# Cavers React to the Spread of White Nose Syndrome: A Survey

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In the long history of the NSS, seldom has any issue confronted the community of organized cave explorers with such potential to adversely affect our caving environment as that presented by the recent outbreak and expansion among bat populations of a disease known as white-nose syndrome (WNS). The disease threatens not only these cherished icons of the underground wilderness but has also resulted in increasing restrictions on cave access and widespread cave closings. Following the initial discovery of infected bats in a cave near Albany, New York, during the winter of 2006-2007, the disease has spread to other areas of the United States, resulting in a total mortality estimated to exceed one million bats.

Although bat-to-bat transmission has been demonstrated and is the primary cause of high mortality in the crowded conditions of bat hibernacula and nurseries, the exact means by which the disease extends its geographic range remains unknown and controversial. In March 2009, the U.S. Fish and Wildlife Service (USFWS) issued an advisory suggesting that WNS was inadvertently spread by humans carrying the organism from cave to cave on their footgear, clothing or equipment, an assumption derived entirely from circumstantial evidence. The USFWS acknowledged that there was no conclusive proof of human transmission, but asked cavers to curtail all caving activity not only in states affected by WNS but also, as a prescriptive measure, in adjacent states. In a very short period, the USFWS advisory and justification was accepted and acted upon by numerous state agencies and various conservation organizations, who issued orders closing nearly all caves under their jurisdiction to cave exploration for virtually any purpose.

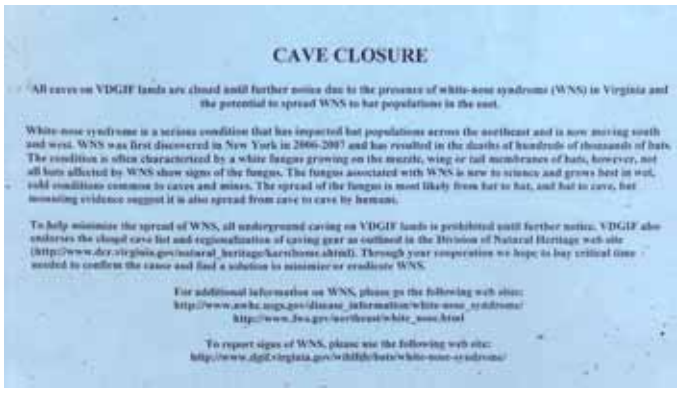
Despite a considerable amount of research undertaken since the outbreak, much remains unknown about the syndrome, even as to whether the fungus, *Geomyces destructans*, is the primary agent associated with bat mortality or whether this organism simply represents a symptomatic association with the disease. Given the lack of concrete evidence, the mode of disease transmission and, consequently, measures to reduce the spread, particularly cave avoidance, disinfection of clothing and equipment, and cave closure, remain highly controversial and even contentious. Many other possible causes have been proposed for the spread of WNS, including the routine migration of bats, unintentional bat transport, and even local environmental factors, such as pollution, that might inhibit bat immune systems and render certain populations more vulnerable to infection. In a recent article in the *NSS News*, Tom Aley observed that, in light of other potential causal factors, "transmission by people…is not necessary to explain the spread and distribution of WNS."

Like many NSS members, senior author O'Dell followed the progress of WNS with increasing concern. O'Dell was, however, shocked and a little angered when, in May 2009, the US Forest Service announced that nearly all caves in the Southern Region would be closed as a precaution, including those in his own primary area of activity, Kentucky's Daniel Boone National Forest, even though WNS had not yet been observed in the state. While noting his own reactions and that information about WNS consisted mainly of scientific studies of the disease and policy statements by bureaucracies, O'Dell wondered about the reactions of ordinary members of the caving community to the threat posed by WNS, particularly in regard to the two most controversial issues, transmission of the disease and cave closures. Were cavers, in general, accepting the view promoted by the USFWS, that WNS was most likely being spread from cave to cave by human traffic? If so, had cavers actually modified their behavior, following the agency recommendations to specifically avoid WNS-affected caves, reduce overall caving activity, and to carry out disinfection procedures on clothing and gear between caves?

In the fall of 2010 O'Dell, an associate professor of geography at Morehead State University in Kentucky, recruited MSU senior student Tim Engle to develop a research project to investigate caver reactions to WNS. Some of the groundwork for the WNS study was undertaken by O'Dell prior to the beginning of the fall semester in order to expedite the project. In April, O'Dell contacted the NSS office to obtain permission to use the membership list to distribute a survey by e-mail, providing a one-paragraph summary of the proposed research project. Because the Society is, appropriately, very protective of members' privacy, the list may only be used for certain non-commercial purposes of apparent benefit or interest to members. For this reason, the NSS will not provide a database of member snail-mail or e-mail addresses but will, for a fee, provide mailing labels or e-mail bursting services. The proposed WNS survey project was subsequently approved for distribution via e-mail.

At this time the specific questions to be included in the survey had not yet been developed. This task was delegated at the beginning of the fall semester to Engle. Since the survey was to be sent out by e-mail, a web-based platform known as SurveyMonkey was chosen to provide respondents with access to the survey, and to collect and tabulate answers. No personally identifiable information is collected by SurveyMonkey, so all responses were completely anonymous. A message was composed, to be sent as e-mail to the group of potential respondents, in which Engle identified himself as a student at MSU working on a research project directed by O'Dell, gave a brief summary of the project and its purpose, and provided a web link to the survey. On November 1, 2010, the message was forwarded to the NSS office, which subsequently transmitted the message to Society members in a specified geographic region with valid e-mail addresses.

The target population consisted of NSS members in six states: Kentucky, New York, Pennsylvania, Tennessee, Virginia, and West Virginia. These particular states were chosen to provide information from members living either in states currently affected by WNS, or adjacent to the affected region and potentially under threat of WNS spread. Of the 1,685 Society members who were sent the e-mail invitation and link, 402 chose to participate in the survey. This is a relatively high response rate of nearly 24 percent, but not surprising because the target population was a select group for whom the issue was expected to be of great interest.


CAVE CLOSURE

All caves on VDGIF lands are closed until further notice due to the presence of white-nose syndrome (WNS) in Virginia and the potential to spread WNS to bat populations in the east.

White-nose syndrome is a serious condition that has impacted bat populations across the northeast and is now moving south and west. WNS was first discovered in New York in 2006-2007 and has resulted in the deaths of hundreds of thousands of bats. The condition is often characterized by a white fungus growing on the muzzle, wing or tail membranes of bats, however, not all bats affected by WNS show signs of the fungus. The fungus associated with WNS is new to science and grows best in wet, cold conditions common to caves and mines. The spread of the fungus is most likely from bat to bat, and bat to cave, but increasing evidence suggest it is also spread from cave to cave by humans.

To help minimize the spread of WNS, all underground caving on VDGIF lands is prohibited until further notice. VDGIF also endorses the closed cave list and regionalization of caving gear as outlined in the Division of Natural Heritage web site (http://www.dcr.virginia.gov/natural_heritage/karstbossa.shtml). Through your cooperation we hope to buy critical time needed to confirm the cause and find a solution to minimize or eradicate WNS.

For additional information on WNS, please go the following web sites:
http://www.nwhc.usgs.gov/disease_information/white-nose_syndrome/
http://www.fws.gov/northeast/white_nose.html

To report signs of WNS, please use the following web site:
http://www.dgif.virginia.gov/wildlife/bats/white-nose-syndrome/

**In 2009, the Virginia Department of Game and Inland Fisheries placed warning signs near the entrances to more than sixty caves in the state, such as this one at Marshall's Cave.Source: Rick Lambert, VSS**

## WNS Survey Questionnaire and Responses

*An invitation to participate in this WNS opinion survey was sent out by email in November 2010 to NSS members residing in Kentucky, New York, Pennsylvania, Tennessee, Virginia, and West Virginia. The survey was not sponsored by the Society, but was a undergraduate research project developed primarily by Tim Engle, a student at Morehead State University, Kentucky, and approved by the NSS office.*

1. In what state do you reside?
   - VA 24%
   - TN 19
   - PA 15
   - NY 12
   - KY 12
   - WV 10
   - Other 6

2. In what state do you conduct MOST of your cave exploration?
   - WV 25%
   - TN 14
   - VA 13
   - KY 13
   - NY 10
   - PA 7
   - Other 7
   - Multiple states 7

3. How long have you been involved in cave exploration?
   - a. Less than one year 1%
   - b. 1 to 5 years 15
   - c. 6 to 10 years 13
   - d. 11 to 15 years 12
   - e. 16 to 20 years 11
   - f. More than 20 years 48

4. How long have you been a member of the National Speleological Society?
   - a. Less than one year 6%
   - b. 1 to 5 years 19
   - c. 6 to 10 years 16
   - d. 11 to 15 years 11
   - e. 16 to 20 years 11
   - f. More than 20 years 37

5. How familiar with white-nose syndrome (WNS) are you?
   - a. Quite familiar 69%
   - b. Somewhat familiar 28
   - c. Not very familiar 2
   - d. Have not heard of it <1

6. What is your primary source of information regarding WNS?
   - a. NSS periodicals 42%
   - b. Grotto newsletters 5
   - c. Caver forums online 15
   - d. In-person contacts 19
   - Other (please specify)

COMMENT BOX PROVIDED

7. Has the news about WNS affected your cave exploration?
   - a. The frequency of my caving trips has decreased 68%
   - b. The frequency of my caving trips has increased <1
   - c. The frequency of my caving trips has not changed 32

8. Have you seen firsthand the effects of WNS while caving?
   - a. Yes - I have seen infected bats, as identified by an expert 11%
   - b. Yes - I have seen what appear to be infected bats based on my knowledge of WNS 13
   - c. No - I have not seen any infected bats 75

9. Are you aware that evidence suggests that the spread of WNS from cave system to cave system is at least partially due to cave explorers' clothing and equipment acting as a vector for the fungus?
   - a. Yes - I concur that cavers most likely inadvertently spread the WNS fungus 41%
   - b. Yes - but I do not think cavers spread the WNS fungus 37
   - c. No - I have not heard this 4
   - Other theories (please specify)

COMMENT BOX PROVIDED

10. Please indicate what steps you have taken to reduce the spread of WNS. Please choose all that apply.
   - a. Thoroughly disinfected clothing after a caving trip 61%
   - b. Thoroughly disinfected equipment after a caving trip 57
   - c. Avoided exploring caves known to be infected 58
   - d. Generally cut back on caving trips 57
   - e. Educate other cavers on WNS 49
   - f. I have not altered my behavior due to WNS 8
   - Other (please specify)

COMMENT BOX PROVIDED

11. Do you think it is a good idea for landowners who have cave entrances located on their property to (at least temporarily) close these caves to cavers in an attempt to stem the spread of WNS?
   - a. Yes - All caves that harbor bat populations 32%
   - b. Yes - but only those caves where WNS is present 18
   - c. No 41
   - Any additional comments on this.

COMMENT BOX PROVIDED

12. Are you aware that the US Fish & Wildlife Service offers suggestions for stemming the spread of WNS: http://www.fws.gov/whitenosesyndrome
   - a. Yes - I have read them 68%
   - b. Yes - but I have not read them 19
   - c. No 13

COMMENT BOX PROVIDED

13. Would you like to see organizations such as the National Speleological Society set up guidelines for its members to try to stem the spread of WNS? If so, what would you like those guidelines to include?

COMMENT BOX PROVIDED

**Survey questionnaire with proportion of respondents choices on each question. See text for summary of responses in the comment boxes.**

The survey was short, consisting of only 13 questions. The first four questions were intended to provide limited demographic information: state of residence, most frequent area of personal caving activity, and length of involvement in cave exploration. The next few questions concerned knowledge and information sources regarding WNS. The next set of questions directly addressed perceptions and behavior modification in response to WNS spread, and the last three questions were concerned with the role of landowners and organizations such as the USFWS and the NSS. Questions involving opinion or behavior also included a comment box to allow participants to respond at length, if they so desired. The questions and summary data for responses are shown in the table on page 5.

A few respondents noted that some of the questions were phrased poorly or even somewhat misleading. We acknowledge that this may be true in some cases, and discuss this concern in regard to specific questions below. The project would have benefited greatly had it been possible to run a pilot study beforehand to discover potential defects and revise the survey instrument accordingly. The time frame limitation of a single school semester, in which Engle was required to develop and execute the project, analyze generated data, present findings orally, and prepare a lengthy written project report, simply did not allow for a trial run to work out potential "bugs" in methodology. We apologize if any Society members were annoyed by what they may have perceived as an attempt to promote particular theories or behavior via the survey. No such intention was present, but only an effort to gauge what members perceived to be true (or not) and how cavers are responding to the spread of WNS.

### General characteristics of participants

All of the targeted states were well represented in responses received, the breakdown, as might be expected, being roughly proportional to the actual NSS membership in each state. The greatest number of responses came from Virginia, followed by Tennessee, Pennsylvania, New York, Kentucky, and West Virginia. Although the survey link was sent out only to cavers whose address in the membership directory was listed in one of the six states, nearly six percent of those responding indicated residence in another state, and a small number (four responses) claimed residence outside the United States. Responses from outside the target area were included in tabulation of the survey results on the assumption that these represented former residents who had recently relocated to other areas, either temporarily or permanently.

West Virginia was by far the major caving area for the entire sample population; more than 100 cavers, or 25% of respondents, indicated this state as their primary focus of activity. Tennessee represented the next most popular caving area, followed by Virginia, Kentucky, New York, and Pennsylvania. For seven percent of respondents, caving activity was centered on single states outside the target area, whereas about the same number indicated that their activity typically involved multiple states rather than a single area of interest. Four survey participants indicated that most of their caving activity took place outside the United States. Seven persons reported that, for a variety of reasons, they were not involved in caving at this time, but two stated that they had stopped caving specifically because of the WNS outbreak. Subsequent survey responses indicate a much higher percentage of total caving abstinence because of WNS.

When caving activity is analyzed by place of residence, unsurprisingly cavers are most active in the states where they live. There are, however, some significant variations. Whereas residents of Kentucky (88%) and West Virginia (93%) cave almost exclusively in their home states, activity regions for residents of other states tend to be more diverse. West Virginia is the second leading caving destination for respondents from Pennsylvania (36%) and Virginia (37%). For Tennessee cavers, 16% cited the "TAG" region (Tennessee-Alabama-Georgia) as their primary activity area, with 12% reporting a variety of other states. About three-quarters of New York cavers favored their state of residence, but 8% were focused on West Virginia, 4% on Kentucky, and 16% a mixture of other states.

Survey respondents were generally cavers of long experience and long association with the Society. Seventy-one percent had been involved in caving for more than ten years, with nearly fifty percent having more than twenty years experience; only 16% percent reported five years or less caving experience. Without data on the number of actual cave explorers in the United States it is not possible to draw any real conclusions as to the overall success of the Society in recruiting from the ranks of casual cavers. It does appear that, for the sample population at least, many respondents spent several years involved in cave exploration prior to obtaining NSS membership. This interpretation is supported by comparing survey responses for length of caving involvement to length of membership. The responses show that nearly 59% have been Society members for more than ten years, with 37% claiming twenty or more years, and fully one-quarter of respondents have been members for less than five years.

### Knowledge about WNS

Given the nature of the sample population, it was no surprise that nearly all participants reported being either "quite familiar" or "somewhat familiar" with WNS, with only 2% gauging themselves as "not very familiar." The surprise was, perhaps, that one respondent indicated not having heard of WNS at all.

The survey provided four possible selections as to the primary source of information about WNS, as well as a comment box so that respondents could indicate other sources. Of the given choices, "NSS periodicals" received the greatest number of responses, followed by personal contacts, online forums, and grotto newsletters. This question provoked one of the largest number of non-responses of any in the survey. This did not indicate a lack of interest in the subject, but rather a perception that the choices provided were insufficient. Nearly all of the non-responders chose instead to list other sources, or a variety of sources, in the comment box provided. "All of the above" was the most frequent comment provided by participants.

Other significant information sources included government agencies (mainly USFWS, USFS, and various state agencies), popular media, scientific literature, non-government organizations or NGOs (including Bat Conservation International and various state or regional conservation organizations), and contact with persons conducting research on WNS. At least six survey respondents described themselves as scientists involved in such research. The Internet was obviously an important component in providing information, and although difficult to assess its direct impact in the survey responses, was the most likely conduit used to access information in nearly all of the categories listed above.

Three-quarters of all the survey participants have never, to their knowledge, seen a bat infected with WNS. Of the remaining respondents, who reported having observed infected bats, about half made this identification based on their own personal knowledge of the symptoms, and the other half had identification made for them by persons perceived as experts on the subject. The story is quite different when responses are broken down by individual states. In Kentucky, which at the time of the survey had not experienced an outbreak of WNS, 98% of respondents have not seen infected bats; those reporting such an experience were presumably visiting other areas.[1] In Tennessee, where the first cases of WNS were confirmed in Sullivan county in

1 In April, 2011, WNS was detected in a cave in Trigg County, Kentucky, that serves as a hibernaculum for six different bat species.

February, 2010, 90% of responding cavers had not yet observed the disease. In states where WNS has been present for several years, significant proportions of respondents have first-hand experience, either through self-identification or made by experts: 45% of New York cavers have seen WNS, 39% for Pennsylvania, 29% for Virginia, and 18% of West Virginia respondents.

### How WNS spreads

Possibly the most controversial question was that intended to assess beliefs concerning the spread of WNS, based on the most widely circulated hypothesis supported by the USFWS. Obviously, scientific truth cannot be measured simply by the popularity of an explanation. A hypothesis, such as that offered by the USFWS, is a theory that has yet to be subjected to rigorous testing and verification, yet quite often actions are taken on the basis of unproven but apparently reasonable propositions. Such has been the case with the theory of human transmission of WNS. Although this theory is supported only by limited and circumstantial evidence, the consequences of continuing spread of the disease are sufficiently dire (potential bat extinction) to prompt policymakers to accept any theory which suggests that control may be possible through proactive means, even if the measures taken may be drastic (cave closure) or of doubtful efficacy (disinfection). Since the cause of WNS spread remains unknown and human transmission the only theory that appears to have gained even partial acceptance, we wished to discover how much credibility was attached to this theory by the caving community. Beliefs are not proof of anything, but beliefs and perceptions tend strongly to influence behavior.

The survey question addressing this subject was worded as follows: "Are you aware that evidence suggests that the spread of WNS from cave system to cave system is at least partially due to cave explorers' clothing and equipment acting as a vector for the fungus?" A few respondents complained that the question was poorly phrased and even misleading, particularly in regard to the use of the word "evidence." In retrospect, we find that we have to agree with the critics. A better phrasing would have been, "The U.S. Fish and Wildlife Service has proposed that the spread of WNS from cave system to cave system is at least partially due to cave explorers' clothing and equipment acting as a vector for the fungus. Do you agree or disagree with this theory?" Despite this apparent flaw, the question as worded, being combined with a comment box to allow respondents to propose alternative theories or to discuss human transmission, served its intended purpose.

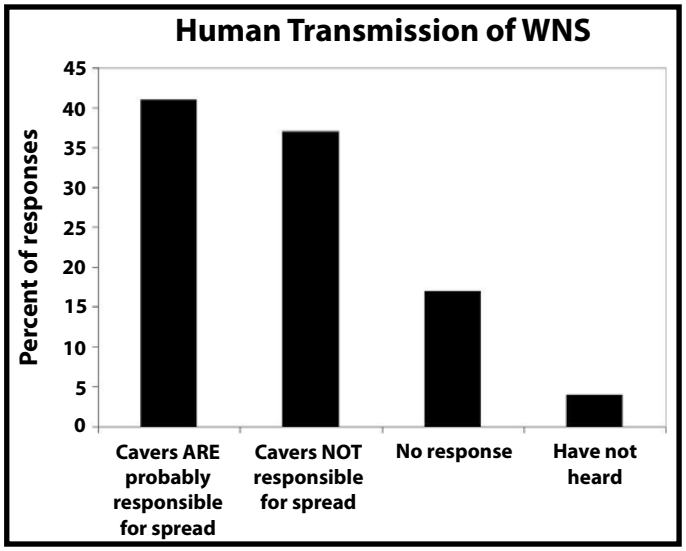
Responses were almost evenly divided between those who agreed that WNS was probably spread by human transmission and those who held that cave explorers were not responsible. Only a few respondents had not heard of this theory. Slightly more than 17% percent preferred not to make a selection among the given choices, most instead responding in the comment box. Interestingly, more than half of the non-responders acknowledged the possibility of human transmission, even though they had not made this choice for the survey question. Most such were in the form of qualified support, in that they believed human transmission played a part in WNS spread but was not the primary vector. Of the remaining non-responders, most indicated that they could not agree nor disagree with the theory of human transmission because there simply was not sufficient evidence one way or the other. Based on these responses, it is clear that the survey instrument would have been improved by the addition of a selection for "No opinion - insufficient evidence."

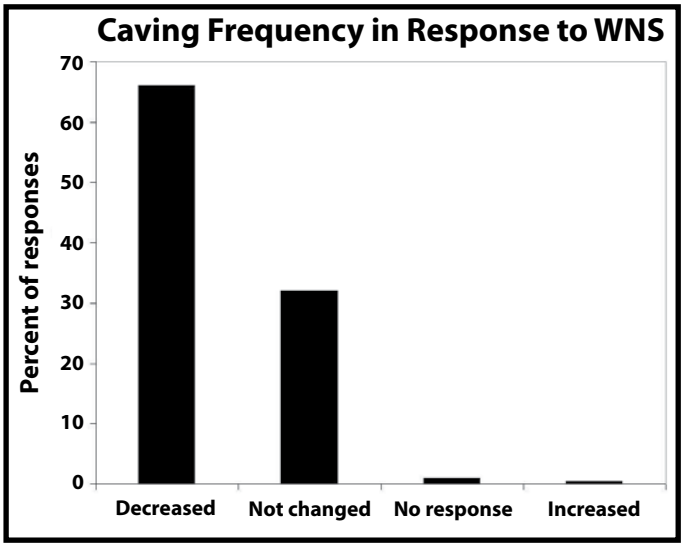
The comment box associated with this question proved a rich source of alternate transmission theories, which were provided by 25% of survey participants, including those who selected one or another of the given choices. The comments were coded into 12 categories. Of the 99 responses, most (71%) indicated a belief that bat-to-bat contact was a major factor in WNS spread. Nearly 35% held that bat-to-bat contact alone was responsible, and an additional 36% believed that spread was caused by a combination of bat-to-bat contact and possibly/probably human transmission. If only comments by respondents who selected "I do not think cavers spread the WNS fungus" are evaluated, the proportion favoring bat-to-bat transmission is exactly the same, 71%, although 47% indicated spread was entirely by this means and, oddly, 24% indicated that cavers, in addition to bats, might spread the disease. Sixteen percent of the comments attributed the spread to other, unspecified, factors.

Ironically, five cavers asserted that it was the persons conducting research on WNS who were themselves responsible for spreading the disease (three of these comments were made by persons who did not agree that WNS was spread by human transmission). The remaining theories were each proposed by only one or two persons, and included spread of the disease via transported bats, by other animals, birds or insects, or promoted by, specifically, pesticides, or more generally, by air or water pollution.

### Behavioral Responses to WNS

Seven of the survey respondents indicated that they had retired from caving prior to the outbreak of WNS, and four respondents were cave divers who reported that they seldom if ever participated in other



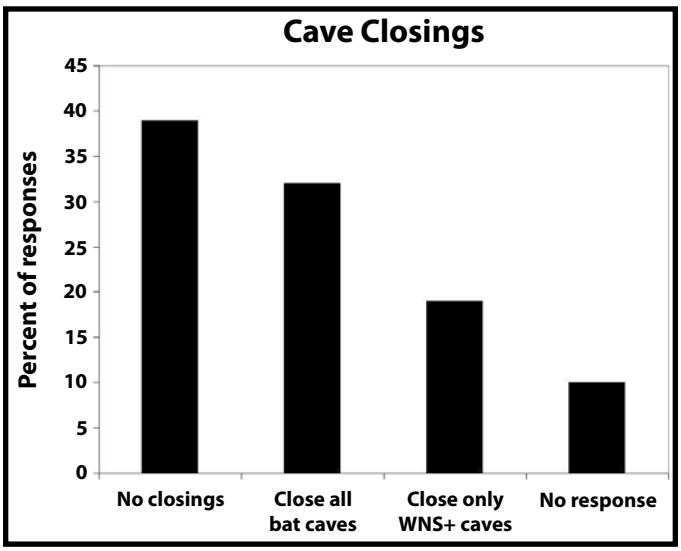



types of caving activity ("WNS not an issue where we explore," stated one, "no bats underwater"). Responses from persons in these two categories were included in the preceding analysis where they concerned knowledge and perceptions about WNS, but are excluded from the following analysis of behavioral responses.

Nearly two-thirds of all survey participants reported a decrease in caving activity, whereas only two persons reported an actual increase; the remainder indicated having made no significant change in the frequency of caving trips. When responses are broken down according to the state or region considered to be the primary focus of caving activity, the greatest reductions in caving activity were reported for Pennsylvania and Virginia (>80%), followed by West Virginia (77%), and, for the three states constituting the TAG region, 67%. Kentucky, which at the time of the survey had no reported cases of WNS within the state, experienced the least reduction (61%) from normal caving activity. Strangely, since WNS was first observed in New York and this state may thus be considered the epicenter of the outbreak, reduction of caving activity here was also low (62%) compared to other states represented in the survey. At the extreme, a rather significant number of persons ceased all caving activity upon learning of the WNS threat. This was specifically indicated in comments made by nearly six percent of all survey participants. Since two-thirds of all respondents reported a decrease in caving frequency, but most did not provide additional commentary, it is possible that a much higher percentage have actually given up caving for the interim, at least until more is known about WNS spread.

There are, of course, other possible behavioral responses by cavers to WNS in addition to changes in caving frequency. The tenth survey question attempted to elicit some of these possible responses, first by providing a selection of choices, and second through provision of a comment box to discover other response types. Only a small proportion (about 20%) of respondents made use of the comment box, but many of these comments were quite revealing. Because of the relatively small number of comments, no effort was made to extrapolate percentages to the larger sample population, but reference to these comments is made where relevant. Less than ten percent of all respondents indicated that they had not changed their behavior in any way in response to WNS.

Disinfection of clothing and equipment used in caving, using a bleach solution or other disinfection chemicals, was recommended by the USFWS in their initial report. This strategy, although its effectiveness was then and still remains unknown, was subsequently recommended by most agencies and organizations involved in cave exploration, including the NSS. Most respondents routinely disinfected clothing and equipment as a precautionary measure. One respondent made a significant point in regard to a serious potential safety hazard arising from the process, observing that "I clean and disinfect my horizontal caving gear and clothing. I will not put harsh chemicals that have been proven to deteriorate fabrics on the [vertical] gear that my life depends on. I value my life more than the life of a bat." A few persons indicated that, after visiting an infected region, they had afterwards taken the extra step of actually disinfecting the vehicle used to travel to the cave. One respondent, involved in research at Mammoth Cave, reported not only observing strict disinfection protocols but also treating each section of the Mammoth system as a separate cave and disinfecting between each trip. Others noted that they only disinfected when caving in areas known to be positive for WNS; one person reported that, after visiting an infected region, having afterward discarded (in that region) all clothing that had been worn caving rather than risk bringing WNS back to an unaffected area. Several persons stated that they had sincere doubts as to whether disinfection was at all effective, but did so as a courtesy to other cavers and cave owners who believed it to be necessary, or as one respondent put it, because "it was the accepted thing to do." At the other extreme, a number of respondents reported that they made a point of caving only with persons who shared their belief that disinfection was necessary.




Most respondents tended to avoid infected caves. Comments also indicate that some cavers confine their activity only to areas where WNS is still absent, but others took the opposite approach to limit WNS spread by caving only in areas known to be positive for the disease and staying away from unaffected regions. Anecdotal evidence suggests that, prior to the WNS outbreak, cavers generally avoid visiting caves known to be inhabited by significant bat populations, particularly during the hibernation or nursery seasons when bats are particularly vulnerable. Comments indicated that many cavers also view bat cave avoidance as an important control measure for WNS.

Two distinct behavioral modifications, which appear to be widely adopted strategies for WNS control, were revealed by the comments. Many cavers, even when not reducing their actual caving activity, have chosen to circumscribe the geographic bounds of such activity. This has been accomplished by confining activity to a very limited area of a single state, perhaps a single county or watershed, or by limiting activity to a handful of caves or even to a single cave. The other strategy involved maintaining multiple sets of caving clothing and gear, sometimes separated between those used in affected and unaffected regions, but sometimes separate clothing and gear dedicated to specific caves.

Nearly half of all respondents reported that they had engaged in efforts to educate other cavers about WNS. Several persons, in their comments, noted that they had stopped leading youth groups on caving trips because of the WNS outbreak. The implications of this are conflicting. If WNS is spread by human transmission, then a temporary discouragement of potential new cavers might help limit such spread. On the other hand, it is likely that many young people in such groups will go caving anyway, and without guidance, the opportunity is lost to provide education not only about WNS but also about general principles of cave conservation and safe caving techniques.

### Closing caves

The practice of closing caves in an effort to stem the spread of WNS proved to be no less controversial than the issue of how the disease is spread from cave to cave, and generated a large number of comments in addition to the standard survey responses. One-half of survey participants selected responses favoring limited cave closure. Nearly four out of ten survey respondents were against any cave closings, and a rather

large number of persons (10%) were sufficiently ambivalent on the issue as to make no response to the question.

Additional comments and observations were provided by 153 persons. The greatest proportion of such responses (32 persons) indicated a general belief that closing caves will not be effective in slowing the spread of WNS; ten persons explicitly stated that, since WNS was spread by bat migration, closing caves was a futile gesture. Although most opinions asserting ineffectiveness of this measure were expressed by persons choosing "no" to cave closure, there were also several respondents who agreed in principle with closure but who thought there would be little practical effect. Several persons observed that there was little point in closing caves in areas where WNS had achieved complete saturation. One extreme was represented by a handful of persons who believed that ALL caves should be closed and all caving activity suspended until the WNS threat recedes. "Just because there are no bats in the cave does not mean that the cave does not contain *Geomyces destructans* that can then be carried elsewhere by visitors to the system," wrote one caver. Another observed, "We are guests in the homes of the bats. Would you invite a person with an infectious disease into your home?" On the other hand, one respondent stated an opinion which may well be representative of many others who disagreed with closure: "It is drastically clear that closures have failed miserably to ebb the spread of the malady… the entire closure concept has failed, and there is no way to deny that fact."

Various respondents suggested caveats attending cave closings. Many expressed the opinion that there was no reason responsible cavers who carried out strict disinfection protocols should not be allowed access to caves. A large number of persons also observed that it was important to allow continued access to caves, infected and non-infected, by scientists conducting research on WNS, and by responsible cavers who could monitor and report on progress of the disease. Another frequently expressed opinion was that only those caves harboring large bat populations should be closed. A couple of respondents noted that closing infected caves might not be a bad strategy even if the disease was not transmitted by humans, since visitation might disrupt sick bats and reduce their chances of survival. Several respondents suggested that cave closure should be resorted to only if proven to be an effective control against the spread of WNS.

**Rick Lambert, president of the Virginia Speleological Survey, demonstrates disinfection procedure at his home decon station, Clockwise, from upper left: mixing a bleach solution; adding caving clothing; vigorous stirring; and disinfecting gear with a bleach solution spray. Richmond Area Speleological Society also maintains a decon station at their field hut.**

Many respondents identified potential problems associated with implementation of cave closure. The most significant problem, in their opinion, was that cave entrances usually cannot be monitored and only responsible cavers would abide by such a ban. The practice would be unenforceable against casual cavers—"the sneakers and flashlight spelunker types" who know and care nothing about bats except "they are to be feared and killed"—who are, of course, the group least likely to disinfect clothing and gear. Another major concern was that closure for any reason was a "slippery slope" with adverse long-term consequences. Once a cave has been closed, it is very likely to stay closed even if it should be proven that human visitors have nothing to do with the spread of WNS. "It gives landowners the idea that cavers are unwelcome and the main source of the problem, rather than helpful," one participant observed. Another wrote, "Cavers are making the discovery and being blamed in part for it. Don't shoot the messenger," and also predicted it was only a matter of time before some salamander or crayfish disease will be discovered, assumed to be spread by cavers, and used as a rationale for more cave closings.

### Organization guidelines

At the onset of the WNS outbreak, the USFWS took the lead in establishing and promoting guidelines in an effort to check the spread of the disease, guidelines which set the standard for other agencies responsible for managing caves located on federal lands, such as the Forest Service, Bureau of Land Management (BLM), and the Tennessee Valley Authority (TVA), as well as state agencies with similar roles concerning caves. Conservation organizations and other NGOs also involved with cave management, horrified by the WNS threat, adopted similar strictures, often including blanket closure of caves. An effort to develop a coordinated, multi-agency approach for addressing WNS was initiated in June 2008 among federal and state wildlife management agencies, which resulted in a draft national plan issued in October 2010. Because so much action and reaction has been associated with the USFWS guidelines, we wished to determine how familiar cavers were with these controversial yet highly influential guidelines. Survey responses indicated that nearly all respondents were aware of the USFWS guidelines, and that most had read these guidelines. Thirteen percent of respondents were unaware that the USFWS had issued any such guidelines.

The National Speleological Society, as the primary organization representing the interests of cave explorers, has long maintained a considerable body of information about WNS on its web site, and has issued challenges and critiques of federal and state agency WNS guidelines and actions as well as brief policy statements concerning the disease. The most recent NSS policy iteration was approved by the Board of Governors on April 17, 2010. This policy statement acknowledged the serious nature of the WNS threat, and stated that the Society will "do what it can to ensure that any restrictions on cave access are based on demonstrated threats, sound evidence, and recognition that risks are site and strategy-specific." The statement further noted that cavers are

"natural partners in the collaboration necessary to address WNS" and emphasized the importance of providing WNS education to the membership and to the public. The policy did not present any specific recommendations or guidelines.

Despite the availability of this policy statement by the NSS leadership, for the purpose of the survey we decided to treat the situation as though it did not exist and determine whether respondents believed an official policy statement was needed and what sort of policies should be endorsed by the NSS in such a statement. This question received a high rate of non-response (30.5%), possibly because many respondents were aware of the existing policy statement; many participants, in fact, pointed out that the NSS already had such a policy and made no further observations. Thirty-eight percent of survey participants believed that an official Society policy on WNS was necessary; 13% stated that no such policy was needed or desirable.

The largest block of comments (nearly 60) suggested that NSS policy should, more or less, follow the USFWS guidelines in recommending cave avoidance (but generally not agreeing with actually closing caves) and conducting disinfection of clothing and equipment; a few were of the opinion that the USFWS guidelines should be adopted exactly for the sake of uniformity. Another large block (33) indicated that the Society should provide information concerning decontamination procedures. Several persons noted that current information about disinfectants, including a recent article in the *News*, was unclear. A total of nearly 50 comments concerned WNS education, divided almost equally among provision of current information about the disease, focusing on public education, and supporting research on WNS. Several persons wished to see a list of WNS-affected caves.

Eleven respondents suggested that a total moratorium on all caving would be desirable until the WNS crisis was resolved; nearly an equal number were of the opinion that the NSS should take a strong stand against the closure of caves. More than a dozen comments can be described simply as "don't tell me what to do," being of the opinion that the Society had no right to dictate the behavior of its members. Nearly as many persons were inclined to believe that, regardless of whatever policy the NSS adopted, it would have little or no effect on slowing the spread of WNS.

These comments are indicative of what members believe should be NSS policy, many of which, such as recommendation of disinfection, provision of WNS information to members and the public, and a stance against closing caves, are all measures currently being undertaken by the Society.

### Conclusion

It is clear from the survey responses received that there is considerable diversity of opinion among the NSS membership as to the causes and possible remedies for WNS. Certainly it appears that potential impacts of the disease on bat populations are so serious that the majority of members, whether or not they agree with human transmission or with the effectiveness of decontamination procedures, are willing to curtail (if not abandon) their caving activity and to disinfect, just in case it might possibly do some good. One respondent perhaps summed a majority opinion by observing, "While I firmly believe that restricting caving will not noticeably if at all cut back on the spread of WNS, I still do what I can to avoid this possibility in case I am wrong. I love bats like everyone else, and do not want to see them eliminated. But I strongly believe that efforts to reduce caving are misguided at best."

Despite all the well-intentioned efforts to halt the spread of WNS, the disease has rapidly progressed through the eastern core area and leapfrogged across the country, with recent reports of outbreaks received from Indiana, Ohio, North Carolina and Kentucky, and cave closures undertaken by authorities in several western states where the disease has not yet appeared. In a recent email exchange with O'Dell (21 February 2011), Rick Lambert, president of the Virginia Speleological Survey, observed "We lost the war against WNS in Virginia. It is everywhere." One consequence of this development is that the Virginia Cave Board, a state agency, is considering elimination of the requirement for cave visitors to disinfect clothing and gear in that state; there no longer seems to be any point.

The caving environment may be quite different in the near future from that we have known. If WNS continues in the future to leap from one region to another, it may be possible that in a few years nearly every caving region in the United States could be affected. Once populous bat caves have been already decimated, and since bats breed slowly, disease-resistant remnants will be long in recovering. Given that many species of cave-dwelling bats were already considered endangered due to habitat disruption and other environmental pressures, for some species WNS may represent one more nudge on the long slide toward extinction. Since bats are integral parts of the food web in the caves they inhabit, in a cascade effect cavern ecologies are likely to be severely disrupted and perhaps other rare or even site-unique species may disappear forever. Despite all efforts by modern science and best intentions by most cave explorers, it seems that we may be able to do little but mourn the loss.

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### Tracks of Change

Air from a crack, a rock to move,
now a small hole, who would go,
what mysteries wait down in this groove,
someone brave and small to check below.

The dig was short, crawl not too tight,
as I sat on the ledge and gazed
at the dark void that had never seen light,
several minutes passed as I froze amazed.

Enter a place never seen before,
sealed, never open, this special place,
where crystals grow and maybe more,
events that created it, left hardly a trace.

Layers of red clay, hid by a covering of black,
tranquil and quiet, but that would all change,
one small step, as I made the first track,
now it was done, this world we would rearrange.

***Hubert Crowell***