Session 1

Why Bats?

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ECOLOGICAL AND ECONOMIC IMPORTANCE OF BATS

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Abstract

Abandoned mines now serve as important year-round sanctuaries for bats. Many of North America's largest remaining bat populations roost in mines. These include more than half of the continent's 45 bat species and some of the largest populations of endangered bats. Bats have lost countless traditional roosts in caves and old tree hollows and many have gradually moved into abandoned mines, which can provide similar environments. Mine closures without first surveying for bats can have potentially serious ecological and economic consequences. Bats are primary predators of night-flying insects, and many such insects rank among North America's most costly agricultural and forest pests. These include cucumber, potato, and snout beetles; corn-earworm, cotton-bollworm, and grain moths; leafhoppers; and mosquitoes. A single little brown bat (*Myotis lucifugus*) can catch more than 1,200 mosquito-sized insects in an hour. A mine roosting colony of just 150 big brown bats (*Eptesicus fuscus*) can eat sufficient cucumber beetles each summer to protect farmers from 33 million of these beetles' root worm larvae, pests that cost American farmers an estimated billion dollars annually. And a colony of Mexican free-tailed bats (*Tadarida brasiliensis*) living in the old Orient Mine consumes nearly two tons of insects nightly, largely crop-consuming moths. In the western states, pallid bats (*Antrozous pallidus*) benefit ranchers by consuming large quantities of grasshoppers and crickets. Lesser and greater long-nosed bats (*Leptonycteris curasoae* and *L. nivalis*) and long-tongued bats (*Choeronycteris mexicana*) are believed to be important pollinators for some 60 species of agave plants and serve as both pollinators and seed dispersers for dozens of species of columnar cacti, including organ pipe and saguaro, which rank among the southwestern deserts' most familiar and ecologically important plants. Despite their critical role in our environment and economy, available evidence suggests that millions of bats have already been lost during abandoned mine safety closures or renewed mining in historic districts. These actions could endanger even currently abundant species, forcing the need for Federal listing at considerable taxpayer expense. The loss of bats can increase our reliance on chemical pesticides (which often threaten both environmental and human health), jeopardize whole ecosystems of other plants and animals, and harm human economies. The cost of surveying and protecting key mine roosts is small compared to the benefits provided by these valuable night-flying allies.

Introduction

Bats are one of the most important, yet least understood, groups of animals in the world. Across North America, bats play a vital role in both natural and managed ecosystems. Bats are key predators of night-flying insects that cost American farmers and foresters a billion dollars annually, and they are pollinators of several keystone desert plants in the American southwest

and Mexico. Despite their importance, bats are often persecuted both intentionally and unintentionally, and their numbers continue to decline from habitat loss, environmental toxins, and disturbance at key roost sites. Bats currently represent the most imperiled order of land mammals in the United States and Canada.

Due to disturbance of bats' traditional roosts in caves and tree hollows, abandoned and inactive underground mines have now become refuges of last resort for more than half of the 45 bat species found in the United States and Canada, including some of the largest remaining populations. As thousands of abandoned mines are being reclaimed, available evidence suggests that millions of bats have been inadvertently buried or have lost crucial habitats. Closure of abandoned mines without first evaluating their importance to bats is perhaps the single greatest threat to many North American bat populations.

The Role of Bats in Ecosystem Management

Bats are primary predators of vast numbers of insects that fly at night, including many that rank among North America's most costly agricultural and forest pests. Just a partial list of the insects these bats consume includes cucumber, potato, and snout beetles; corn-borer, corn earworm, cutworm, and grain moths; leafhoppers; and mosquitoes. Just one of the little brown bats that hibernate in Michigan's Millie Hill Mine can catch 1,200 mosquito-sized insects in an hour. Bats are just one of several groups of animals that naturally prey upon mosquitoes. Although not the only insect consumed, from 77.4 to 84.6 percent of little brown bats living in the northern U.S. and Canada eat mosquitoes (Anthony and Kunz, 1977; Fascione, et. al., 1991). A Florida colony of 30,000 southeastern myotis (*Myotis austroriparius*) eats 50 tons of insects annually, including more than 15 tons of mosquitoes (Zinn and Humphrey, 1981). The loss of bats increases our reliance upon chemical pesticides that typically cause more long-term problems than they solve. Chemical poisons often kill natural mosquito predators more effectively than mosquitoes. Over time, predators such as fish, insects, and bats die out while mosquitoes develop resistance, multiplying in ever larger numbers in a losing battle often referred to as "the pesticide treadmill."

Mexican free-tailed bats, like those living in the famed Carlsbad Caverns and Bracken Cave, eat incredible numbers of insects nightly and just one colony living in Colorado's old Orient Mine consumes nearly two tons of insects nightly. In Texas' largest bat caves alone, up to 1,000 tons (2 million pounds) of insects, primarily moths, are eaten each night by Mexican free-tailed bats. U.S. Department of Agriculture research shows that in early June, billions of corn earworm moths (America's number-one agricultural pest) emerge from agricultural regions of Mexico, flying at high altitudes into the U.S. on prevailing winds—often traveling more than 250 miles a night. Days later, the moth's peak egg-laying occurs on corn, cotton, and other crops in agricultural regions of Texas. Their destructive larvae, which have fattened on the crops for about three weeks, give rise to the next generation of moths that emerge and continue a northward "hopscotch," infesting crops through much of central North America.

Doppler radar studies confirm that Mexican free-tailed bats fly at altitudes from 600 to 10,000 feet or more above the ground, sharing the same winds as moths, in the season when bats have their greatest energy needs (McCracken, 1996). To prove that bats prey upon this prime

agricultural pest, fecal pellets were collected as bats returned to a Texas bat cave. In mid-June, moths comprise about 96 percent of the diet of these bats (Whitaker, et. al., 1996). Using DNA markers it was confirmed that corn earworm moths were the species being consumed (McCracken, 1996). Further proof came when bat detectors were affixed to weather balloons floating freely with the moths, recording bat calls and feeding buzzes to corroborate that free-tailed bats are indeed flying and feeding at the same altitudes and locations as the moth migrations (*ibid.*). The regional impact these bats are having on corn earworm moths is staggering.

Mexican free-tailed bats are also known as "guano bats" for the enormous quantities of droppings they produce. From 1903 to 1923, at least 100,000 tons were removed from Carlsbad Caverns alone and sold to fruit growers in California (Tuttle, 1994). Railroad officials estimated that, early this century, they annually transported 65 carloads at 30,000 pounds each from Texas, making bat guano the State's largest mineral export before oil (*ibid.*). Guano extraction for use as a natural fertilizer is still being extensively used in developing countries and is making a comeback with organic gardeners. Free-tailed bats have supported several American war efforts since gun powder's most valuable ingredient, saltpeter, is made from guano. And a single ounce of guano contains billions of bacteria useful in detoxifying industrial wastes, producing natural insecticides, improving detergents, and converting waste byproducts into alcohol.

Another common North American species, the big brown bat, specializes on beetles and true bugs, including cucumber beetles, May beetles or June bugs, green and brown stinkbugs, and leafhoppers. In one summer season the 150 bats of an average Midwestern maternity colony can conservatively eat 38,000 cucumber beetles, 16,000 June bugs, 19,000 stinkbugs, and 50,000 leafhoppers (Whitaker, 1995). By eating 38,000 adult cucumber beetles in a season, these bats control about 33 million of these beetles' rootworm larvae (*ibid.*). Both cucumber beetle adults and larvae attack crops, costing U.S. farmers about one billion dollars annually, with the larvae doing considerable damage—they can reduce corn productivity 10 to 13 percent and force farmers to spray $15 to $25 in insecticides per acre (Whitaker, 1993). Adult June bugs defoliate trees and their larvae (grubworms) feed on the roots of grasses and other plants. Stinkbugs are often pests in orchards and on soybeans. Leafhoppers are serious pests of many plants since they feed on the sap, rendering the plant vulnerable to various plant diseases and reducing the plant's productivity. In one study, these four bugs collectively totaled 37.8 percent of the food eaten by 184 big brown bats from various parts of Indiana (*ibid.*). At certain times and places, however, they often total nearly 100 percent of the diet of big brown bats.

With the growing agricultural emphasis on biological control and integrated pest management, more and more farmers are using bats as a weapon in the war against insect pests. Instead of eradicating bat colonies from their farmhouses and barns, farmers are exploring ways of attracting bats to their fields. Many farmers are living with their bat allies and even encouraging their colonization by constructing artificial habitats. In addition to consuming insect pests, it is suggested that bats protect crops from pests by "chasing" away insects with their echolocation calls. Researchers saw a 50 percent reduction in damage to corn plots by corn borers when they broadcast bat-like ultrasound over test plots (Belton and Kempster, 1962).

North American bats are boosting local economies by encouraging tourism at renowned locations like Carlsbad Caverns and Austin's Congress Avenue Bridge. In Austin, just one decade ago, citizens petitioned for the bridge's bat colony to be eradicated. In 1999, Bat Conservation International (BCI) initiated a study which showed that the Congress Avenue Bridge bat colony generates nearly $8 million in tourism revenue each year (Ryser and Popovici, 2000). More than 100,000 people watch the bat emergence annually, including many who specifically travel to Austin to view the bats, spending millions on lodging, transportation, food services, and entertainment.

Bats are also key pollinators of many familiar desert plants. The endangered lesser and greater long-nosed bats, and Mexican long-tongued bat, serve as both pollinators and seed dispersers for dozens of columnar cacti species including organ pipe, and saguaro, and are important pollinators for some 60 species of agave plants. Agaves have been closely associated with man since the beginning of civilized America as a food item, a fermented beverage, and a fiber source. Today, tequila, made from distilled agave juices, is by far the best known Mexican liquor, and its rising popularity in international markets contributes to a multi-million dollar industry. Yet agave propagation, in the absence of bats, falls to 1/3000th of normal (Howell, 1980; Fleming, 1991). The bat-plant association is so strong that the disappearance of one would threaten the survival of the other.

In addition to consumptive uses, cacti rank among the southwestern desert's most ecologically important plants (Howell, 1980). Bees, moths, lizards, hummingbirds, woodpeckers, orioles, finches, sparrows and field mice all depend on plants pollinated by bats for food and shelter, and are affected indirectly by the loss of bat pollinators and subsequent decrease in plant populations, such that entire ecosystems are damaged.

Habitat destruction is likely the major factor affecting pollinating bats and contributing to their endangered or "at risk" status. Their specialized nectar diet and disappearance of their food plants could explain population declines. The fragile bat-plant relationship is magnified in the case of the long-nosed bats because of their migratory habits. These bats depend not only on the plants in a given region, but on a continuous supply of food along their migratory routes. The destruction of habitat in Mexico, for example, could have severe effects, through the bats, on the plant communities in Arizona. Mexican cattlemen, in misguided attempts to control numbers of vampire bats (*Desmodus rotundus*), have also indiscriminately destroyed countless colonies of highly beneficial bats, including pollinators.

In tropical ecosystems, bats play a critical role in seed dispersal and pollination. And because loss of rain forest habitats is one of the most serious environmental problems today, the loss of bats can have serious environmental and economic consequences. In one recent West African study, bats were shown to be far more effective seed dispersers than birds. Because most bats prefer to carry fruit away from the tree before eating, apparently to avoid predators, they cross cleared areas and sometimes travel up to 50 km or more in a single night. In Africa, up to 95 percent of forest regrowth on cleared land comes from seeds dropped by bats (Tuttle, 1983). In contrast, birds and other animals drop seeds mostly beneath existing trees.

Bats also are the primary pollinators of numerous tropical plants. More than 130 genera of trees and shrubs are already known to rely on bats for pollination, and many more such relationships await discovery (*ibid.*). Recent studies demonstrate that seed dispersal activities of bats can be critical to reforestation of clear-cut areas, and that many of the tropics' most economically important plants depend on bats for propagation. The nearly endless list of valuable products from these plants includes many grocery store fruits such as peaches, bananas, and avocados, as well as kapok and hemp fibers for surgical bandages, life preservers, and rope, latex for chewing gum, prized lumber for furniture and crafts, beads for jewelry, and carob for candy. The harvest of Durian fruits in Southeast Asia and iroko timber in West Africa accounts for annual sales of over 100 million dollars. The former requires bats for pollination and the latter for seed dispersal.

In the Old World, exaggerated reports of crop damage from fruit bats have led to bat killings. Farmers are alarmed by the sight of large bats eating fruit that ripens prematurely or that is missed during picking. Because fruit bats prefer strong-smelling, ripe fruits, commercial crops that are picked green for shipping are seldom damaged. Birds and rats are not so picky, leaving their depredations to be blamed on the more conspicuous bats. As a consequence, large colonies of big flying fox bats are being destroyed. In the Old World and throughout the South Pacific Islands, bats are considered a delicacy and are over harvested for human food, folk medicine and even aphrodisiacs. Many populations of large flying fox bats are seriously threatened. On Guam, bat dinners may sell for $25 a plate, and in West Africa, bats are so valuable that two poachers working together can make $1,000 in a single day.

The Importance of Mines to Bats

Although caves are numerous in some regions, most are now too frequently disturbed by humans to permit bat use. In addition, bat populations have lost countless traditional roosts in old tree hollows due to logging. Over the past 100 or more years, displaced bats have gradually moved into abandoned mines, which often provide microclimates similar to caves. In regions where natural caves do not occur, mines represent new “super habitats” that have concentrated colonial bat populations formerly distributed in smaller numbers across the landscape (Brown and Berry, 1991).

Mines are key to the life history of bats and are critical for many purposes such as rearing young in the summer, winter hibernation, gathering for social activities (such as courtship and mating), and night roosting (places where bats temporarily rest to digest their prey between foraging bouts). Mines also serve as crucial rest stops between spring and fall migration. Abandoned mines are often the only suitable shelters left midway between summer and winter roosts. Without these protected resting places, migratory mortality could increase tremendously. Although mines are utilized for many reasons, their use as bat maternity and hibernation sites is essential to the survival of several North American species. The microclimate, most importantly the temperature, determines whether bats will use a particular mine. Warm sites are selected for maternity roosts, while cold sites are chosen for hibernation.

Bats that roost in smaller groups typically require temperatures between 70 and 90EF for

maternity use. Big-eared bat (*Corynorhinus* spp.) maternity roosts have sometimes been recorded in colder sites where ambient temperatures are as low as 60EF. Approximately one-quarter of the bat species in the United States and Canada are believed to hibernate almost exclusively in old mines or caves (Tuttle and Taylor, 1994). Suitable hibernation sites for bats in all regions must protect bats from freezing, and for most species, should provide stable temperatures throughout the winter above the freezing point but below 50EF. Some desert dwelling bats may be an exception and often hibernate in mines with temperatures up to 58EF (Brown, pers. com., 1997).

While any abandoned mine may be important to bats, the larger, more complex and dangerous mines, with multiple entrances, often harbor the most significant populations. This is because large and complex mines offer bats a measure of security no longer found in caves. The complexity and associated airflow of these mines provides a range of internal temperatures suitable for bats (Altenbach, 1995). These complex sites are most often found on private mining industry lands.

Of the more than 8,000 mines surveyed by researchers in Arizona, California, Colorado, New Mexico, Oregon, and Washington, approximately 45 to 75 percent showed signs of use by bats, with an average of 10 percent containing important bat colonies. From the Great Lakes Region north and eastward in the United States and Canada, up to 70 percent of open, unflooded subsurface mines having sufficient volume to protect bats from freezing, may be used by hibernating bat populations.

Abandoned Mine Closures: Effects on Bats

In the last decade alone, thousands of abandoned mines have been permanently closed by backfilling, capping, blasting, or other method, and until recently few were first evaluated for their importance to bats. Available evidence suggests that millions of bats have already been lost, or their roosts destroyed. Bats now have few alternatives to abandoned mines, and are so instinctively committed to certain sites that they often cannot change roosts in the time allowed by current rates of mine closure (Altenbach, pers. com., 1996). Due to their colonial nature, many bat species are especially vulnerable to mine closures, and hundreds of thousands of bats can be lost in a single closure.

Little brown bats are among North America's most abundant bat species. However, in the northern United States and Canada, these bats rely almost exclusively upon abandoned mines for hibernation sites. If a mine is closed during winter months (trapping the bats inside), a multi-state region can be affected. This is due to the fact that little brown bats travel from summer colonies that may be thousands of miles away to hibernate in mines. Closure of mines without first checking for bats could drastically reduce bat numbers, needlessly endangering many species.

In the western United States, Townsend's big-eared bats (*Corynorhinus townsendii*) are particularly dependent on abandoned mines (Altenbach, 1995). The largest known populations, numbering up to 10,000, have been found in deep, complex workings, however, even shallow or

simple workings will often be used by small groups of up to several hundred. Endangered Indiana bats (*Myotis sodalis*) and southwestern cave myotis (*M. velifer brevis*) have been found in mines in numbers approaching 100,000. Similarly, the largest known hibernating populations of the southeastern big-eared bat (*Corynorhinus rafinesquii*), a candidate for the endangered species list, live in abandoned iron and copper mines in small groups ranging from a few dozen to more than 500.

All of the known remaining nursery roosts of the endangered lesser long-nosed bat in the United States are found in mines. In California, all winter roosts and all but one maternity colony of California leaf-nosed bats (*Macrotus californicus*) are found in abandoned mines (Brown, pers. com., 1997). Many other bat species rely heavily on mines for hibernation, even though they may congregate in smaller colonies throughout a greater number of abandoned mines. Table 1 provides a list of North American bats known to use mines (Tuttle and Taylor, 1994).

Many examples underscore the magnitude of potential bat losses from abandoned mine closures. More than 50,000 little brown bats were temporarily entombed in a western Wisconsin mine closure before biologists were able to have the mine reopened. The old Neda Mine in Iron Ridge, Wisconsin, was threatened with closure before being acquired by a local University. It is now home to nearly half a million little brown bats, as well as large populations of big brown bats, eastern pipistrelles (*Pipistrellus subflavus*), and northern long-eared myotis (*Myotis septentrionalis*).

The largest hibernating population ever recorded of another species in decline, western big-eared bats (*Corynorhinus townsendii pallescens*), was destroyed in a New Mexico mine shaft when vandals set old timbers on fire (Altenbach, pers. com., 1996). In New Jersey, the State's largest population of hibernating bats was inadvertently trapped in the Hibernia Mine when it was capped in 1989. These bats would also have died had biologists not convinced state authorities to reopen the entrance immediately. Likewise, the Canoe Creek State Park limestone mine in Pennsylvania was reopened in time to save its bats and now shelters a population of endangered Indian bats and the largest hibernating bat population in that state.

In December 1992, an estimated three quarters of a million little and big brown bats were found in the Millie Hill Mine in Iron Mountain, Michigan. It was slated to be backfilled the following spring. Instead, BCI convinced the town to close the mine with a large steel cage, protecting the bats and human safety (Tuttle and Taylor, 1994). These bats comprise the second largest hibernating bat population ever discovered in North America. A local mine inspector from Iron Mountain, Michigan, reported that of the 12 mines closed prior to 1993, some contained significantly large bat populations, perhaps even more than were saved in the Millie Hill Mine.

Mine and cave roosting bats are exceptionally vulnerable to human disturbance in their nursery and hibernation caves. Entire populations can be destroyed in single incidents, emphasizing the need for public education and protection of critical sites. Requiring up to an hour or more to arouse from hibernation, bats cannot quickly fly away from danger, and in any event cannot survive outside of their roost in winter. Helpless, thousands at a time have been intentionally killed by vandals. Many more die as a result of inadvertent disturbance by mine or cave

explorers who do not realize the dire consequences of their actions. When hibernating, bats must conserve energy until spring when insects are once again abundant. A single disturbance can cost a bat over 60 days of stored fat reserves (Thomas, et. al., 1990). Excessive disturbances can cause the bat to burn up all its fat reserves and perish.

Large colonies of bats are at risk as well. Mexican free-tailed bats have declined at Carlsbad Caverns from over 8 million to just a few hundred thousand. Likewise, the bats at Eagle Creek Cave in Arizona that once numbered between 25 and 50 million have declined by 99.9 percent to just under 30,000 (Tuttle, 1991).

Pesticide poisoning can also affect bats in many ways. By reducing non-target insects, bats are unable to find adequate sources of insect prey. Bats also can ingest sub-lethal doses of pesticides, which become stored in their fat reserves. During times of stress, such as hibernation or migration, when large stores of fats are released, pesticides are released too, sometimes at lethal levels.

Because bats are consuming vast quantities of insect pests, the general health of entire ecosystems are compromised in the absence of bats. How many bats can we lose before their numbers become too few to survive and service our ecosystems? When humans modify ecosystems for natural resource production such as timber, minerals, or agriculture, maintaining habitat for bats will not only ensure the survival of these important wildlife species, but will also benefit the sustainable production of natural resource products.

The North American Bats and Mines Project

BCI and the United States Bureau of Land Management founded the North American Bats and Mines Project (NABMP) in 1993 to address conservation issues facing mine-roosting bats. The purpose of the NABMP is to eliminate the loss of bats during abandoned mine-land reclamation, while still protecting human safety. The NABMP has five primary objectives: (1) to educate natural resource managers and the public on the importance of mines for bats; (2) to train wildlife and mine-land managers on mine assessment and closure methods that protect both bats and people; (3) to assist agencies and industry in protecting and enhancing bat roosts in abandoned mines; (4) to provide leadership and coordination among Federal, State, and private agencies and the mining industry, thus minimizing bat losses; and (5) to aid with active research and monitoring efforts. By establishing and achieving these goals, BCI and its agency partners will ensure that bat conservation measures are incorporated into the planning and operating procedures of agencies and organizations responsible for mine-land management and wildlife conservation. To date, we have already provided funding and technical support to protect critical habitats for more than 2 million mine roosting bats, hosted 18 bats and mines workshops, distributed 20,000 copies of our resource publication, *Bats and Mines*, and translated this publication into Spanish for our Latin American Partners. As we continue to learn about our vital and fascinating bat species, we are better suited to manage for their long-term survival.

Table 1. North American bats that use mines for maternity and/or hibernation sites.

Species	Colony Sizes	Range	Use Time
Ghost-faced bat *Mormoops megalophylla*	Dozens to hundreds	AZ & TX	Year-round
California leaf-nosed bat *Macrotus californicus*	Dozens to over a thousand	AZ, southern CA & NV	Year-round
Mexican long-tongued bat *Choeronycteris mexicana*	A dozen or fewer	AZ, southern CA & NM	Summer
Lesser long-nosed bat *Leptonycteris curasoae**	Hundreds to thousands	AZ & NM	Summer
Greater long-nosed bat *Leptonycteris nivalis**	Hundreds to thousands	TX & NM	Summer
Southeastern myotis *Myotis austroriparius*	Hundreds to thousands	Southeastern U.S.	Year-round
California myotis *Myotis californicus*	Up to a hundred	Western U.S.	Year-round
Western small-footed myotis, *Myotis ciliolabrum*	Up to hundreds	Western U.S.	Year-round
Long-eared myotis *Myotis evotis*	Dozens	Western U.S.	Year-round
Gray bat *Myotis grisescens**	Hundreds to 50,000 or more	Southeastern U.S.	Year-round
Small-footed myotis *Myotis leibii*	Dozens	Eastern U.S.	Winter
Little brown bat *Myotis lucifugus lucifugus*	Hundreds to a million or more	Northern U.S.	Year-round
Arizona myotis *M. l. occultus*	Hundreds	Southwestern U.S.	Year-round
Northern long-eared myotis *Myotis septentrionalis*	Hundreds to thousands	Eastern U.S.	Winter
Indiana bat *Myotis sodalis**	Hundreds to 100,000 or more	Eastern U.S.	Winter

Table 1. (Cont.) North American bats that use mines for maternity and/or hibernation sites.

Species	Colony Sizes	Range	Use Time
Fringed myotis *Myotis thysanodes*	Dozens to hundreds	Western U.S.	Year-round
Cave myotis *Myotis velifer*	Hundreds to 100,000 or more	Southwestern U.S.	Year-round
Long-legged myotis *Myotis volans*	Hundreds	Western U.S.	Year-round
Yuma myotis *Myotis yumanensis*	Hundreds to thousands	Western U.S.	Year-round
Western pipistrelle *Pipistrellus hesperus*	Dozens	Western U.S.	Year-round
Eastern pipistrelle *Pipistrellus subflavus*	Dozens to thousands	Eastern U.S.	Winter
Big brown bat *Eptesicus fuscus*	Dozens to hundreds	North America	Year-round
Allen's lappet-browed bat *Idionycteris phyllotis*	Dozens to about two hundred	Mostly AZ, also parts of NV & CO	Year-round
Southeastern big-eared bat *Corynorhinus rafinesquii*	Dozens to several hundred	Southeastern U.S.	Year-round
Pacific big-eared bat *C. townsendii townsendii*	Dozens to hundreds	Western U.S.	Year-round
Ozark big-eared bat *C. t. ingens**	Dozens to hundreds	Ozark Mountains	Year-round
Western big-eared bat *C. t. pallescens*	Dozens to thousands	Western U.S.	Year-round
Virginia big-eared bat *C. t. virginianus**	Dozens to thousands	KY, VA & WV	Year-round
Pallid bat *Antrozous pallidus*	Dozens to hundreds	Western U.S.	Year-round
Mexican free-tailed bat *Tadarida brasiliensis*	Hundreds of thousands	Southwestern U.S., north to OR	Mainly summer, some year-round

* Endangered

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IMPORTANCE OF MINES FOR BAT CONSERVATION

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Abstract

Bat populations in the United States are in decline. Of the 45 species present, six are listed as threatened or endangered and twenty more are considered species of special concern by wildlife management agencies. Abandoned mines provide important habitat for many bats and some mines have been identified as critical to the continued existence of local populations and species. Bats use abandoned underground mines for protection from predators, for maternity roosts to bear and raise their young, and for hibernation. Abandoned surface mines are important foraging and summer roosting areas for many species. Abandoned mine land (AML) reclamation programs and public land management agencies have unique opportunities to both enhance and to damage bat populations through the way reclamation projects are evaluated, designed and constructed. Hundreds of mine shafts and portals are closed each year and thousands of abandoned surface mine acres are graded and revegetated by AML Programs. Modern surface mining operations manipulate thousands of acres of land annually, changing vegetation characteristics, disturbing feeding and roosting areas and modifying the contour of mined areas. Mine regulatory and land management agencies have opportunities to affect protection and enhancement of bat habitat through both regulatory and industry education efforts. This paper presents a broad overview of bat conservation opportunities and accomplishments associated with mines in the U.S. by reviewing the number of abandoned mine openings, and comparing the total number of openings closed by reclamation agencies, with the number closed or protected using bat-friendly methods. It also outlines the scope of bat protection opportunities associated with both the reclamation of abandoned surface mines and of active surface mining and reclamation through a discussion of acres disturbed each year by such activities. By educating reclamation agency personnel, mining industry officials, and the regulatory community on the scope of the potential impacts, we can improve the conservation and protection of bat populations and species, without sacrificing public safety, environmental quality, or the utilization of our coal and mineral resources.

Introduction

Bat Populations in the United States are declining. Of the 45 species present, six are either threatened or endangered and twenty more are species of special concern by the U.S. Fish and Wildlife Service (Harvey, Altenbach and Best, 1999[1]). Population declines can be attributed to a number of human activities. Hibernation and summer roost caves in many areas of the country are disturbed by recreational users and vandals. Commercial and residential development

eliminates bat access to many natural caves by closing surface openings. Mining also eliminates access to caves when openings are destroyed by excavation or road building processes or when old mines are reactivated. Human activities also disturb spring and summer feeding, watering, and roosting areas critical for many bat species. Over much of the U.S., natural vegetation has been lost due to land clearing for conversion to agricultural crop and pasture land and for conversion to residential, highway, and commercial uses. Construction of major irrigation and flood control reservoirs has flooded millions of acres and closed many natural cave openings along rivers and streams. Loss of native plant communities because of these activities has disrupted insect and plant food supplies, changed roosting and hibernation patterns, and presented obstacles to historic migration routes.

Mines provide important habitat for many bat species. Sixty two percent, or 28 of the 45 continental U.S. bat species, roost in mines. While, for some species the use is only occasional, for most of the 28 species, mines constitute important roost areas (Altenbach and Pierson 1995[2]). Underground mines provide both winter and summer roosting areas for bats. During winter, many abandoned mines contain areas with constant, above-freezing temperatures necessary for hibernation. During summer, underground mines may act as cold-sinks similar to caves, protecting bats from extreme summer temperatures while providing shelter from predators at the same time.

Use of underground mines by bats has been demonstrated all across the U.S. Of more than 6,000 mines in Arizona, California, Colorado, and New Mexico surveyed for bat use prior to 1994, 30 to 70 percent showed signs of bat use, with an average of 10 percent containing important colonies. In the northern and eastern United States, up to 70 percent of open underground mines may also be used by bats (Tuttle and Taylor 1994[3], Altenbach and Pierson 1995[2], Mesch and Lengas 1996[4]). Twelve of the 16 species of bats found in Wyoming are known to use mines (Luce 1993[7]). For some western species, such as Townsend's big-eared bat *(Corynorhinus townsendii)* and California leaf-nosed bat *(Macrotus californicus)*, the largest colonies now are found in man made habitat (Brown and Berry 1997, Luce 1993[7]). Mines are known to be the most significant bat hibernation sites in Michigan (Kurta 1999,[3]). Many other examples are available which have not been illustrated here. In summary, bats have been shown to use underground mines all across the U.S. for hibernation, day roosting, maternity shelter, feeding, and watering.

Closure of mines can have both immediate and long term impacts on bat populations. Historically, mine closure meant filling the mine entrance with solid fill or constructing a solid door over the opening. Closure of old mines during hibernation season, while bats are inside, can have disastrous results. A mine in Pennsylvania's Canoe Creek State Park was closed without regard to bat use but was reopened in time to save hibernating bats. The largest known hibernating population of bats in New Jersey was also trapped when the Hibernia mine was closed. Luckily, these bats were also rescued by the quick actions of biologists who convinced authorities to reopen the mine. Many other bat populations have not been so lucky.

For these reasons, we conducted a study to identify the scope of potential positive and negative impacts on bat conservation that may be realized by mining and abandoned mine reclamation activities. This paper presents the findings and conclusions of that study.

Methods

The study was conducted in two parts:

1. An E-mail/telephone survey of State mine reclamation and State wildlife agencies and Federal land management agencies.
2. A literature search on bat conservation, mine reclamation and mine permitting/production information.

The survey was conducted over a four month period from May to August, 2000. The following questions were asked of each survey recipient:

1. Number of coal mine openings
2. Number of non-coal openings
3. Number of mines closed
4. Number of bat-friendly closures
5. Acres of abandoned mine land reclaimed annually

E-mail surveys were initially sent to State mining and reclamation agencies and the U.S. Bureau of Land Management (BLM); U.S. Forest Service(USFS) and U.S. National Park Service (NPS). After receiving initial responses and tallying results, additional email and telephone contacts were made to State wildlife agencies and other organizations recommended by initial respondents. The intent was to continue attempting to make contacts until we had a high level of confidence that data represented a profile of the best information available across the nation. It was not assumed that any specific confidence interval could be reached due to the almost complete lack of comprehensive National tracking systems for data related to non-coal mines.

Trend information regarding mine closures was derived by querying the U.S. Department of Interior, Office of Surface Mining (OSM), Abandoned Mine Land Inventory System (AMLIS) on October 23, 2000. Numbers of completed vertical openings and portals were queried for all program areas, and all States, for the period 1978 to September 30,1994, and for the subsequent two year periods ending September 30, 1996; September 30, 1998; and September 30, 2000.

OSM and the NPS have more complete data sets. NPS has an inventory that includes mine openings and bat-friendly closures installed in each park. OSM has an extensive inventory of coal mine openings in the States, but the non-coal inventory is inconsistent and incomplete. OSM does not have a comprehensive inventory of bat-friendly closures constructed by either OSM or the States or Tribes.

Limitations of Survey Data

The reported numbers of coal mine openings are based primarily on input from State programs that administer the Surface Mining Control and Reclamation Act (SMCRA). State responses were correlated with data from the OSM AMLIS system and significant discrepancies were discussed and reconciled with respondents. Discussions with State respondents indicate that the reported numbers of openings in the eastern U.S. are less than actual because there are so many coal mining problem features in the Appalachian States that inventories have not been completed.

The reported numbers of non-coal mine openings were derived primarily from State respondents. The confidence levels of these numbers vary dramatically from State to State and agency to agency. Data in some States are derived from detailed field inventories while data in others are merely educated guesses by State officials. At the present time, there is no national requirement to inventory and catalog non-coal data.

Numbers of bat-friendly closures are expected to be quite accurate. These numbers came entirely from survey respondents who are the local bat experts, or who worked with reclamation agencies involved in the mine closure programs.

Data for Indian Tribes were derived only from the OSM AMLIS System. Data were not solicited from Tribal governments because of time constraints. The number of Mine Openings and Bat-friendly closures on Tribal lands are unknown.

The numbers of closed mines in this report do not necessarily reflect the number of instances where bat habitat was lost. Many States were unable to separate the number of mine shafts and portals from the number of openings that resulted from mine subsidence. Subsidence openings often occurred as sudden events, and were only accessible to the surface for days or weeks making it unlikely that bats were making use of them. Many other openings probably did not exhibit proper conditions for bat habitation. They may have been full of water to the ground surface or may have not exhibited proper temperature or humidity conditions for bat use.

Even with these stated limitations, we believe that the data represents a reasonably accurate picture of the breath and scope of mine related openings that are or were available for bat habitation.

Results

Underground Mines

Responses were received from 47 states. No response was received from Georgia, Rhode Island, or Hawaii. The BLM and National Forest Service were unable to provide comprehensive summaries of Federal lands that they manage. Certain BLM and Forest Service district offices did provide data and this was combined with State provided data to create more complete State by State summaries.

The survey indicates there are more than 367,000 abandoned mine openings in the U.S. This estimate is probably conservative because many of the survey respondents stated that detailed inventories are not available for their area. Numbers were based on best available information for each State. For example, the author used an estimate of 165,000 openings for the State of Nevada provided by the Bureau of Land Management, yet other sources estimate with less confidence that the number may be as high as 300,000 openings. As another example, the Missouri estimate of 258 openings includes only 200 lead mine openings from a 2 county area. Missouri has been the leading State in lead production for much of the nation's history, producing lead in many counties in the southern one third of the State. While the actual number of lead mine openings is expected to be much greater, detailed inventories are just not available to support accurate estimates and State officials did not speculate on the number. While these two examples probably indicate that the number of mine openings may be much greater, the

367,000 openings reflected in our study serves to illustrate that a great many open mines exist that may serve as seasonal habitat for bats. Table 1 provides the number of mine openings reported by State during the 2000 survey.

TABLE 1 - NUMBER OF MINE OPENINGS REPORTED BY STATE

STATE	NUMBER OF COAL MINE OPENINGS	NUMBER OF NON-COAL MINE OPENINGS	TOTAL MINE OPENINGS
Alabama	230	150	380
Alaska	50	350	400
Arizona	0	80,000	80,000
Arkansas	30	Unknown	30
California	4	48,944	48,948
Colorado	150	18,000	18,150
Connecticut	0	5	5
Delaware	0	Unknown	ND
Florida	0	0	0
Georgia	0	Unknown	ND
Hawaii	0	Unknown	ND
Idaho	20	5,000	5,020
Illinois	68	15	83
Indiana	6	24	30
Iowa	7	Unknown	7
Kansas	424	100	524
Kentucky	1,362	Unknown	1,362
Louisiana	0	0	0
Maine	0	Unknown	ND
Maryland	26	Unknown	26
Massachusetts	0	Unknown	ND
Michigan	50	Unknown	50
Minnesota	0	100	100
Mississippi	0	1	1
Missouri	58	200	258
Montana	0	281	281
Nebraska	0	0	0
Nevada	0	165,000	165,000

STATE	NUMBER OF COAL MINE OPENINGS	NUMBER OF NON-COAL MINE OPENINGS	TOTAL MINE OPENINGS
New Hampshire	0	Unknown	ND
New Jersey	0	Unknown	ND
New Mexico	71	20,000	20,071
New York	0	100	100
North Carolina	0	Unknown	ND
North Dakota	0	Unknown	ND
Ohio	141	11	152
Oklahoma	169	481	650
Oregon	24	Unknown	24
Pennsylvania	964	Unknown	964
Rhode Island	0	Unknown	ND
South Carolina	0	Unknown	ND
South Dakota	0	Unknown	ND
Tennessee	560	Unknown	560
Texas	0	100	100
Utah	43	20,000	20,043
Vermont	0	Unknown	0
Virginia	2,085	Unknown	2,085
Washington	115	Unknown	115
West Virginia	1,932	Unknown	1,932
Wisconsin	0	Unknown	ND
Wyoming	10	5	15
Total	8,599	358,867	367,538

ND = No Data Available

Mine Closures

According to survey respondents in 47 States and information contained in OSM's AMLIS system, over 32,000 mine openings have been closed by local, State, Tribal, and Federal agencies. Table 2 summarizes the number of mine closures by State and Indian Tribe. This number includes 25,075 mine closures reported in the OSM - AMLIS, from 31 States and 11 Indian Tribes. The AMLIS numbers are expected to be less than the number derived from survey respondents because they do not contain data from 16 States, the National Forest Service, Bureau of Land Management, State wildlife agencies, or local governments. The authors therefore believe that the survey results represent the best data currently available.

TABLE 2 - NUMBER OF MINE OPENINGS CLOSED IN THE UNITED STATES

STATE	NUMBER CLOSED BY ALL METHODS	
Alabama	1400	15
Alaska	34	0
Arizona	83	68
Arkansas	143	14
California	68	198
Colorado	5254	321
Connecticut	5	5
Delaware	0	0
Florida	0	0
Georgia	123	0
Hawaii	0	0
Idaho	13	51
Illinois	1282	22
Indiana	596	15
Iowa	22	0
Kansas	10	0
Kentucky	1985	114
Louisiana	0	0
Maine	0	0
Maryland	66	8
Massachusetts	0	0
Michigan	64	14
Minnesota	2	2
Mississippi	0	0
Missouri	109	2
Montana	1856	5
Nebraska	0	0
Nevada	5615	28
New Hampshire	8	1
New Jersey	1	1
New Mexico	1252	127

New York	11	11
North Carolina	11	6
North Dakota	160	0
Ohio	557	17
Oklahoma	216	0
Oregon	15	4
Pennsylvania	1039	24
Rhode Island	0	0
South Carolina	0	0
South Dakota	6	0
Tennessee	346	20
Texas	394	55
Utah	4500	300
Vermont	1	1
Virginia	1024	52
Washington	106	24
West Virginia	2112	20
Wisconsin	31	11
Wyoming	1500	75
Tribal Lands	Mine Closures Reported in OSM - AMLIS	Hopi, Navaho and Crow Tribes Surveyed for Bat Gates
Wind River	36	Not Surveyed
Ute Mountain Ute	8	Not Surveyed
Unitah Ouray	10	Not Surveyed
Southern Ute	15	Not Surveyed
Hopi	11	1
Northern Cheyenne	7	Not Surveyed
Fort Peck	11	Not Surveyed
Jicarilla Apache	3	Not Surveyed
Navajo	592	4
Rocky Boys	6	Not Surveyed
Crow	19	0
Total State and Tribe	**32738**	**1639**

Bat-Friendly Closures

No previous attempt had been made to count bat-friendly closures on mines across the U.S. Survey results indicate that 1,639 Bat-friendly mine closures have been installed by State, Federal, Tribal and local government agencies. Several respondents stated that bat gates were only installed when endangered species were suspected to use the opening. When other species were the only users, mines were completely sealed. Other respondents said that bat gates were installed when any significant bat population was found.

Tribal governments were not surveyed due to lack of time, however, available data indicated that at least 5 gates were installed by Tribal governments. The National Park Service has installed 103 bat-friendly closures as of August 2000. Most of these are included in the State summary totals, however, because some State respondents did not provide itemized lists of closures by location, we are not sure that all NPS sites were included in the total. The survey results may include a small number of closures performed by mining companies on Bureau of Land Management (BLM) lands, because some BLM offices were unable to separate them from agency closures. However, mining companies were not surveyed. Table 2 shows the number of bat-friendly closures, listed by State and Tribe.

Active Surface Mining and Surface Effects of Underground Mines

Underground mine openings are not the only mine features to potentially effect bats. Surface mining activities including transportation facilities, milling and processing sites, and mine waste disposal areas also present opportunities for both positive and negative impacts on bat survival. We attempted to evaluate the scope of potential impacts by these mining activities by researching the acres of land disturbed annually by mining and processing activities. Reviews of U.S. Government and mining industry documents revealed detailed and extensive records of mineral, metal, stone, and coal production on a tonnage basis and even recorded tons of waste rock for some industries, but acres disturbed by mining were found on a national level only for coal mining. The basis of coal mining acres are the 1998 and 1999 Office of Surface Mining - Annual Reports, published by the agency in January 1999 and January 2000 respectively. At the close of 1999, there were 4,722,404 acres of land in 27 States and 4 Indian Tribes in the U.S. under permit for coal mining and processing activities. On the average, during the late 1990's an additional 86,000 acres of land are permitted for coal mining operations annually.

To get some idea of how non-coal mining disturbance may compare to coal mining, we looked at the tons of non-coal minerals mined by surface and underground methods compared to the tons of coal mined. In 1998, 58 non-fuel minerals were mined over all 50 States. This mining removed 6 billion metric tons of ore from the ground, a 9 percent increase over the previous year. Ninety seven percent of this was mined by surface mining methods. By contrast, the average 86,000 annual acres of new coal mining permits produced 1.1 billion tons of coal. Only 52 percent of the coal was by surface mining methods.

Abandoned Mine Reclamation

Abandoned mine reclamation offers many opportunities to change surface habitat of bats such as summer roosting areas, watering and foraging areas, migration and daily commuting routes. Because of this, the authors asked survey participants how many acres of abandoned mine land are reclaimed annually by their respective programs. Most respondents suggested that we refer to the OSM AMLIS for this information. While accomplishments of some States without OSM funded reclamation programs are not represented in the AMLIS, the number of acres reclaimed

by those State programs is small compared to the overall total. Therefore, we decided to use the annual reported acreage from AMLIS for this measure of overall potential effect on bat habitat. Information from 27 States and 11 Indian Tribes reported in AMLIS indicates that approximately 9,000 acres of abandoned mine lands are reclaimed each year in the US.

Discussion

Open underground mines offer thousands of opportunities nationwide, for bat use. The 367,000 open mines reported by respondents are scattered across 34 States from the Atlantic to the Pacific coasts. The majority of mine openings are in the western 1/3 of the U.S. and nearly 80 percent are reported in just 3 States: Nevada, Arizona, and California. Table 1 provides a breakdown by State. Some openings provide winter hibernation sites because they exhibit the right combination of temperature, humidity, and air flow for bat survival. Many mines have been found to be critical hibernation sites for certain species. Closure of these mines without allowance for continued bat use could prove disastrous for certain species. Other mines are used as summer day or night roosts, or for maternity habitat when young are most vulnerable. These mines may also be critical for the survival of specific populations or species due to the loss of natural cave habitats to development or other human activities. On the other hand, many mines receive only occasional use by bats and complete closure of such would not be expected to harm bats as long as none were trapped inside during the closure effort.

Government agencies have closed over 32,000 mine openings in 40 States and 11 Indian Tribes (Table 2), and the rate of closures is increasing. According to AMLIS, 12,557 mine openings were closed between 1978 and 1994, reflecting an average annual rate of 785 openings (Table 3). The average rate of mine closures between 1994 and 2000, was 2000 per year, with the average going up to 2813 openings annually in the last 2 years. With the rate of mine closures continuing to increase, the possibilities go up each year that critical habitats will be lost.

Table 3 - MINE CLOSURES REPORTED IN OSM AMLIS 1978 - 2000*

Reporting Period	Total Vertical Openings and Portals Closed - Cumulative	Average Openings Closed Per Year
1978 to 9/30/94	12,557	785
10/1/94 to 9/30/96	4,645	2322
10/1/96 to 9/30/98	2,247	1,123
10/1/98 to 9/30/2000	5,626	2,813

*AMLIS data does not include all States or time periods covered by the Summer 2000 survey and may not include U.S. Forest Service or Bureau of Land Management Data. The total reported in AMLIS is less than that in the Survey.

Federal agencies are also increasing the number of mine closure projects. The Office of Surface Mining is working in Tennessee, Michigan, Oregon, Washington, and California to address the remaining abandoned coal mines problems. Beginning in 1998, the BLM and FWS each began receiving in the range of $10 million annually for mine relation activities. These funds are being used for abatement of numerous mining related problems including closure of mine openings. The NPS has worked throughout the late 1990's to inventory health and safety hazards on Park Service lands. The Service is now working to address the worst safety hazards, many of which are open mines.

In recent years, more government agencies and offices have begun taking the needs of bats into consideration by surveying mines for bat use prior to closure and by installing bat-friendly closures (gates, fences and cages) over mine openings when they are found to be important bat habitat. Most mines are closed by government agencies for one of two reasons: either to exclude people for public safety reasons, or to keep people out to protect important bat populations. In either case, closure methods must be permanent and vandal proof.

We found that approximately 1,639 of the mine closures reported in Table 2 have been bat-friendly closures. This represents a mere 5 percent of all reported closures. There may be many reasons for this small percentage. We list some of them here. One primary reason is that many mines openings are not occupied by bats due to physical and environmental conditions in the mine. Some mines are flooded nearly near the surface, naturally prohibiting bat use. Other reported closures involved mine subsidence openings that were only open for days or weeks prior to closure, leaving little opportunity for bats to take up residence. Some mines probably contained bat populations that were never discovered because proper bat surveys were not conducted. In some States, mines are only surveyed or protected when endangered species are known to inhabit the area, or are specifically known to use the mine slated for closure. Mines that are not located in the territory of endangered species may not even be surveyed. Another reason for failure to use bat-friendly closures is concern by some agency officials that gates and cupolas are not as secure from vandalism as solid fill closures. This concern is based largely on old information and experience involving gates installed prior to today's improved designs and materials. Other reasons could surely be found, but we will not speculate on those here. However, we believe that improved education of agency officials about bat values and bat habitat needs would increase the percentage of bat-friendly closures installed.

Bat-friendly closures can generally be grouped in the following five categories:

- **Bat gates** are made of welded steel bars, plates or angle irons, placed horizontally across a mine entrance at pre-determined spacings. These are generally installed in the mouth of horizontal or sloping openings and are anchored into solid rock or into poured concrete footers.
- **Bat cages** or **copulas** are installed over vertical openings and are also constructed of steel tubing, angle iron or other bar stock.
- **Gated culvert** pipes are sometimes used in openings where the near-surface materials are too unstable to construct traditional bat gates and cages.
- **Cable nets** and **fences** are sometimes used to exclude human entrance into mines, but are not as secure as welded gates or cages and they often do not provide the same level of bat access. These have been used where access is extremely difficult and where funding is inadequate for other closure methods. Fences were used in years past when other closure designs were not well known by agency officials.

Increased awareness of bat habitat needs protects bat populations in another way. While surveys find considerable bat use of some mines, many others find no, or find only occasional bat use by small populations of non-threatened species. Survey respondents told us that many of these small, non-critical bat populations have been spared entrapment in mines because they were detected by a bat survey. Once the populations were determined to be non-critical or non-endangered, the bats were spared entrapment by the agency simply waiting for bats to leave the mines prior to installation of solid closure methods. This shows that the completion of bat surveys prior to development of preliminary reclamation plans resulted in protection of bat

populations while allowing the agencies to complete their missions.

Agencies across the U.S. do not necessarily give equal consideration to the needs of bats during mine closure. Table 2 shows us that the majority (58 percent) of all bat-friendly closures in the U.S. have been installed in four western States, Colorado (321), Utah (300), California (198) and New Mexico (127). Kentucky has also installed a considerable number of bat-friendly closures, with 114 reported. Other States reporting large numbers of mine closures reported few bat-friendly closures. This may reflect a prevalence of mines that do not support bats. Alternately, it may indicate that bat surveys are not conducted in many States prior to closure design.

Active mines

Active mining operations disturb contemporary habitat in many ways. Mining removes surface vegetation, changes the physical configuration of the land and modifies or eliminates associated streams and lakes. Mining companies construct facilities to clean and refine mined commodities. These include slurry ponds, cyanide leach piles, and holding ponds. Open cyanide ponds and other toxic chemical impoundments can poison bats, especially in desert areas where clean water sources are scarce (Brown and Berry 1997 [3]). For example, one study conducted in Arizona, California, and Nevada from 1984 to 1989 found that 33.7 percent of 519 animals found dead near cyanide extraction gold mines were bats (Clark and Hothem 1991[4]). Active mines also disturb abandoned underground mines that have become roosts for bat populations. Geologic exploration may disturb roosting bats due to increased human activity (Brown and Berry 1997). Reactivation of old mining districts often eliminates underground roosting habitat by reworking mined areas using open pit methods.

Because of State and Federal laws, most mining companies must take actions to reclaim mined land and replace vegetation removed by mining activities. The nature and extent of these reclamation activities vary substantially across the nation. While coal mines are governed by the Federal Surface Mining Control and Reclamation Act which provides a strict set of national standards that must be adhered to by all coal mining operations, other types of mining are covered by a mixed bag of State and local reclamation regulations and land management agency permit requirements. All these mining and reclamation activities provide opportunities for protection of bat habitat during mining and for restoration and enhancement of bat habitat during the reclamation process.

Our study found that 86,000 acres of land are affected by coal mining annually to remove 1.1 billion tons of coal. Not all land placed under permit for coal mining is actually mined. Many acres are permitted for roads, processing areas and buffer zones. Native vegetation and topography in these areas are disturbed in different ways than in areas actually mined. Some lands are included in permits merely for convenience and are not disturbed at all. It would be extremely difficult on a national level to separate the acres physically disturbed from the total permitted acres. Yet we know it is somewhat less. For purposes of this study, we must assume that acres permitted equals acres affected in some way by mining processes.

Government records show us that six billion metric tons (2204 pounds or 6.6 billion short tons) of non-coal minerals are mined annually in the U.S., nearly six times the tonnage of coal produced. However, we found no estimate of acreage disturbed by those operations and no industry standard for converting mine tonnage to acreage disturbed. Based upon the tonnage figures, we speculate that the total acreage disturbed by mining activities may be two to three times the coal acreage. This level of disturbance provides many opportunities for protection, creation and enhancement of bat surface habitat each year. These opportunities can best by

realized by educating the mining industry about the benefits of considering bat habitat needs in the mining and reclamation planning processes. Education of State permitting personnel can also help realize these opportunities by providing a conduit of information to the mining industry.

Abandoned Surface Mines

Approximately 9,000 acres of abandoned mine lands are reclaimed annually in the U.S. These lands range in vegetative quality from barren land and acid water to lush, well vegetated mine spoil piles with high quality water impoundments and wetlands. Lands are most often reclaimed to eliminate serious public health and safety hazards. Environmental quality and wildlife habitat enhancement receive varying levels of emphasis depending on the attitude of the reclamation agency, the wishes of landowners, and the availability of funds.

Reclamation of abandoned surface mines provides many of the same opportunities for bat habitat protection, creation, and enhancement as do active mining operations, with the additional opportunities provided by the fact that reclamation and environmental restoration rather than mineral extraction are top goals of the reclamation agencies. Bat habitat has been successfully restored through abandoned mine reclamation projects. On a series of reclamation projects during the late 1990's in Crawford County, Kansas, strip mine pits located adjacent to roads were known to be critical feeding and travel habitat for the Federally Endangered Gray Bat (Myotis grisescens). Through the reclamation process, mine pits were filled in and relocated a safe distance from the roads and native trees were reestablished along the banks of the new ponds. Ponds with varying depths replaced the deep, steep sided strip pits to enhance the variety and number of insects that the gray bats feed on. Visual and bat detector surveys conducted after completion of reclamation demonstrated that Gray Bats and other species have returned to feed along the new water bodies (Imhof, 2000[8]).

Conclusion

Abandoned mines provide important bat habitat. With over 367,000 open abandoned mine shafts and tunnels in the U.S., mines must be considered a valuable resource for bat conservation efforts. Closure of abandoned mine shafts and tunnels can significantly affect the availability of roost habitat for many species. Reclamation and land management agencies have closed over 32,000 mine openings through August, 2000, and at the current closure rate of over 2,800 openings per year, opportunities are abundant for bat protection or bat harm. Mine surveys in the western U.S. indicate that 30 to 70 percent of mines are used by bats. And yet, out of 32,000 mine closures nationwide, approximately 1,639 or 5 percent, utilized bat gates and other bat-friendly closure devices. While no conclusions may be directly drawn from this percentage, it suggests that more mines should be surveyed for bat use prior to closure. It may also suggest that agencies may be permanently sealing some mines used by non-endangered species merely because there is no statutory requirement for maintaining bat access to those mines.

Surface mining and reclamation activities can have significant positive or negative impacts on amount of available habitat, the quality of habitat and the security of roosting areas from human disturbance. With over 9,000 acres of land reclaimed annually by AML agencies and more by local governments, chances to create or enhance bat foraging, watering and summer roosting habitat abound. Contemporary coal mining operations affect another 86,000 acres of land annually by mining, processing, transportation and power transmission activities. Mining for non- coal commodities may double or triple that acreage figure. While bat conservation is unlikely to be important to mining companies, education of mining officials on the importance of bat protection and the low cost of including bat conservation actions into the mining process, can

result in significant positive impacts on habitat protection and creation.

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Importance of Mines for Bat Conservation

A National Perspective

Len Meier, Office of Surface Mining
Jesse Garcia, University of Oklahoma

Bats

Photo by Scott Altenbach

Overview

- What do bats need for survival?
- How do underground and surface mines effect these needs?
- What opportunities do mining and reclamation present for bat conservation?
- How big are those opportunities.

Needs of Bats

- Shelter
- Food
- Water
- Safe Travel Routes

Underground Mines

Provide Shelter for:

- Winter hibernation areas
- Summer roosting areas
- Maternity and nursery areas

Surface Features of Mines and Land to be Mined

- Shelter
- Food
- Water
- Travel routes

Mines Provide Possibilities

Three Kinds of Possibility:

- Damage and degrade bat habitat
- Protect existing habitat values
- Create or enhance habitat

Study To Determine National Scope of Mining - Reclamation

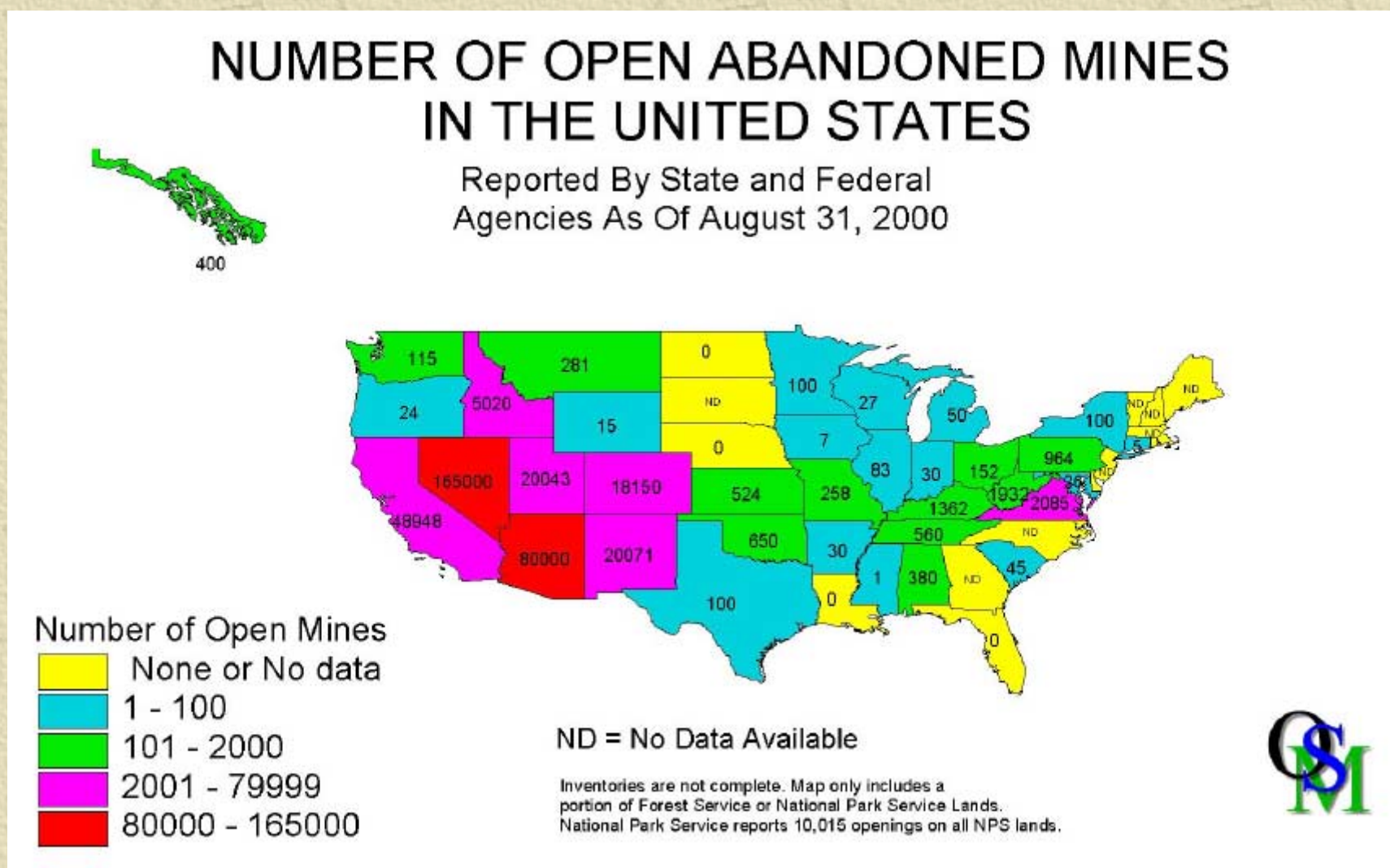
- Three month study
- E-mail and telephone survey – Response from 47 states.
- Research of mine permitting and production records
- Research on bats and mines literature.

Open Underground Mines

Bats and Mines Facts

- 30% to 70% of mines in western, northern and eastern U.S. are used by bats
- 12 of 16 Wyoming species use UG mines
- Largest colonies of some western species are found in mines
- Most significant hibernation sites in Michigan are UG mines

More Than 367,000 Abandoned Mine Openings In The U.S.



Over 32,000 Mine Openings Have Been Closed.

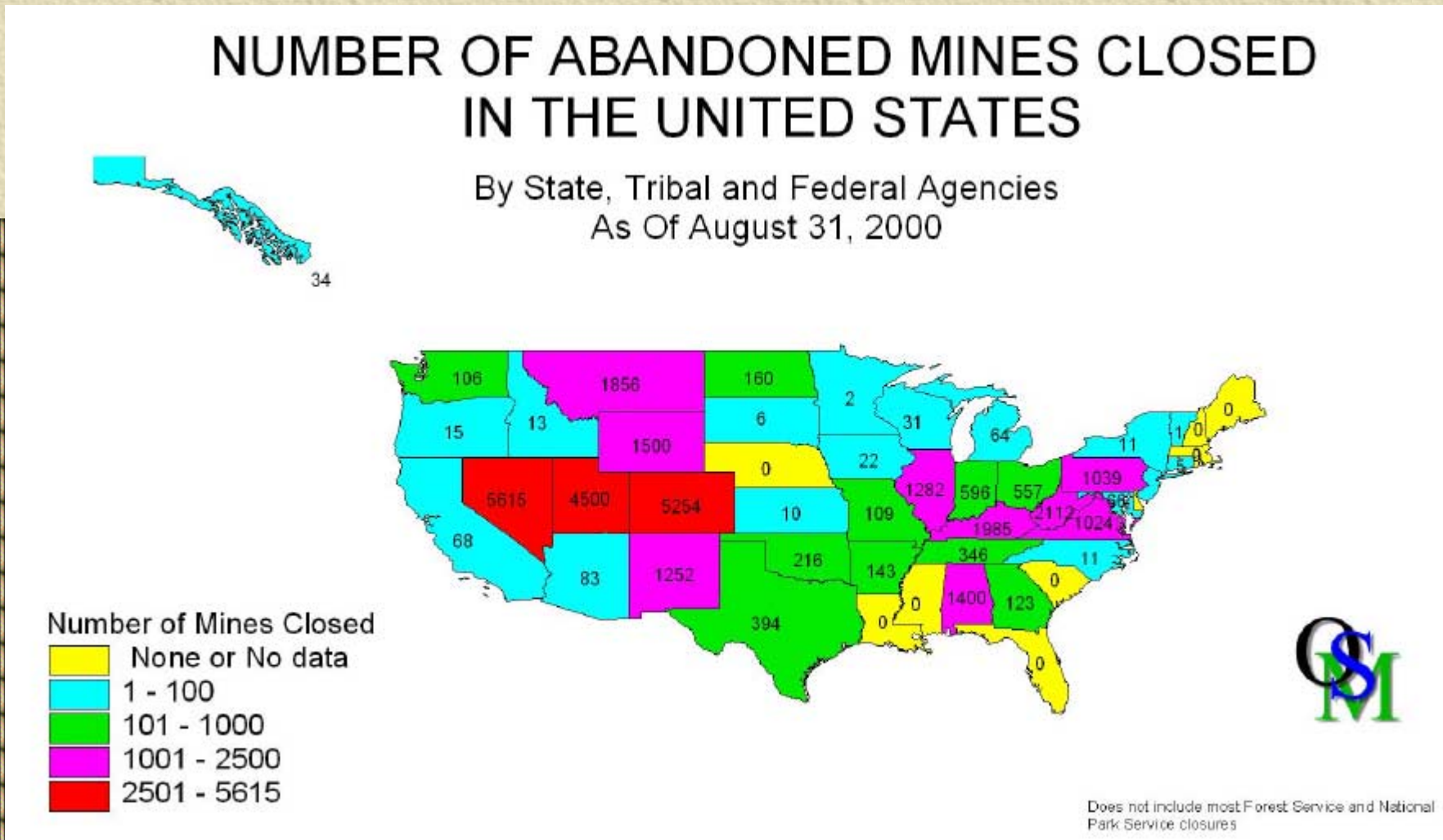


Table 3 - MINE CLOSURES REPORTED IN OSM AMLIS 1978 - 2000*

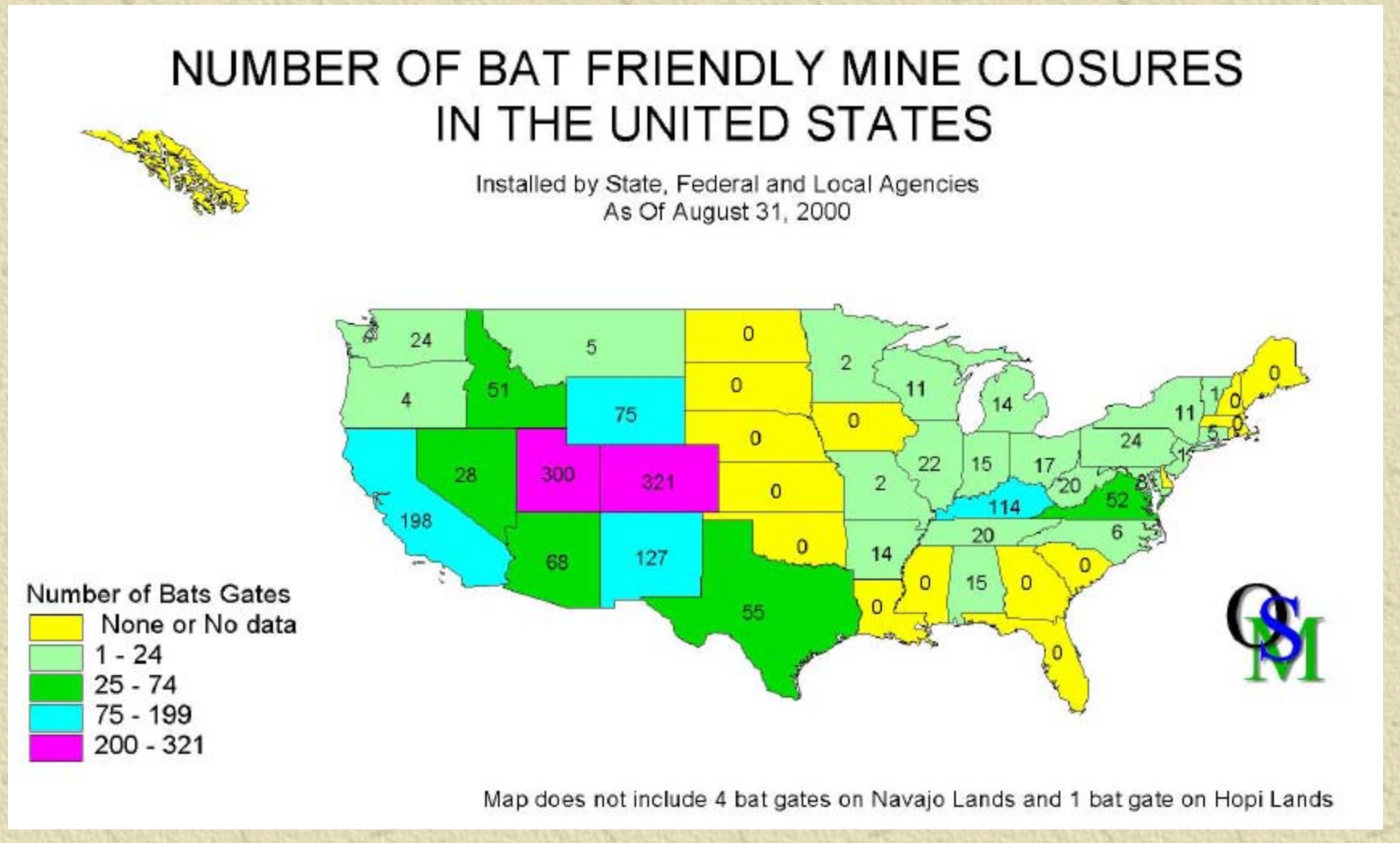
Reporting Period	Total Vertical Openings and Portals Closed - Cumulative	Average Openings Closed Per Year
1978 to 9/30/94	12,557	785
10/1/94 to 9/30/96	4,645	2322
10/1/96 to 9/30/98	2,247	1,123
10/1/98 to 9/30/2000	5,626	2,813

Possibilities

- Protect bat colonies from disturbance
- Protect habitat with Bat-Friendly closures
  - 600,000 bats protected in Wisconsin by survey of just 2 mines
- Lose Habitat
- Entrap bats during closure
  - Canoe Creek State Park PA
  - Hibernia Mine in New Jersey
  - Others

Bat Friendly Closures

Roughly 1,634 Bat Friendly Closures Nationwide



-Above Ground-

Surface Features Provide

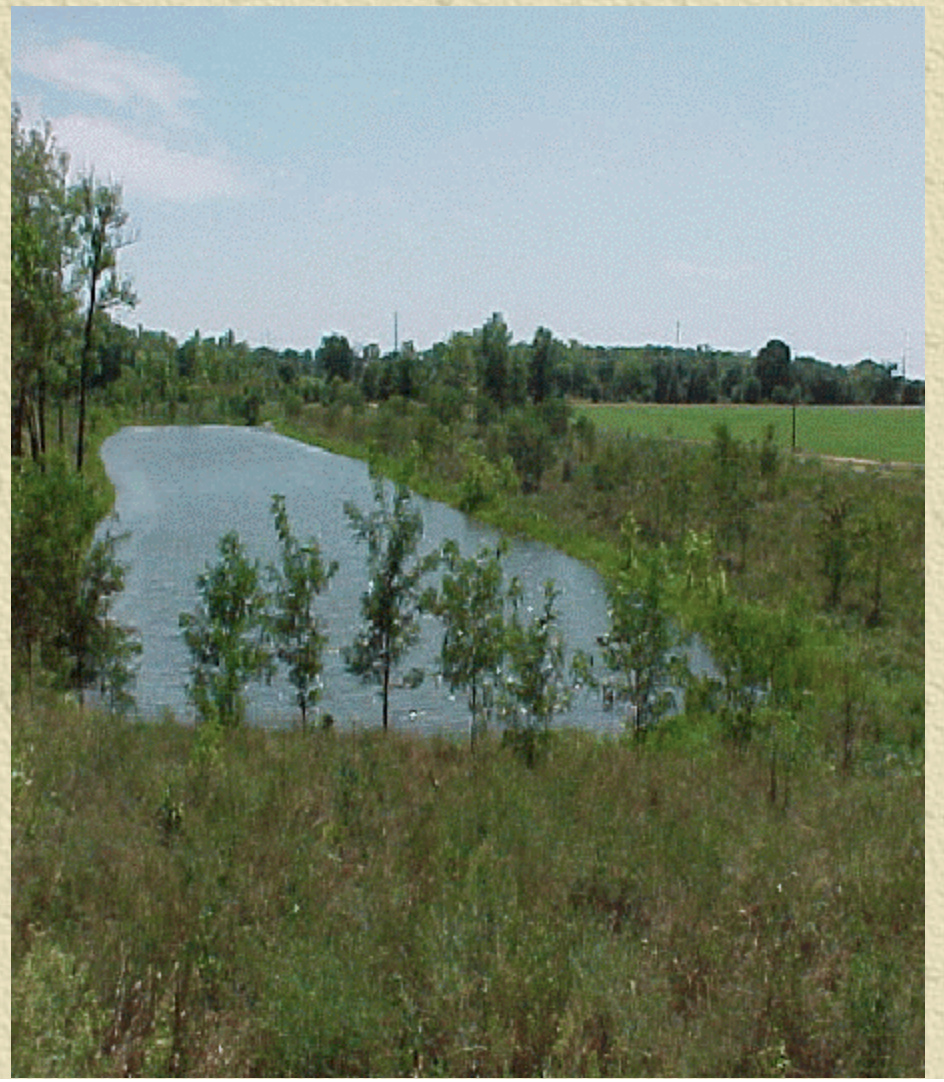
- Shelter
- Food
- Water
- Travel routes

Abandoned Surface Mines

Abandoned Surface Mine Reclamation

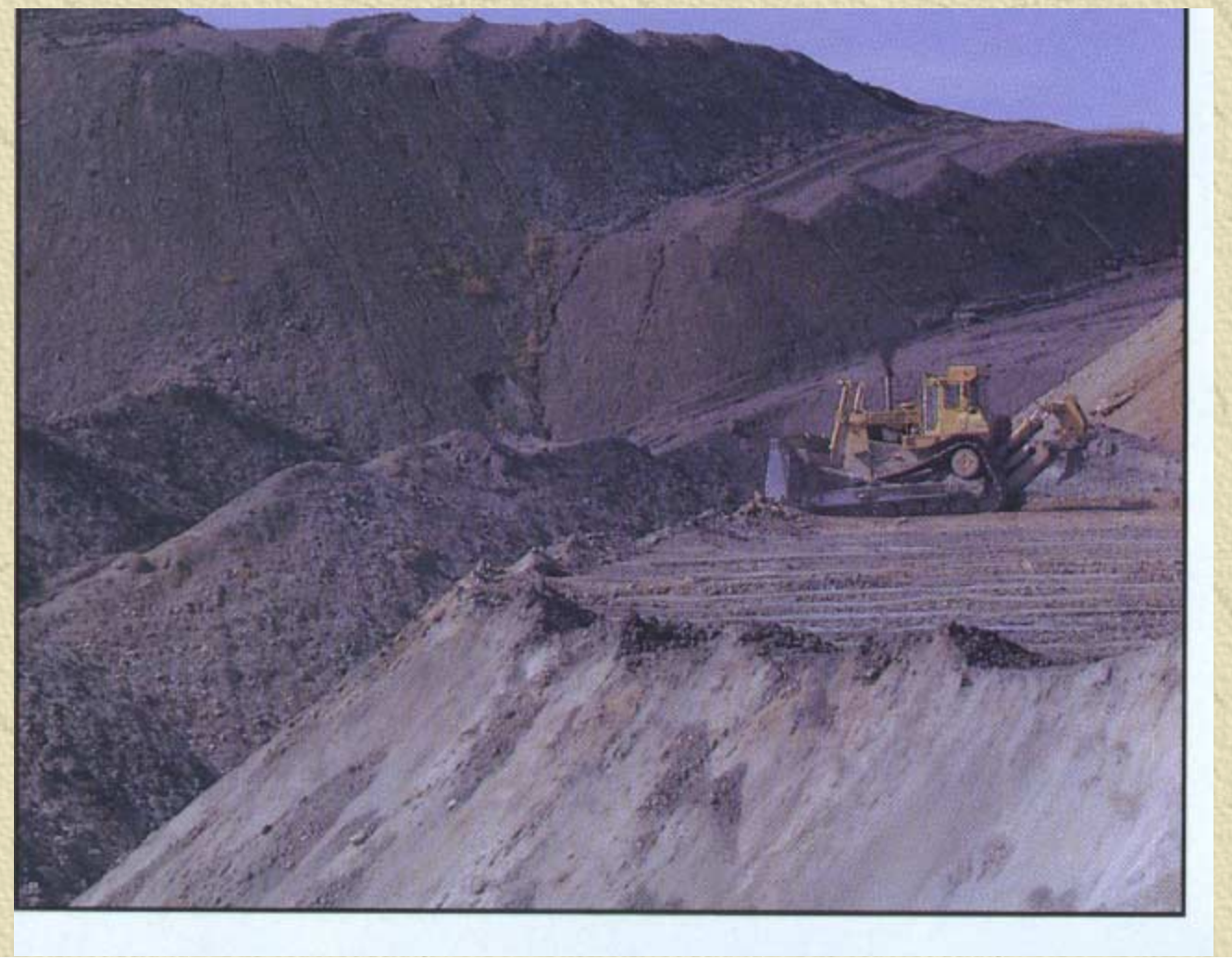
- 9000 acres AML reclaimed each year by government agencies
- Reclamation expected to increase as states, Tribes, BLM, Forest Service and Park Service begin to use Clean Water Action Plan and other AML funds

Bat Friendly Reclamation



Not So Friendly Reclamation

Active Mining and Reclamation



Active Mining Possibilities

- Destroy or degrade habitat
- Destroy nursery populations
- Protect existing bat populations
- Maintain habitat by temporary measures during mining
- Create new habitat during reclamation

National Scope of Active Mining

- 86,000 acres new coal permits annually for 1.1 billion tons coal
- 6.6 billion tons of metal ore mined annually.
- Actual acres effected annually may be 200,000 or more.

Summary

- Abandoned mines provide important bat habitat:
  - 367,000 open mines, 32,000 closed, 1,634 bat friendly.
- Abandoned surface mines can provide food, water, shelter for bats - 9000 acres reclaimed/year.
- Reclamation activities can have positive or negative impacts on bat habitat.
- Active mining operations can diminish or enhance bat habitat – 86,000 acres permitted for coal mining/year. ? acres disturbed by other mining.

Bat Populations are in the United States are in Decline

Of the 45 species present:

- Six are either threatened or endangered
- Twenty more are species of special concern
- Habitat destruction continues to escalate

Why Are Mines So Important?

- Caves have been disturbed
- Areas where bats historically lived have been changed by human activity:
  - drained for agriculture
  - cut over and converted to farms, subdivisions, highway interchanges, commercial uses
  - Mined and in some cases reclaimed

Survey Questions

- Number of Coal Mine Openings
- Number of Non-coal openings
- Number of Mines Closed
- Number of Bat Friendly Closures
- Acres of Abandoned Mines Reclaimed Annually

CHALLENGES IN PROTECTING BATS

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Abstract

During the past century, abandoned mines have become an important part of the habitat of cave dwelling bat species in many parts of the United States. This paper focuses on the current challenges to individuals and agencies trying to safeguard abandoned mines from human entry. The challenges can be divided into two broad categories. The first category is the cost both in time and money for habitat assessment and the design and construction of bat compatible closures. The second category is the lingering concerns in many agencies over the increased liability that bat compatible closures may have over conventional backfill closure of mines. Each State varies in its liability laws, funding of reclamation programs, number of abandoned mines, and their importance as bat habitat. Resolution of these challenges will continue to occur on a project by project basis by each State, Tribe or local group. The goal of this talk is to provide only a general understanding or framework. Later presentations will provide the detailed information needed to evaluate the challenges faced in each project. When this conference is completed, you should have the knowledge needed to better serve the public needs in both safety and bat conservation.

Introduction

During the past century, abandoned mines have become an important part of the habitat of cave dwelling bat species in many parts of the United States. Following the passage of the Surface Mining Control and Reclamation Act (SMCRA) by Congress in 1977, programs were established to safeguard coal mines. SMCRA provided funds for States and Tribes with a history of coal mining to develop Abandoned Mine Lands (AML) programs. AML programs were started in the 1980's and safeguarded almost all mine openings by backfilling them. By 1990, many of the western States were safeguarding non-coal as well as coal mines. Around 1990, AML programs also became aware of the importance of evaluating old mines as bat habitat. Though less than a decade old, the AML programs had developed a “program tradition of backfilling” as the quickest, cheapest, and easiest way of safeguarding mine openings. The world changes and agencies must change with it. This paper focuses on the challenges commonly raised by the old backfilling tradition toward efforts to include wildlife values as a major consideration in AML programs.

The technical challenges of bat habitat assessment and bat grate design will be covered in later sessions. Many of the topics I mention now will be covered in detail later in the conference. I will focus on the challenges caused by old attitudes that still linger in many agencies. The first talk this morning stressed the importance of bats, and the second talk the importance of mines to many species of bats. If you accept these concepts, as most people do, then why has government

been slow to develop and implement mine reclamation programs that fully meet the needs of bat habitat preservation? The AML programs supervised by OSM have come a long way in the past decade. However, the challenges to OSM and each State and Tribal AML and active coal mine reclamation program still exist and will continue to exist after this conference.

The competing goals faced by AML programs result in compromises at almost every level in most projects. OSM and local governments want maximal public safety and reclamation as quickly as possible. This is to be done at the minimum cost. Obviously, compromises must occur. An abandoned mining site's historic and wildlife values can not always be preserved while providing for public safety and environmental restoration. The preservation of a mining site's historic values as well as its bat habitat has only recently been recognized as of equal importance with public safety. The balancing of safety with preservation of the nation's historic and biological heritage is the goal we are all striving to achieve. How well those goals are reached will continue to evolve. The degree of success will continue to vary from AML program to AML program depending on local pressures. The challenge to OSM and State AML programs is to find a balance that meets the goals the public wants us to achieve.

Everyone from the AML program managers down to the decision makers in the field have to constantly evaluate and balance the conditions that conflict with maximal bat habitat preservation. The costs and time delays involved in the assessment and construction of bat compatible treatments of mine sites will always exist. However, these can be minimized by long range planning and the exchange of information. The questions of safety and liability of bat grates in underground mines may be resolvable through State laws and diligent monitoring. These conflicts will not be resolved at this conference, but have to be dealt with in each project. The decisions on how a century and a half of abandoned mines are safeguarded will all be made in the next 20 years. Safeguarding will virtually be completed by 2020, after which only active mine reclamation will continue. It is the goal of this conference to provide a state of the art understanding of the challenges you and the bats face in mine safeguarding and reclamation.

The Challenges to Bat Habitat Preservation in Mine Safeguarding

I will focus on two categories of concern that have been challenges to AML programs in their bat habitat protection programs. First, the concern that liability is increased by bat grates and second, that they increase costs both in time and money.

1. Liability or Legal Questions on bat compatible closures.

The concern that the liability of an agency may increase by building bat grates has been one of the most common objections to them in the past. In order to evaluate this, we did a search to see if any law suits had occurred that set any legal precedent relating to bat grates. Our attorney did a search of the on-line computer law service, 'Westlaw.' for bats, bat grates and abandoned mines. To our surprise, we found that there have been a lot of law suits related to liability and bats over the years. However, none of them related to animals that fly. The cases all related to a game called "base ball." He found no cases dealing specifically with liability for bat grates and only one case dealing with abandoned mines.

This case dealing with abandoned mines was decided by the Missouri Court of Appeals in 1992. In that case, Miller v. River Hills Development, 831 S.W.2d 756 (Mo.App.1992), a private land owner was sued on behalf of a fourteen-year-old boy who fell into an abandoned mine shaft. The boy breached a steel barricade and a fence, ignored a sign warning of the danger of the abandoned mine, and knew of the danger. The Missouri Court of Appeals affirmed a lower court ruling that the landowner was not liable.

The Federal Government, States, and Tribes have varying degrees of immunity to prosecution. Private industry and land owners face greater potential risk of law suits. Government has broader protection against liability than private landowners. However, those differences have little bearing on the likelihood of a law suit being filed. They only bear on the potential cost of settlement. In this age of litigation, all governments get sued regardless of their immunity to prosecution and settlements of cases are often made just to avoid the costs of litigation. Lawyers are well aware of this and thus encourage their clients to name governmental units in their law suits. In New Mexico, the AML program was named, along with the property owner, in a wrongful death suit on an un-safeguarded mine in a remote area. The charge was that the State was negligent for not having closed all the abandoned mines in the State. The case did not go to trial.

To my knowledge, there has not yet been a case specifically related to someone being injured by breaching a bat compatible closure. We have been fortunate that the bat closures that have been vandalized, allowing people to later enter a mine, have not resulted in a death or injury. The odds are that some day it will happen and the agency building the gate will be charged in a law suit. Until then, there is no "Case Law" as termed by attorneys. There have been no cases of people being killed or injured in a mine that they entered through a breached bat grate.

Any engineered closure probably involves additional potential liabilities over total backfilling of a mine portal. It is unlikely that a litigant would claim engineering design failure. That potential exposure is eliminated by modern designs and good engineering. This risk can be covered by careful design of the bat compatible closure. The increased exposure comes from vandalism, such as individuals breaking through the bat compatible closure with blow torches, electric saws or other devices. Vandal breaching of bat closures can not be eliminated by engineering, but can be greatly reduced by engineering and will be discussed in a later session. Litigants will claim that they found the site breached prior to their entry of the mine. Although there is a small liability increase by bat grate installation over that from backfilling, it is very small.

The liability exposure is probably different from State to State due to State law. There is no specific legal precedent (i.e. case law) on bat grates. How then do we judge the liability question? The answer is in your agency's general exposure to 'torts,' or charges of wrong doing. In New Mexico, State governmental liability is governed by the New Mexico Tort Claims Act, NMSA 1978, Section 41-4-1 et seq. The purpose of the Act is to recognize that "while a private party may readily be held liable for his torts [negligent acts] within the chosen ambit of his activity [for his actions], the area in which the government has the power to act for the public good is almost without limit, and therefore government should not have the duty to do everything that might be done." Section 41-4-2(A). Consequently, the Act limits governmental liability. It

provides that "[a] governmental entity and any public employee while acting within the scope of duty are granted immunity for any tort" except as defined in the Act. In layman's language this means that the New Mexico AML program is immune to suits for negligence, providing reasonable caution was followed.

> The exceptions are relatively narrow. Government is liable for negligent operation of motor vehicles and water craft, or negligent operation, design, or maintenance of buildings, public parks, machinery, equipment and furnishings, airports, public utilities, medical facilities, negligence of health care providers, and negligent design and maintenance of highways and streets, and the negligence of law enforcement officers. Sections 41-4-5 to –12. " Nothing in the Act applies to mines or mine closures. **Therefore, I conclude that our agency would be immune from liability, under the Tort Claims Act, for any tort resulting from a mine closure. ... I believe that a governmental agency would not be liable so long as reasonable care was used in designing the grate and warning signs were used.** " (Informal opinion by memorandum, Bruce Rogoff, 9/21/00)

Thus the increase in liability exposure created by bat grates is reasonable. Virtually all States/Tribes and land management agencies seem to have decided that this is the case and started the construction of bat grates during the past decade.

> Generally, an owner or occupier of premises must exercise ordinary care and make safe an unreasonably dangerous condition known to, or discoverable upon reasonable investigation, by the owner or occupier. Brooks v. K-Mart Corp., 125 N.M. 537, 964 P.2d 98 (1998). A dangerous condition means a condition which a person using ordinary care would foresee as being likely to cause injury to one using ordinary care for his own safety. Id. The landowner may have a duty to warn of dangerous conditions, as well. Koenig v. Perez, 104 N.M. 664, 726 P.2d 341 (1986)("The law requires…warnings for the unwary—not for those who have knowledge of a dangerous condition and choose to ignore ordinary precautions necessary to protect themselves); Ryan v. New Mexico State Highway Dept., 964 P.2d 149 (N.M.Ct.App.1998)(Highway Department had a duty to warn of elk on the roadway). (Informal opinion by memorandum, Bruce Rogoff, 9/21/00)

Though laws vary from State to State on agency liability, if the following two criteria are met the chance of losing a liability suit are very small: (1) The bat grates are designed and constructed in as reasonably secure a fashion as current knowledge allows; and (2) that signs warning of the danger are placed on, in front of, or behind the bat grate.

It is doubtful that anything can be made 'child proof.' This was a challenge posed to bat grates in the early years. Generally coming from staff members whose attitudes were developed when AML programs were nothing but 'backfill programs.' Grates can be made child resistant just as they are adult resistant. This will be discussed in the session on bat grates. A third element in minimizing liability is monitoring bat closures at reasonable intervals. It is incumbent upon the State/Tribal agency or land manager doing the construction that they monitor the grates

periodically, as long as their agency exists. This monitoring requirement will vary by location as to what is a reasonable frequency. Repairs to vandalism should be as rapid as possible. Not only will this prevent trespass potential for accidents, but act as a further discouragement to the vandals.

All closures, including backfill, should be monitored. Bat grates are no exception. Other closures such as doors for land owner or mineral right owner access have also increased potential for vandalism.

The added costs in dollars and time with bat compatible closures.
DOLLARS:

- The added cost of bat habitat assessment is minimal in most projects.
- In most situations, the construction cost of bat grates is greater than backfill. At mine sites with mechanical access and adjacent waste piles that can be used for backfill material, backfilling is more economical. However, at sights without mechanical access, such as remote areas or wilderness areas, the cost may even be less than hand backfill, especially with deep shafts. The Colorado AML has an informal cooperative agreement to share bat grate costs. State AML programs should try to get similar agreements with the Forest Service or wildlife agencies to help cover the added costs of bat grates. Depending on the number of bat grates and their location, the added costs may or may not be significant for a project. However, on a program-wide basis, they are a small percentage of the total costs.
- Cost of monitoring visits and repairs should be very small. Federally funded AML program projects are supposed to be monitored yearly. Unless more frequent visitation seems warranted, there is no additional cost in monitoring past projects with bat grates. However, vandalism does create additional repair costs. In some states, the BLM has agreed to cover maintenance costs of bat grates on their lands. Grate designs all have one or more weak links that will be the site of vandalism. Well equipped professional vandals can not be stopped by any design. The design of bat grates should anticipate vandalism and be built to facilitate quick and easy repair.

TIME/DELAYS:
Time delays can be minimized or totally eliminated with adequate advance planning. Bat grates will delay projects unless advance planning takes them into consideration:

- Delays due to habitat assessment: One to one and a half years should be allowed for bat habitat evaluation. Added time may be needed for contract preparation if assessment is done by outside contractors. Project development needs to be started a year earlier to allowed for bat habitat evaluation studies.
- Delay due to engineering design: Engineering delays can be reduced by the exchange of bat grate designs between government agencies.
- Delay due to longer construction time: Actual increases in the amount of on-site construction time can generally be reduced to a matter of days per bat grate in most projects. Also, some habitat values will restrict the seasons during which safeguarding construction of any type can occur.

Conclusion

Laws are on the book for endangered and threatened species of bats and we obey them. At this time, there are only a few States that have endangered bat species. Those States must do extensive evaluations. Some bat species not currently listed, but under study, have wide ranges and, if they become listed as endangered in the future, this will impact almost all States. The degree to which future safeguarding of mines prevents other bat species from joining the endangered list is a day by day or project by project decision. OSM and the agencies it supervises will make the decisions that will determine future species status. We do not write the laws, but in our daily actions we function like judges in interpreting them. The more bat species that become threatened, the more restrictive will be the environment in which future mine safeguarding and reclamation will have to occur. Thus, unless you plan to change occupations in the near future, the future of America's bat species will dictate your working environment. If any additional bat species are added to the endangered species list, it will impact your work conditions and make your job more difficult. Self interest, if not enlightenment, should persuade your agency of the importance of bat habitat preservation.

Homer Milford has served as the Environmental Coordinator for the New Mexico AML Program for the past 10 years. He received his bachelors in Biology from the University of New Mexico and Masters in Biology from University of Idaho followed by two years at the State U of New York. He has conducted hundreds of underground bat habitat assessments in conjunction with Dr. Scott Altenbach over the past 10 years. He coauthored with Dr. Altenbach the publication "Evaluation and Management of Bats in Abandoned Mines in the Southwest."

EASTERN BAT SPECIES OF CONCERN TO MINING

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Abstract

Forty-five species of bats inhabit the United States. Twenty species occur in the eastern United States, herein defined as those 31 states east of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. Mines provide important winter and/or summer habitat for several of these species. Ten eastern United States species, often referred to as cave bats, usually inhabit caves and/or mines during all or part of the year. Three eastern cave/mine bat species, Indiana bat (*Myotis sodalis*), gray bat (*Myotis grisescens*), and Townsend's big-eared bat (*Corynorhinus townsendii*) are considered endangered by the U.S. Fish and Wildlife Service, as well as by most state wildlife agencies (U.S. Fish and Wildlife Service 1982,1984, 1995, 1999). Three additional eastern cave/mine species, southeastern bat (*Myotis austroriparius*), eastern small-footed bat (*Myotis leibii*), and Rafinesque's big-eared bat, *Corynorhinus rafinesquii*) are considered to be of special concern and may be proposed for listing as endangered or threatened in the near future. The other four eastern cave/mine species, big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), and eastern pipistrelle (*Pipistrellus subflavus*) are thought to be declining in portions of their ranges.

The additional 10 eastern United States bat species (Jamaican fruit-eating bat, *Artibeus jamaicensis;* silver-haired bat, *Lasionycteris noctivagans;* eastern red bat, *Lasiurus borealis;* hoary bat, *Lasiurus cinereus;* northern yellow bat, *Lasiurus intermedius;* Seminole bat, *Lasiurus seminolus;* evening bat, *Nycticeius humeralis;* Wagner's mastiff bat, *Eumops glaucinus;* Pallas' mastiff bat, *Molossus molossus;* and Brazilian free-tailed bat, *Tadarida brasiliensis*), usually referred to as tree bats, seldom enter caves or mines.

Certain mining activities, especially those involving deforestation and those resulting in stream degradation, can be detrimental to bats. All eastern United States bats are dependent, to some degree, on forest for shelter, roost sites, and/or foraging areas. Good quality water sources provide drinking water and are important to bats as sources of aquatic insects and foraging habitat.

Eastern U.S. Bat Species

Following are brief species accounts of the 10 eastern United States bats that inhabit caves and/or mines. Accounts are similar to those in Harvey et al. (1999), with additional information added.

Indiana Bat – *Myotis sodalis* – Endangered
Weight is 6-9 grams (0.2-0.3 ounce), wingspan is 24-28 centimeters (9-11 inches). Distribution includes cave regions in the eastern United States and, during summer, areas to the north, of cave regions. Indiana bats usually hibernate in large dense clusters of up to several thousand individuals in sections of the hibernation cave or mine where temperatures average 3-6^{o}C (38-43^{o}F) and with relative humidities of 66-95 percent. They hibernate from October to April, depending on climatic conditions. Females depart hibernation sites before males and arrive at summer maternity roosts in mid-May. The summer roost of adult males often is near maternity roosts, but where most spend the day is unknown. Others remain near the hibernaculum, and a few males are found in caves during summer. Between early August and mid-September, Indiana bats arrive near their hibernation sites and engage in swarming and mating activity. Swarming at cave or mine entrances continues into mid- or late October. During this time, fat reserves are built up for hibernation. When pregnant, females eat soft-bodied insects; they eat moths when lactating, and moths, beetles, and hard-bodied insects after lactation. Males also eat a variety of insects. One baby is born in June, and is raised under loose tree bark, often in wooded streamside habitat. Life spans of nearly 14 years have been documented. The present total population of this endangered species is fewer than 360,000, with more than 85 percent hibernating at only nine locations, making them extremely vulnerable to destruction. Most important hibernation caves have been gated. However, populations continue to decline in spite of protection and recovery efforts. Relatively large numbers of Indiana bats hibernate in several abandoned mines in Missouri, Illinois, and Ohio.

Until recently, Indiana bat maternity colonies were not known to exist in the southeastern United States, although a few reproductively active females had been reported, primarily in Kentucky. During the summer of 1999, a maternity colony was discovered in the Nantahala National Forest in western North Carolina; during the summer of 2000 an additional maternity colony was found in Great Smoky Mountains National Park in eastern Tennessee.

Gray Bat – *Myotis grisescens* – Endangered
Weight is 8-11 grams (0.3-0.4 ounce), wingspan is 27-32 centimeters (11-13 inches). Distribution includes cave regions of Arkansas, Missouri, Kentucky, Tennessee, and Alabama, with occasional colonies found in adjacent States. Gray bats are primarily cave residents year-round, but different caves usually are occupied in summer and winter. Few have been found roosting outside caves or cave-like habitats. They hibernate primarily in deep vertical caves with large rooms acting as cold-air traps (5-11^{o}C or 42-52^{o}F). In summer, females form maternity colonies of a few hundred to many thousands of individuals, often in large caves containing streams. Maternity colonies occur in caves that, because of their configuration, trap warm air (14-25^{o}C or 58-77^{o}F) or provide restricted rooms or domed ceilings capable of trapping combined body heat from clustered individuals. Because of their specific habitat requirements, fewer than 5 percent of available caves are suitable for gray bats. Males and non-reproductive females form bachelor colonies in summer. Gray bats primarily forage over water of rivers and lakes. Moths, beetles, flies, mosquitos, and mayflies are important in the diet, but gray bats also consume a variety of other insects. Mating occurs in September and October,

and females enter hibernation immediately after mating, followed by males. Females store sperm through winter and become pregnant after emerging from hibernation. One baby is born in late May or early June, and begins to fly within 20-25 days of birth. Life span may exceed 14-15 years. Listed as endangered, about 95 percent of these bats hibernate in only eight caves, making them extremely vulnerable to destruction. Most important gray bat hibernation caves, and several summer caves, are now protected by gates or fences. Populations appear to be increasing throughout most of their range. Gray bats are known to inhabit some mines.

Townsend's Big-eared Bat – *Corynorhinus townsendii* – Endangered
Weight is 8-14 grams (0.3-0.5 ounce), wingspan is 30-34 centimeters (12-13 inches). Distribution includes western Canada, the western United States to southern Mexico, and a few isolated populations in the eastern United States. These bats hibernate in caves or mines where the temperature is 12^{o}C (54^{o}F) or less, but usually above freezing. Hibernation sites in caves often are near entrances in well-ventilated areas. If temperatures near entrances become extreme, they move to more thermally stable parts of the cave. They hibernate in clusters of a few to more than 100 individuals. During hibernation, the long ears may be erect or coiled. Solitary bats sometimes hang by only one foot. Maternity colonies usually are located in relatively warm parts of caves/mines. During the maternity period, males apparently are solitary. Where most males spend the summer is unknown. No long-distance migrations are known. Like many other bats, they return year after year to the same roost sites. It is believed to feed entirely on moths. Mating begins in autumn and continues into winter, sperm are stored during winter, and fertilization occurs shortly after arousal from hibernation. One baby is born in June. Babies are large at birth, weighing nearly 25% as much as their mother. They can fly in 2.5-3 weeks and are weaned by 6 weeks. Life span may be 16 or more years. The two subspecies in the eastern United States, *C. t. virginianus* (Virginia big-eared bat) and *C. t. ingens* (Ozark big-eared bat), are considered endangered. Two western subspecies, *C. t. townsendii* (Townsend's big-eared bat) and *C. t. pallescens* (western big-eared bat), are of special concern. A few have been reported inhabiting mines.

The endangered subspecies *Corynorhinus townsendii virginianus*, Virginia big-eared bat, inhabits caves in Virginia, West Virginia, Kentucky, and North Carolina. The total population numbers only ca. 20,000. The endangered subspecies *Corynorhinus townsendii ingens*, Ozark Big-eared bat, is currently known to exist only in northwestern Arkansas and eastern Oklahoma. The total population is estimated to number less than 1500.

Southeastern Bat – *Myotis austroriparius* – Special Concern
Weight is 5-8 grams (0.2-0.3 ounce), wingspan is 24-29 centimeters (9-11 inches). Distribution includes the southeastern United States from southern Illinois and Indiana to northeastern Texas and northern Florida. Caves are favorite roosting sites, although buildings and other shelters sometimes are used. Maternity colonies comprised of thousands of individuals inhabit caves. Throughout much of the South, these bats reside in buildings and hollow trees, but in the northern part of their range they roost primarily in caves. In winter, they leave the maternity caves and take up residence in small groups

at outdoor sites. Predators include opossums, snakes, and owls, but by destruction of roosting sites and killing of these bats humans are the major threat to the species. Southeastern bats usually are associated with bodies of water, over which they feed. They forage low, close to the water's surface. A variety of insects are consumed, but the diet of this species has not been studied. Mating time is unknown, but about 90 percent of pregnant females bear twins in late April or mid-May. The production of twins is unique among bats of the genus *Myotis* in the United States; all other *Myotis* usually produce one baby. Clusters of babies often are separate from adult females during the day. Young bats can fly when 5-6 weeks old. Once common, populations of the southeastern bat have decreased significantly; it is now considered a species of special concern.

Eastern Small-footed Bat – *Myotis leibii* – Special Concern
Weight is 3-5 grams (0.1-0.2 ounce), wingspan is 21-25 centimeters (8-10 inches). Distribution is from eastern Canada and New England south to Alabama and Georgia and west to Oklahoma. This is one of the smallest bats in the United States. Eastern small-footed bats hibernate in caves or mines and are among the hardiest of bats. They are one of the last to enter caves/mines in autumn and often hibernate near cave or mine entrances where temperatures drop below freezing and where humidity is relatively low. Several have been found hibernating in cracks in cave floors and under rock slabs in quarries and elsewhere. The tolerance for cold, relatively dry places for hibernation is remarkable for such a small bat. In summer, they often inhabit buildings and caves; one small summer colony was behind a sliding door of a barn. Small colonies have also been found in bridges. They often fly repeated patterns within less than 1 meter (3 feet) of the floor of a cave or crevice, hang up on the wall, and then fly again. These bats emerge to forage shortly after sunset, and fly slowly and erratically, usually 1-3 meters (3-10 feet) above the ground. Apparently these bats fill their stomachs within an hour after beginning to forage in the evening. They consume flies, mosquitos, true bugs, beetles, ants, and other insects. One baby is born in late spring or early summer. Nursery colonies of up to 20 bats have been reported from buildings. Life span is unknown, but may be more than 9 years. It is uncommon throughout most of its range and is a species of special concern.

Rafinesque's Big-eared Bat – *Corynorhinus rafinesquii* – Special Concern
Weight is 8-14 grams (0.3-0.5 ounce), wingspan is 26-30 centimeters (10-12 inches). Distribution is the southeastern United States. This species is one of the least known of all bats in the eastern United States. In the northern part of its range, it hibernates in caves, mines, or similar habitats, including cisterns and wells. In contrast, Rafinesque's big-eared bats usually are not found in caves during winter in the more southern parts of their range. Maternity colonies usually are found in abandoned buildings, sometimes in rather well-lighted areas. They usually consist of few to several dozen adults. Maternity colonies are found more rarely in caves and mines. Males generally are solitary during summer, roosting in buildings or hollow trees. When approached in summer, these bats are immediately alerted and begin to wave their ears, apparently trying to keep track of the intruder. This species and the eastern pipistrelle bat choose more open and lighted day roosts than other kinds of bats. Both species commonly hang in the open in plain

sight. Rafinesque's big-eared bats emerge late in the evening to forage; apparently it does not forage at twilight. Its flight is remarkably agile. Moths and other night-flying insects are eaten. One baby is born in late May or early June in the northern part of the range and about mid-May in the South. The young shed their milk teeth in mid-July and reach adult size by August or early September. This species is uncommon over most of its range and is of special concern. Some of the largest known colonies of this species (numbering in the hundreds) inhabit abandoned copper mines, during both summer and winter, in Great Smoky Mountains National Park.

Big Brown Bat – *Eptesicus fuscus*

Weight is 14-21 grams (0.5-0.7 ounce), wingspan is 32-40 centimeters (13-16 inches). Distribution is from southern Canada through southern North America into South America, including many islands in the Caribbean. These bats are closely associated with humans and are familiar to more people in the United States than any other species of bat. Most summer roosts are in attics, barns, bridges, or other man-made structures, where colonies of a few to several hundred individuals gather to form maternity colonies. They move into caves, mines, and other underground structures to hibernate only during the coldest weather. Where most of these bats spend the winter remains unknown. They emerge at dusk and fly a steady, nearly straight course at a height of 6-10 meters (20-33 feet) in route to foraging areas. Their large size and steady flight make them readily recognizable. Apparently, some individuals use the same feeding ground each night, for a bat can sometimes be seen following an identical feeding pattern on different nights. After feeding, the bat flies to a night roost to rest; favored night roosts include garages, breezeways, and porches of houses. These bats consume beetles, ants, flies, mosquitos, mayflies, stoneflies, and other insects. Mating occurs in autumn and winter, females store sperm, and fertilization takes place in spring. In the eastern United States, big brown bats usually bear twins in early June. In the western United States, usually only one baby is born each year. It is common throughout most of its range.

Little Brown Bat – *Myotis lucifugus*

Weight is 7-14 grams (0.3-0.5 ounce), wingspan is 22-27 centimeters (9-11 inches). Distribution is from central Alaska to central Mexico. The little brown bat usually hibernates in caves and mines. During summer, it often inhabits buildings, usually rather hot attics, where females form nursery colonies of hundreds or even thousands of individuals. Where most males spend the summer is unknown, but they likely are solitary and scattered in a variety of roost types. Colonies usually are close to a lake or stream. This species seems to prefer to forage over water, but also forages among trees in rather open areas. When foraging, it may repeat a set hunting pattern around houses or trees. It eats insects, including gnats, crane flies, beetles, wasps, and moths. Insects usually are captured with a wing tip, immediately transferred into a scoop formed by the forwardly curled tail and interfemoral membrane, and then grasped with the teeth. Mating occurs in autumn, but also may occur during the hibernation period. One baby is born in May, June, or early July. When the mother is at rest during the day, she keeps the baby beneath a wing. Life span may be more than 20 years. This species is one of the most common bats throughout much of the northern United States and Canada, but is scarce or only locally common in the southern part of its range. A subspecies found in

the southwestern United States, *M. l. occultus* (Arizona bat), is considered to be of special concern.

Northern Long-eared Bat – *Myotis septentrionalis*
Weight is 6-9 grams (0.2-0.3 ounce), wingspan is 23-27 centimeters (9-11 inches). Distribution includes southern Canada and the central and eastern United States southward to northern Florida. Northern long-eared bats hibernate in parts of caves and mines that are relatively cool, moist, and where the air is still. Hibernation may begin as early as August and may last for 8-9 months in northern latitudes. In summer, they roost by day in a variety of shelters, including buildings and under tree bark and shutters, but at night they commonly use caves as night roosts. Northern long-eared bats seem much more solitary in their habits than other members of the genus *Myotis*, and they generally are found singly or in small groups containing up to 100 individuals. Although they frequently hang in the open, they seem to prefer tight crevices and holes. Sometimes only the nose and ears are visible, but they can be distinguished from most other species of *Myotis* by their long ears. These bats forage mainly on forested hillsides and ridges rather than in streamside and floodplain forests. They consume a variety of small night-flying insects. Presumably most mating occurs in autumn prior to hibernation. Apparently small nursery colonies are formed in June and July where pregnant females give birth to one baby. Mothers may be able to retrieve their young that fall from roost sites. Life span may be more than 18 years. This species is common over much of its range.

Eastern Pipistrelle – *Pipistrellus subflavus*
Weight is 6-8 grams (0.2-0.3 ounce), wingspan is 21-26 centimeters (8-10 inches). Distribution includes eastern Canada, most of the eastern United States, and southward through eastern Mexico to Central America. Caves, mines, and rock crevices are used as hibernation sites in winter, and occasionally as night roosts in summer. These bats rarely occur in buildings, and apparently most roost in trees in summer. This species inhabits more caves and mines in eastern North America than any other species of bat, usually hanging singly in warmer parts of the cave/mine. An individual may occupy a precise spot in a cave/mine on consecutive winters; it usually has several spots in which it hangs, shifting from one to another during the winter. This bat emerges from its daytime retreat early in the evening. It is a weak flier and so small that it may be mistaken for a large moth. Eastern pipistrelle bats usually are solitary, although occasionally in late summer four or five will appear about a single tree. The flight is erratic and the foraging area is small. It often forages over waterways and forest edges and eats moths, beetles, mosquitos, true bugs, ants, and other insects. Mating occurs in autumn, sperm are stored during winter, and fertilization takes place in spring. These bats usually bear twins in late spring or early summer. Babies are born hairless and pink with eyes closed, and they are capable of making clicking sounds that may aid their mothers in locating them. They grow rapidly and can fly within a month. This species is common throughout its range.

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WESTERN BATS AND MINING

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Abstract

In North America north of Mexico, there are 45 species of bats and 32 of these species occur west of approximately 100° W longitude. At least 22 of the western species are known to use abandoned mines to some extent and all 32 species could be affected by mine-related activities. Two species are listed as Federally Endangered and another 11 taxa are species of concern. As a group, bats have a low reproductive potential and disturbance to colonies or loss of roosting or foraging habitat can depress population levels. Aspects of their natural history, roosting habitat, and foraging habitat are discussed herein and related to potential impacts of mining.

Introduction

There are about 4200 different kinds or species of mammals and bats (Order Chiroptera) are the second largest group, after rodents, comprising about 1000 species. Globally, only primates (including humans) are more widely distributed, as bats occur on all continents except Antarctica, from tree line to tree line, as well as on many remote oceanic islands. The majority of bats, about 88 percent of all species, are tropical in distribution with fewer species in the temperate zones (Table 1). Among bats in temperate regions (e.g., North America) most belong to the family Vespertilionidae (vespertilionid or evening bats), primarily in the genera *Myotis*, *Pipistrellus,* and *Eptesicus* (Findley, 1993).

One of the clearest geographic patterns that bats exhibit is that of increasing species diversity towards the equator. In the New World for example, bats demonstrate a clear latitudinal gradient. At the Equator, there are about 100 species; at 15° N latitude, 70 species; at 20° N, 50 species; at 30°N, 20 species; above 35° N latitude, 10 species; and above 55° N latitude, only a handful (Findley, 1993). Exact reasons for this decline in diversity towards the poles are unknown but probably include absence of suitable roosting sites, extreme seasonality of food (primarily insects), and extreme weather conditions.

In North America north of Mexico, there are 45 species of bats representing 19 genera and 4 families. West of approximately 100° W longitude in the United States there are about 32 species of bats (Table 2). Of this number, roughly 26 species are exclusively western in distribution with an additional 6 species occurring more or less continent-wide. In contrast, the East has only about 12 species that occur there exclusively (Pierson, 1998). Humphrey (1975) demonstrated that increasing bat species diversity in the West is due in part to increasing topographic relief, which in turn translates into greater availability of roosting sites.

Of the 32 species occurring in the West, at least 22 species are known to use mines to some extent (Table 3; Altenbach and Pierson, 1995), and all 32 species could be affected in some way by mine-related activities. Two of the 22 species are Endangered nectar-feeding bats of the genus *Leptonycteris* and are discussed by Currie (this volume). An additional 11 species (including *Myotis lucifugus occultus*) are former U.S. Fish and Wildlife Service Category 2 Candidate Species, now usually referred to as species of concern. These 11 species, and others, are frequently listed by various states as "at-risk" species.

Although we have some understanding of regional and global patterns of species diversity and life history, we have very little rigorous data on population numbers of most species and almost no data on population trends. For some species of colonial bats in the eastern United States we do have data that document population declines and, in a few cases, recovery of populations. However, for most western bats we have almost no satisfying population data (O'Shea and Bogan, 2000). What is clear is that there are many instances of large numbers of bats disappearing from known roosts. Such disappearances are often linked with known events such as frequent disturbance, vandalism, alteration of caves or mines that make them unsuitable for bats, or various types of land-use change.

Life History Features of Western Bats

There are several unifying features of the life history of bats in western North America. Most are insectivorous and pursue their insect prey in a variety of ways; three are nectar-feeders and occur only seasonally in the United States. All the species have low reproductive rates for a small mammal of this body size, typically having only one young per female per year (Findley, 1993). In North America, bats of the genus *Lasiurus* may have up to five young in a litter although the average is lower. Gestation is usually two to three months long and following birth in early summer there is an extended period of maternal care of up to 1.5 months before the young are able to forage on their own. Juvenile mortality is high but once an individual survives its first year, there is a good probability of a relatively long life. Maximum known age of a North American bat is over 30 years (Findley, 1993) and the average is probably 4 to 7 years or so, depending upon the species. Although there are a variety of predators on bats, the assumption by most biologists has been that predation risks are low for most bats.

Once the young are independent in late summer, both they and the females have a narrow window of time during which they must obtain energy in the form of insect prey to last them through the rigors of winter. Most western species probably travel relatively short distances to winter quarters where they hibernate. However, some species are known or believed to escape winter by migrating longer distances to areas where temperatures and insect populations remain high enough for continued activity (Findley, 1993). In the spring, bats typically return to their natal areas where young are born and grow to maturity. Mating in most species occurs in the fall, just before hibernation, and sperm are "stored" in the uterus of the female over the winter. In spring, the female ovulates, the egg is fertilized, and development of the young bat ensues.

Western bats occur in a wide variety of ecological situations and, based on their life histories and distributions, some species appear to be rather general in their requirements whereas others appear to have more specific requirements. Generally, bats need two kinds of habitat to survive:

roosting habitat and foraging habitat. Roosting habitat is critical to long-term survival of bat populations and may be limiting to North American bats (e.g., Humphrey, 1975). Equally important however, and not always equally considered, (but see Pierson, 1998) is the importance of areas where bats can forage and drink.

Roosts used by Western Bats

Western bats use a variety of roosts and differences are correlated with gender, reproductive condition, time of the year, and feeding strategy. During summer, females of most species aggregate in colonies within which the young are born and nursed; colony sizes range from scores to thousands of mothers and young (Barbour and Davis, 1969). At this time, males are usually dispersed across the landscape, often in different areas or even regions of the country (e.g., Findley and Jones, 1964), and frequently roost alone. One reason for this is that males and females have different thermoenergetic strategies during the summer. Males forage nightly and then typically seek a roosting site during the day that allows them to lower their body temperature to conserve energy. Females, however, appear to seek roosting sites that are somewhat cooler than ambient temperatures during the day and warmer than ambient at night. Development of the embryo and growth of young is dependent on maintaining a more or less constant body temperature; generally, torpor is uncommon in pregnant or lactating females and growing young (Racey, 1982). Maternity roosts also appear to be chosen to provide security from predators and disturbance.

Once the young are independent, all individuals begin to pursue the "male" strategy of obtaining as much energy at night as possible and then conserving energy during the day. Thus maternity colonies begin to break up and individuals seek roosts that allow torpor (lowering of body temperature) to occur. As fall progresses, and depending on the species of bat, individuals may move among a network of roosts, where mating may occur. Subsequently, they move to the winter roost where hibernation occurs; such roosts are called hibernacula. In the western U.S., some species (e.g., California myotis, western pipistrelle, pallid bat) may not enter hibernation or may hibernate only short periods of time. Individuals of these species may be observed on winter evenings and nights (O'Farrell et al., 1967). In the case of migratory species, once sufficient energy has been obtained and stored as fat, they begin their flights to areas to the south (Cockrum, 1969).

Thus, over the course of a year, most species will use several different kinds of roosts. As noted above, summer roosts used during daylight hours tend to be gender specific with females typically aggregated in a few, historically-used roosts and males often using sites that are more abundant on the landscape; both types of sites must meet certain thermal requirements. However, at night between foraging bouts both sexes may use the same kind of roost. Night roosts are usually occupied only for short periods of time, are frequently common across the landscape, and may be relatively open, allowing bats to arrive and depart freely. Although night roosts may just be sites for rest and digestion of food, they also may serve a social function as well. During the day, night roosts are unoccupied and can be recognized by the presence of stains and guano. We know little about the extent to which western bats use temporary night roosts in the spring and fall. In the eastern U.S. swarming of bats occurs at temporary roosts in

the fall; this is thought to be important for reproduction and as a precursor to entering hibernation. It seems likely that such roosts are important in the West as well.

Lewis (1995) has suggested that fidelity of bats to their roosts is related to the type of roost that is occupied. In particular, high fidelity appears to be directly related to roost permanency and inversely related to roost availability. Bats, that occupy spatially abundant but less permanent roosts, are more likely to change roosts frequently. Conversely, bats appear to show high site fidelity to roosting sites that are uncommon and permanent within an area.

Overall, two kinds of roosts are of particular importance: maternity roosts and hibernacula. Mines are known to provide both kinds for some species. Maternity roosts, where young are born and develop, are critically important, especially given the relatively low reproductive potential of most species of bats. When such roosts are destroyed or made uninhabitable, bat populations may be locally depressed due to failure of reproduction. This may be especially true if the roosts do not occur commonly across the landscape. Disturbance to bats while they are in either maternity roosts or hibernacula can be devastating to local populations. Disturbance at maternity roosts may cause females to drop and abandon their young; if the young are unable to forage on their own they will die.

Hibernating sites where bats can escape the rigors of winter and food scarcity are equally important and appear to be chosen based on strict temperature, humidity, airflow, and security requirements. Hibernacula are usually uncommon across the landscape and some species are known to be completely dependent upon only a very few sites for hibernation. Closing or alteration of such hibernacula is known to have caused population declines in some species. Often, relatively slight changes in temperature or airflow are sufficient to cause bats to abandon a roost. Disturbance in hibernacula causes bats to arouse, a process that results in expenditure of limited energy stores. It is generally believed that most bats enter hibernation with only a narrow safety margin in terms of stored energy (Humphrey and Kunz, 1976). If disturbances occur frequently, bats may be forced out of the hibernaculum to feed at a time when insects may not be available.

Actual natural sites used by western bats over the course of a year include cavities and cracks in trees, under the bark of trees, foliage of trees (including palms and yuccas), caves (both complex and simple), cracks and crevices in sheer cliffs, under rocks and boulders, and cracks in boulders. These sites, and similar ones, provide security and meet the physiological requirements of roosting bats. With settlement and development of the West, bats have lost some natural roosts but now also roost in structures such as houses, garages, barns, silos, warehouses, hangars, bridges, as well as abandoned mines. Tuttle and Taylor (1998) note that of 8,000 mines that were surveyed for bats nationwide, 30 to 80 percent showed some signs of use by bats and 10 percent contained important colonies. Factors that contribute to making a mine desirable to bats include location, proximity to foraging and drinking areas, internal structure, volume, temperature and temperature stability, airflow, ventilation, presence of other species, and absence of predation. Mines, especially those at high latitudes or altitudes, may be too cool for reproductive females in the summer but may be very desirable for hibernation. Alternatively, warmer mines, such as those in the southern U.S., may not be good for hibernation but may be

used by reproductive females. A good discussion of how attributes of mines affect bat use can be found in Tuttle and Taylor (1998).

Foraging Habitat

Although North American bats are mostly insectivorous, they display an impressive array of feeding types (Table 4). Aerial insectivory, the capture of flying insects, is the "classic" form of feeding by bats but some scientists now distinguish between two different types of this feeding mode. Some bats capture flying insects in open space that is unfettered by obstacles, such as above a forest canopy, whereas others forage for flying insects in or near vegetation, such as in forests. Two other foraging modes are the capture or "gleaning" of insects directly from vegetation or trees and the capture of insects off the surface of the water or directly above it. Finally, among North American bats, three species specialize on the pollen and nectar of selected species of flowering plants (e.g., columnar cacti and agaves).

The extent to which bats are "specialists" in any of several areas, including diet, is a subject of some discussion among bat biologists (e.g., Fenton, 1982). Nonetheless, an awareness of the basic ways that bats forage (Table 4), coupled with the understanding that in most bat communities there will be multiple species using different modes, suggests that the concept of foraging areas or habitat for bats is likely to be complex. Additionally, it seems likely that just as bats show fidelity to some types of roosts (Lewis, 1995), they also continue to use productive foraging sites over time (Pierson, 1998). In terms of how western bats and mining may interact, it is fairly intuitive that closure or modifications of an abandoned mine may have direct effects on bats in the vicinity. However, foraging habitat for bats is neither obvious nor intuitive and this may obscure the effects of mining on potential foraging areas. Negative effects may be direct or indirect. If water sources are contaminated or drained bats may be affected directly, due to poisoning or loss of a place where they can drink. More subtly and indirectly, if land use causes changes in vegetation, there also may be changes in the insect community upon which the bats depend. For example, bats are known to forego foraging in lush non-native vegetation and instead travel some distance to forage in more natural vegetation (e.g., Brown et al., 1994).

Most western bat communities probably consist of six to twelve species (or more). Depending on the region, the community may include species that forage for insects over water surfaces (e.g., stock ponds, settling pools, or rivers), ground foragers that actually alight on the ground to feed, aerial insectivores feeding in open spaces above the vegetation, and finally species that pursue insects in and near vegetation. Usually, nearly all bat species in a community are dependent on nearby sources of water. Habitat change or loss of water sources due to land management, mining, or other activities have the potential to affect insect populations that bats depend upon as well as preferred foraging areas. To fully assess the effects of land-use practices on bats we need information on the habitat associations of insect prey (Pierson, 1998). Unfortunately, this information is not available for most bats. It seems likely that conversion of formerly diverse plant communities to various monocultures (e.g., agriculture, urbanization) has impacted bat communities to some degree. Invasion by, or reclamation with, non-native plants may also affect foraging opportunities for bats.

Loss of Habitat from Mining

Historically, most early mining in the West was directed at high-grade veins of precious metals that were most efficiently mined through underground workings. Although underground mining probably had some direct effects on bats (e.g., tailings, road-building, contaminants), it may have been more benign than some modern practices. Most mining today is focused on more disseminated, lower-grade, deposits that are most efficiently mined by surface or open-pit mines. This type of mining has a greater potential to modify large areas and consequently impact foraging habitat for bats.

Henry (1995) discussed environmental issues associated with mining and noted three general topics: impacts on surface and ground water, effect on wildlife habitat, and visual-aesthetic values. He notes that the greatest negative impact of mining has been on surface and ground water. Contaminated water sources are certainly a concern for bats, especially in arid areas, but there are other issues as well. O'Shea et al. (this volume) discussed the effects of mining-related contaminants on bats and their foraging habitat.

The negative effects of mining and reclamation (or lack thereof) on habitat are issues for wildlife in general (Henry, 1995). In the case of bats, habitat loss can occur in multiple ways. Initial mining efforts, including road building, site clearing, blasting, excavation, and disposal of waste rock may disturb bats roosting in the vicinity and will probably have negative effects on bat roosting and foraging habitat. Quarrying operations may disturb or destroy cracks and crevices in cliffs where bats roost. Open pit mining may have significant impacts on foraging habitat through destruction of native vegetation and loss of the native insect communities; water sources may be destroyed or polluted. Renewed mining in historic underground workings may displace bats that have found roosts in abandoned mines and have negative consequences for foraging areas as well. Other than the use of abandoned mines as roosts, I suspect that few reclamation specialists ever consider bat habitat needs during reclamation of abandoned mines. Nonetheless, the often sterile, monocultural aspect of many reclaimed areas is probably a barren wasteland for most bats. This may be especially true if non-native vegetation has been used in the reclamation.

Conclusions

Although we lack conclusive evidence of actual population declines in many western bat species, scientists and managers are in general agreement that such declines have occurred, both locally and regionally. Furthermore, most authorities believe that such declines are continuing. It seems obvious that with settlement of the West bats have lost both roosting and foraging habitat and have been subjected to disturbance and destruction in many areas. Although many bats have proven to be adaptable and have moved into anthropogenic structures we have no way of knowing the extent to which this has compensated for loss of natural habitat. Certainly, abandoned mines have become important to many species, vitally so for a few (e.g., *Macrotus californicus*). It is imperative that as abandoned mine closures are contemplated, adequate surveys for roosting bats are conducted prior to closure and alternative gating methods are considered (Altenbach et al.; Currie; Sherwin et al.; this volume).

If abandoned mines, properly gated and secured for use by bats, are the good news, then the bad news, arguably, is that existing mines and mining practices have the potential to alter or destroy both roosting and foraging habitat for bats in the West. Although research is badly needed on the interactions between bats and mining (e.g., impact of loss of natural vegetation on insect prey of bats), much can be done to alleviate potential negative impacts. We know enough about bat foraging and roosting habits to be able to develop some understanding of the potential effects in a given area and to implement mitigation measures in many cases. Pre-project surveys for bats, roosts, and foraging areas should be conducted, especially for species of concern. Hopefully, areas of importance, especially roosts, can be protected during actual mining. During the mining project, if roosts or important foraging areas have been found, monitoring of these resources should be continued. Where bat roosts conflict with mining plans, appropriate times and techniques for exclusion of bats should be used (Sherwin, personal communication). If possible, alternative roost structures should be provided. Finally, reclamation of abandoned mine lands should consider the unique needs of bats, both for foraging and roosting, and use native vegetation and appropriate real or artificial roosting habitat.

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Table 1. Summary of numbers of families, genera, and species of bats in the major geographic divisions of the world (after Altringham, 1996).

Taxon	North America	South America	Europe and Asia	Ethiopan Region	Oriental Region	Australian Region
Families	4	9	8	8	9	6
Genera	19	67	23	44	57	48
Species	45	230	90	190	270	166

Table 2. Species of bats occurring in the western United States.

Family Mormoopidae (Mormoopid or ghost-faced bats)
Mormoops megalophylla (Ghost-faced bat)

Family Phyllostomidae (Phyllostomid or leaf-nosed bats)
Macrotus californicus (California leaf-nosed bat) C2
Choeronycteris mexicana (Mexican long-tongued bat) C2
Leptonycteris curasoae (Southern long-nosed bat) E
L. nivalis (Mexican long-nosed bat) E

Family Vespertilionidae (Vespertilionid or evening bats)
Myotis auriculus (Southwestern myotis)
M. californicus (California myotis)
M. ciliolabrum (Western small-footed myotis) C2
M. evotis (Long-eared myotis) C2
M. keenii (Keen's myotis)
M. lucifugus (incl. *M. occultus*; Little brown myotis) C2
M. septentrionalis (Northern myotis)
M. thysanodes (Fringed myotis) C2
M. velifer (Cave myotis) C2
M. volans (Long-legged myotis) C2
M. yumanensis (Yuma myotis) C2
Lasionycteris noctivagans (Silver-haired bat)
Lasiurus blossevillii (Western red bat)
L. borealis (Eastern red bat)
L. cinereus (Hoary bat)
L. xanthinus (Western yellow bat)
Pipistrellus hesperus (Western pipistrelle)
Eptesicus fuscus (Big brown bat)
Euderma maculatum (Spotted bat) C2
Corynorhinus townsendii (= *Plecotus townsendii*; Townsend's big-eared bat) C2
Idionycteris phyllotis (Allen's big-eared bat) C2
Antrozous pallidus (Pallid bat)

Family Molossidae (Molossid or free-tailed bats)
Tadarida brasiliensis (Brazilian free-tailed bat)
Nyctinomops femorosaccus (Pocketed free-tailed bat)
N. macrotis (Big free-tailed bat) C2
Eumops perotis (Western mastiff bat) C2
E. underwoodi (Underwood's mastiff bat) C2

E = Federally Endangered
C2 = Former Category 2 Candidate Species (now Species of Concern)

Table 3. Species of western bats known to use mines (after Altenbach and Pierson, 1995). Common names of species especially dependent on mines are in bold-faced type.

Family	Species	Common Name
Mormoopidae		
	Mormoops megalophylla	Ghost-faced bat
Phyllostomidae		
	Choeronycteris mexicana*	Mexican long-tongued bat
	Leptonycteris curasoae E	**Lesser long-nosed bat**
	Leptonycteris nivalis E	Greater long-nosed bat
	Macrotus californicus*	**California leaf-nosed bat**
Vespertilionidae		
	Antrozous pallidus	Pallid bat
	Conrynorhinus townsendii*	**Townsend's big-eared bat**
	Eptesicus fuscus	Big brown bat
	Idionycteris phyllotis*	Allen's big-eared bat
	Lasionycteris noctivagans	Silver-haired bat
	Myotis auriculus	Southwestern myotis
	M. californicus	California myotis
	M. ciliolabrum*	Western small-footed myotis
	M. evotis*	Long-eared myotis
	M. lucifugus (occultus*)	Little brown myotis
	M. septentrionalis	Northern myotis
	M. thysanodes*	Fringed myotis
	M. velifer*	**Cave myotis**
	M. volans*	Long-legged myotis
	M. yumanensis*	Yuma myotis
	Pipistrellus hesperus	Western pipistrelle
Molossidae		
	Tadarida brasiliensis	Brazilian free-tailed bat

E = Species listed as Endangered under Endangered Species Act
* = Former U.S. Fish and Wildlife Service Category 2 Candidate Species

Table 4. Foraging strategies of some western bats (after Findley, 1993).

Forest/Clearing aerial insectivores

Eptesicus fuscus
Lasionycteris noctivagans
Mormoops megalophylla
Myotis californicus
M. ciliolabrum
M.volans
Pipistrellus hesperus

Open-air aerial insectivores

Eumops perotis
E. underwoodi
Lasiurus blossevillii
L. borealis
L. cinereus
L. xanthinus ?
Nyctinomops femorosacca
N. macrotis
Tadarida brasiliensis

Gleaning insectivores

Antrozous pallidus
Euderma maculatum
Idionycteris phyllotis
Corynorhinus townsendii
Macrotus californicus
Myotis auriculus
M. evotis
M. septentrionalis
M. thysanodes

Water-surface foragers

Myotis lucifugus
M. velifer
M. yumanensis

Nectarivores

Leptonycteris curasoae
L. nivalis
Choeronycteris mexicana

FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES OF IMPORTANCE TO MINING

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Abstract

Six North American bats are listed as endangered under the Endangered Species Act of 1973, as amended. All of these Federally listed species are dependent upon caves or abandoned mines during all or part of the year. The Indiana bat (*Myotis sodalis*), a species that is currently undergoing a serious population decline, uses caves or mines for hibernation. The gray bat (*Myotis grisescens*) is dependent upon cold caves or mines during hibernation and warm caves or mines during the summer maternity season. The Virginia big-eared bat (*Corynorhinus townsendii virginianus*) is restricted to small populations in four eastern States and uses caves or mines year-round. The Ozark big-eared bat (*Corynorhinus townsendii ingens*) is the rarest of the endangered bats and is dependent on caves year-round. Historically, it was found in three States, Arkansas, Oklahoma and Missouri. It has apparently been extirpated from Missouri and only about 2,000 bats remain in Arkansas and Oklahoma. Although only one mine roost for this species is currently known, it could potentially be found in some of the abandoned mines found just south and west of its currently known distribution. The Mexican and lesser long-nosed bats *(Leptonycteris nivalis* and *Leptonycteris curasoae yerbabuenae*) are migratory non-hibernating species found in the southwestern US and Mexico. Both species are integral components of southwestern desert ecosystems and mines provide essential roosting habitat for them. Threats to all these species include; roosting and foraging habitat destruction and alteration, chemical contamination of their food supply and human disturbance at their summer and winter roosts. Intensive disturbance of the bats at their maternity and/or hibernation caves has increased the importance of protecting and maintaining bat access to mines. Without this protection it will be difficult to meet the Service's long-term protection and recovery goals for these endangered species.

Endangered Species Act of 1973

The Endangered Species Act of 1973 (Act) was enacted in 1973, by the 100th Congress of the United States. Section 2 of the Act states that the purposes of the Act are "...to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered and threatened species..." This is a noble objective that continues to be a valid, although sometimes problematic, goal for all involved in implementation of the Act. The Act defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range." A threatened species is - "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Critical habitat has been formally designated for some listed bats that occur in areas impacted by active

and abandoned mine programs. Critical habitat is defined as "The specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical or biological features,(I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of the Act, upon a determination by the Secretary that such areas are essential for the conservation of the species."

Section 4 of the Act establishes the process the Departments of Interior and Commerce must use in identifying endangered and threatened species, designating critical habitat, and developing recovery plans.

Section 7 of the Act prohibits Federal agencies from undertaking, permitting, authorizing or funding any activity that will jeopardize the continued existence of Federally listed species. This Section also requires Federal agencies to be proactive and use their programs to enhance the status of Federally listed species.

Section 9 of the Act prohibits taking a listed species without a permit issued under Section 10 of the Act. Take is defined by regulations promulgated to implement the Act to mean "..to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect (a listed species) , or to attempt to engage in any such conduct."

There are six Federally listed endangered bats that occur within the continental U.S. In implementing abandoned mined land reclamation activities and other mine related programs, Federal and State agencies must insure that all of their activities are in compliance with Section 7 of the Act and that these activities do not violate Section 9.

Indiana bat (*Myotis sodalis*)

The Indiana bat was listed on March 11, 1967, as an endangered species throughout its range. Critical Habitat which includes most of its most important hibernation sites was formally designated on September 24, 1976. A recovery plan for the species was issued on October 14, 1983. This plan is currently under revision and an Agency Draft Indiana Bat Revised Recovery Plan was published in March 1999 (U.S. Fish and Wildlife Service 1999.)

The Indiana bat is a medium sized bat with a wingspan of about 11 inches and a weight of 5 to ll grams. It is differentiated from other species in the genus by its smaller foot, short toe hairs, keeled calcar and fur texture and coloration. It occurs in the eastern U.S. from North Carolina west to Oklahoma and North to Iowa, Michigan, and Vermont. During the winter the Indiana bat hibernates in cold (4-8 C) caves and mines in the central portion of its range. In Summer the species disperses out from its hibernation sites to form small (30-300 females with young) maternity colonies. These colonies roost under the sloughing bark of dead and dying tress and under the exfoliating bark of live trees like shagbark hickory. Roosts are found in riparian, bottomland hardwood and upland forests (Barbour and Davis 1969, U.S. Fish and Wildlife Service 1999.) Excellent photographs and generalized range maps for the Indiana bat and all of

the other bats that occur in the U.S. can be found in the recent booklet on bats entitled: *Bats of the United States* (Harvey, et al. 1999.) This booklet is available, free of charge, from the U.S. Fish and Wildlife Service's Field Office in Asheville, North Carolina.

Historically, the primary threat to the species was believed to be disturbance at its hibernation sites. Early emphasis of recovery efforts was to protect these sites with suitable gates or fences to control human access and thereby eliminate disturbance. Despite these efforts, the species continues to decline. At the present time, the cause of this decline is unknown. Potential explanations include: (1) currently unidentified changes with the species' summer habitat, (2) inappropriate protection efforts at hibernation sites, and/or (3) pesticides. The current draft of the Indiana bat Recovery plan identifies a series of tasks that should determine what is causing the current decline and permit more effective recovery of the species. The Indiana bat has experienced a serious decline over the past 40 years. We estimate that in 1960 there were approximately 808,505 Indiana bats, by 1980 the population had declined to about 589,120, and during the 1995-1997 survey period only 353,185 were found (U.S. Fish and Wildlife Service 1999.)

Abandoned mines are extremely important to the continued existence of the Indiana bat. Two abandoned mines were designated as Critical Habitat for the species in 1976 and the species has since been found in numerous abandoned mines throughout its range. Most of the mines used by the species are hard rock mines or quarries. However, in 1981, John MacGregor (U.S. Forest Service, personal communication,1981) observed the Indiana bat in an abandoned coal mine in Kentucky and the potential thus exists for this species to depend upon abandoned coal mines.

Gray bat (*Myotis grisescens*)

The gray bat was listed on April 28, 1976, as endangered throughout its range. No critical habitat has been designated for the species. The Gray Bat Recovery Plan was issued on July 1, 1982 (U.S. Fish and Wildlife Service, 1982).

The gray bat is slightly above average size for the genus, the gray bat is easily distinguish from other members of the genus by its uniformly gray fur and the attachment point of the wing membrane to the foot. Its wingspan is about 12 inches and it weighs 5 to10 grams.

The gray bat is primarily found in the cave regions of Alabama, Kentucky, Tennessee, Arkansas, and Missouri, however, small populations also occur in Kansas, Indiana, Illinois, Oklahoma, and Florida.

The gray bat is dependent upon caves or mines all year. During the winter it primarily hibernates in cold caves in the heart of its range. During the summer the females disperse out to suitable warm caves and other cave-like structures. Foraging habitat is primarily along large to medium sized streams and rivers and reservoirs. Although most foraging takes place over open water, the species occasionally feeds in wooded areas adjacent to their primary foraging areas. (Barbour and Davis 1969, U.S. Fish and Wildlife Service 1982.)

The primary threat to the gray bat, at the time it was listed, was human disturbance at its summer and winter roost sites. Other factors that caused the decline that lead to its addition to the Federal list included loss of roost sites to commercialization and reservoir construction. Persistent pesticides such as DDT probably also played a role in the decline of the species (U.S. Fish and Wildlife Service 1982.)

Since 1982, the severe declines that resulted in the Federal listing of the species have been reversed by the positive conservation actions undertaken by States and Federal agencies. All appropriate agencies have taken part in this effort but some, such as the Missouri Department of Conservation and the Tennessee Valley Authority deserve special mention. Because of these conservation activities we may be at the point where the species may qualify for downlisting to threatened status. Dr. Michael J. Harvey, Tennessee Technological University (personal communication 2000) is now in the process of reviewing the current status of the species and will have a preliminary report completed in February 2001.

The gray bat primarily uses caves for its roost sites, it does however, readily use man-made structures whenever these provide the right microclimate and are protected from disturbance. Gray bats have been found roosting in abandoned coal mines, bridges, culverts, and dams. Any abandoned mine within the range of the species that has the appropriate temperature and humidity could support the species.

Virginia big-eared and Ozark big-eared bats (*Corynorhinus townsendii virginianus and C. t. ingens*)

The genus Corynorhinus is the most distinctive group of species found in the eastern US. They are similar in size to the gray bat but all have distinctive, large ears that are not found on any other bats in the Eastern U.S. Two subspecies of Townsend's big eared bat (Ozark and Virginia big-eared bats) are listed as endangered. The closely related Rafinesque's big-eared bat (Corynorhinus rafinesquii) is easily distinguished by gray colored dorsal fur. Both subspecies of Townsend's big-eared bat have brownish colored dorsal fur.

Virginia big-eared (*Corynorhinus townsendii virginianus*)

The Virginia big-eared bat was listed as endangered throughout its range on November 30, 1979. Critical habitat, that included many of its most important roost sites, was designated at the time it was listed. A recovery plan was prepared for the species on May 8, 1984 (U.S. Fish and Wildlife Service, 1984.)

The Virginia big-eared bat is a medium-sized bat with forearms measurin
(mm) long and weighing 7 to 12 grams. Total body length is 98 mm, th
hind foot is 11 mm long. This bat's long ears (over 2.5 centimeters) an
side of the snout are quite distinctive. Fur is light to dark brown in colo
bats that resemble the Virginia big-eared bat are Rafinesque's big-eared
rafinesquii)and the Ozark big-eard bat. Rafinesque's big-eared bat has t
beyond the end of the toes and the dorsal fur is gray rather than brown.

Rafinesque's big-eared bat is white or whitish rather than light brown or Barbour and Davis 1969.) This subspecies is found in Kentucky, North Carolina, Virginia, and West Virginia.

The Virginia big-eared bat roosts in caves and mines year-round. During the winter it hibernates in cold caves and mines and during the summer the females establish maternity colonies in warm caves or mines.

The primary threat to this subspecies is disturbance at its roost sites, it seems to be more susceptable to disturbance than other endangered bats. There are several instances of colonies abandoning favored roosts sites after only one intensive disturbance (John MacGregor, personal communication, 2000, Barbour and Davis 1969.) Once disturbance is eliminated the species will usually return to its favored roost after a few years.

The Virginia big-eared bat's current county distribution and population estimates follow:

- West Virginia (Pendleton, Grant and Tucker Counties) - 10,927.
- Virginia (Tazewell County) - 2,200.
- Kentucky (Lee County) -5,105.
- North Carolina (Avery County) - 260.

The current population of the Virginia big-eared bat population is estimated to be 18,442 individuals, the estimated total population in 1996 was 15,360 individuals. At the time the species was listed, the population was thought to contain only a few thousand individuals. (Traci Wethington, Kentucky Department of Fish and Wildlife Resources, personal communication, 2000, Craig Stihler, West Virginia Department of Natural Resources, personal communication, 2000, Rick Reynolds, Virginia Department of Game and Inland Fisheries, personal communication, 2000, Chris McGrath, North Carolina Wildlife Resources Commission, personal communication, 2000.)

This subspecies has a limited distribution. Its microhabitat requirements for roost sites are specific and any site that meets these requirements, whether it is natural or manmade, can support the species. An abandoned mine in North Carolina supports a small population of the Virginia big-eared bat. This mine is one of the best hibernation sites in the State and if the mine can be protected from the regular human disturbance that it now receives, the population should dramatically increase. The largest known population (about 1,700 bats) of the closely related Rafinesque's big-eared bat uses an abandoned series of mines in the North Carolina portion of Great Smoky Mountains National Park during both the summer and the winter.

Ozark big-eared bats (*Corynorhinus townsendii ingens*)

The Ozark big-eared bat was listed as endangered throughout its range on November 30, 1979, no critical habitat has been designated for the species. The most recent recovery plan for the Ozark was released on March 28, 1995 (U.S. Fish and Wildlife Service 1995.)

This subspecies is very similar to the Virginia big-eared bat in appearance and habitat

requirements. Historically it was found in Arkansas, Missouri, and Oklahoma. It is believed to have been extirpated from Missouri.

The current threats to the Ozark big-eared bat are believed to be low population numbers, human disturbance and loss of habitat. When this subspecies was listed only a few hundred individuals were known to exist. The current estimated population of the Ozark big-eared bat is about 1,800 bats in Arkansas and Oklahoma (Steve Hensley, U.S. Fish and Wildlife Service, personal communication, 2000)

All other members of the genus Corynorhinus readily use abandoned mines when these are available and are suitable. Any mines found within the range of the species could, it they provide suitable conditions, support the species. Michael J. Harvey (personal communication, 2000) reports that a few individuals have been observed in an abandoned lead mine in Arkansas.

Lesser long-nosed bat (*Leptonecterius curasoae yerbabuenae*)

The lesser long-nosed bat was listed as endangered throughout its range on September 30, 1988, no critical habitat has been designated for the species. A recovery plan for the species was released on May 4, 1994 (U.S. Fish and Wildlife Service 1994.)

The lesser long-nosed bat is a migratory, non-hibernating species that feeds almost exclusively on nectar, pollen, and fruit of columnar desert cacti and agave plants. It is a medium sized bat that weighs 20-25 grams and has a wing span of about 16 inches. Fur color is gray to reddish brown dorsally and brownish ventrally. Seasonally the bats move very long distances. Their distribution appears to be directly related to food supply and the availability of suitable roost sites (U.S. Fish and Wildlife Service 1994.)

In the U.S. the species is found in Arizona and New Mexico. It also occurs in Mexico and Central America.

The lesser long-nosed bat inhabits warm caves and mines year-round. The species is an important component of the southwestern desert ecosystem. They pollinate agave plants and several of the columnar cacti such as the saguaro. Later they return and feed on the fruits of the cacti and then play a role in the dispersal of seeds.

This species is vulnerable to disturbance at its cave and mine roost sites and to loss and changes in the composition of the desert flora that provides its food supply. The current population level of this species is much larger now than at the time it was listed, however, it is still considered to be vulnerable (U.S. Fish and Wildlife Service 1994.)

The lesser long-nosed bat is very dependent upon abandoned mines as roost sites and loss of these roosts would seriously impact the species. Six of the eight roost sites for the species in Arizona and New Mexico listed in the recovery plan for the species are mines. Several of the known Mexican winter roost sites are also mines. Protection of the known roost sites and evaluation for potential use by this species of mines for which closure plans are under

consideration is essential if we are to protect this species.

Mexican long-nosed bat (*Leptonecterius nivalis*)

The Mexican long-nosed bat was listed as endangered throughout its range on September 30, 1988, no critical habitat has been designated for the species. A recovery plan for the Mexican long-nosed bat was released in September 1994 (U.S. Fish and Wildlife Service 1994.)

The Mexican long-nosed bat is slight larger than the lesser long-nosed bat with a wingspan of about 17 inches. It also has more brownish colored fur. In the U.S. it occurs in New Mexico and Texas. It is primarily a Mexican and Central American species with its range barely extending into the Big Bend area of Texas and the southwest corner of NM.

The habitat and threats to the continued existence of the Mexican long-nosed bat are similar to those listed for the lesser long-nosed bat. It is however, a much rarer species.

The largest known U.S. site for the species is a cave in Big Bend National Park, Texas. Because the Mexican long-nosed bat's habitat requirements are similar to those for the lesser long-nosed bat, mines may plan a similar role in their survival and recovery.

Summary

Abandoned mines have become extremely important to the conservation and recovery of most of the bats that are currently listed as endangered species under the Endangered Species Act. Closure of abandoned mines, reclamation of abandoned mined land, renewed mining and new mines can all adversely affect these endangered species. Federal agencies, State agencies implementing Federal programs, and State agencies and private organizations and individuals that need some form of Federal authorization or permit for their activities must comply with the provisions of Section 7 of the Act. Everyone must insure that their activities do not violate Section 9 of the Act. Bats are a unique, vulnerable and valuable part of naturally functioning ecosystems. Past human activities have pushed many cave and mine dependent bats to the brink of extinction. To reverse these declines and to provide for their long-term protection and recovery, we must incorporate impact analysis and proactive bat conservation measures into all of our mine related activities. If we don't, the recovery and eventual delisting of these bats will be difficult, if not impossible.

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