4	adit			45° 36' 10"	112° 27' 45"		Mist net
April Claims	shaft/pit	29 Jun 98	5800	45° 35' 59"	112° 28' 04"		Anabat
Gold King	shaft	16 Oct 97	5900	45° 36' 04"	112° 30' 03"	T3SR7WS4SWSE	visual
Emma A (grated)	shaft	15 Oct 97+	6050	45° 35' 53"	112° 31' 01"	T3SR7WS5NWSW	Anabat
Emma B (grated)	shaft	10 Jun 98		45° 35' 54"	112° 30' 59"	T3SR7WS6SESW	Anabat, Mist net
+Emma C	shaft			45° 35' 56"	112° 30' 57"		Anabat, Mist net
Emma D (grated)	shaft			45° 35' 56"	112° 30' 56"		visual
Emma E (grated)	shaft			45° 35' 58"	112° 30' 55"		visual

Table 1 (cont.) Mine sites surveyed for potential/actual use by bats in southwestern Montana during 1997-1998. Sites with evidence of bat activity are indicated with a "+", mine workings inspected internally are marked with a "**".

Mine Site	Type	Date	Elev. (ft)	Lat. (N)	Long. (W)	Legal TRS	Survey Method
+*Unnamed	adit	9 Jun 98+ 11 Jun 98+** 2 Sep 98*	5860	45° 35' 08"	112° 29' 21"	T3SR7WS8SESE	Anabat Harp trap, Mist net visual
+*Gold Seal	shaft	11 Jun 98+ 2 Sep 98*	5880	45° 35' 26"	112° 29' 43"	T3SR7WS8SWNE	Anabat visual
+*Eclipse (at house)	shaft	11 Jun 98+ 2 Sep 98*	5880	45° 35' 35"	112° 29' 42"	T3SR7WS8SWNE	Anabat visual
+Unnamed (above Eclipse)	adit	10 Jun 98+ 18 Aug 98	6040	45° 35' 38"	112° 30' 01"	T3SR7WS8SENW	visual (grano) Anabat visual
+Shoemaker A	shaft	1 Oct 97+	5900			T3SR7WS8SWNW	Anabat
Shoemaker B (grated)	shaft	9 Jun 98					Anabat, Mist net
Shoemaker D	shaft						Anabat
Shoemaker E	adit						visual
Shoemaker F	adit						visual
Shoemaker G	shaft						Anabat, Mist net
+Shoemaker H	shaft						Anabat, Mist net
+Unnamed adits	adits (2)	11 Jun 98	5600	45° 35' 40"	112° 29' 20"	T3SR7WS9NNW	visual (grano)
Unnamed adit	adit	11 Jun 98	5480	45° 35' 30"	112° 29' 59"	T3SR7WS9SWNW	visual
+Unnamed shaft	shaft	11 Jun 98+ 29 Jun 98	5740	45° 34' 53"	112° 30' 28"	T3SR7WS18NENE	Anabat
Nez Perce North (partially collapsed)	shaft	30 Jun 98	5640	45° 33' 57"	112° 29' 10"	T3SR7WS20NENE	Mist net visual
Unnamed (collapsed)	shafts (2)	29 Jun 98	5500	45° 33' 26"	112° 29' 09"	T3SR7WS20NESE	visual
"Water Tank" (collapsed)	shaft	29 Jun 98	5150	45° 32' 35"	112° 27' 32"	T3SR7WS27NW/SW	visual
+Unnamed	shaft	29 Jun 98	5350	45° 31' 46"	112° 28' 41"	T3SR7WS33NESW	Anabat, Mist net
+Ajax (partially collapsed)	shafts (4)	30 Jun 98	6040	45° 36' 37"	112° 32' 35"	T3SR8WS1NNW	Anabat (#3)
Montana Boy	shafts (3)	8 Aug 98	5370			T4SR1WS2SWNE	visual
Unnamed Gold Deposit #1 (collapsed)	adit	23 Jul 98+ 3 Sep 98+*	5800			T4SR4WS32SENE	visual
+*Unnamed Gold Deposit #2	adit						Anabat, visual
+*Unnamed Gold Deposit #3	adit						Harp trap
Unnamed (collapsed)	adit	23 Jul 98				T4SR1WS33NNWSW	visual

Table 1 (cont.). Mine sites surveyed for potential/actual use by bats in southwestern Montana during 1997-1998. Sites with evidence of bat activity are indicated with a "+", mine workings inspected internally are marked with a "**".

Mine Site	Type	Date	Elev (ft)	Lat. (N)	Long. (W)	Legal TRS	Survey Method
Union #1	shaft	11 Jul 98+	5960			T4SR5WS3SENE	Anabat
Union #2 (grated culvert)	adit	1 Sep 98*	5960	45° 31' 06"	112° 11' 55"		Anabat
Union #3 (grated)	shaft		5940	45° 31' 06"	112° 11' 55"		visual
+*Union #4 (gated, in brick)	adit		5920				Harp trap, visual
+*Union #5 (grated culvert)	adit		5920				Mist net, (gnano)
+Unmanned (doors)	adits (2)	6 Aug 98	6040			T4SR8WS7NWNW	Anabat
+*Unmanned	adit	7 Aug 98+	5800			T4SR8WS7SWNW	Anabat, Mist net
		3 Sep 98*					visual
+*Unmanned	adit	6 Aug 98+	5640			T4SR8WS18SENW	Harp trap
		17 Aug 98+					Harp trap
		3 Sep 98*					visual
Granite Creek Prospects	pits (2)	7 Aug 98	6100			T6SR3WS10NWNW	visual
Unmanned (collapsed inside)	adit	7 Aug 98	6000			T6SR3WS28SWSW	visual
Galena (collapsed)	shaft?	18 Aug 97	6700			T6SR10WS17SENW	visual
Joker (collapsed)	shaft?	18 Aug 97	6900			T6SR10WS18SESE	visual
Horn Silver	shaft	26 Jul 98	6850			T6SR10WS18NWESE	Anabat
+Goodview	shaft	18 Aug 97	6885			T6SR10WS18SWSW	Anabat
+Dexter (grated)	shaft	18 Aug 97	6900			T6SR10WS18SWSW	Anabat
+Carbonate	shaft	18 Aug 97	7120			T6SR10WS18SWNW	Anabat
Rena (collapsed)	shaft	18 Aug 97	7060			T6SR10WS18SWNW	Anabat
Boaz (collapsed)	shaft?	18 Aug 97	6550			T6SR10WS19NESE	visual
+Ermont #19	pit	18 Aug 97+	6560			T6SR11WS35NEENE	Anabat, Mist net
+Ermont #19 (grated)	shaft	29 Sep 97					Anabat, Mist net
		8 Jun 98					
Ermont West ("Reblish adit")	shaft	18 Aug 97	6560			T6SR11WS35NEENE	Anabat
		8 Jun 98					Anabat, Harp trap
Ermont East (grated)	shaft	8 Jun 98	6490	45° 16' 11"	112° 54' 22"	T6SR11WS35SENE	Anabat
+Ermont #2 (grated)	adit	18 Aug 97+	6400			T6SR11WS35NWSE	Anabat
		8 Jun 98					Anabat, Mist net
+Nick Preen	adit	25 Aug 97	7340			T6SR12WS14NESE	Anabat
+Agnes Load	adit	25 Aug 97	7640			T6SR12WS14NENW	Anabat
Little Hawk (collapsed)	pit	25 Aug 97	7950			T6SR12WS15NEENE	visual
Mayflower	shaft	25 Aug 97	7500			T6SR12WS22SWSE	visual

Table 1 (cont.) Mine sites surveyed for potential/actual use by bats in southwestern Montana during 1997-1998 Sites with evidence of bat activity are indicated with a "+", mine workings inspected internally are marked with a "**"

Mine Site	Type	Date	Elev (ft)	Lat. (N)	Long. (W)	Legal TRS	Survey Method
+Sunrise #2	adit	25 Jul 98	7160			T6SR12WS24SENW	Anabat, mist net (guano)
Unnamed Prospect	pit	7 Aug 98	8180			T7SR3WS15SWSE	visual
Ermont South (grated)	shaft	9 Jun 98	6790	45° 15' 27"	112° 55' 13"	T7SR11WS2SENW	visual
Opx (grated)	shaft	9 Jun 98	6350	45° 14' 44"	112° 54' 59"	T7SR11WS11NENW	visual
Unnamed (collapsed)	shaft?	9 Jun 98	6350			T7SR11WS11NW/SW	visual
Bonnie Group (collapsed)	adit?	20 Aug 97	7200			T7SR11WS15SW/SW	visual
Stevenson (collapsed)	adit?	20 Aug 97	7150			T7SR11WS27SENE	visual
+Leonic's Tunnel (grated culvert)	adit	19 Aug 97	6560			T7SR11WS28SESE	Anabat
+Huron/Cottontail A	shaft	20 Aug 97+	6950			T7SR11WS28NWSE	Anabat
+Huron/Cottontail B	shaft	20 Aug 97	6900				Anabat
+Huron/Cottontail C (cable net)	adit	24 Jul 98+	6700				Mist net
+Huron/Cottontail D	shaft		6720				Mist net
+Huron/Cottontail E (grated)	shaft		6720				Mist net
Huron/Cottontail (cable net/grated)	shafts (4)		6700				visual
	adits (1)		6700				visual
Huron/Cottontail (open)	shafts (4)		6700				visual
+Pomeroy A	adit	20 Aug 97	6700			T7SR11WS28NW/NW	Anabat
+Pomeroy B	shafts (2)						Anabat
+Kent/Bluewing B	adit	19 Aug 97+	7000			T7SR11WS33NWNE	Mist net
+Kent/Bluewing C	adit	30 Sep 97+	6740				Anabat, Mist net
+Kent/Bluewing D	adit	24 Jul 98+	6740				Anabat, Mist net
+Kent/Bluewing E (cable net)	adit		7030				Anabat, Mist net
+Kent/Bluewing F (cable net)	adit		7070				Anabat, Harp trap
+*Hendricks (grated)	shafts (2)						visual
+*Hendricks (gated)	adit	21 Aug 97+	6000			TRSR11WS7NENW	Anabat
		12 Jun 98					Anabat, Harp trap
		13 Jun 98+*					visual
		4 Sep 98*					visual
		4 Dec 98+*					visual
+Hendricks (Suffield portal)	adit	21 Aug 97+	6200			TRSR11WS7SWNW	Anabat, Mist net
		12 Jun 98+					Anabat, Mist net

Table 2. Bats captured (mist-net or harp trap) or observed in 1997-1998 during abandoned mine surveys on BLM lands in Beaverhead, Madison, and Silver Bow counties, southwestern Montana.

Mine Site	Type	Location	Date	Species ¹	Sex
Unnamed	adit	T2SR6WS10SWNW	19 Aug 98	MYCI	5M
Gold Rod #1	adit	T2SR6WS22NENE	10 Jul 98	MYCI	1M
Beacon Light	adit	T2SR7WS31SWSE	30 Jun 98	MYCI	1M
Jackrabbit	adit	T2SR8WS21NESW	6 Jul 98	MYCI	1M
Tidal Wave B	shaft	T3SR5WS28NENW	10 Jul 98	MYEV	1M
Plainview B	adit	T3SR5WS28NWNW	11 Jul 98	COTO	1?*
Unnamed	adit	T3SR7WS8SESE	11 Jun 98	MYCI COTO	5M, 3F 1M
Unnamed Gold Deposit #2	adit	T4SR4WS32SENE	3 Sep 98	MYCI	1M*
Unnamed Gold Deposit #3	adit	T4SR4WS32SENE	24 Jul 98	MYCI	2M
Union #4	adit	T4SR5WS3SENE	11 Jul 98	MYCI COTO	2M 1M
Unnamed	adit	T4SR8WS7SWNW	7 Aug 98	MYCI	2M
Unnamed	adit	T4SR8WS18SENW	6 Aug 98	MYCI MYEV	5M 1F
			17 Aug 98	MYCI MYEV	5M 1F
Ermont #19	pit	T6SR11WS35NENE	18 Aug 97	MYCI	5M, 1F
Huron/Cottontail C	adit	T7SR11WS28NWSE	20 Aug 97	MYCI MYEV	1M 2M
Huron/Cottontail D/E	shaft	T7SR11WS28NWSE	20 Aug 97	MYCI	2M
Kent/Bluewing D	adit	T7SR11WS33NWNE	19 Aug 97	MYCI MYEV	3M 1M
Kent/Bluewing E	adit	T7SR11WS33NWNE	24 Jul 98	MYEV EPFU	3M 1M
Kent/Bluewing F	adit	T7SR11WS33NWNE	24 Jul 98	MYCI	1M
Hendricks (Suffield adit)	adit	T8SR11WS7SWNW	21 Aug 97	MYCI	2M
Hendricks (gated adit)	adit	T8SR11WS7NENW	13 Jun 98	MYCI	1F*
			4 Dec 98	MYCI EPFU	1?*

¹ MYCI (*Myotis ciliolabrum*), MYEV (*M. evotis*), EPFU (*Eptesicus fuscus*), COTO (*Corynorhinus townsendii*).

* Observed during internal survey.

Table 3. Bats detected with ANABAT ultrasound monitors in 1997-1998 on BLM lands in Beaverhead, Madison, and Silver Bow counties, southwestern Montana. Species assignments are tentative. Number of passes in parentheses, sites with equipment malfunction marked with *.

Mine Site	Type	Location	Date	Species ¹
Strawberry D	shaft	T2SR3WS14SENW	17 Sep 97	MYSP(1)
Strawberry E	shaft			MYSP(5)
Mohawk A	adit	T2SR6WS10SENW	25 Sep 97	MYSP(5), MYEV(6)
Mohawk B	shaft			MYSP(4)
Gold Rod	adit	T2SR6WS22NENE	10 Jul 98	UNKN(1), MYSP(13), MYEV(1)
Watseca	shaft	T2SR7WS31SENE	6 Aug 97	MYSP(5)
Champion	shaft	T2SR7WS31NESE	6 Aug 97	UNKN(1), MYSP(7), EPFU(1)
Dick & Billy Jane	shaft	T2SR7WS31NESW	6 Aug 97	MYSP(17)
Camp Creek	adit	T2SR8WS11NENW	1 Jul 98	UNKN(#?)
Maiden Rock	adit	T2SR9WS5NENE	5 Aug 97	UNKN(1), MYSP(1)
Unnamed N. Helene	shaft	T3SR1ES19NENW	8 Aug 98	UNKN(2), MYSP(3)
Helene	adit	T3SR1ES19NENW	8 Aug 98	UNKN(4)
Plainview A	adit	T3SR5WS28NWNW	11 Jul 98	MYSP(3), MYEV(12)
Tidal Wave A	adit	T3SR5WS28NENW	10 Jul 98	UNKN(6)
Tidal Wave B*	shaft		23 Sep 97	MYSP(2), EPFU(1)
Falcon Prospect*	shaft	T3SR5WS34NESW	24 Sep 97	MYSP(3)
			10 Jul 98	UNKN(1)
Walker	shaft	T3SR5WS34NWSW	24 Sep 97	MYSP(11), EPFU(1)
Black Ace #1	adit	T3SR5WS34NWNE	24 Sep 97	MYSP(5), MYEV(1)
			22 Jul 98	UNKN(5)
Black Ace #2*	adit	T3SR5WS34NWNE	22 Jul 98	UNKN(1), MYSP(1), LANO/LACI(1), EPFU(2)
Germania 2	adit	T3SR7WS3NWSW	28 Jun 98	UNKN(1), MYSP(1), MYEV(1)
Germania 4	shaft			UNKN(2), MYSP(1)
Emma C	shaft	T3SR7WS6SESW	15 Oct 97	MYSP(1)
Unnamed	adit	T3SR7WS8SESE	9 Jun 98	UNKN(7), MYSP(1), MYEV(1)
Gold Seal	shaft	T3SR7WS8SWNE	11 Jun 98	UNKN(1)
Eclipse	shaft	T3SR7WS8SWNE	11 Jun 98	UNKN(1)
Shoemaker A	shaft	T3SR7WS8SWNW	1 Oct 97	MYSP(9)
Shoemaker H	shaft			MYSP(3), COTO?(1)
Unnamed shaft	shaft	T3SR7WS18NENE	11 Jun 98	UNKN(1), MYSP(5)
Unnamed	shaft	T3SR7WS33NESW	29 Jun 98	UNKN(18), MYSP(158), MYEV(10), EPFU(1)
Ajax	shaft	T3SR8WS1NWNW	30 Jun 98	MYSP(1)
Unnamed Gold deposit	adit	T4SR4WS32SENE	23 Jul 98	MYEV(2)
Unnamed	adit	T4SR8WS7NWNW	6 Aug 98	UNKN(30), MYSP(36)
Unnamed	adit	T4SR8WS7SWNW	7 Aug 98	UNKN(6)
Goodview	shaft	T6SR10WS18SWSW	18 Aug 97	MYSP(5), LANO(1), COTO(2)
Dexter	shaft	T6SR10WS18SWSW	18 Aug 97	UNKN(3), LANO(1), EPFU(20), COTO(3)
Carbonate	shaft	T6SR10WS18SWNW	18 Aug 97	MYSP(12)
Ermont #19	shaft	T6SR11WS35NENE	18 Aug 97	MYSP(100), MYEV(35), COTO?(10)
Ermont #2	adit	T6SR11WS35NWSE	18 Aug 97	MYSP(4), EPFU(5)
Nick Preen	adit	T6SR12WS14NESE	25 Aug 97	EPFU(1)
Agnes Load	adit	T6SR12WS14NENW	25 Aug 97	EPFU(5)
Leonnie's Tunnel	adit	T7SR11WS28SESE	19 Aug 97	MYSP(6)

¹ UNKN (unknown bat species), MYSP (*Myotis* species), MYEV (*M. evotis*), EPFU (*Eptesicus fuscus*), COTO (*Corynorhinus townsendii*), LANO (*Lasiurus noctivagus*), LACI (*Lasiurus cinereus*).

Table 3 (cont.). Bats detected with ANABAT ultrasound monitors in 1997-1998 on BLM lands in Beaverhead, Madison, and Silver Bow counties, southwestern Montana. Species assignments are tentative. Number of passes in parentheses, sites with equipment malfunction marked with *.

Huron/Cottontail A*	shaft	T7SR11WS28NWSE	20 Aug 97	MYSP(2), EPFU(4)
Huron/Cottontail D	shaft		24 Jul 98	UNKN(5)
Pomeroy A	adit	T7SR11WS28NWNW	20 Aug 97	MYSP(2)
Pomeroy B	shaft			MYSP(13), MYEV(2), LANO/LAC1(1), COTO?(1)
Kent/Bluewing B*	adit	T7SR11WS33NWNE	19 Aug 97	MYSP(29), EPFU(9)
Kent/Bluewing D	adit		30 Sep 97	MYSP(4)
Kent/Bluewing E	adit		19 Aug 97	UNKN(6), MYSP(50), EPFU(20)
			30 Sep 97	MYSP(3)
Kent/Bluewing F	adit		19 Aug 97	UNKN(6), MYSP(14), MYEV(1), COTO(13)
			30 Sep 97	MYSP(3), MYEV(2)
Hendricks (gated)	adit	T8SR11WS7NENW	21 Aug 97	UNKN(23), MYSP(104), COTO(27)
Hendricks (Suffield)	adit	T8SR11WS7SWNW	12 Jun 98	UNKN(1)

¹ UNKN (unknown bat species), MYSP (Myotis species), MYEV (M. evotis), EPFU (Eptesicus fuscus), COTO (Corynorhinus townsendii), LANO (Lasionycteris noctivagans), LAC1 (Lasiurus cinereus).

Table 4 Mine workings surveyed internally (partially or completely) in southwestern Montana in 1998. Sites with data loggers installed are indicated with a "+".

Mine Site	Elev. (ft)	Type	Survey Date	Underground Extent (ft)	Max. Temp. (F)	Bats Present*
+Ruth & Copper Bottom	7400	simple adit	2 Sep	183	50	none
Plainview A	5680	simple adit	11 Jul	35	69	1 COTO
+Unnamed (T3SR7W/SNSESE)	5860	simple adit	11 Jun, 2 Sep	186	57.5	none
Gold Seal	5880	simple decline	2 Sep	120	---	none
Eclipse	5880	multilevel decline	2 Sep	>500	---	none
Unnamed Gold Deposit #2	5800	multilevel decline	3 Sep	>100	---	none
Unnamed Gold Deposit #3	5800	multilevel adit	3 Sep	>300	49	1 MYCI (dead)
+Union #4	5920	multilevel adit	1 Sep	>500	62	none
Union #5	5920	simple adit	1 Sep	139	59	none
+Unnamed (T4SR8W/S7SWNW)	5800	simple adit	3 Sep	134	47	none
+Unnamed (T4SR8W/S8SENW)	5640	multilevel adit	3 Sep	271	51	none
+Hendricks (gated)	6000	multilevel adit	13 Jun, 4 Sep, 4 Dec	>2000	54	1 MYCI (Jun); 1 MYCI, 1EPFU (Dec)

* MYCI (*Myotis chlotchii*), EPFU (*Eptesicus fuscus*), COTO (*Corynorhinus townsendii*).

Figure 1. The elevational distribution of two categories of mine workings (adits, shafts: see methods for definitions) in southwestern Montana that were monitored in 1997-1998. Sample sizes are indicated above each bar.

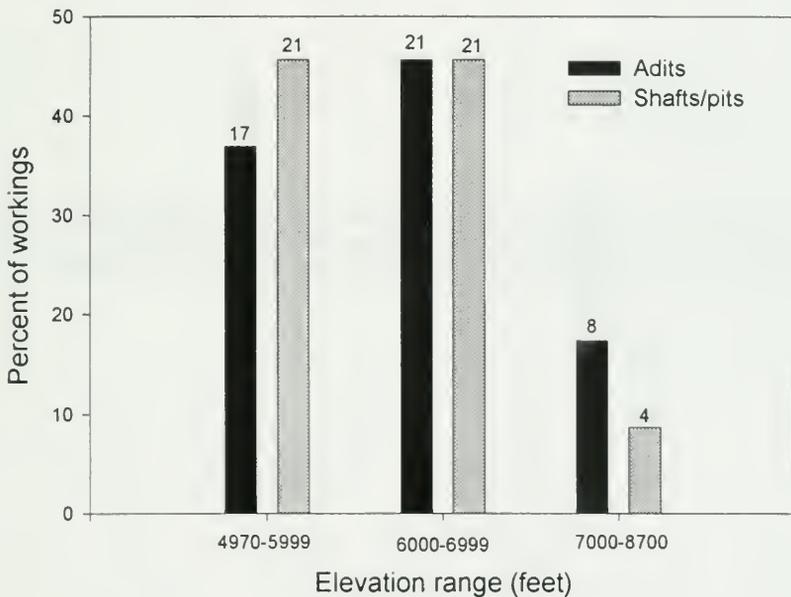


Figure 2. The influence of elevation on the use of monitored mine sites by bats (“used” or “not used” classification is based on captures, sightings, ANABAT, or droppings). Collapsed mines are not included in the samples. Sample sizes are indicated above each bar.

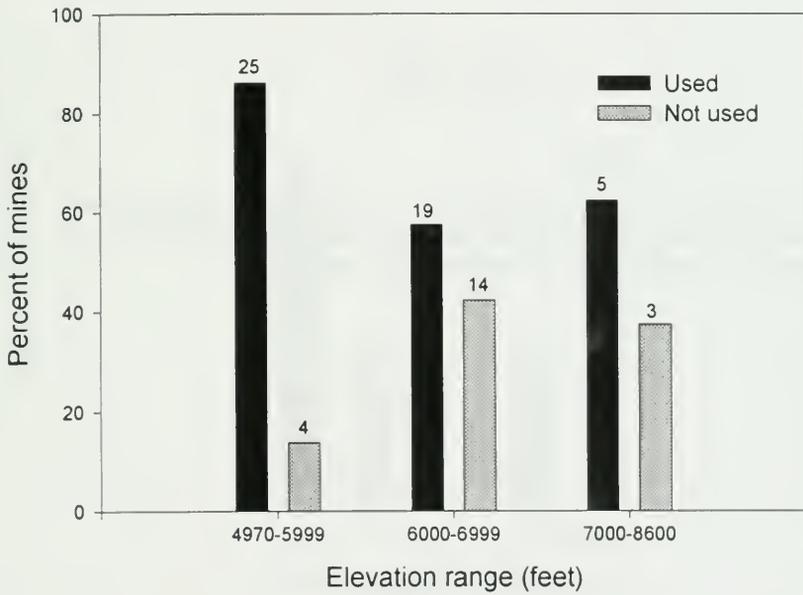
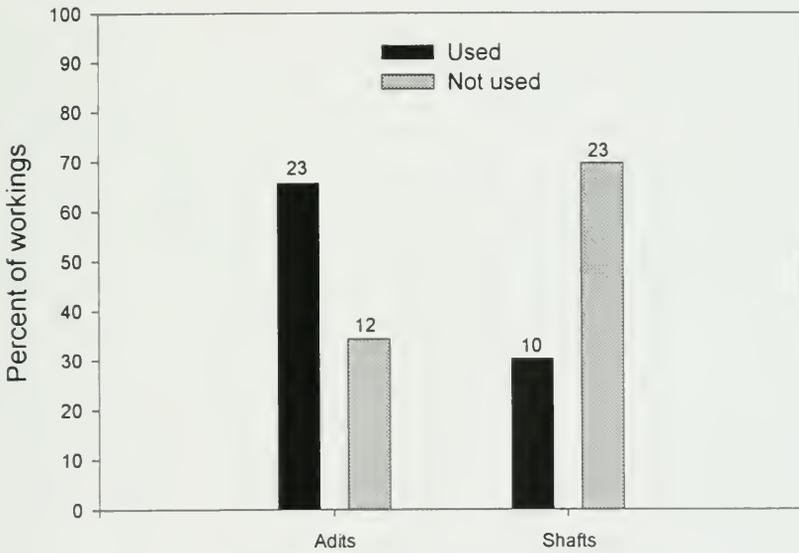


Figure 3. The influence of mine working type (adit or shaft) on their use by bats in 1998. "Used" or "not used" classification is based on captures, sightings, ANABAT, or droppings. Sample sizes are indicated above each bar.



Monitored mine workings (1998)

