RENEWED MINING AND RECLAMATION: IMPACTS ON BATS AND POTENTIAL MITIGATION [1]

by

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Abstract. Historic mining created new roosting habitat for many bat species. Now the same industry has the potential to adversely impact bats. Contemporary mining operations usually occur in historic districts; consequently the old workings are destroyed by open pit operations. Occasionally, underground techniques are employed, resulting in the enlargement or destruction of the original workings. Even during exploratory operations, 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. Bats can also be disturbed by the entry of mine personnel to collect ore samples or by recreational mine explorers, since the creation of roads often results in easier access. In addition to roost disturbance, other aspects of renewed mining can have adverse impacts on bat populations, and affect even those bats that do not live in mines. Open cyanide ponds, or other water in which toxic chemicals accumulate, can poison bats and other wildlife. The creation of the pits, roads and processing areas often destroys critical foraging habitat, or change drainage patterns. Finally, at the completion of mining, any historic mines still open may be sealed as part of closure and reclamation activities. The net result can be a loss of bats and bat habitat. Conversely, in some contemporary underground operations, future roosting habitat for bats can be fabricated. An experimental approach to the creation of new roosting habitat is to bury culverts or old tires beneath waste rock. Different bat species with varying seasonal roost requirements will require customized designs. Mining companies can mitigate for impacts to bats by surveying to identify bat-roosting habitat, removing bats prior to renewed mining or closure, protecting non-impacted roost sites with gates and fences, researching to identify habitat requirements and creating new artificial roosts.

Additional Key Words: historic mines, mine closure, bat habitat, cyanide ponds.

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 excellent roosting areas with stable temperatures that could shelter larger colonies (Brown and Berry, 1991). Whatever the reason for colonization, mines have now become an important roosting habitat that concentrate large numbers of bats. For some species in the western United States, such as the California leaf-nosed bat (*Macrotus californicus*) (Figure 1) and Townsend's big-eared bat (*Corynorhinus townsendii*), the largest colonies now occur in man-made mine habitat. This concentration of bats in relatively few roosts makes then vulnerable to disturbance and eradication (Tuttle and Taylor 1994).

Now the same industry that was responsible for creating bat habitat has the potential to adversely impact bats. 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. At the end of a mining project, reclamation requirements often require the closure of any remaining historic workings still open.

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Figure 1. California leaf-nosed bat (*Macrotus californicus*) are dependent on abandoned mines for roosting habitat.

Impacts

Exploration

Bats are often disturbed in miens during the exploration phase by the entry of mine personnel to collect ore samples and by the creation of drill roads and associated drilling operations. Mine openings are inadvertently covered as drill roads are bulldozed. An example of this occurred in the Cargo Muchacho Mountains when the debris from a road above an historic portal covered the entrance during the maternity season entombing at least 5 species of bats. Occasionally, the drill bit can penetrate and collapse underground workings (Figure 2) . The noise and vibration associated with drilling may be disruptive, especially to hibernating bats or to maternity colonies. Following exploratory drilling, the new roads often permit easier access for recreational mine explorers.

Active Mining

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. The creation of the pits, waste rock dumps, roads, leach pads and processing areas destroys critical foraging habitat and changes drainage patterns. The net result is often a reduction of the local bat population.

Ore Processing

In addition to roost destruction, other aspects of renewed mining can have adverse impacts on bat populations, and affect even those bats that do not live in mines. Open cyanide ponds, or other water in which toxic chemicals accumulate, can poison bats and other wildlife. This is especially important in desert areas where any water source is a magnet for wildlife. Whereas the cyanide concentrations of the ponds are not fatal to man in moderate amounts, many bats will drink up to 25 per cent of their body weight in a short period of time. At one operation with an uncovered pond in California, dead bats were not recovered directly from the ponds, but were found out in the desert within a kilometer radius. Since dead bats may be eaten by scavengers, only a small fraction of the bat mortalities may be recovered.

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Figure 2. Drilling rig in Cargo Muchacho Mountains of California penetrating mine workings containing California leaf-nosed bats.

Reclamation

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.

Mitigation

Potential reasons for permanently closing an historic mine can be for renewed mining activity or hazard abatement during reclamation (where gating is not feasible). Two major considerations from the bat conservation perspective are the safe exclusion of bats (and other wildlife) from the mine at a non-critical season and the identification and protection of replacement roosting and foraging habitat.

Exclusion

The methods and timing of bat exclusion will need to be modified in specific situations. Where large colonies of bats are at risk, a bat biologist with the necessary equipment and experience should be involved. The basic considerations are described below.

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 exit count is necessary to document bat habitation. During the warm season, bats usually exit within 90 minutes of dusk. Watching with night vision equipment and ultrasonic detectors during this period will usually determine if bats occupy the mine. Observers should be quietly in place before dusk and attempt to watch all entrances of a mine, 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 exit count 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.

Exclusion protocol. Schedule the time of bat exclusion during that period when the fewest bats are using the mine. If there is any possibility of a maternity colony, then no closure should be made between May and August. If a mine cannot be safely entered to survey for hibernating bats, then no closures should be scheduled for the winter months. Attempting to arouse and move hibernating bats may lead to their demise. This generally leaves exclusion windows in April or September-October in order to avoid hibernation and maternity periods. Closure 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 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 (Brown and Berry, 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. Be prepared to be flexible and return later.

After most bats appear to exit the mine (the number of bats having been determined by a prior night exit count), then 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.

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 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 is 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.

Some of the best bat roosts are in mines that provide a variety of temperatures at different seasons. Many of these mines have multiple entrances, and will "breathe" in response to external temperatures. 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. If the covered mine is not destroyed or permanently sealed within a few weeks of covering with mesh, 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.

Habitat Replacement

Additional Surveys. If bats are discovered in the initial survey of a mine slated for closure, then mines in a radius of about 5 miles from the closure site should be surveyed as potential replacement habitat. 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 are known, they may be used to identify alternate roosts. For example, *Macrotus* selects mines warmer then 80 F. If bats of the same species are using a mine in the vicinity it should provide a good mitigation site. If a mine has all the right qualities and no bat sign (but human disturbance is evident) then gating or fencing might result in a suitable habitat for acceptance by evicted bats. The mine to be closed is often the best habitat and the bats will not use another mine until they are disturbed or evicted from the original. 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.

Protection of Replacement Habitat. Mines selected as mitigation sites should be gated (Figure3) or fenced to provide protection from human disturbance prior to eviction of the bats from their current roosts (see Burghardt in these proceedings). In situations where the bats cannot be captured and banded, the mines with the best bat potential as deducted from habitat requirements of the species should be selected for gating.

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Figure 3. Replacement mine habitat being gated by American Girl Mining Joint Venture personnel.

Creation of Replacement Habitat. 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. 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 has done at the McLaughlin Mine. Bat Conservation International is encouraging innovative approaches to bat habitat creation (see Ducummon in these proceedings). Different bat species with varying seasonal roost requirements will require customized designs.

Monitoring. Ongoing remote monitoring of the gated mine 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, 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.

Research

In addition to roosting habitat, critical bat-foraging areas near mining districts need to be identified. In southeastern California, radio-telemetry studies sponsored by American Girl Mining Joint Venture have shown that *Macrotus* (Figure 4) 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 (see Burghardt in these proceedings) 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.

Conclusion

Historic mines provide roosting habitat for many bat species. 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. Mining companies can mitigate for impacts to bats 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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Figure 4. California leaf-nosed bat with transmitter. Radio-telemetry study was sponsored by American Girl Mining Joint Venture to document critical foraging habitat.

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