EVICTING BATS WHEN GATES WON'T WORK:
UNSTABLE MINES AND RENEWED MINING

Patricia E. Brown, J. Scott Altenbach, and Richard E. Sherwin

Dept. Physiol. Sciences, UCLA, 134 Eagle Vista, Bishop, CA 93514 (PEB); Dept. of Biology, Univ. of NM, Albuquerque, NM 87131 (JSA, RES)

ABSTRACT

At most abandoned mine sites, the installation of bat gates can protect both humans and bats. However, sometimes the openings are too large or the mine too unstable to be considered for bat gates. The mine may be in danger of collapse, thereby entombing bats. Acid mine drainage may be polluting water supplies. Radioactivity could be a threat to people and bats. The only option may be to evict the bats and to seal the mine permanently.

While historic mining created new roosting habitat for many bat species, contemporary mining practices can adversely impact bats. Renewed mining in historic districts usually destroys old workings in the creation of open pits. Occasionally underground techniques are employed, but this method usually enlarges or destroys the original drifts. Even during exploratory drilling, historic mine openings can be covered as drill roads are bulldozed, or drills can penetrate and collapse underground workings. Nearby blasting associated with mine construction and operation can disrupt roosting bats. Finally, at the completion of mining, any historic mines still open on the property may be sealed as part of closure and reclamation activities. The net result can be a loss of bats, and bat roosting and foraging habitat. Sometimes in contemporary underground or surface mining operations, future roosting habitat for bats is created or can be fabricated. An experimental approach to the creation of new roosting habitat is to gate new underground workings or to bury culverts beneath waste rock. Different bat species with varying seasonal roost requirements will require customized designs. Temperature profiles of the bat mines that will be closed are useful in the identification of alternate habitat. Mining companies and agencies can mitigate for impacts to bats by identifying roosting habitat in non-impacted mines that can be protected with gates and fences, and by basic research to identify and protect critical foraging habitat.

Whether the concern is public safety or renewed mining, bats (and other animal tenants) may need to be evicted. The challenge is to accomplish this in a manner that removes the most bats with the least impact. Previous surveys for bats should provide knowledge of the seasonal occupancy and type of roost (maternity colony, migratory stopover, hibernaculum, breeding site, etc.) in order to plan the method and time of exclusion. If surveys conducted in another year or season did not disclose the presence of bats, it is important that a survey be conducted immediately prior to exclusion, since bats are mobile and can change roosts between seasons and years. For example, the closure of other mines in the vicinity may cause bats to relocate to a previously unoccupied mine.

INTRODUCTION

Historic mining operations created new roosting habitat for many bat species. Some bat populations colonized mines when traditional roosts in caves or trees were disturbed or destroyed. In areas where natural caves never existed, bats may have congregated in abandoned mines because they offered protected roosting areas with stable temperatures that can shelter large colonies (Brown and Berry, 1991). Whatever the reason for colonization, mines have now become an important roosting habitat that concentrate large numbers of bats. This concentration of bats in relatively few roosts makes then vulnerable to disturbance and eradication (Tuttle and Taylor 1994). Determining why, how and when bats use mines presents many challenges. For some species in the western United States, such as the California leaf-nosed bat (*Macrotus californicus*) and Townsend's big-eared bat (*Corynorhinus townsendii*), the largest colonies now occur in man-made mine habitat.

Now the same industry that was responsible for creating bat habitat has the potential to adversely impact bats (Brown, 1995a,b; Brown and Berry, 1997). Contemporary mining operations usually occur in historic mining districts where bats are commonly found. New methods of sampling ore bodies, such as drilling, often detect reserves that are now economical to extract. New mining activity typically produces an open pit and destroys historic adits and shafts. Occasionally underground techniques are employed, but only if high quality ore is located deep beneath the surface. This method usually enlarges or destroys the original drifts. Even if a mine working is not directly impacted, nearby blasting associated with mine construction and operation can disrupt roosting bats. Besides the physical disturbance of mining, other aspects of contemporary operations can have adverse impacts to bats and other wildlife, such as the introduction of cyanide and other contaminants or the removal of foraging habitat. At the completion of renewed mining, any historic mines still open may be sealed as part of closure and reclamation activities. The motivation for closing potentially hazardous mines is to reduce liability while at the same time possibly removing the unsightly scars of old dumps. Agencies might require this closure as part of the reclamation plan, without knowledge of the potential impacts to the bats and other wildlife inhabiting the mines. Safety is an issue since new or improved road access into the region can bring increased human visitation to an area after the cessation of active mining. The goal of protecting bat habitat in mines and excluding people by the installation of bat-accessible gates is the preferred option, although it may not be feasible if the mine entrance is too large or the substrate unstable. Acid mine drainage or radioactivity can pose threats that are only solved by permanently sealing the mine.

Ideally, when a mine needs to be closed either for renewed mining or public safety, all information on the use of that mine by bats and other wildlife has been determined in advance: what species, what season, for what purpose and how frequent the use. In addition, alternate roost sites in the region (close to good foraging habitat) could be identified and protected with gates. The targeted mine can then be closed when bats are not in residence, or at a time when eviction has the least impact. Unfortunately this is not an ideal world, and usually mining companies and land management agencies to not have the time, expertise and/or money to get the necessary data to make the best management decision. This paper aspires to provide some guidelines for mitigating impacts to bats when mine gates are not feasible.

EXCLUSION CONSIDERATIONS

The methods and timing of bat exclusion will need to be modified in specific situations. A bat biologist with the necessary equipment and experience should be involved in the preliminary surveys. Surveying mine openings during the day is not an adequate method to determine bat use. More detailed surveys are required to determine when and how the mine is being used by bats (i.e. maternity colony, males, hibernation, mating, migratory stopover, etc.). This usually requires entering the mine to search for bats or guano (Altenbach, 1995). The size, shape, odor and deposition pattern of guano as well as culled insect remains can aid in bat identification and seasonal use even if bats are not present in the roost. If entry into the mine is not feasible due to safety considerations or the mine is so complex that it cannot be thoroughly surveyed even if entered, then an external survey using night vision equipment and/or infrared video is necessary to document bat habitation. All entrances of a mine should be monitored, although without an underground survey, connections between surface features may not be understood. During the winter, most bats hibernate and do not exit to forage; therefore an external survey will not determine presence or absence of bats. "Winter" will vary with altitude, latitude and between years, and signifies that time of year when bats remain torpid and survive on stored energy reserves.

Timing of Exclusion. Schedule the time of bat exclusion during that period when bats are absent or the fewest bats are using the mine. If there is any possibility of a maternity colony, then no closure should be made during that season, usually between April and August. The exact months of the maternity season may vary between years as well as with geographic location and species of bat. A local bat biologist should be consulted to determine when maternity colonies begin to form and when they will disperse. A maternity colony as a group may move between mines several times during the reproductive season. For example, in a survey of over 200 mine workings in Battle Mountain Nevada, the maternity colony of Townsend's big-eared bats used at least three mines: preparturition, post-parturition and after the young begin to fly. Additional mines were used for courtship and breeding activities in the fall (Brown and Berry, 2001). If only a single survey of a mine site is conducted during the warm season, the significance of some mines would be missed, and exclusion inadvertently might be scheduled for a time that bats are using the mine. Mine closures should avoid winter, especially if a mine cannot be safely entered to survey for hibernating bats. Even in mines that can be entered, torpid bats are often hidden in very small crevices. Attempting to arouse and move hibernating bats may lead to their demise.

In order to avoid hibernation and maternity periods, exclusion is usually scheduled for early spring or late summer/early fall (i.e. April or September-October). This is always subject to the local conditions in the year closure occurs. Eviction should not be attempted if the weather during any month becomes cold and windy, since the bats may not exit to forage during these conditions. Always monitor the mine for bat activity using night vision equipment or infrared prior to any closure. We have been surprised to see large numbers of *Macrotus* entering a mine after dark in the fall for courtship activities (Berry and Brown, 1995). This could be the case with other species. A site may be used for a specific function for only a few weeks a year and may have been missed during an initial survey. Bats may have moved into a mine since the initial

survey due to closure or disturbance at other mine sites. Be prepared to be flexible and return later if conditions are not favorable for exclusion.

Exclusion protocol. A “cookbook” approach should be used cautiously as no one method will work for all species in all locations. Our methods have evolved for mines in the arid southwest, and may not be applicable for bats in other regions. A sample protocol would require that a mine be watched with night vision equipment for at least an hour after dark or until most bats appear to exit the mine (the number of bats having been determined by a prior night exit count). The mine opening can be covered with one-inch chicken wire. After years of experimentation, this material has been selected for the following reasons: 1) Most bat species, if inadvertently trapped in the mine, can squeeze through the wire and escape, yet they do not appear to want to squeeze into the mine on subsequent nights. 2) Chicken wire can be molded to provide an awning effect so that bats inside the mine detect a window, yet bats approaching from outside the mine perceive a barrier. 3) Woodrats and other rodents cannot incorporate chicken wire into their nests, while they will readily gather tarps, fish seine and other soft netting. Bird netting can be used if the permanent closure is going to occur within the week of the exclusion.

If the mine contains a large number of bats (i.e. >10), then the chicken wire should be partially removed prior to dusk on the next night to allow trapped bats to exit. Not all bats exit every night, especially if some detect the presence of a large predator (i.e. human) near the mine. Usually these bats will exit the following night. Two-way bat traffic is encountered in most mines. Little brown bats (*Myotis* sp.) and pallid bats (*Antrozous pallidus*) may be entering a mine to night roost before the Townsend's big-eared bats have exited. The use of two finger tallies (or tape-recorded voice notes) with the night vision equipment will help to keep track of bats entering and exiting the mine. In the case of two-way bat traffic, the creation of awnings and one-way valves may be necessary, so that bats can exit a mine through a “window”, but the opening will not be apparent when bats approach it from the outside. If the mine can be safely entered, any bats remaining in the mine might be captured in hand nets and removed. This would be impossible in shafts and complex mines.

All entrances to a mine complex must be closed. Some of the best bat roosts are in mines with multiple entrances that provide a variety of temperatures at different seasons. Without conducting a thorough internal survey, multiple openings of a mine may not be known. Old mine maps (if they exist) may be outdated, since new openings may have been created or old connections destroyed. If only one access into a mine is sealed, the bats may continue to use a "back door". The conservative approach is to systematically close any opening that might possibly connect. Some of these might be on the other side of the hill or on the next ridge.

The chicken wire should be left in place a few days to allow bats to escape before being permanently closed or covered with a more opaque material. Whereas large colonies of bats may be deterred by the chicken wire, individual bats may enter the mine again. Especially prior to winter hibernation, bats have been known to squeeze through small openings (even chicken wire) to enter a favorable site. Additionally, if the covered mine is not destroyed or permanently sealed within a few weeks of covering, it will be necessary to periodically check it to be sure that openings do not erode open and

bat access is restored. If this happens, then exclusion will need to be repeated at a favorable time.

MITIGATION

Habitat Replacement: When bats are roosting in a mine slated for closure, then mines in a radius of about 5 miles from the closure site should be surveyed for potential replacement habitat. The exact distance that a bat will travel between roosts is a function of the species, geographic location and the season. The replacement mines should be evaluated with respect to prior or current bat use, complexity, temperatures (if entered), direction the entrance faces, etc. in order to select micro-environments similar to those in the mine(s) to be closed. Where critical roost temperature and/or configuration requirements of a particular species are known, alternate roosts are easier to identify (Sherwin *et al*., 2000). For example, *Macrotus* selects mines warmer then 80° F (Brown, 1999; Brown and Berry, 1996). If a mine has all the right qualities and no bat sign (but human disturbance is evident) then gating or fencing might result in an acceptable habitat for the evicted bats. If the mine to be closed is used by bats, it may be the "best" habitat in the area. The bats will not use another mine until they are disturbed or evicted from their first choice. When closure is inevitable and the mine slated for closure is safe to enter, the bats can be captured during the day and banded (but not during the maternity season or hibernation). Most of the bats will usually move to an alternate roost after this disturbance. The ability of bats to accept bands varies with species, and this method should not be used without prior research on any adverse effects.

Protection or Creation of Replacement Habitat. Mines selected as mitigation sites should be gated or fenced to provide protection from human disturbance prior to eviction of the bats from their current roosts. In situations where the bats cannot be captured, banded and allowed to relocate, the mines with the best bat potential as deducted from habitat requirements of the species should be selected for gating. In contemporary underground operations, future roosting habitat for bats can be created. For example, the American Girl Mining Joint Venture left some of the underground areas open when they finished mining, and gated the entrances (Brown *et al.*, 1995). An experimental approach to the building of new roosting habitat is to bury culverts with multiple openings beneath new waste rock, or old mining truck tires as Homestake Mining Company has done at the McLaughlin Mine. Bat Conservation International is encouraging innovative approaches to bat habitat creation (Ducummon, 1997), although none of the "artificial habitat" has yet to be colonized. Different bat species with varying seasonal roost requirements will require customized designs.

Monitoring. Ongoing monitoring of the gated mines or replacement habitat over several years at different seasons is necessary to evaluate the effectiveness of the relocation. In a successful bat relocation project at Homestake's McLaughlin Mine in Northern California, remote monitoring of bat movements was automated (Pierson *et al.*, 1991). If after several seasons, the numbers of bats in the replacement habitat do not increase, additional surveys should be conducted to discover the roosting location of the excluded bats. Modifications may need to be made in the gate design.

Research. In addition to roosting habitat, critical bat foraging areas or water sites near mining districts need to be identified. In southeastern California, radio-telemetry studies sponsored by American Girl Mining Joint Venture have shown that *Macrotus* forages among desert wash vegetation (Brown *et al.*, 1993; Brown *et al*., 1995). When mining operations removed this vegetation near mine roosts, California leaf-nosed bat populations declined. Good foraging habitat within a mile of the roost is especially important in the winter, when bats spend most of the night in warm mines and relatively little time out in the cold. As new mines in the range of *Macrotus* plan for the future placement of waste dumps and facilities, they can avoid impacting the critical wash vegetation. More research is needed to determine foraging habitat for other bat species.

Reclamation. As mining projects enter their reclamation phase, historic mines still open on the property that could provide bat-roosting habitat should be fitted with bat-compatible gates or fenced. Educational signs can be displayed to inform the public of the purpose of the barriers. Uncontaminated water sources on site will also attract bats. If specific vegetative communities are known to provide foraging habitat for bats (i.e. desert wash vegetation for *Macrotus*), these can be planted during the reclamation phase.

SUMMARY

Historic mines provide roosting habitat for many bat species. Whenever possible, abandoned mines should be closed with bat-accessible gates to protect the bats and people. This may not be feasible or desirable for large or unstable mine openings, mines with radioactivity or acid drainage, or in areas of active mining. Renewed mining in historic districts impacts bats during the exploration, active mining and reclamation phases by death or disturbance of the bats and the removal of roosting and foraging habitat. Impacts to bats by mine closure for all reasons can be mitigated by initial surveys at appropriate seasons to identify bat roosting habitat, exclusion of bats prior to mine closure, identification and protection of alternate roost sites with gates and fences, creation of replacement habitat, and monitoring the success of relocation. Research to identify habitat requirements could be used in the development of mitigation plans.

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