

White-nose Syndrome response at Mammoth Cave National Park

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Since it was first identified in the United States in 2006, white-nose syndrome (WNS) in bats has become an important issue in the management of caves and bats at Mammoth Cave National Park (MACA). First the threat of its arrival and later its actual arrival and effects have led to interventions with both the visiting public and researchers, restrictions on access to colonial bat roosts, increased monitoring of bat populations, support of scientific studies, and upgraded interpretation on bats, wildlife disease, and public health. Table 1 contains a timeline of activities and responses related to WNS that the park has undertaken.

The most visible response to WNS at MACA has been the interventions with visitors to prevent first human-caused arrival of the fungus in the park (before Spring 2014) and later (after April 2011) visitors potentially leaving with the fungus after a tour (or research). This is a very important aspect of WNS response at MACA, since over 400,000 people visit caves at the park each year. Beginning summer 2009 park staff screened cave visitors to prevent accidental introduction of the fungus by visitors. Screening methods included public announcements, pre-tour briefings by guides, and printed posters in the Visitor Center. Visitors were asked if they have been in a cave since 2005. If so, they are asked about whether they were wearing or carrying things that have been in a cave. If they had things that had been in a cave, park staff worked with them to reduce the potential for bringing in fungal spores. Measures that

were taken included decontamination, bagging items, or disallowing items from the cave. This type of pre-visit screening ended in spring 2014, when bats in major tour areas of the cave were found to have WNS.

Starting April 2011, when WNS was first identified in Kentucky, MACA began requiring visitors to walk over a biosecurity mat after taking walking tours of the cave. This measure was taken to reduce the possibility that MACA visitors could take the fungus away from the cave with them, even before it had not been detected in Mammoth Cave. The biosecurity mats consisted of a 12-foot run of outdoor carpet (to physically remove dirt and spores) followed by a six-foot-long wet walkover mat with a cleaning solution. From April 2011 through September 2012, the walkover mats used a Lysol solution. In September 2012, the park stopped using Lysol solution mats, because the use of Lysol in mats was deemed to be off-label use. From September 2012 through June 2013, the park used only the twelve-foot lengths of plastic outdoor carpet to physically remove spores from the soles of shoes. The carpet was decontaminated daily to kill spores that might accumulate on it. In July 2013 MACA began using a Woolite solution in the walkover mats. This solution will help clean spores from shoes, it is also deemed safe for contact with people's skin and can be used on footwear.

Intervention for people on caving tours is more intense. Visitors on those tours are required to use park supplied gear that is only used on park. Their shoes undergo a

Date	Response or existing activity modifications
May 2009	Colonial bat roosts closed year-round (except approved WNS and bat research); Decontamination required of incoming gear for researchers
June 2009	Screening of incoming tour visitors and intervention (decontamination, disallowing items, etc.). Park WNS intervention station and displays start
Winter 2009-10	Enhanced monitoring of caves for WNS, biennial counts of <i>Corynorhinus</i> hibernation roosts
August 2010	Begin requiring decontamination between caves and after cave trips for researchers
January 2011	Park releases original WNS Response Plan
Winter 2010-11	Enhanced monitoring of caves for WNS, biennial counts of <i>Myotis</i> hibernation roosts, no evidence of WNS seen
April 2011	KY (non-park) site confirmed with WNS; Tours began post-visit decontamination with walk-over mats containing Lysol solution
Winter 2011-12	Enhanced monitoring of caves for WNS, biennial counts of <i>Corynorhinus</i> hibernation roosts
August 2013	Tri-colored bat swabbed during fall trapping at Colossal Cave tests positive for Pd. Analysis occurred after WNS found on park. First evidence of Pd on park.
Sept. 2012	Post tour walk-over mats changed to dry carpet due to restrictions on Lysol use
Fall 2012	Filming for NPS series on bats and WNS on park
January 2013	WNS confirmed at park in Long Cave
Winter/Spring 2013	WNS found in all six colonial <i>Myotis</i> hibernation sites known on park. Biennial counts of <i>Myotis</i> roosts show normal count numbers and no evidence of increased mortality.
July 2013	Post tour walk-over mats changed to Woolite solution; Filming on park for Battle for Bats: Surviving White Nose Syndrome.
Winter 2013-14	Enhanced monitoring of caves for WNS, biennial counts of <i>Corynorhinus</i> hibernation roosts; WNS identified in three largest <i>Corynorhinus</i> hibernation sites (in other species); WNS located on some park cave tour trails; prior cave visitation screening of incoming visitors ceases
Spring 2014	Increased human bat contacts on cave tours. Increase training and preparation on human-bat contact and rabies issues.
March 2014	AP and WKYU stories on WNS impacts at park
Sept. 2014	Filming of bat research and WNS discussion for CW Network
Fall/Winter 2014-15	Develop enhanced human-bat contact procedures with Public Health Service and state assistance
Winter/Spring 2015	Biennial counts of <i>Myotis</i> roosts indicate significant decreases in little brown, Indiana, and tri-colored bat counts. Numerous dead and dying tri-colored bats recovered along Historic Tour Route. Elevated bat-human contacts and rabies intervention. Increased bat surveillance. WNS at all tour entrances.
February 2015	Louisville, Bowling Green, and Glasgow stories on WNS impacts at park
April 2015	Relaxed decontamination procedures between Pd+ sites on park
May 2015	Seasonal (summer) reopening of WNS+ hibernation sites for research and education

Table 1 – Timeline of Mammoth Cave National Park WNS-related Activities and Responses

more thorough cleaning than those of people on walking tours.

Although even prior to WNS all 400+ caves in Mammoth Cave National Park were closed to human access except via ranger-led

tours, research permits, or special use permits. WNS did cause some changes in access restrictions to caves on the park. Prior to WNS response, colonial bat hibernacula on park

were closed in the winter and maternity colonies were closed during the summer to protect bats when they were in sites. In spring 2009, all colonial bat caves on park were closed to access for all activities except those related to WNS and bat research. In May 2015, access restrictions were eased on sites that are known to have WNS or the fungus that causes it. These sites reverted to their previous seasonal closures, since there is no longer a danger that off-season visitation will introduce WNS to these sites.

WNS has also led to gear restrictions for park caves. Beginning in May 2009 people entering caves under research and special use permits have been required to decontaminate all gear using current approved national decontamination protocols before entering park caves. In August 2010 decontamination requirements were added between caves on the park (if they are visiting multiple ones) and after visiting park caves. In April 2015, decontamination requirements between caves were eased to allow gear to go between WNS+ sites on park without decontamination. The park continues to require decontamination following cave trips before going to any cave off-park and before visiting any parkcave with unknown WNS status.

With over 400,000 people taking cave tours each year, MACA has a great opportunity to inform people about the importance of bats and the threat posed to them by WNS. Before WNS, information on bats was part of our interpretive message, but since WNS that messaging has increased greatly. People are informed about WNS and bats at the beginning and end of every tour. The post-tour walk over the biosecurity mat provides an important message that WNS is an important threat, and that people have a role in keeping it from spreading. Sometimes visitors have even had the opportunity to see bats with WNS symptoms along tour routes. The park has also participated in numerous media projects on bats and WNS. These have included national

and regional television programs, video productions, and print and web media stories.

Additional bat and WNS related messaging became necessary at the park beginning in Spring 2014. WNS caused unusual bat numbers and behavior near toured cave entrances at the park. This led to increased bat-human contacts on cave tours. The increases affected both visitors and park staff. Several people required rabies post-exposure inoculations as a result of bat-human contacts. The park assisted by a NPS Disease Outbreak Investigation Team developed a series of responses including improved messaging and increased monitoring for unusually behaving bats.

When WNS arrived in the northeast United States, many agencies lacked significant baseline data on healthy bat populations. Beginning in 2009, MACA increased surveillance and monitoring of its bat roosts (both hibernacula and summer roosts) to gather baseline data, detect the arrival of WNS, and to document potential population changes. This monitoring includes biennial hibernation counts, summer emergence counts, and summer acoustic mobile transects. Disease surveillance includes regular entrance checks of bat roosts, targeted winter visits to bat roosts to check for signs of WNS, and cave entrance acoustic monitoring. In 2014 the park added additional monitoring for dead and dying bats along tour routes in response to concerns about bat-human contacts.

Biennial hibernation counts of colonial *Myotis* sites in 2015 showed significant decreases in several bat species. Preliminary counts indicate little brown bat (*Myotis lucifugus*) declines slightly above 80%, Indiana bat (*Myotis sodalis*) declines of nearly 80%, and tricolored bat (*Perimyotis subflavus*) declines near 70%. On the other end, gray bat (*Myotis grisescens*) and Rafinesque big-eared bat (*Corynorhinus rafinesquii*) numbers continue to be stable or increasing on park as of this year. Mist netting on several projects suggest that northern long-eared bats are greatly decreased on the summer landscape in the park in 2015.

The park has also supported a wide range of bat and WNS related research by NPS scientists, researchers from other federal agencies, and from academic researchers. Some of these studies have been supported through access to sites, assistance with sample collection, or direct staff assistance in research. Other studies have been funded by the NPS to assist in gathering information needed for management of affected bat species and caves. These studies have included work on such topics as bat physiology; roosting behavior; WNS fungus prevalence and distribution; decontamination techniques; bat and insect distribution and abundance before and during WNS outbreak; and bat condition going into hibernation and

coming out (pre- and during WNS outbreak).

WNS and its effects have led to a dynamic management environment for parks with caves, and in particular for parks with large show cave operations. The need to prevent the spread of WNS tempts managers into simply closing sites to prevent people from coming in contact with the fungus (or to prevent them from introducing it to places it has not previously been found). However, the opportunity to provide strong messaging on bats and the threat that WNS poses to them also provides a drive for managers. At Mammoth Cave, we believe that strong intervention with both visitors and researchers can sufficiently reduce the threat to allow access while protecting bats and caves.

