THE NORTH AMERICAN BATS AND MINES PROJECT: A COOPERATIVE APPROACH FOR INTEGRATING BAT CONSERVATION AND MINE-LAND RECLAMATION[1]

by

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Abstract: Inactive underground mines now provide essential habitat for more than half of North America's 44 bat species, including some of the largest remaining populations. Thousands of abandoned mines have already been closed or are slated for safety closures, and many are destroyed during renewed mining in historic districts. The available evidence suggests that millions of bats have already been lost due to these closures. Bats are primary predators of night-flying insects that cost American farmers and foresters billions of dollars annually, therefore, threats to bat survival are cause for serious concern. Fortunately, mine closure methods exist that protect both bats and humans. Bat Conservation International (BCI) and the USDI-Bureau of Land Management founded the North American Bats and Mines Project to provide national leadership and coordination to minimize the loss of mine-roosting bats. This partnership has involved federal and state mine-land and wildlife managers and the mining industry. BCI has trained hundreds of mine-land and wildlife managers nationwide in mine assessment techniques for bats and bat-compatible closure methods, published technical information on bats and mine-land management, presented papers on bats and mines at national mining and wildlife conferences, and collaborated with numerous federal, state, and private partners to protect some of the most important mine-roosting bat populations. Our new mining industry initiative, Mining for Habitat, is designed to develop bat habitat conservation and enhancement plans for active mining operations. It includes the creation of cost-effective artificial underground bat roosts using surplus mining materials such as old mine-truck tires and culverts buried beneath waste rock.

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 billions of 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 they 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 44 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.

Bat Conservation International (BCI) and the United States Bureau of Land Management (BLM) founded the North American Bats and Mines Project (NABMP) in 1993 to address conservation issues facing mine-roosting bats. The NABMP provides national leadership and coordination among federal, state, and private agencies and the mining industry to minimize the loss of mine-roosting bats. The NABMP has four primary objectives: to educate natural resource managers and the public on the importance of mines for bats; to train wildlife and mine-land managers on mine assessment and closure methods that protect both bats and people; to assist agencies and industry in protecting and enhancing bat roosts in abandoned mines; and to develop techniques to create new bat habitats during mine-land reclamation on federal and private lands.

The Importance of Mines to Bats

Although caves are numerous in some regions, most are now too frequently disturbed by humans to

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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 bat 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 90°F for maternity use. Big-eared bat (*Corynorhinus* spp.) maternity roosts have sometimes been recorded in colder sites where ambient temperatures are as low as 60°F. 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 50°F. Some desert dwelling bats may be an exception and often hibernate in mines with temperatures below 58°F (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 methods, 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 (*Myotis lucifugus*) 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 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 (*Leptonycteris curasoae*) 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 I 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 (*Eptesicus fuscus*), 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 recently 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.

The Role of Bats in Ecosystem Management

Bats are primary predators of vast numbers of insects that fly at night, and many such insects rank among North America's most costly agricultural and forest pests. Just a partial list of the insects these bats consume includes cucumber, potato, bark, 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 600 mosquito-sized insects in an hour. A colony of Mexican free-tailed bats (*Tadarida brasiliensis*) living in the old Orient Mine in Colorado consumes nearly two tons of insects nightly, mostly moths. The larva of one of these, the cotton bollworm moth (*Helicoverpa zea*), attacks a wide variety of crops including corn, cotton, tomatoes, and pumpkins. Since each female cotton bollworm moth can lay thousands of eggs, as few as 100 moths can force a farmer to spray hundreds of acres of crops with pesticides. Recent research in Indiana has shown that just 150 big brown bats can eat sufficient cucumber beetles each summer to protect farmers from 30 million of these beetles' root worm larvae, pests that cost American farmers an estimated billion dollars annually (Whittaker 1995).

Long-nosed (*Leptonycteris curasoae* and *L. nivalis*) and long-tongued (*Choeronycteris mexicana*) bats are important pollinators for some 60 species of agave plants, and they serve as both pollinators and seed dispersers for dozens of columnar cacti species including organ pipe and saguaro. These cacti rank among the southwestern desert's most familiar and ecologically important plants (Howell 1980). Many wildlife species depend on these plants for food and shelter. The loss of bat pollinators could further jeopardize these already declining plant populations, damaging an entire ecosystem. When ecosystems are modified 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

The NABMP is a partnership between BCI and the BLM created to address the plight of mine-roosting bats. BCI is the world leader in bat conservation initiatives, and the BLM manages some 270 million acres of public lands, which contain a large proportion of North America's abandoned mines. The Forest Service, Natural Resources Conservation Service, Fish and Wildlife Service, and many state agencies are also participating in the project. Mining companies have been the newest addition to collaborative bat conservation efforts through our new Mining for Habitat initiative.

The purpose of the NABMP is to eliminate the loss of bats during abandoned mine-land reclamation, while still protecting human safety. By establishing and achieving the following NABMP goals, BCI and its

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

Species	Colony Sizes† (Approx. # of individuals)	Range	Use Time
Ghost-faced bat *Mormoops megalophylla*	Dozens to hundreds	AZ & TX	Year-round
California leaf-nosed bat *Macrotus californicus*	Dozens to a almost 2,000	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*	Dozens to hundreds	Western U.S.	Year-round
Western small-footed myotis *Myotis ciliolabrum*	Dozens	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
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

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

Species	Colony Sizes† (Approx. # of individuals)	Range	Use Time
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

† This table attempts to quantify typical bat colony sizes found in mines. The numbers are approximate since the size of a bat colony may vary based on several factors. For example, bats use mines differently based on the season (hibernation, maternity, or migratory). Physical factors such as floods, drought, disturbances, mine closures, and insect abundance can influence yearly bat numbers. In addition, the mine's geographic location may affect bat populations. Suitable hibernation sites are often limited in the eastern United States, therefore, one bat species may hibernate in colonies of millions in the east as compared with smaller colonies of tens to thousands in the west.

* Endangered

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.

Goal 1: Awareness, Education, and Training

Due to the NABMP, great progress has been made in raising awareness among key governmental agencies, private industry, and the public regarding the tremendous impact of mine closures on bats. BCI has developed an interpretive display booth on the bats and mines issue, which is being exhibited at key wildlife and mining conferences across North America. The display, along with technical paper presentations, is exposing thousands of mine-land and wildlife managers to the bats and mines issue. Dozens of articles on the NABMP have appeared in local and national newspapers, popular and trade magazines, Internet information services, and professional journals, including North America's largest mining and wildlife trade publications and journals, reaching additional thousands of land managers.

Training in mine assessment for bats is essential to ensure that wildlife and mine-land managers have the knowledge and skills necessary to identify, prioritize, and protect key bat roost sites. In December of 1994, BCI and its agency partners produced the *Bats and Mines* Resource Publication. This informative document summarizes the current knowledge of bat/mine habitat relationships, mine assessment and inventory techniques, and bat-compatible mine closure methods. *Bats and Mines* has been distributed to all major federal agencies responsible for bat conservation and mine reclamation, and is having a tremendous impact on resolving the bats and mines crisis. The handbook will be updated and a second printing will be produced in 1997.

Since the fall of 1993, BCI, the BLM, the Forest Service, other state and private partners, and the mining industry have collaborated to host 12 Mine Assessment for Bats workshops, in Arizona, California, Idaho, Michigan, Montana, Nevada, Ontario, Oregon, Virginia, and Wyoming. These three-day workshops have trained over 500 mine-land and wildlife managers from more than 70 agencies and organizations in mine assessment and protection techniques for bats. Additional workshops are planned for 1997 and 1998.

Goal 2: Conservation Action

BCI is frequently contacted by agencies, organizations, and individuals across North America requesting financial and technical assistance to protect important mine-roosting bat populations. BCI has provided assistance to dozens of natural resource managers nationwide, protecting more than a million bats at some of the largest and most important abandoned mine bat roosts in the states of Arizona, California, Colorado, Idaho, Illinois, Michigan, Minnesota, New Jersey, New York, Oregon, Pennsylvania, and Wisconsin.

Goal 3: Interagency Coordination and Legislation

BCI is fostering cooperation and communication between government agencies, private organizations, and industry to ensure that wildlife and mine-land managers have the best and most current information available on mine assessment and closure techniques for bats, thereby increasing the efficiency of bat conservation efforts. BCI continues to initiate cooperative agreements with federal, state, and private agencies and industries that promote cooperation and partnership. Already, cooperative agreements have been developed with the BLM, Forest Service, Natural Resources Conservation Service, National Park Service, and Fish and Wildlife Service.

Mine closure programs and policies, regulated by both federal and state law, can have profound effects on bat conservation. BCI plans to begin a status review of all existing and proposed state and federal abandoned mine reclamation legislation to determine the extent to which bat conservation needs are addressed. When necessary and appropriate, BCI will develop and propose suitable bat conservation language for incorporation in local, state, and federal mine reclamation legislation.

Goal 4: Research and Monitoring

BCI will support and conduct research and monitoring with direct implications for improving bat conservation and abandoned mine-land management. Research in bat conservation is essential for providing natural resource managers the most current information available upon which to base critical management decisions. Monitoring will ensure the effectiveness of future bat conservation measures.

In 1995, BCI and scientists from the United States Bureau of Mines completed a national evaluation of abandoned underground mine distribution relative to sensitive mine-roosting bat species ranges. A Geographic Information System (GIS) was used to map the overlap of regions with high mineral potential, abandoned mine habitats, and endangered or candidate bat species ranges. These maps are available to public and private mine-land and wildlife management agencies and organizations. They can be essential planning tools to assist managers with prioritizing regional abandoned mine inventories and bat habitat restoration efforts.

BCI is currently involved in several monitoring projects such as recording effectiveness and species-specific acceptance rates of bat-compatible gates, especially during the critical maternity season. Data on specific habitat characteristics selected by bats at mine-roost sites, such as temperature, humidity, and air flow, is also needed. This data is being collected at several mines throughout the United States. This information will also be important in future artificial bat roost construction projects.

Mining for Habitat

Because many of the largest and most important mine-roosting bat populations are located on private mining industry lands, BCI recently initiated an innovative partnership program, entitled "Mining for Habitat." This partnership program is designed to help mining companies enhance and conserve bats and bat habitat during active mining and mine-land reclamation. BCI is working with industry partners to develop bat conservation and management plans for individual mine sites. Potential projects may include installing bat-gate mine closures to protect existing and potential underground mine roosts, providing bat-compatible wildlife water sources, and even creating cost-effective artificial underground bat roosts during active mining and reclamation. Because BCI is a nonprofit organization, cooperating companies benefit through tax deductible cost-sharing and other contributions.

Response to "Mining for Habitat" has been excellent. Many mining companies have joined to protect these important bat species and have received outstanding coverage in major industry journals and professional publications, such as *Mining World News, The Mining Journal, Mining Engineering, Mining Voice, American Metal Market, Gold News, National Coal Leader, Randol International's Mining Opportunity Bulletin,* and *Green Mining Guide,* as well as several national and local newspapers and magazines including *The Chicago Tribune, Popular Science,* and *National Geographic.* The following examples highlight some current achievements.

The Unimin Corporation collaborated with BCI and the Forest Service to gate one of their recently inactivated silica mines in southern Illinois. This site had become an important fall and winter roost for approximately 3,000 bats including endangered Indiana bats, little brown bats, and northern long-eared myotis. Phase II of this project will involve gating a second dangerous adit, and is scheduled to begin in mid-1997. This is an excellent example of how the mining industry is actually creating and protecting habitat for an endangered bat species.

Last fall, the Nevada Mining Association and their members joined forces with BCI and the BLM's Ely District to complete a restoration project that protected 70,000 Mexican free-tailed bats at Nevada's largest bat roost, the Rose Guano Cave and historic guano mine. The mine tunnel driven into the bats' roosting chamber to mine guano in the 1920s was blocked with a steel grate and removable steel plates to prevent disturbance to roosting bats and restore the cave to its pre-mining conditions.

After attending one of BCI's Mine Assessment for Bats workshops, and learning how important mines are as bat habitat, managers from BHP Copper contacted BCI for assistance surveying more than 400 old mine workings for bats on their properties in Superior, Arizona, and Ruth, Nevada. Surveys revealed that 13 percent of the abandoned mines have important bat colonies and excellent bat habitat. These old workings were slated for closure within weeks but BHP agreed to protect these sites, and has already installed more than five bat-compatible steel gates using surplus angle-iron. The abandoned mines not suitable as bat habitat are being backfilled. BCI even hosted a "bat education night." More than 25 people attended, including BHP Copper employees, their families, and other members of the local community interested in learning about bats and the proactive achievements of BHP Copper.

The first industry-sponsored Mine Assessment for Bats workshop was held in August 1996, in Ontario, hosted by the Inco and Falconbridge Mining Companies and the Ontario Ministry of Mines. Taught by BCI biologists and leading bat experts, the workshop was attended by more than 30 mine-land managers from eastern Canada. This workshop is expected to have far-reaching impacts in maintaining Canada's largest remaining bat populations on private industry lands. Inco Mining Company has already committed to protecting critical bat habitats at their mine sites.

In perhaps the most exciting development of the Mining for Habitat Program, BCI is working with mining companies to create new underground bat habitat using on-hand mining materials buried during active mining and reclamation. Most mines have surplus mine-truck tires, culverts, and other structures suitable for roost creation of which can legally be difficult to dispose. If artificial roosts prove successful, as every indication has suggested, we can cooperatively solve a long-standing problem for the mining industry while providing new homes for bats nationwide. Artificial bat roost plans could become a routine part of reclamation, even at surface mines. To date, two artificial underground roosts have been constructed by Homestake Mining Company in California and Monsanto Corporation in Idaho.

At their McLaughlin Mine in northern California, the Homestake Mining Company worked with bat biologist and BCI associate, Dixie Pierson, to build the first artificial bat roost. Made from old mine-truck tires connected by a precast concrete bunker, this artificial roost was buried under mine waste rock during surface mine-land reclamation.

In a similar effort, BCI and the Monsanto Corporation used surplus large-diameter culverts at their Soda Springs Phosphate Mine in Idaho to create both a hibernaculum and maternity roost for western big-eared bats. The culverts have been especially configured to hold stable cold air in the winter and trap warm air in the summer and have been buried and contoured into the landscape during reclamation.

Conclusion

Why are so many mining companies concerned about bats? Because mining companies have created essential habitats for a vital and fascinating wildlife species. Mining industry partnerships with BCI provide an excellent opportunity to demonstrate the benefits of mining, not only to the economy, but to the environment as well. In the future, BCI hopes to have bat conservation measures incorporated into standard reclamation practices. By sharing responsibilities for conservation actions, by cooperating and partnering, and by being proactive, solutions will be reached that allow bats to thrive and mining companies to garner the positive benefits.

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