HABITAT PROFILE

Caves and Mines

Associated Species: Northern Myotis, Eastern Small-Footed Bat, Myotis sodalis, , Eastern Pipistrelle
Global Rank: G5
State Rank: S1
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Element 1: Distribution and Habitat

1.1 Habitat Description

Caves and mines are distinguished from all other New Hampshire habitats by being located below ground. Cave and mine habitat does not represent an ecosystem, but rather an abiotic habitat type. Prior to the 1800s, no underground cave or mine habitat existed in New Hampshire other than the small fracture "caves" located in tourist areas such as Lost River and The Polar Caves; such structures are not true caves.

1.2 Justification

Six of New Hampshire's 9 bat species overwinter in the state, hibernating in thermally stable underground caves or mines. A small number of mines in New Hampshire are known to provide habitat for hibernating bats, although historic mining data suggest that there could be additional mines that provide suitable winter habitat. For conservation, it is necessary to maintain mines with attributes (e.g., temperature, airflow, low disturbance) that are required by hibernating bats. Some individuals, such as *Eptesicus fuscus*, undoubtedly hibernate in buildings (Whitaker and Gummer 1992). Managers need better knowledge of hibernacula sites to conserve overwintering animals.

3.3 Protection and Regulatory Status

The Bureau of Land Management and Office of Surface Mining provide no data regarding use of abandoned mines. They may provide public service announcements indicating the danger of entering abandoned mines, but no specific federal law appears to regulate non-commercial use of mines.

At the state level, under the Revised Statutes Annotated (RSA), Title I (the State and its Government), Chapter 12-E regulates mining and reclamation activities in New Hampshire. Section 12-4:V discusses the requirements of post-mining reclamation, and states "post-mining uses may include agricultural, recreational, residential, commercial, industrial, forestry or open space land use." This post-mining reclamation appears to relate to the habitat surrounding the mine, but not the mine itself. Chapter 12-E does not provide regulations pertaining to use of the mine after commercial mining activities have ceased.

1.4. Population and Habitat Distribution

There are 7 known abandoned mines that serve as winter hibernacula in New Hampshire. Within the Northeast region, approximately 198 hibernacula have been documented to date (approximate numbers per state are: Connecticut = 2, Maine = 3, Massachusetts = 16, New York = 150, Rhode Island = 0, and Vermont = 27), with just 55 in New England.

New Hampshire's hibernacula are concentrated in Grafton County (5 of 7 sites), with one site located in each of Coos and Merrimack Counties. Additionally, *potential* hibernacula are located in Grafton County (6 mines), Sullivan County (2 mines), and Cheshire County (1 mine). Mean minimum distance between nearest neighbor mine sites was 20.7 km (range 1.7 – 61.8 km).

1.5 Town Distribution Map

See attached.

1.6 Habitat Map

Profile authors visited each mine during the summer of 2004 and GPS coordinates were gathered using a Garmin 12XL receiver. Map coordinates were provided to the habitat mapper. Coordinates provide accurate localities of each mine.

1.7 Sources of Information

The main source of information pertaining to mine locations was the New Hampshire Natural Heritage Inventory: Bat Hibernaculum Records for abandoned mines. Existing GPS coordinates were found to be inaccurate for some mines (e.g., Mt. Kearsarge Mine) and therefore only the coordinates provided to the habitat mapper from the 2004 field work (section 1.6) should be used.

Several sources were used to identify potential hibernacula including databases, published literature, and consultation with state agencies, local spelunkers, historical societies, and landowners. The main database used to determine historical mine sites was the United States Bureau of Mines, Minerals Availability System Domestic Deposit Listing (maintained by the Utah State Historical Society). Morrill (1960; New Hampshire Mines and Mineral Localities) provided more detailed information about potential mines.

Authors consulted with the state geologist (David Wunsch, New Hampshire Department of Environmental Services) and a land manager (Bill Carpenter, New Hampshire Department of Resources and Economic Development, Land Management Bureau). For each mine identified as a potential hibernacula, the local historical society was contacted about mine ownership, condition, etc. Two active New Hampshire spelunkers (Michele Tremblay and Steven Landry) were consulted about the presence of additional mines that we had not identified, as well as data about the condition of known mines. Finally, local landowners near potential sites were consulted during the survey to gather additional data on mine location and condition.

1.8 Extent and Quality of Data

Trends in the habitat quality of New Hampshire's mines are unknown. In addition, the lack of data on caves/mines in New Hampshire precludes an accurate assessment of the statewide or regional significance of New Hampshire's mines.

1.9 Distribution Research

It is important to survey all known mines for use by bats. Sites should be described in terms of microclimate and disturbance regimes; this will allow managers to determine the potential of a mine to serve as a hibernaculum.

Element 2: Species/Habitat Condition

2.1 Scale

Due to the relatively small number of New Hampshire mines that are known to provide habitat or potentially provide habitat, each mine is treated individually as a conservation planning unit.

2.2 Relative Health of Populations

The 7 mines that have been surveyed for bats in New Hampshire have hibernating populations ranging in size from 12 bats (Beebe River Mine) to 1,579 bats (Mascot Lead Mine). Species diversity within these mines ranges from 2 species (Carter Mine) to 5 species (Mascot Mine). Although Bristol Mine was only surveyed once (1989), the remaining 6 mines have been surveyed at least three times since 1986. From these data, it appears that hibernating populations of bats are generally stable, with 5 of the mines having larger populations in recent surveys. The only mine to see a decline was the Beebe River Mine, which saw a 79% reduction from 1988 to 1991.

A *Hibernacula of Special Concern* is defined as any cave or mine that contains at least four species of bats, at least 1,000 individuals, or any threatened or endangered species (Butchkowski 2003). New Hampshire has two Hibernacula of Special Concern: Mascot Lead Mine and the Red Mine.

To estimate the hibernating population of bats in New Hampshire, we assumed changes in population size between surveys were a linear function of

time and conducted a smoothed-line interpolation of data between surveys. We took two approaches to estimate the current population of bats in hibernacula. The first approach assumed all populations would remain stable since the last survey; because all but one of the mines had increasing population trends, this was considered a conservative estimate. The second method involved extrapolating data from the last survey date using the rate of increase estimated from prior surveys; this was considered the potential estimate. The conservative estimate was 2,928 bats and the potential estimate was 3,283. Because the largest mine (Mascot Lead Mine) was surveyed in 2004, the potential estimate is only 12% higher than the conservative estimate.

The little brown bat (*Myotis lucifugus*) is the dominant hibernating bat in New Hampshire, being found in all seven mines and representing 86.5% of all bats. Northern myotis (*Myotis septentrionalis*) are also found in each of the known mines and represent 12.5% of the total hibernating population. Northern myotis is the only species that appears to be declining, with the 2004 estimate reflecting a 36% decrease from 1989 estimates. This decline may be due to population pressures outside the hibernacula, but may also reflect differences in survey methods and misidentification of little brown bats as northern myotis. Big brown bats (*Eptesicus fuscus*) represent 0.3% of the current hibernating population and are currently known from two hibernacula (Red Mine and Beebe River Mine), although they were found in the Paddock Copper Mine as recently as 1991. Similarly, eastern pipistrelle bats (*Pipistrellus subflavus*) represent 0.3% of the current hibernating population and are currently known from two hibernacula (Dodge Mine and Mascot Lead Mine), although they were found in the Mt. Kearsarge Mine as recently as 1991. Eastern small-footed bats (*Myotis leibii*) represent 0.3% of the current hibernating population and are only known from Mascot Lead Mine. The 2004 population estimate of eastern small-footed bats (9 animals) reflects an increase from the previous survey, but a 43% reduction from the peak estimate in 1987.

2.3 Population Management Status

2.4 Relative Quality of Habitat Patches

Several physical characteristics are predictive of hibernacula. These include cool and stable interior temperatures (Hall 1956, McManus 1974, Harmata 1987, Jones et al. 1995, Tuttle and Kennedy 2002, Tuttle 2003), low air flow (Jones et al. 1995, Kath 2002), long or complex adits (Lopez-Gonzalez and Torres-Morales 2004), and a high degree of protection from human disturbance and vandalism (Martin et al. 2002, Tuttle and Kennedy 2002). Updates on population information and physical attributes of known hibernacula suggest that New Hampshire Natural Heritage ranks need revision.

2.5 Habitat Patch Protection Status

Mascot Lead Mine is the only mine that currently contains (state) endangered species. Mascot Lead Mine, Paddock Copper Mine, and Mt. Kearsarge Mine are the three largest hibernacula in the state. Five of the seven known mines (Carter's Mine, Beebe River Mine, Bristol Mine, Paddock Copper Mine, and Red Mine) are located on private land. Two mines (Mascot Lead Mine and Mt. Kearsarge Mine) are managed by the Department of Resources and Economic Development (DRED). Each mine identified as potential habitat is located on private land. The exact location of one mine (Keyes Mine) could not be determined, and therefore protection status is unknown.

2.6 Habitat Management Status

The only ongoing habitat management action occurring in New Hampshire is the maintenance of a bat gate at Mascot Lead Mine. Bat gates have been installed at hibernacula for the last 35 years to reduce or eliminate disturbance (Tuttle 1976). These gates are steel-welded structures installed at the entrance to a mine or cave that restrict human access while producing minimal impact on air flow and flight behavior of bats. Because many caves and mines are found in remote locations, bat gates have been described as "the only means available for protecting these [colonies]" (Pierson et al. 1991). Some states, such as Pennsylvania, have installed bat gates hibernacula that contain Indiana bats (Butchkoski 2003)

Despite the increased use of gates as a conserva-

tion tool, there has been little attempt to quantify the effectiveness of gating (Currie 2002). In fact, there are several instances of mines and caves experiencing population declines or complete abandonment following construction of bat gates (Tuttle 1976, Johnson et al. 2002).

Two bat gates were installed at the Mascot Lead Mine in 1992—one on the lower adit (Level 1) and another on the upper adit (Level 2). Prior to installation, a census of bats in the mine estimated a hibernating population of 874 bats representing five species. A 1993 survey (1,504 bats representing five species) strongly suggests that the bat gate has not negatively impacted the microclimate of Mascot Lead Mine nor has it impeded the flight behavior or hibernacula preferences of the bats. Given the design of the gate and the security of the access door, it is reasonable to assume these bat gates have been highly effective at minimizing human disturbance.

2.7 Sources of Information

The physical attribute information on four of the known bat hibernacula (Mt. Kearsarge Lead Mine, Paddock Copper Mine, Carter's Mine, and Red Mine) were collected by Durham (2000). Measured variables included temperature, relative humidity, shaft height, shaft width, bat cluster temperature, species composition, roost height, and roost depth. These data were used to generate mine maps and look at species-specific thermal preferences.

2.8 Extent and Quality of Data

The quality and extent of data collected varies between the mines. There have been four winter surveys at Mascot Lead Mine since 1987; two were conducted since installation of the bat gate in 1992. Red Mine has been surveyed four times since 1986 and the Mt. Kearsarge Lead Mine and Paddock Copper Mine have been surveyed five times since 1986. The smaller hibernacula have generally been surveyed less frequently, including Carter's Mine (three surveys since 1989), Beebe River Mine (three surveys since 1988), and Bristol Mine (one survey in 1989). With the exception of data collected in 1999 and 2000 at Red Mine, Paddock Copper Mine, Carter's Mine, and Mt. Kearsarge Lead Mine (Durham 2000), no microclimate data have been collected at any of these sites. Furthermore, bats have not been surveyed at Ruggle's Mine.

2.9 Condition Assessment Research

It is important for the conservation of bats in the Northeast to identify and determine the importance of mines as winter roost habitat (Ellison et al. 2002). This requires establishing a monitoring program that will assess the physical attributes of a mine to determine its' potential suitability as a hibernacula, document the population status of hibernating bats using non-intrusive monitoring techniques, and evaluate the need for, and effectiveness of, mine gates to minimize disturbance.

One priority should be to continue to seek additional mines that may contain hibernating bats. Previous surveys across the country have shown that approximately half of abandoned mines show some evidence of bat use (Tuttle 1995). In New Hampshire, a small fraction of the summer bat population can be accounted for by existing hibernacula. Therefore, it is likely that additional surveys will discover new hibernacula.

For each potential hibernaculum, it is important to measure the physical characteristics of the mine and key microclimate conditions that influence bat occupancy. Foremost of these microclimate variables is core mine temperature (Tuttle and Kennedy 2002). Most bats prefer mines that maintain a stable winter temperature slightly above freezing (1°C - 10°C: Tuttle 2003). This is consistent with the temperatures recorded in Red Mine near hibernating bats (6°C - 9°C; Durham 2000). Most rigorous surveys now rely on battery-operated data logger probes (such as the Hobo Pro ™ series) to record mine temperature throughout the hibernation period (Tuttle and Kennedy 2002). These devices can be installed in the autumn and programmed to record temperature each hour during the winter. Devices can be recovered in the spring without disturbing the bats. Air flow can also be important in larger mines because it indicates air exchange within the mine and may be the result of chimney-effect air flow that is produced by a secondary opening. Chimney-effect air flow maintains cool air in mines and often enhances temperature stability (Tuttle and Kennedy 2002).

For mines with hibernating bats, periodic monitoring is essential to assess population stabil-

ity. Surveys involving Species of Concern should be conducted every second or third year (Johnson et al. 2002, Tuttle 2003). Hibernacula surveys should be conducted during December through February when bats are most abundant. Details of the survey protocol are available from Veilleux and Reynolds (2005). Technical climbing support may be required to access the habitats. Microclimate needs to be measured to determine a mines' suitability as hibernacula.

For mines subject to vandalism and disturbance, it may be necessary to install bat gates across the mine entrance. Well-designed bat gates can protect bats from disturbance without impacting cave microclimate. Although gates can be expensive to install, they appear to be the only effective method of reducing human disturbance. Research into the value of chain-link fences and signage suggests they do not deter vandalism at all (Johnson et al. 2002). Johnson et al. (2002) did find, however, that a motion-activated alarm reduced human entrance into a mine in Indiana.

Element 3: Species and Habitat Threat Assessment

3.1.1 Recreation

(A) Exposure Pathway
Humans that enter New Hampshire mines during winter may disturb hibernating bats and cause individual bats to arouse from hibernation. These disturbances may expend a portion of an individual's energy reserve that is required for successful hibernation. If human disturbance of wintering bats and the subsequent arousals from hibernation occur too frequently, energy reserves may be depleted and individuals may die before spring emergence. As evidence of this, Johnson et al. (1998) documented lower body masses in Indiana bats hibernating in caves that were subject to human disturbance.

(B) Evidence
Thomas (1995) examined whether non-tactile disturbance by humans (i.e. disturbance by light and sound, rather than direct physical contact with bats) visiting hibernacula during the hibernation period affected winter arousal rates of bats. Data indicated that the presence of humans in hibernacula causes a dramatic increase in arousal of bats (little brown bats and northern myotis) and an increase in flight activity. Thomas (1995) suggested that non-tactile disturbance may cause bats to attempt to copulate (males) with hibernating females, and attempt to reposition themselves within a hibernating cluster of non-aroused bats. Aroused bats may arouse others due to tactile disturbance.

Costs for normal metabolic functions during hibernation and natural periodic arousals likely consume the majority of available fat reserves during winter. Each time human disturbance causes arousal by bats in a hibernaculum, limited energy supplies are exhausted, and this may lead to mortality. This is particularly important for juvenile bats that enter hibernation with limited fat reserves.

3.1.2 Development (Habitat Loss and Conversion)

(A) Exposure Pathway
Landowners with abandoned mines on their property may try to reduce risk of litigation by backfilling (closing) the mine entrance. If backfilling occurs in the fall or early spring, hibernating bats may be trapped in the mine and experience direct mortality from the mine closure. If backfilling occurs during summer, it is unlikely that bats would be trapped in the mine, but bats returning to the mine in the fall would not be able to gain entrance. Natural again also contributes to mine collapse, which may trap bats within mines, exclude them entirely, or merely disturb them during the winter.

(B) Evidence
Five of the known mine hibernacula and each mine identified as a potential hibernaculum are located on private land, and therefore may be at risk of landowner modification in the form of backfilling. Some of these mines have vertical shafts that present a potential hazard. Limited investigation yielded no information on serious injury or death of individuals entering New Hampshire mines for recreational purposes. Other Northeast states with more intensive mining histories have had injuries or deaths at abandoned mines. For example, in Pennsylvania, at least 45 deaths and 19 injuries at abandoned mines sites have been reported in the past 30 years (<www.doi.gov/news/040206d>, accessed 7 April 2005).

It is difficult to estimate the likelihood of a land-

owner backfilling a hibernaculum, but if the threat materializes, it may have severe consequences for bat populations. Conservation efforts should be pro-active. By identifying important hibernacula on private lands and initiating a protection program for the mine (for example, bat gating), wildlife management agencies can work to mitigate this threat.

3.2 Sources of Information

Sources of information on threats to cave/mine habitat included peer-reviewed scientific articles, gray literature, expert review by John O. Whitaker of Indiana State University, and information from New Hampshire residents familiar with local mines.

3.3 Extent and Quality of Data

The threats described under element 3.1 and their potential impact on bat populations are well documented, both for caves/mines in general, and for New Hampshire mines. The available data for the severity and likelihood of the threats for the mines located in New Hampshire are moderately well understood, but more data are required to fully realize the impact of each threat.

3.4 Threat Assessment Research

It is important to document the level of human disturbance at mines that serve as hibernacula A potential indicator of the threat could be a system (e.g. infrared monitoring devices) that would document human visitation rates at each non-gated hibernaculum. Such data could be correlated with costs of arousal for hibernating bats (see Element 3.1.1 B) to generate a probability of mortality to hibernating bats (and the corresponding decrease in habitat suitability) resulting from disturbance. This analysis would provide managers with criteria for aiding management decisions, such as whether to construct a bat gate.

It is important to assess the structural stability of each hibernaculum. A potential indicator of stability could be the degree of fissuring at mine entrances and other areas within the mine (Fig. 1). Such data could be used to determine which mines contain structural components (entrance, wall, or ceiling) that may be stressed and eventually collapse. This would provide managers with specific locations within mines that may require support structures.

The probability of a landowner blocking mine access by backfilling should be assessed. It is not recommended that state (or other) agencies inform landowners of the potential for litigation if a person was to be injured in a mine located on their property. Such action is likely outside the purview of state wildlife agencies. Rather, if a mine was to be documented as a high priority site for conservation, such information may be useful in convincing landowners of the utility of installing bat gates at their mines (e.g. excluding humans but allowing bats to utilize the mine).

Element 4: Conservation Actions

4.1.1 Gating, Habitat Protection

(A) Direct Threats
Human disturbance at mines, Landowner backfilling of mines

(B) Justification

1. Installing bat gates at high priority hibernacula will restrict human access to the mine during the winter. Therefore, the immediate threat of human disturbance causing arousals will be eliminated at the gated site. Convincing private landowners to install bat gates at high priority hibernacula will also remove the threat of potential litigation for personal injury, as cavers and spelunkers will be unable to enter the mines.

2. Too few data exist on historical bat populations to know whether gating will have a measurable impact on the number of hibernating bats present at a hibernaculum. Pre-gating surveys during winter at each hibernaculum will provide a current estimate of the number of species and individuals utilizing the mine. Post-gating surveys will allow managers to determine whether the gate has had a positive, negative, or neutral impact on hibernating bat populations. In addition, pre-gating measurements of mine microclimate will help determine whether gate construction significantly alters microclimate.

3. Several hibernacula in New Hampshire are currently experiencing human disturbance during winter. For example, Paddock Copper Mine (containing several hundred hibernating bats) was recently determined to be a popular site for "geocaching" activity. Geocaching involves placing an object at a specific GPS (latitude/longitude) location. The location is posted on the Internet for other individuals to locate. A cache was placed within the Paddock Copper Mine (approximately 70 m into the mine) and it appears that several individuals are entering the mine during winter. Carter Mine and Beebe River Mine also show signs of human activity during the winter.
4. Once a gate is constructed, it may be difficult to adapt the gate if new information arises about the effects of gating on bats. The gate could be removed if the gate was found to be a strong negative influence on the hibernating bats within a particular mine.

(C) Conservation Performance Objective
Construct bat gates that will restrict human access to the mine during winter and remove the threat of personal injury litigation against landowners from unauthorized humans entering at privately owned mine. A measurable performance indicator for this conservation action is periodic monitoring of the gate during the winter to ensure that the gate is not vandalized or opened by humans (this has been observed at the Roxbury Mine in Roxbury, CT, J. Veilleux personal observation).

(D) Performance Monitoring
During the first winter after a gate is installed, visit the mine three times (one visit every 2 months beginning in November and ending in April). If a gate shows signs of tampering, or the mine has been entered, personnel could enter the mine to assess evidence of disturbance (presence of trash, evidence of fire, etc.). Subsequently, the gate could be assessed every 2-3 years for evidence of tampering.

(E) Ecological Response Objective
The habitat protection response objective is to maintain or increase the current number of bats hibernating in each mine that is gated (conservation action). The minimal ecological response should be to maintain the current population size. An increase in population size at a hibernaculum following gate construction may suggest that gating has restored habitat quality (lower disturbance rate).

(F) Response Monitoring
A suggested long-term monitoring protocol for determining whether bat populations are being maintained or enhanced following gate construction is to survey gated mines every three years. This will provide detailed demographic data for each species of bat hibernating in the mine.

(G) Implementation
After high priority hibernacula are identified (see Section 2.5), the state should coordinate gaining landowner permission to construct the gate if the mine is on private land, purchasing gating materials, hiring a contractor (welder) to construct the gate, and delivering gate materials to the mine site. Gates should be constructed at each hibernaculum where bats are at risk.

Preliminary survey work to document current species distribution and abundance at known and potential hibernacula, as well as the documentation of human visitation rates at the hibernacula during winter, should be initiated as soon as possible.

The Office of Surface Mining (under the Bureau of Land Management) offers grant opportunities for the construction of bat gates at abandoned hibernacula. Additional funding opportunities may be available through the Nature Conservancy and other NGOs. Bat Conservation International provides construction specifications for the design of bat gates.

(H) Feasibility
Two bat gates have been constructed in New Hampshire (both at Mascot Lead Mine), and several bat gates have been constructed in other Northeast states (e.g. Connecticut, Vermont, and New York). Therefore, the technical competence to complete the construction of bat gates is available. The overall feasibility of gating hibernacula is limited by the availability of funding for pre-gating hibernacula surveys and gate construction.

4.1.2 Mine Condition Assessment, Habitat Protection

(A) Direct Threats
Shaft/adit collapse due to weathering

(B) Justification

1. One historic hibernaculum (North Woodstock Silver Mine) is known to have experienced at least one adit collapse. Nancy Mine No. 2, a potential hibernaculum, shows evidence of structural compromise at the main entrance.
2. Assessing the structural integrity of mine walls and ceilings will allow managers to determine the mines, and the sections of a particular mine, that are structurally compromised. Managers can then develop strategies for constructing physical support structures for protecting an area, thereby reducing the threat of collapse.
3. Maintaining the structural integrity of hibernacula will preserve the hibernating population of bats within the mine.
4. Once a mine is assessed for structural integrity, periodic assessments (perhaps once per 10 years) for structural integrity, as well as general assessments of integrity during hibernacula surveys, should allow managers to continually gather new information about the integrity of hibernacula.

(C) Conservation Performance Objective
Assessing hibernacula for structural integrity will determine whether sections of a mine are structurally compromised. A method to reinforce structural weaknesses must be developed to ensure structural integrity and long-term habitat protection. There is no definite endpoint of the conservation action, since the threat level can change as a mine system modifies over time. A partial endpoint goal is to assess each known and potential hibernacula and develop a plan for addressing any high priority breach in the mine structure.

(D) Performance Monitoring
Following the initial assessment, surveys to assess changes in structural integrity could be completed every ten years. A general bat survey could be conducted every three years. If a reinforcement action was required and completed, the action should be assessed at least once during the winter following construction, and then during each general assessment as described above.

(E) Ecological Response Objective
The habitat protection response objective is to maintain current number of bats hibernating in the mine by maintaining the structure stability of the mine. Populations would not be expected to decrease or increase due to the implemented conservation action, since the action is only maintaining habitat.

(F) Response Monitoring
A suggested (long-term) monitoring protocol for determining whether bat populations are being maintained is to perform hibernacula survey every three years at affected hibernacula. Such monitoring efforts will provide detailed demographic data for each species of bat hibernating within the mine as they respond to the action.

(G) Implementation
High priority sites for receiving reinforcement will have a combination of presence of rare/listed species, high population numbers, and high threat level to habitat/bats. After high priority sites are identified, the state should coordinate gaining landowner permission to modify the mine structure if the mine is on private land, purchasing reinforcement materials, hiring a contractor to construct the reinforcement structure, and delivering reinforcement materials to the mine site.

(H) Feasibility [Categorical Rank]
The technical competence to assess the structural condition of New Hampshire mines should be available within state agencies (e.g. USGS) and in colleges and universities (geology faculty). The overall feasibility of reinforcing hibernacula is limited by funds to purchase materials and construct the reinforcement structure.

4.2 Conservation Action Research:

Element 5: References

5.1 Literature

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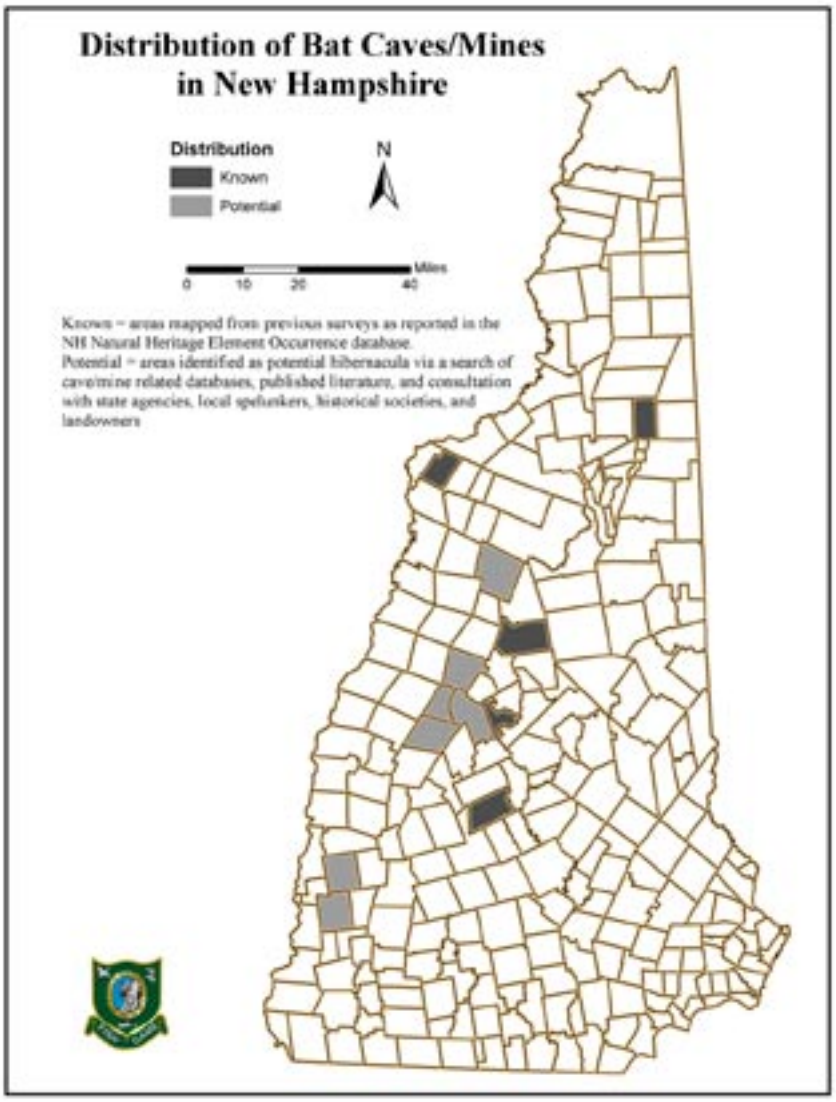
5.2 Data Sources

1) Database: Minerals Availability System Domestic Deposit Listings located within the United States Bureau of Mines Collection: A register of the collection of at the Utah State Historical Society. Collection Call Number: OVERSIZE Mss B 1033. The collection can be accessed at http://history.utah.gov/FindAids/B01033/b1033.html

Distribution of Bat Caves/Mines in New Hampshire



Known = areas mapped from previous surveys as reported in the NH Natural Heritage Element Occurrence database.
Potential = areas identified as potential hibernacula via a search of cave/mine related databases, published literature, and consultation with state agencies, local spelunkers, historical societies, and landowners