IMPLICATIONS OF THE OCCURRENCE AND SPREAD OF THE WHITE-NOSE SYNDROME TO PROTECTION OF ENDANGERED BATS UNDER SMCRA[1]

Kimery C. Vories[2]

Abstract. Protection of threatened and endangered species is an important component of every surface coal mining permit and every abandoned mine land (AML) project under the Surface Mining Control and Reclamation Act (SMCRA). Protection of endangered bats has the potential to impact surface coal mining permits and AML projects in most of the states in the eastern and Midwestern U.S. During the winter of 2006/2007, an affliction called "White-Nose Syndrome" (WNS) began devastating colonies of hibernating bats around Albany, New York. Colonies of hibernating bats were reduced 81-97% at affected caves and mines. Since then, WNS has been detected more than 450 miles away from the original site, and has infected bats in nine surrounding states, including four coal mining states, and possibly one Canadian province. No one knows for certain how quickly or how far WNS will ultimately spread. The extent to which WNS results in the listing of more bat species as threatened and endangered would be expected to negatively impact permitting and operation of coal mines in the eastern and Midwestern U.S.

The emergence and spread of a pathogenic fungus (*Geomyces destructans*) that infects hibernating bats has the potential to undermine the basic survival strategy of more than half the bat species in the U.S. and all species of bats that occur in the higher latitudes of North America. Most species of bats that hibernate in the region are known to be affected and the endangered Indiana bat (*Myotis sodalis*) has been hit particularly hard. The sudden and widespread mortality associated with WNS is unprecedented in hibernating bats. If the spread of WNS is not slowed or halted, further losses could lead to the extinction of entire species and could more than quadruple those that are federally listed as endangered in the U.S.

This paper will provide the current status on WNS and its potential to impact protection of endangered bat species related to surface coal mine permitting and AML project planning by state mining programs within the range of these bats.

Additional Key Words: coal mining and reclamation, wildlife habitat

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[2] Kimery C. Vories, Natural Resource Specialist, U.S. DOI Office of Surface Mining Reclamation and Enforcement, 501 Belle St., Alton, Illinois 62002

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White-Nose Syndrome

Origin of the Disease

During the winter of 2006/2007, an affliction of unknown origin dubbed "White-Nose Syndrome" (WNS) began devastating colonies of hibernating bats in a small area around Albany, New York. Colonies of hibernating bats were reduced 81-97% at the affected caves and mines that were surveyed (USGS[1]). Since then, White-Nose Syndrome has been detected more than 700 Km (450 mi) away from the original site, and has infected bats in nine surrounding states and possibly one Canadian province. Most species of bats that hibernate in the region are now known to be affected and little brown bats (*Myotis lucifugus*), northern long-eared bats (*M. septentrionalis*), and the federally listed (endangered) Indiana bat (*M. sodalis*) has been hit particularly hard. The sudden and widespread mortality associated with White-Nose Syndrome is unprecedented in hibernating bats, which differ from most other small mammals in that their survival strategy involves a slow reproductive rate. Their life history adaptations include high rates of survival and low fecundity, resulting in low potential for population growth. Most of the affected species are long lived (~5-15 years or more) and have only one offspring per year. Subsequently, bat numbers do not fluctuate widely over time, and populations of bats affected by White-Nose Syndrome will not recover quickly. Epizootic disease outbreaks have never been previously documented in hibernating bats (USGS[1]). It is believed that the fungus is European in origin, new to North America and bats species in this region show little or no resistance. The WNS outbreak will likely be similar to other introduced pathogens such as chestnut blight or Dutch elm that spread rapidly and completely throughout the range of the host.

Characteristics of the Disease

The newly identified cold-loving fungus, *Geomyces destructans*, is now thought to be the primary causative agent of White-Nose Syndrome (Gargas, A. et al. 2009). This fungus thrives in the darkness, low temperatures (5-10ºC; 40-50ºF), and high levels of humidity (>90%) characteristic of bat hibernacula. Unlike typical fungi, this species of *Geomyces* cannot grow above 20°C (68ºF), and therefore appears to be particularly adapted to persist in caves and mines and to colonize the skin of hibernating bats (USGS[1]). A consistent pattern of fungal skin penetration has been observed in over 90% of bats from the WNS-affected region that were submitted for disease investigation. Available evidence suggests the fungus establishes itself in the skin tissues of bats when their body temperatures are lowered during torpor (2-10ºC; 35-

50ºF). Although life-threatening skin fungal infections of this sort are rare in warm-blooded birds and mammals, they occur more frequently in "cold-blooded" animals (e.g., *chytridiomycosis* in amphibians, and crayfish plague). The cold-loving fungus seems to be infecting bats when they reduce their body temperatures during hibernation to levels characteristic of "cold-blooded" animals. Fungal infiltration of the wing membranes of bats may be particularly problematic. Wing membranes represent about 85% of a bat's total surface area and play a critical role in balancing complex physiological processes. Healthy wing membranes are vital to bats, as they help regulate body temperature, blood pressure, water balance, and gas exchange—not to mention the ability to fly and to feed. Although White-Nose Syndrome was named after the obvious sign of white noses on affected bats, bat wings may indeed be the most vulnerable point of infection (USGS[1]).

Impact of the Disease

A recent consensus by concerned scientists found that *"*White-nose syndrome is a devastating disease of hibernating bats that has caused the most precipitous decline of North American wildlife in recorded history. Since it was first discovered in 2006, WNS has infected six species of insect-eating bats in the northeastern and southern U.S., causing declines approaching 100% in some populations; estimated losses have exceeded one million bats over the past three years. If the spread of WNS is not slowed or halted, further losses could lead to the extinction of entire species and could more than quadruple those that are federally listed as endangered in the U.S. Such losses alone are expected to have unprecedented consequences on ecosystem health throughout North America, with unknown economic consequences. Most bat species in North America feed on night-flying insects, of which many are pests of forests, agriculture, and garden crops or pose risks to human health. The number of insects consumed annually by one million bats is staggering—equivalent to 694 tons—emphasizing the extraordinary value of these bats to the normal function of both terrestrial and aquatic ecosystems (BCI).*"*

The potential for the spread of the disease to winter hibernacula in the eastern and Midwestern U.S. has been projected by Bat Conservation International on the map (Fig. 1).

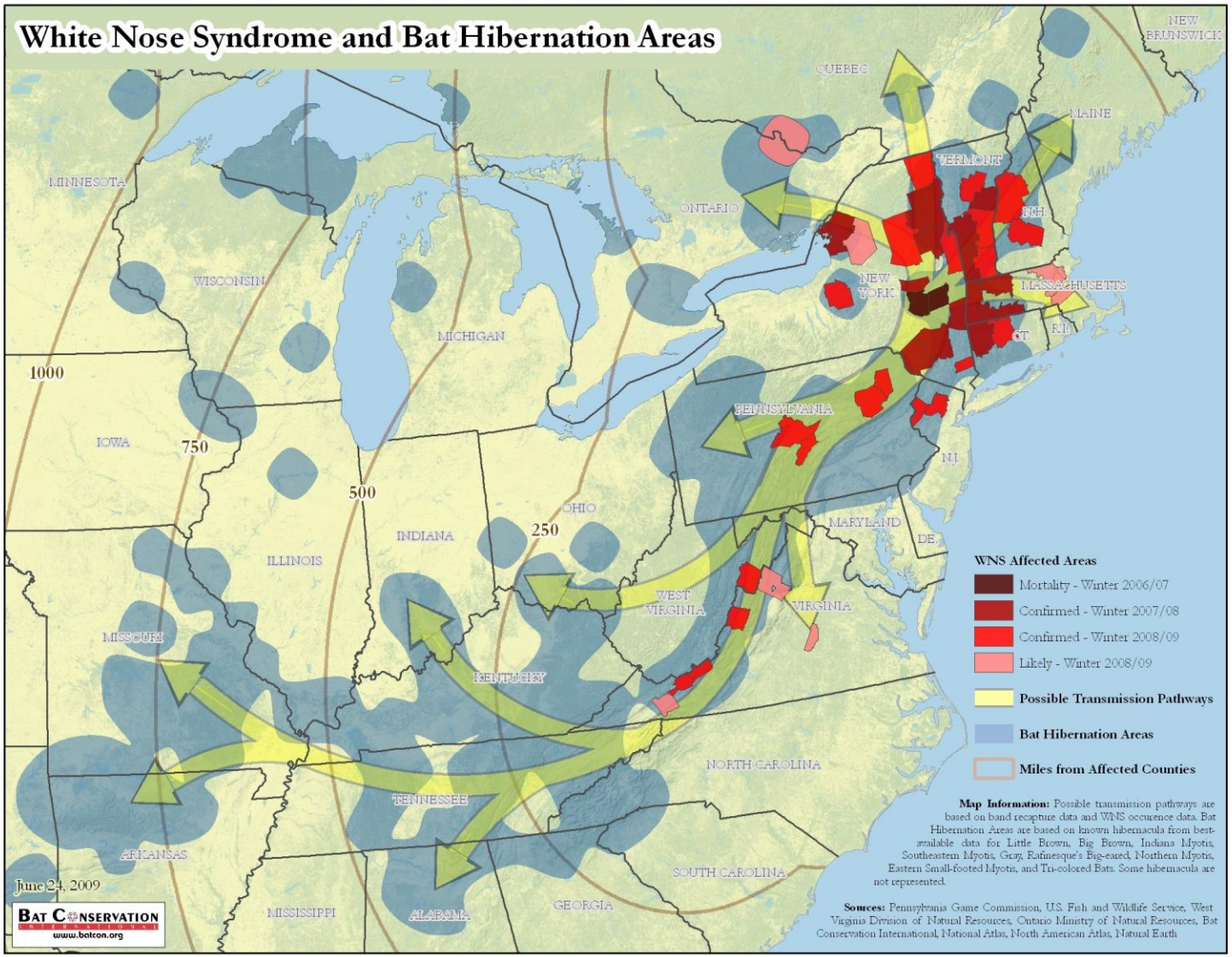

Figure 1. Projected spread of the WNS to bat hibernation areas from its origin in the northeastern U.S. (BCI)

The current distribution of White-Nose syndrome (Butchkoski, 2010) indicates that the disease is continuing to spread each winter since its first occurrence in 2006. (Fig. 2.)

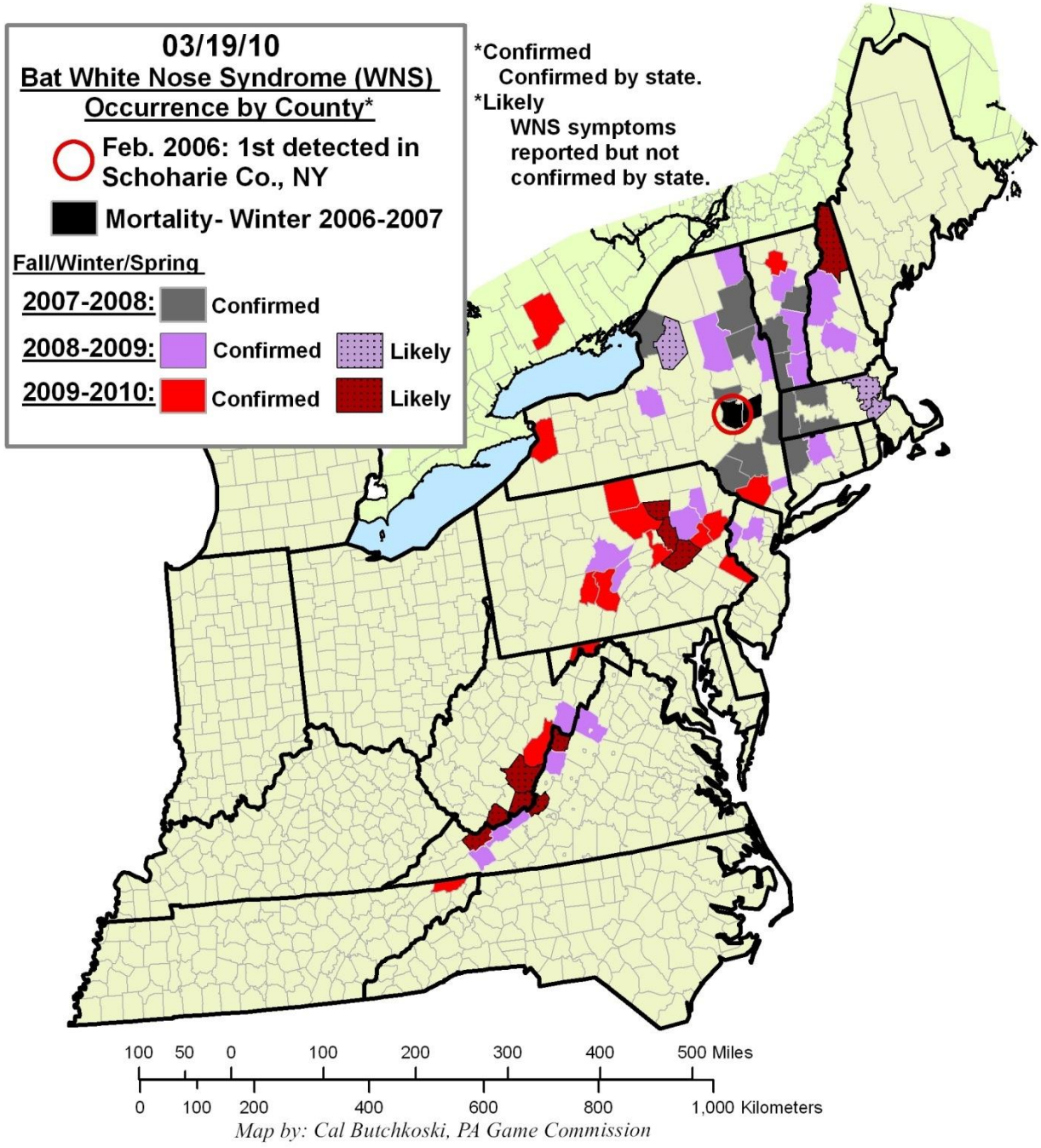

Figure 2. Status of WNS geographic distribution as of March 19, 2010 (Butchkoski, 2010)

Bat Species Impacted

Currently the tri-colored (*Perimyotis subflavus*), little brown (*Myotis lucifugus*), northern long-eared (*M. septentrionalis*), big brown (*Eptesicus fuscus*), small-footed (*M. leibii*) and Indiana bats (*M. sodalis*) have died from WNS (USFWS). WNS has the potential to undermine the basic survival strategy of more than half the 45 bat species in the U.S. and all species of bats occurring in the higher latitudes of North America. With the exception of 4 species of migratory tree bats, the other 18 bat species that occur above 40ºN in North America (from the top of California across Nebraska to Virginia) hibernate to survive winter. All four endangered species and subspecies of hibernating bats in the U.S., which rely on undisturbed caves or mines for successful hibernation, are at risk from White-Nose Syndrome. Two of these species (Indiana bat and gray bat) are currently within the affected area, and the remaining two (Virginia big-eared bat *Corynorhinus townsendii virginianus* and the Ozark big-eared bat *Plecotus Townsendii Ingens*) may be affected in the next few years if not sooner (USGS[1]).

Transmission of the Disease

Scientists do not know how WNS is transmitted, but there is strong evidence that it can be transmitted in three ways:

- *Bat-to-bat Transmission* – Certain species of bats often congregate in tightly clustered groups (up to several hundred per square foot) in winter hibernacula, providing the opportunity for many individuals to be exposed to the fungus.
- *Bat-to-cave/mine Transmission* – Bats periodically wake up while in the cave or mine. Upon waking, they will groom themselves and potentially ingest the fungus that is then excreted in the bat's guano onto the cave/mine floor.
- *Human Transmission* - The fungus can grow on many different organic materials, and appears to persist in caves and mines year-round. Fungal spores, and/or other microscopic organisms, can easily become attached to skin, hair, clothing and equipment. It is possible that such elements could remain alive for weeks or months after leaving an underground environment.

White-Nose Syndrome was first observed in 2007 in a commercial cave in the Albany, New York area. By 2009, it had "leap-frogged" its way to Virginia. By 2010, it was observed in Tennessee. Because many of the early infected caves and mines were are located at significant distances from each other while caves and mines closer to the infected sites remained unaffected,

scientists believe something other than bat-to-bat transmission is contributing to the spread of WNS. For example, many of the newly infected caves in West Virginia and Virginia are popular destinations for recreational cavers. But, caves that are inaccessible to humans that are located near or between these infected caves remain unaffected by WNS. Records of caver movements also reveal a connection between sites in these affected regions, suggesting of a link to human activity (US Forest Service).

Intervention

Several technologies have been suggested for methods of intervention that have the potential to reduce the impact on the bats or spread of the fungus. One untested method suggests that artificial warming of the portion of the hibernacula occupied by bats to a temperature of 28º C could improve survival by up to 75% (Boyles and Willis 2010).

Cave Closure Advisory

The USFWS, the US Forest Service, and several states have issued closure notices for all caves on their respective lands. They have requested that cavers observe all cave closures and advisories and avoid caves, mines or passages containing hibernating bats to minimize disturbance to the bats. The U.S. Forest Service asks that cavers and cave visitors stay out of all caves in the affected states and adjoining states to help slow the potential spread of WNS. Detailed decontamination procedures are provided when people must enter these caves (USFWS[2]).

SMCRA and Endangered Bats

SMCRA regulation

U.S. coal mining is regulated under the Surface Mining Control and Reclamation Act (SMCRA) and the Federal and State regulatory programs adopted pursuant to SMCRA and its implementing regulations. Federal and State regulations require that every permit application for surface coal mining include fish and wildlife resource information, as well as a plan for protection and enhancement of endangered species and their critical habitats. The regulations also require the regulatory agency to make a written finding that the proposed mining operation would not affect the continued existence of listed species or result in the destruction or adverse modification of their critical habitats.

1996 Biological Opinion

On September 24, 1996, the FWS completed its review of OSM's request for formal consultation and issued a biological opinion regarding the impact of current and future surface coal mining operations on listed species. In the biological opinion, FWS concluded that surface coal mining and reclamation operations, conducted in accordance with properly implemented Federal and State regulatory programs under SMCRA, are not likely to jeopardize the continued existence of listed or proposed species and designated or proposed critical habitats. The biological opinion also included an incidental take statement that authorized the taking of a limited, but unquantifiable, number of listed individuals when the taking is incidental to, and not the intended purpose of, the surface coal mining and reclamation operations. In addition, the biological opinion identified specific terms and conditions that must be met by mining companies and SMCRA regulatory agencies, in order to minimize incidental take of listed species. Compliance with SMCRA requirements and the biological opinion ensures that mining companies and regulatory agencies will provide protection for the Indiana bat during the coal mining process (Meier, L. 2004).

Indiana bat

The Indiana bat (*Myotis sodalis*) is an endangered species as defined under ESA. Indiana bats may be found in many areas of the United States where coal is mined. The Indiana bat occurs in two OSM and three FWS regions; i.e., in twelve states with active coal mining (Alabama, Arkansas, Illinois, Indiana, Kentucky, Missouri, Ohio, Oklahoma, Pennsylvania, Tennessee, Virginia, and West Virginia) and one state (Iowa) with no active mining. Figure 3 illustrates the overlap between the range of the Indiana bat and coal deposits in the eastern and Midwestern U.S.

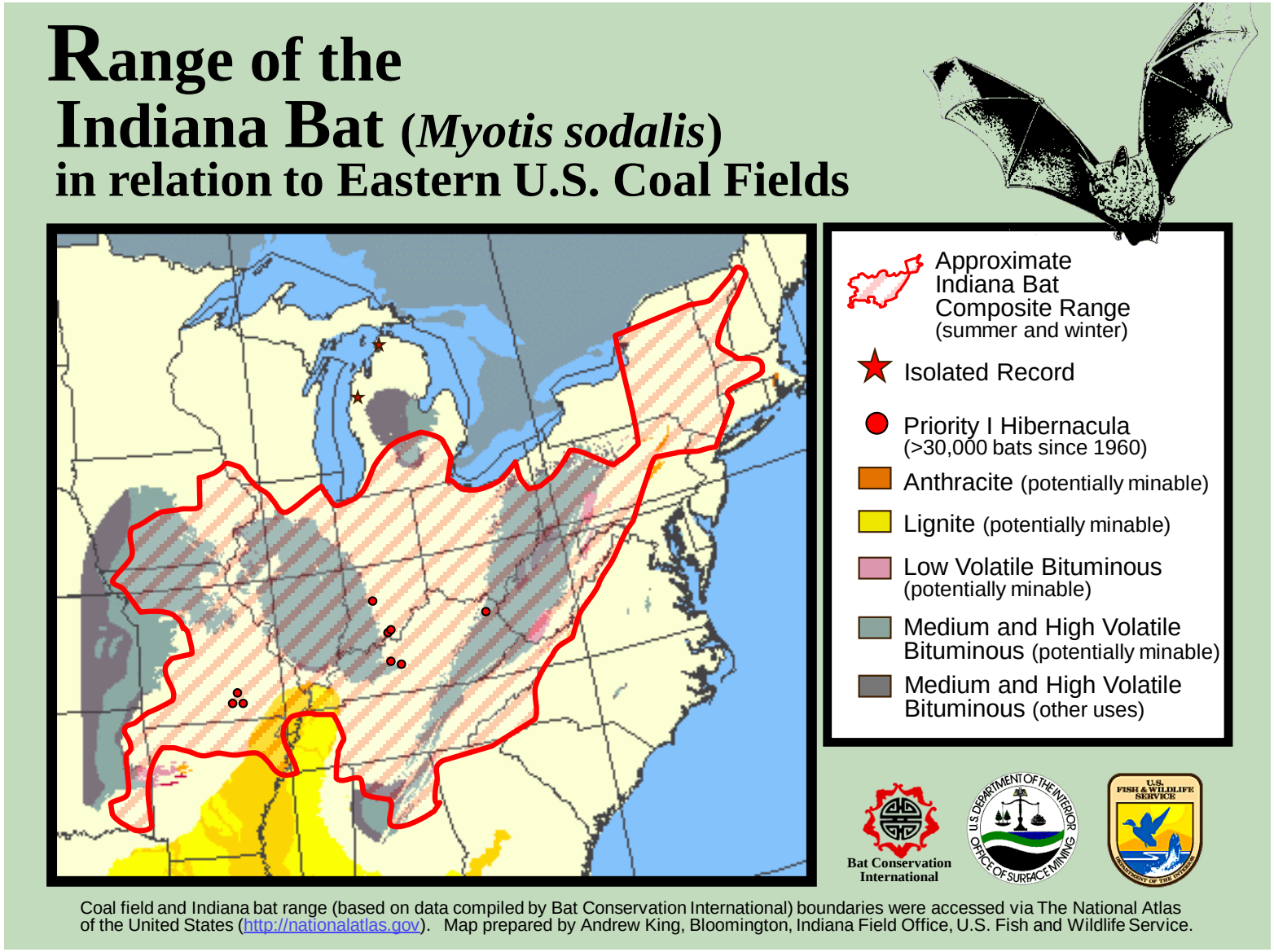

Figure 3. Range of the Indiana Bat and Eastern Coal Fields

Indiana bat Population Trends

Bat population census information shows a dramatic decline in the number of Indiana bats (*Mysotis sodalis*) since 1965 nationwide. On a regional basis within the range of the species, however, the populations are increasing in northern states and decreasing in southern states (See Fig. 4). More recent data shows that the population has been steadily increasing during 2001-2007 (See Fig. 5). Vories, 2008 compared the data on changes in populations of the Indiana bat with data representing coal production from the same states and over the same time period (See Fig. 6). The result of this comparison indicated there are no data that would suggest a correlation between the Indiana bat population trends and: (1) total coal production, (2) rate of growth or decline in coal mining as indicated by percent change in coal production, or (3) surface mining versus underground mining methods.

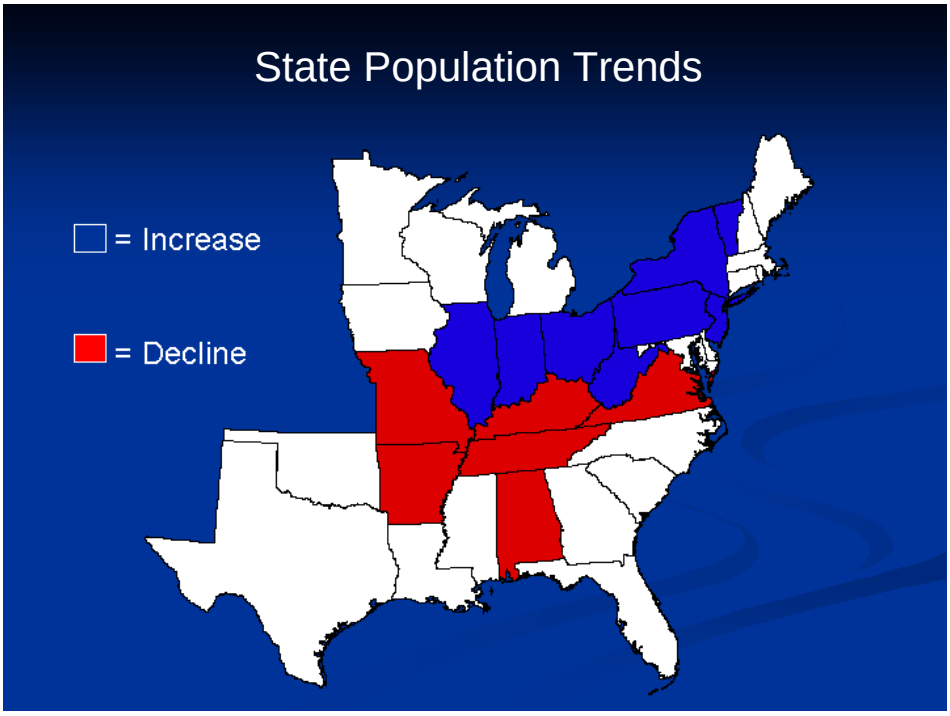

Figure 4. State Population Trends for the Indiana bat from 1960 to 2003 (Clawson, 2004)

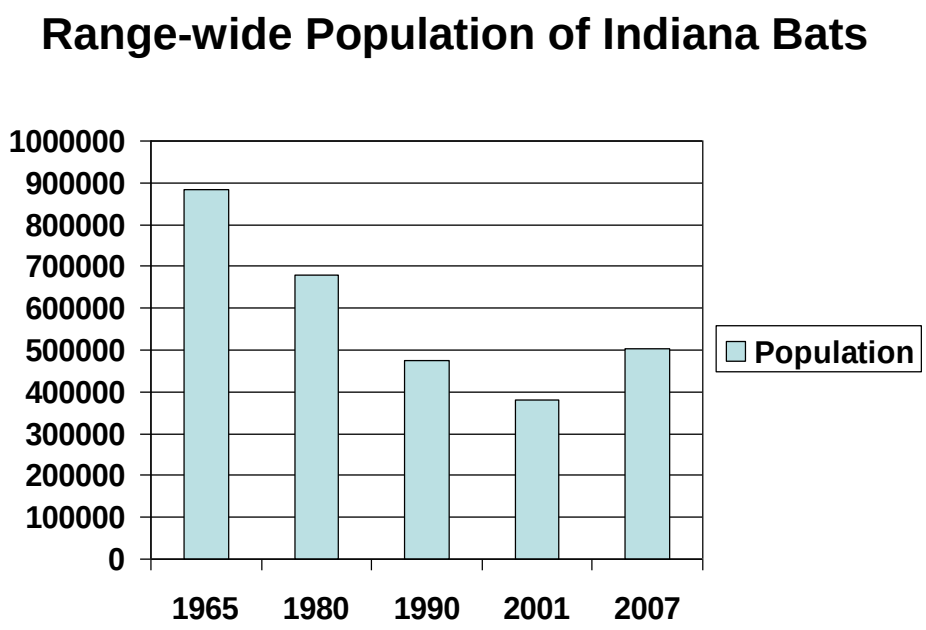

Figure 5. Range Wide Population Trends based on estimates and surveys from 1965 to 2007 for the Indiana Bat (Clawson, 2007)

The conclusion that coal mining is not significantly impacting summer habitat would be supported by a comparison of the data from the U.S. Forest Service that there are 384 million acres of forest cover in the eastern U.S. that has not changed significantly for the last 100 years. A comparison with data from OSM shows that there are 3.07 million acres of total permitted acreage of surface coal mines in the 13 States within the Indiana bat habitat. This means that a maximum of 0.8% of the eastern forest cover habitat could be impacted by surface coal mining, if all permitted acres were forested, which they are not.

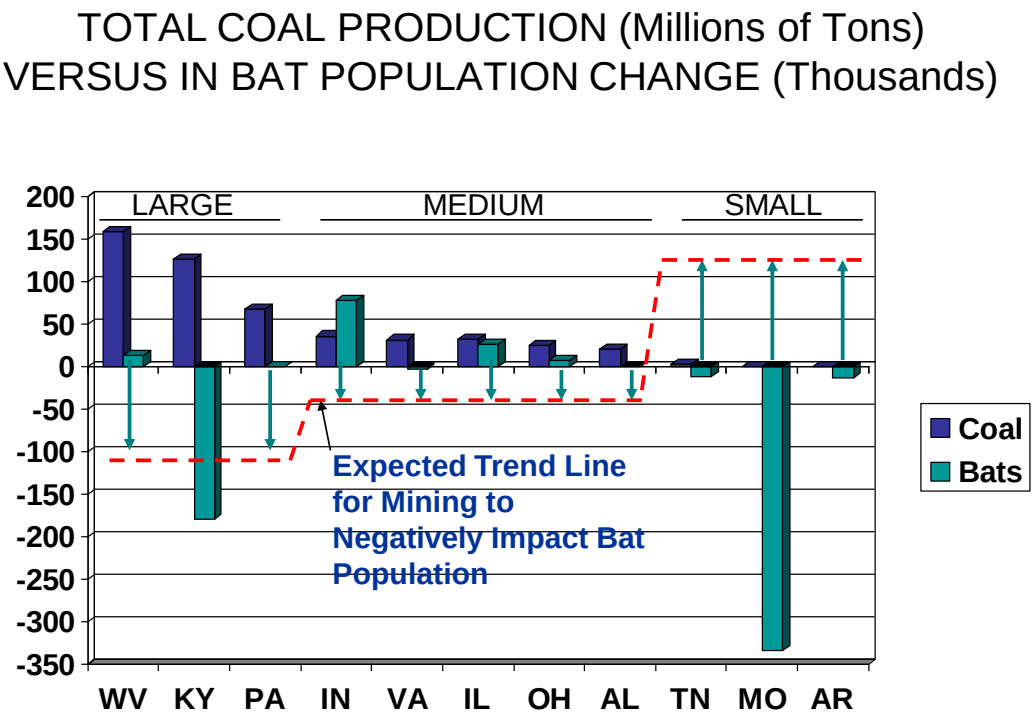

Figure 6. Comparison of total coal production for states within the Indiana bat range in relation to Indiana bat population changes over the same time period from 1965 – 2007 (Vories 2008).

Indiana bat Draft Revised Recovery Plan Workshop

OSM and USFWS held a workshop in Indianapolis, Indiana, June 20-21, 2007. The goal of the Recovery Plan Workshop was to bring together representatives of all mining related constituents that will be potentially impacted by the revised Indiana Bat Recovery Plan to develop the best possible recommendations to the USFWS during the 90 day comment period. There were 72 participants representing affected Federal Agencies, states, mining industry, universities, and conservation groups. The product of the event was letters to the USFWS with informed comments on the plan from the Interstate Mining Compact Commission, the Office of Surface Mining, and the National Mining Association. One of the responses to this workshop was the development of a joint OSM/USFWS/IMCC team to develop an Indiana bat permitting

guidance document that would provide uniform approved guidance when developing SMCRA permits.

Protection and Enhancement Plan (PEP) Guidelines

Despite identical or very similar bat habitat conditions, implementation of the 1996 Biological Opinion and any assorted protective measures has varied widely across political boundaries. In 2008, the Office of Surface Mining Reclamation and Enforcement (OSM), in cooperation with the Interstate Mining Compact Commission, facilitated the formation of a team of state regulatory authorities and USFWS staff to develop consistent, range-wide measures for the Indiana bat. The result was Range-Wide Indiana bat Protection and Enhancement Plan Guidelines, released to the public in September of 2009. The guidelines are not mandatory requirements but provide valuable and standard procedures for protecting the species while permitting coal mining activities. Use of measures from the guidelines will promote consistency within SMCRA permits. The measures should satisfy ESA Section 7 coordination requirements of SMCRA, shorten USFWS review times and become the basis for a simplified U.S. Army Corps of Engineers ESA consultation for section 404 permits under the Clean Water Act.

The AML Solution

Mines provide important habitat for many bat species. A total of 62 percent, or 28 of the 45 continental U.S. bat species, roost in mines. For some species, the use is only occasional, but for most of the 28 species, mines constitute important roost areas (Altenbach and Pierson 1995). 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). 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 also providing shelter from predators.

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. AML reclamation programs and public land

management agencies have unique possibilities to either enhance or 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 (Meier, L. et al., 2004).

The construction of bat gates at AML mine openings and portals in the eastern and Midwestern U.S. were originally built to protect people from the hazards of shafts and portals to underground mines and allow use by bats . These gates can now provide much needed protection of bats from contact with people who might unknowingly be vectors of White-Nose Syndrome. AML programs need to be aware of the urgency and importance of doing everything they can to minimize the spread of White-Nose Syndrome and to reduce its impact on all hibernating bat species. AML programs in the eastern and Midwestern U.S. should be looking for every opportunity to construct bat gates to provide bats with much needed winter habitat free from potential human contact. AML programs also need to become familiar with the recently released Range-wide Indiana Bat Protection and Enhancement Plan Guidelines when assessing the potential impacts of AML projects on possible bat habitat.

Conclusion

Protection of threatened and endangered species is an important component of every surface coal mining permit and every abandoned mine land (AML) project under the Surface Mining Control and Reclamation Act (SMCRA). Protection of endangered bats has the potential to impact surface coal mining permits and AML projects in many of the states in the eastern and Midwestern U.S. A comparison of coal mining activity and populations changes of the endangered Indiana bat in these states since 1965 shows no correlation between coal mining activity and either positive or negative changes in Indiana bat populations. The conclusion that coal mining is not significantly impacting summer habitat would be supported by a comparison of the data from the U.S. Forest Service that there are 384 million acres of forest cover in the eastern U.S. that has not changed significantly for the last 100 years. A comparison with data from OSM shows that there are 3.07 million acres of total permitted acreage of surface coal mines in the 13 States within the Indiana bat habitat. This means that a maximum of 0.8% of the eastern forest cover habitat could be impacted by surface coal mining, if all permitted acres were forested, which they are not. In the opinion of the author, it would be impossible for such a

small percentage of temporarily disturbed eastern forest cover to cause a significant change to the population of the Indiana bat between 1965 and 2007.

Commercial and amateur cave exploration during the time of the decline of the endangered Indiana bat population may have had significant detrimental impacts to crucial underground habitat for bats. The appearance of the White-Nose Syndrome in 2006/2007 in the Northeast provides further evidence of the hazards to underground bat habitat caused by these activities. In sharp contrast to this negative impact, State and Federal mining programs have been constructing bat gates at abandoned mines that provide significant protection for this underground bat habitat from human activity for at least the last two decades. It is the opinion of the author, that without an immediate and substantial commitment to permanent exclusion of recreational human activity to important bat hibernacula in the eastern U.S., that no amount of protective efforts to surface bat habitat, including that temporarily disturbed by surface mining, will be effective in protecting the species from further population decline.

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