Testimony of Thomas H. Kunz, Professor of Biology and Director of the Center for Ecology and Conservation, Boston University, before the House Committee on Natural Resources, the Subcommittee on Insular Affairs, Oceans and Wildlife and the Subcommittee on National Parks, Forests and Public Lands

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Introduction

Chairwoman Bordallo, Chairman Grijalva, and Members of the Subcommittees, I am Thomas H. Kunz, Professor of Biology and Director of the Center for Ecology and Conservation Biology, Boston University. Thank you very much for the opportunity to testify concerning White-Nose Syndrome, a devastating disease of hibernating bats that has caused the most precipitous decline of North American wildlife in recorded history.

My testimony will (1) briefly summarize what we know and don't know about White-Nose Syndrome based on research and monitoring over the past three years, (2) highlight the ecological and economic importance of insectivorous bats to healthy ecosystems, and (3) provide an estimate of the amount of federal funding that will be needed over the next 5 years to address unanswered questions in efforts to identify causes and consequences of this emerging wildlife disease so that we can provide critical scientific information needed for making sound management decisions.

Background and Context

In recent years, bats have become increasingly subjected to a variety of anthropogenic perturbations, as they are being exposed to industrial chemicals, water pollution, air pollution, light pollution, habitat alteration, deforestation, and direct impacts of wind energy facilities. Several species of bats threatened by these and other human activities face a growing risk of extinction. In particular, alteration of natural habitats and subsequently replacement by agricultural monocultures and suburban sprawl, introductions of exotic plant species, human disturbances to caves and mines, and recorded decreases in some aerial and aquatic insect species compromise the ability of bats to successfully feed, reproduce, and hibernate.

Throughout the world, bat species provide important ecosystem services by pollinating flowers, dispersing seeds, and consuming insects, thus playing central roles in the maintenance and regeneration of forests and other ecosystems following natural and anthropogenic disturbances. Insectivorous bats, in particular, play critical roles in many ecosystems by suppressing insect populations in both natural and human-altered landscapes.

As we have already learned from others who have testified, White-Nose Syndrome has infected six species of insect-eating bats in the northeastern and southern U.S. (Appendix 1), causing declines approaching 100% in some populations, and 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 the bat species that are federally listed as endangered in the U.S. Such losses alone are expected to have unprecedented consequences for ecosystem health throughout North America, with potentially extraordinary economic consequences.

Current, Federal, State, Local and Private Responses to the Spread of White-Nose Syndrome

Federal Responses

Federal responses to WNS have been slow, to say the least, not for lack of existing USFWS and USGS staff investing their energies to encourage research and monitoring, and to facilitate and conduct research and monitoring, but largely because of bureaucratic issues relating to the timely release of funds to an emergency situation. One impediment, in particular, to the timely release of funds is the federal requirement for matching non-federal funds, under the State Wildlife Grants Program, before awards can be made. WNS also is issue of national importance and should be on the agenda of other federal funding agencies, such as the National Science Foundation, National Institutes of Health, Department of Defense, and Department of Energy, each of which have a long history of supporting research and monitoring studies of national importance. A reallocation of funds from the existing 2009 FY budget (including funds from the Stimulus Package) would seem prudent, but a new source of funding for research and monitoring on WNS should be allocated starting in FY 2010.

State Responses

State responses to WNS have played an important role in supporting a small amount of research and early monitoring. Most notably, New York State, Vermont, and Pennsylvania, within the region of WNS affected locations in the northeastern U.S., have been the major contributors to research and monitoring, although they have not had sufficient funds to support the type of research and monitoring that is needed in response to early signs of WNS. Due to lack of state funds for travel, many qualified state wildlife biologists were limited in the monitoring work they have been able to accomplish, or to participate in Science Strategy Meetings or other conferences where WNS was on the agenda over the past three years.

Local and Private Responses

By most measures, the rapid responses of non-government agencies and private organizations have made it possible to conduct most of the research that has been conducted to date. Moreover, these resources were used to organize two important Science Strategy Meetings that identified questions, hypotheses, and research needs. At least three international societies—the American Society of Mammalogists and the North American Society for Bat Research—and two international conferences—the International Congress of Speleology (Kerrville, TX) and the International Bat Migration Symposium (Berlin, Germany), over the past two years have organized and sponsored special sessions on WNS.

In response to this developing crisis, two Science Strategy Meetings on White-Nose Syndrome (WNS) have been convened in the past year—the first on June 9-11, 2008, in Albany, New York to identify questions, hypotheses, and research needs related to the increased prevalence and spread of WNS, and another on May 26-27, 2009 in Austin, Texas to review what we know and don't know about WNS, and to identify questions, hypotheses and research needs to address unanswered questions. Both of these meetings were funded largely from non-government sources. Participation in these meetings by state and federal staff were funded by their respective agencies.

Over the past three years, some progress has been made to answer several key questions based on available funding. However, given limited funds available for research and monitoring, and the current rate of spread of WNS since it was first discovered, we can expect this disease in the very near future to advance into regions of the U.S. where some of the largest hibernating bat colonies are known. Many of these hibernating colonies at potential risk are located in southern and mid-western states, and include major populations of three federally listed endangered species, with adverse ecological and economic consequences extending well beyond the northeastern U.S. WNS should be of national concern, and emergency funds should be allocated from federal agencies.

Federal Actions to Further Comprehend and Contain this Unparalleled Crisis

To address the crisis of WNS spreading close to regions of major hibernating colonies in the U.S., at our most recent Science Strategy Meeting this past week in Austin, Texas, the participating scientists made a call to the Federal Government to establishment a national comprehensive research program to identify underlying mechanisms causing WNS that are needed to develop sound management solutions. With the availability of funding to support needed research, we are staged to move forward with the advantage of hindsight of what we know and the foresight of what we need to know to address this emerging disease.

Current Scientific Understanding of White-Nose Syndrome

What We Know

- Unprecedented numbers of dead bats attributed to WNS have been reported from hibernacula in nine states—ranging from New Hampshire to West Virginia.

- A newly described white fungus (*Geomyces* sp.) grows on the nose, ears, and wing membranes of bats affected by WNS.

- The fungus associated with WNS grows optimally at temperatures characteristic of most hibernacula—between 5 and 14 C.

- Histopathological studies have demonstrated that this fungus penetrates the skin and wing membranes of bats affected with WNS.

- Genetically identical isolates of this fungus have been collected from affected bats located in widely dispersed hibernacula in the northeastern United States, suggesting that it is a plausible causative agent of WNS.

- Hibernating bats affected by WNS have severely depleted fat reserves by mid-winter.

- Hibernating bats affected by WNS show low concentrations of polyunsaturated fatty acids.

- Hibernating bats affected by WNS show atypical high frequencies of arousal from torpor, especially in early winter.

- Hibernating bats affected by WNS exhibit atypical flight behavior during winter and often fly outside hibernacula.

- Hibernating bats affected by WNS have a reduced capacity to arouse from deep torpor after fat reserves have been depleted.

- Hibernating bats affected by WNS show compromised immune responses.

- Bats that survive hibernation often have ulcerated, necrotic and scarred wing membranes.

- Preliminary results suggest that concentrations of chlorinated hydrocarbons, pyrethroids, and heavy metals are not markedly elevated in bats thus far examined, nor have known bacterial or viral pathogens been discovered.

To establish the etiology of WNS and to make sound management decisions, research and monitoring are needed to determine whether this cold-loving fungus is a direct cause or a secondary effect of this devastating disease. The recent spread of WNS to the south and west of the epicenter near Albany, in New York State, poses a severe threat to other hibernating species that form some of the largest colonies of hibernating bats in North America.

What We Don't Know

- Is the newly described cold-loving fungus associated with WNS the primary cause of mortality in hibernating bats? If so, what is the mode of action of the fungus in killing bats?

- What is the geographic distribution of the fungus associated with WNS?

- If the fungus is not the cause of WNS, is this condition a secondary manifestation of other underlying factor or factors? If so, what are these factors?

- Are pathogens (bacteria or viruses) a direct or indirect cause of mortality in bats affected by WNS?

- Are contaminants a direct or indirect cause of WNS related bat mortality?

- What causes the premature depletion of fat reserves in bats affected by WNS?

- Can bats mount affective immune responses to the fungus associated with WNS or to other potential pathogens or contaminants?

- Are some bats genetically or immunologically resistant to WNS and thus can survive infection?

- How does WNS affect bats at maternity colonies?

- What is the mode of transmission of WNS?

- Can we predict geographic limits to the spread of WNS?

- Can we slow or stop the spread of WNS?

- Can we reduce the mortality of bats affected by WNS?

- Can some individuals survive WNS, followed by a subsequent population recovery? If so, can population recovery be facilitated?

Why Should We Care?

Each of the six species of bats that are affected by WNS are obligate insectivores—many of which feed on insect pests of agriculture and garden crops, and at times these may include insect species that pose risks to human health. The enormous number and biomass of insects that would have been eaten annually by the estimated 1 million bats that have since died in the northeastern U.S. emphasizes the extraordinary value of insectivorous bats to the normal function and health of both the terrestrial and aquatic ecosystems in which they feed.

During the warm months of the year, one little brown bat (*Myotis lucifugus*), a species that has been most affected by WNS, is known to consume insects ranging from one-half to its entire body weight in a single night. Extraplolated to entire colonies and populations, this level of insect consumption provides an important ecosystem service to human kind, which in turn can reduce the use of pesticides often used to kill insects.

For example, assuming that, on average, one little brown bat that weighs 7 grams eats only half its body weight each night (3.5 grams) from April 15 through October 15 (~180 nights), this would amount to the consumption of 3.5 grams x 180 nights, or 630 grams of insects annually during these warm months. If we multiply 630 grams of insects that can be consumed by one little brown bat times 1 million bats that have already died from WNS, this would amount to 630,000,000 grams of insects that would not have been eaten by bats. When the latter value is converted from metric to English units, this amounts to about 1,388,912 pounds or 694 tons of insects. This biomass is equivalent to the weight of approximately fifty-six M113 fully-equipped armored personnel carriers, twenty-three M3A3 Bradley fighting vehicles, seventeen fully-loaded 18-wheelers, 6 female blue whales, or 5,555,648 quarter pounders—take your pick for comparison.

The level of nightly consumption by one little brown bat would be equivalent to a 150-pound teenage boy eating approximately 300 quarter-pounders. Translated to the number of insects that would not be eaten by one little brown bat in your backyard on a given night, it amounts to the equivalent of 60 medium-sized moths or over 1,000 mosquito-sized insects. On average, this means that approximately 10,800 medium-sized moths or approximately 180,000 mosquito-sized insects each year would not be eaten by just one bat.

Although no studies have been conducted to assess the ecological or economic impact of insectivorous bats on ecosystem in the northeastern U.S., Cleveland et al. (2006) conducted a study in south-central Texas, and have shown that within an 8 county region, the quantity of insects eaten on an annual basis by an estimated 1.5 million Brazilian free-tailed bats saves farmers an average of $741,000 per year in reduced applications of pesticides needed to control cotton bollworm on cotton crops.

Summary and Conclusions

To date, a handful of university, state, federal laboratories have become engaged in research on WNS—largely funded by non-government organizations. Apart from characterizing the fungus associated with WNS, many questions remain unanswered. For example, although the psychrophilic fungus may turn out to be the "smoking gun," it is unclear whether this syndrome results from various anthropogenic conditions that have reached an environmental threshold. Regardless of whether the cause of WNS is the result of anthropogenic or natural conditions, it has become increasingly clear that emergency funds from the federal government are needed to identify the exact causes and consequences in time to implement mitigation and to prevent its spread to other species and geographic regions.

Many questions remain to be answered. For example, have individuals of some bat species evolved resistance to the causative agent of WNS? Given the extraordinarily slow reproductive rates of most bat species (e.g., typically one or two offspring born each year), can significantly decimated populations recover? Some highly gregarious hibernating species with limited geographic ranges (e.g., Indiana bat, gray bat, Virginia and Ozark big-eared bats) face the threat of extinction in the coming years if WNS continues to spread geographically. Given the important role that insectivorous species play as predators and as prey in balancing the structure and function of temperate ecosystems, what ecological and economic impacts will their loss have on both natural and human altered ecosystems? Urgent attention and concerted efforts by the Federal Government are needed to develop a national plan to support research that will help identify the cause and consequences of WNS, and to mitigate the rapid decline in numbers and anticipated spread throughout the geographic ranges of species at risk.

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Estimated Funding Needs to Support Research and Mitigation Efforts to Address WNS Related Questions

Research	Year 1	Total
Mechanisms and modes of transmission of *Geomyces* sp.	300,000	1,200,000
Ecology, origins, and distribution of *Geomyces* sp. associated with WNS	400,000	775,000
Sequence genome of *Geomyces* sp.	200,000	400,000
Develop diagnostic tools for *Geomyces* sp.		
Genetic	300,000	300,000
Colorimetric	1,000,000	1,000,000
Evaluate immune responses to pathogens	120,000	600,000
Measure behaviorial and physiological responses to WNS	500,000	1,500,000
Slow and stop spread of WNS	400,000	1,200,000
Geographic surveillance for WNS	400,000	1,200,000
Epidemiology and modeling of WNS	400,000	1,000,000
Communication/meetings (1 group meeting/year)	250,000	1,000,000
Sub Total	**$4,270,000**	**$10,175,000**
Mitigation/Control		
Develop biocontrol/vaccine		6,000,000
Implementation of biocontrol/vaccine		1,000,000
Total		**$17,175,000**

Appendix 1. Names of six species of hibernating, cave-dwelling bat species (out of nine) in the northeastern U.S. affected by WNS.

Little brown bat (*Myotis lucifugus*)
Northern long-eared bat (*Myotis septentrionalis*)
Small footed bat (*Myotis leibii*)
Indiana bat (*Myotis sodalis*)—U.S. Endangered Species
Tricolored bat (*Perimyotis subflavus*)
Big brown bat (*Eptesicus fuscus*)

Other hibernating cave-dwelling bat species likely to be affected by WNS if this disease spreads further south and westward from the northeastern U.S.

Gray bat (*Myotis grisescens*)—U.S. Endangered Species
Virginia big-eared bat (*Corynorhinus townsendii virginianus*)—U.S. Endangered Species
Ozark big-eared bat (*Cornorhinus townsendii ingens*)—U.S. Endangered Species