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The UNIMIN Corporation Magazine Mine: A Novel Indiana Bat *(Myotis sodalis)* Hibernaculum in Southern Illinois

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ABSTRACT

Magazine Mine, Alexander County, currently supports at least 14,500 wintering Indiana bats (*Myotis sodalis*) and is the largest known winter hibernaculum of this Federally endangered species ever documented within Illinois. Because this mine has been abandoned for more than 20 years, immediate and permanent stabilization at the main entrance was needed to prevent catastrophic collapse and eventual closure. Such a collapse at this Federal Priority II hibernaculum would not only exterminate the large numbers of Indiana bats hibernating within this mine, but permanently prohibit its use by successive generations of *Myotis sodalis*. Recent efforts at the UNIMIN Corporation's "Magazine Mine" to directly protect resources critical to bat reproduction and hibernation have both strengthened and promoted a conservation ethic benefiting not only bats, but the fragile Shawnee National Forest ecosystem as a whole. This paper describes stabilization efforts completed during summer 2001 using specially engineered steel arches.

INTRODUCTION

The Indiana bat (*Myotis sodalis*) is a federally endangered species whose distribution is associated with major cavernous limestone areas and locales in the midwestern and eastern United States (Hall, 1962; Thomson, 1982). Many studies have been done to increase our knowledge of the ecology and specific survival requirements of this species, specifically winter habitat use and thermoregulatory mechanisms during hibernation. Crucial to the survival of any endangered species is both a comprehensive understanding of suitable habitat constraints and a distinctive management protocol which encourages permanent habitat protection (Humphrey et al., 1977). This paper describes the presence of wintering Indiana bats within an abandoned, silica sand mine in extreme southern Illinois. Future management of this privately owned mining complex will be based upon the presence of these mammals. More important, this study yields insight into the specific temperature needs of Indiana bats during hibernation and their ability to find and exploit artificially-created ecosystems.

INDIANA BAT WINTER ROOSTS IN ILLINOIS

Bat populations continue to decline because of habitat loss, environmental pollution and toxins, and disturbance at key roost sites. Representing the most compromised of North America's terrestrial mammals, bats have been forced to use artificial or modified habitat to survive. Abandoned mine lands throughout the midwestern United States now offer a proverbial "refuge of last resort" for many bat species, most notably the Indiana bat. According to the Federal Indiana Bat Recovery Team (March 1999), of the 12 states with regularly occurring hibernating populations of Indiana bats, 4 do not have enough recent survey information for a population trend to be accurately assessed. Unfortunately, Illinois is one of these four states. In reviewing the Revised Recovery Plan for the Indiana bat (Agency Draft - March 1999), Illinois Department of Natural Resources (IDNR) staff provided the Recovery Team with a population status update through January 2001. Based upon an examination of data from 1985-1995 and censuses taken at significant recognized hibernacula over the past six years (through January 2001), the total known wintering Indiana bat population within Illinois is estimated to be approximately 19,500 animals.

The most severe declines of hibernating *Myotis sodalis* in Illinois have occurred at Brasher Cave in Pope County (public land-U.S. Forest Service); Fogelpole Cave in Monroe County (state-owned nature preserve); and Toothless Cave in Jackson County (private land) (Table 1). Brasher Cave has experienced a 100% reduction in hibernating Indiana bats [500 bats in 1993; 0 in 2001]. Fogelpole Cave has suffered a 42% population reduction [403 bats in 1986; 171 in 2000]. Likewise, Toothless Cave has experienced a 23% population reduction [3,200 bats in 1995; 739 in 2000]. However, populations at Blackball Mine Nature Preserve in LaSalle County have steadily increased since the first formal IDNR census in 1987. Critical habitat was designated for the Indiana bat on 24 September 1976 and included 11 caves and 2 mines in 6 states. Blackball Mine Nature Preserve, then containing 115 Indiana bats, was recognized as critical *M. sodalis* habitat. This 122-ha state-owned nature preserve protects a diverse natural area with dolomite cliffs, dolomite prairie, upland forest, floodplain forest, and savanna communities. The preserve was dedicated to the State of Illinois in July 1984. It contains many abandoned limestone mines (mining operations ceased in the early 1900's) in which the Indiana bat has been known to hibernate since at least the 1950's. Although access to the mines is completely restricted from September to May to protect the hibernating bats, the rural nature of the site makes enforcement difficult, and illegal access unfortunately has been a problem. During 1996, a portion of the mines was equipped with "bat-friendly" gates. During summer 1998, a portion of the gate between the upper and lower Blackball Mines was breeched by vandals and three temperature monitors were removed. Despite these intrusions, the number of *M. sodalis* hibernating within the Blackball Mines has slowly increased from 260 animals in 1987 to 1,338 animals in 2001. The Blackball Mine complex was considered to be the largest, documented Indiana bat hibernaculum in Illinois, until the February 1999 survey of the UNIMIN Minerals Corporation's "Magazine Mine" complex in southern Illinois' Alexander County.

MAGAZINE MINE: INDIANA BAT POPULATION STATUS

The UNIMIN Specialty Minerals Corporation is the world's largest producer of crystalline and microcrystalline silica. For decades, the underground mining of silica has occurred beneath several square kilometers of deciduous forest in Alexander County. Much of this forest land is part of the Shawnee National Forest with a majority of the underground mineral rights belonging to UNIMIN. The predominant land cover in this region is oak *(Quercus)*/hickory (*Carya*) woods comprising 42% upland and 10% bottomland resources. This resource rich area encompasses Mississippi River bottomlands, Ozark plateau, and unglaciated hill country (Suloway et al., 1996). Many of the plant and animal resources found here are rare and limited in distribution to this area of the state.

Underground silica mining operations in this region began in the early 1900's. Today, surface extraction techniques are favored over much more dangerous subsurface procedures. Most underground mines were vast, allowing trucks and heavy equipment direct access. Unlike coal mines, it was not necessary to erect shoring or stabilization structures inside these mines. Material was extracted quickly and once exhausted, the mine was left open. It is not uncommon for ceiling heights to exceed 30 m in many of these abandoned mines. Over the past several decades, many of the smaller abandoned mines have collapsed, permanently sealing entrance and/or exit passages. However, a few of the larger mines have remained open thereby attracting bats seeking a suitable winter hibernaculum. Winter surveys of several of these abandoned silica mines were conducted throughout the 1970's and revealed very small numbers of Indiana bats (never exceeding 10 *M. sodalis*/mine). It is unclear from these records whether any portion of Magazine Mine was ever surveyed for hibernating bats. Magazine Mine, approximately 84,730 m^2 in area, is the largest abandoned, underground silica mine within both the UNIMIN complex and Illinois. The average height and width of interior passages is approximately 6 m x 9 m. This mine was opened in 1972 and operations ceased in 1980. Given its vast size and many confusing passages, it is highly unlikely that an inexperienced individual would make it through the first series of chambers without getting lost. Approximately 4.2 km southwest of Magazine Mine is another substantial abandoned, underground silica mine known as Mine #30. This mine is smaller than Magazine Mine, approximately 21,594 m^2 in area. The one remaining entrance to Mine #30 is currently not gated and appears to be much more stable than the Magazine Mine "main" entrance. The average height and width of interior passages is approximately 15 m x 10 m. Mine #30 was opened in the mid 1960's and abandoned in the late 1970's, and also serves as an important Indiana bat hibernaculum within the UNIMIN complex (Table 1).

Magazine Mine has two entrances; a stable "air shaft" entrance and a rapidly deteriorating "main" entrance that once served as the primary portal for service vehicles and mining personnel. Mist net and harp trap surveys near the air shaft entrance were conducted during summer 1995. Five species of bats were documented including the: big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugus*), Indiana bat (*M. sodalis*), northern long-eared bat (*M. septentrionalis*), and eastern pipstrelle (*Pipistrellus subflavus*). To protect bats hibernating within the air shaft, a bat-friendly gate was constructed at the air shaft entrance in 1996. In August 1997, mist net and harp trap surveys were conducted at the main (deteriorating) entrance to Magazine Mine. Several *M. sodalis* were caught exiting the mine. Subsequently, resource managers raised the possibility that Magazine

Mine might be functioning as a winter hibernaculum for these animals. Due to the fragile, unstable nature of the main entrance, gating and/or fencing of this portal was deemed impractical and unsafe.

On 20 February 1998, a small portion of Magazine Mine was investigated. The main (deteriorating) portal was entered and a small number of initial chambers examined. Several large clusters of *M. sodalis* (> 300 animals/cluster) were identified and positively confirmed by hand examination of a few individuals. Upon discovery of these animals, the investigation was immediately terminated. It was decided that a formal inventory of the entire mine should be performed the following winter to assess the true magnitude of *M. sodalis* winter use. Using a map of the mine developed by the UNIMIN Corporation, a grid system was established inside the mine. Each of 12 individual passageways along a general north-south axis was assigned a number and letter resulting in 84 separate survey points. Each survey point was marked with fluorescent flagging and spray paint for easy identification.

On 9 and 10 February 1999, a 13-person survey team entered Magazine Mine. The team was divided into three groups consisting of a data recorder and three or four observers. Each group was assigned specific survey points within the mine and recorded all visible bats, by genus and species, on standardized data forms. For small clusters of *M. sodalis*, or those below a height of 6 m, observers counted each bat. For larger clusters of *M. sodalis*, or for those at greater heights, observers used an estimate of 3,000 bats/m^2. A total of 12,293 bats was counted. Of these, 9,074 were *M. sodalis*; 1,394 *M. lucifugus*; 681 *M. septentrionalis*; 878 *P. subflavus*; and 266 *E. fuscus*. Indiana bats were concentrated in the northernmost one-third of the mine. One large, main roost and three smaller roosts were identified and mapped. During this inventory, six dataloggers (HOBO Pro Temp-RH, Onset Computer Corporation, Pocasset, MA) were installed at various locations inside Magazine Mine. All instruments were programmed to record temperature and relative humidity data at 3-h intervals (BCI, 1999).

On 23 January 2001, a 13-person survey team completed the second formal inventory of Magazine Mine. Census techniques employed during the February 1999 inventory were followed. A total of 18,329 bats was counted. Of these, 14,679 were *M. sodalis*; 1,702 *M. lucifugus*; 205 *M. septentrionalis*; 1,437 *P. subflavus*; and 306 *E. fuscus*. Once again, Indiana bats were concentrated in the northernmost one-third of the mine with one large, main roost and three smaller roosts existing in the same locations as February 1999. All six dataloggers were downloaded and subsequently re-launched to again record temperature and relative humidity data at 3-h intervals. In addition, one datalogger was positioned outside the mine to monitor external conditions.

MAGAZINE MINE: INDIANA BAT MANAGEMENT EFFORTS

Habitat requirements for the Indiana bat within Illinois do not deviate from those needed throughout this species' entire range. Indiana bats require specific roost sites in caves or mines that attain appropriate temperatures to hibernate. Ideal sites are ≤ 10°C when the bats arrive in October and November. Magazine Mine currently meets this specialized temperature requirement. Temperatures from 1 October-31 November (1999-2000) were Mean = 6.7°C; Range = 6.3-6.9°C. Temperatures from 1 October-31 November (2000-

2001) were Mean = 6.3°C; Range = 5.5-6.8°C. Early studies identified a preferred mid-winter temperature range of 4-8°C, but a recent examination of long term data suggests that a slightly lower and narrower range of 3-6°C may be ideal for this species (USFWS, 1999). Only a small percentage of caves and mines provide this specialized requirement. Stable, low temperatures allow these animals to maintain a reduced rate of metabolism and conserve fat reserves through the winter, until spring. Mid-winter temperatures within the Magazine Mine from 1 December-28 February (1999-2000) were Mean = 4.5°C; Range = 1.4-6.9°C. From 1 December-28 February (2000-2001) temperatures were Mean = 4.2°C; Range = 2.7-5.8°C . This supports the concept that *M. sodalis* prefer sites that offer the lowest non-freezing roost temperature possible (BCI, 1999).

Abandoned mines and caves change structurally far more often than is generally recognized. Entrances and internal passages essential to air flow may become larger, smaller, or close entirely, with corresponding increases or decreases in air flow, temperature, and humidity. Blockage or collapse of entry points, even those too small to be recognized, can be extremely important in hibernacula (such as Magazine Mine) that require chimney-effect air flow to function. Recent data show that changes in air flow can elevate temperatures which can cause an increase in metabolic rate and a premature exhaustion of fat reserves. Such air flow changes also may force bats to roost near unsuitable entrances or floors to find low enough temperatures, thus increasing their vulnerability to freezing or predation (BCI, 1998).

The main entrance shaft of Magazine Mine is approximately 70 m in length. The shaft slopes downward at a 40-45° angle until it reaches the main floor of the mine. Since its abandonment in 1980, massive collapses have occurred throughout the entire length of the shaft, reducing the surface entry to a 7-m wide, 3-m high opening. This represents nearly a 70% reduction in surface entry size in < 25 years. Without restoration and stabilization of the entire shaft, Magazine Mine would no longer function as a hibernaculum for *M. sodalis* . Exclusion of Indiana bats from such crucial hibernacula historically has been a major cause of their decline.

A permanent, heavy-duty stabilization of the entire Magazine Mine entrance shaft using specially engineered steel arches and treated timber posts would allow Indiana bats to continue to use this mine for hibernation. A total of 49 arches (4.3-m interior width, 2.7-m interior height) placed approximately 1.2 m apart was needed to complete this task. These arches were custom designed and engineered to support a full roof collapse. After the arches were erected, they were covered with 15 cm x 15 cm x 1.2 m treated timber posts, thereby creating a long, tunnel-like structure (Figure 1). Entrance excavation, grading, and final arch construction activities were completed in August 2001 at a cost of nearly $110,000.00. Construction activities involving either a bat-friendly gate and/or steel fencing surrounding the perimeter of the arch entrance are planned for summer 2003.

This unique project was possible because of partnership between industry, nonprofit organizations, and state and federal governmental agencies. The UNIMIN Specialty Minerals Corporation provided expert consultation on mining safety practices and donated numerous hours of labor and heavy equipment use. As a direct result of *M. sodalis* conservation efforts within the UNIMIN complex, several communities in southern Illinois

printed educational articles on bats, and the importance of summer and winter habitat, in their local newspapers. A willingness by biologists, government administrators, industry representatives, and private citizens to work together can have a direct impact on the survivorship of our nation's flora and fauna.

CONCLUSION

The long term stabilization of the Magazine Mine entrance directly meets the management and recovery objectives addressed in the Federal Indiana bat Recovery Plan, has tremendous potential for natural resource education, and remains an integral component in the recovery of the Indiana bat. This effort has fostered a unique, cooperative partnership between: private industry, the Illinois Department of Natural Resources, the United States Forest Service, the United States Fish and Wildlife Service, as well as numerous environmental organizations and local community groups. Promoting bat conservation by changing attitudes, not by confrontation, has enabled professional resource managers throughout Illinois and the Midwest to work directly with citizen groups, schools, and businesses. Extracting solutions to complex environmental problems through community and industry partnerships was quite successful.

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Table 1. Indiana bat (*Myotis sodalis*) hibernacula in Illinois documented by IDNR as of 2001.

Hibernacula	**County (IL.)**	***Historic*** **Population Size**	***Current*** **Population Size**
Blackball Mine	LaSalle	260 bats (Feb. 1987)	1,338 (Feb. 2001)
Brainerd Cave	Jersey	150 (Feb. 1998)	426 (Jan. 2000)
Brasher Cave	Pope	500 (Oct. 1993)	0 (Jan. 2001)
Ellis Cave	Pope	426 (Jan. 2000)	475 (Jan. 2001)
Fogelpole Cave	Monroe	403 (Jan. 1986)	171 (Jan. 2000)
Toothless Cave	Jackson	3,200 (Feb. 1995)	739 (Jan. 2000)
UNIMIN Mine #30	Alexander	495 (Feb. 2000)	1,500 (Jan. 2001)
UNIMIN Magazine Mine	Alexander	9,074 (Feb. 1999)	14,679 (Jan. 2001)

Figure 1. Stabilization arch constructed at Magazine Mine, Alexander County, IL.