White-nose Syndrome

Science Strategy Meeting II

May 27-28, 2009
Austin, Texas

BAT CONSERVATION INTERNATIONAL
www.batcon.org

NATIONAL PARK SERVICE

Disney WORLDWIDE CONSERVATION FUND

DEPARTMENT OF DEFENSE LEGACY PROGRAM

NATIONAL CAVES ASSOCIATION

The planning committee for the WNS Science Strategy Meeting II included Merlin D. Tuttle (Bat Conservation International), Thomas H. Kunz (Boston University), Dianne Odegard (Bat Conservation International), and Bonnie J. Ram (Energetics Incorporated). Energetics also coordinated facilitation, final layout and production with Wendy Wallace (scribe), Tommy Finamore (graphic artist), Susan Kaczmarek (document production) and Nora Phillips (summer intern).

Cover Photo: Little brown myotis showing visible effects of White-nose Syndrome in spring 2008.

Photo by Alan Hicks, New York State Department of Environmental Conservation
Location: Graphite Mine (Hague, New York) April 2008

TABLE OF CONTENTS

INTRODUCTION

The second White-nose Syndrome (WNS) Science Strategy Meeting was held in Austin, Texas, May 27-28, 2009. This meeting was organized by Bat Conservation International (BCI) and the Center for Ecology and Conservation Biology, Boston University. Strategic planning and facilitation services were provided by Energetics Incorporated. BCI hosted the meeting and organized funding for facilitation and participant travel with financial support from the U.S. Department of Defense Legacy Program, the Disney Rapid Response Fund, the National Caves Association, and the U.S. National Park Service. Fourteen leading scientists from the most relevant disciplines, representing universities, national laboratories, and state agencies, participated. In addition, representatives of 12 federal and state wildlife agencies and non-government organizations joined in discussions in the two-day meeting (see Appendix A for full participant list).

The overall goals of this meeting were to further explore the symptoms, causes, and consequences of this emerging disease, some of which were initially discussed at the first WNS Science Strategy Meeting convened in Albany, New York, June 9-11, 2008. At that meeting, six hypotheses were proposed as possible causes of WNS. Most of these hypotheses were subsequently tested in the field and laboratory by the research community. The U.S. Fish and Wildlife Service (FWS) sponsored WNS-related research activities and convened a webinar on WNS in February 2009 to update researchers and managers on progress since the 2008 Albany meeting.

The 2009 meeting in Austin was called to evaluate the seriousness of the crisis and to seek consensus on the next research and conservation priorities. This meeting was intended to advance understanding of bat mortality associated with WNS, explore how best to slow or prevent its spread, and to help ensure the viability of surviving bat populations.

The specific goals of this meeting were to:

- Review the status of current knowledge about WNS and identify critical research gaps
- Reach consensus on the magnitude of the WNS threat
- Identify short-term research and monitoring activities needed to address research gaps and to build the evidence base
- Discuss appropriate research protocols for moving forward
- Recommend research, monitoring and conservation priorities

Merlin D. Tuttle, then-Executive Director of BCI, opened the meeting with a new map showing the recent spread of WNS across nine states, including New York, Vermont, New Hampshire, Massachusetts, Connecticut, New Jersey, Pennsylvania, Virginia and West Virginia (See map "White-nose Syndrome and Major Indiana and Gray Bat Colonies" on page 3). He highlighted the urgent need to confirm a cause or causes and possible modes of transmission, noting that sound management requires such information. He also emphasized the need to develop a strong consensus statement that could be used as part of a press release, and to galvanize the research and management communities. Al Hicks, of the New York State Department of Environmental Conservation, reviewed the history of WNS and its spread from the epicenter near Albany, New York, to other regions. During the opening plenary session of the first day, invited researchers presented their latest findings on WNS research and explored the current state of knowledge and uncertainties related to this emerging disease. Presentations were given on the following topics: bat ecology, hibernation and migration, physiological ecology, immunology, microbial ecology, cave ecosystems, microbiology, mycology, modeling, epidemiology,

and control and mitigation strategies. In the afternoon, a facilitated discussion identified current knowledge about WNS, including what may be considered speculative or probable (see Table 1). The participants discussed research conducted over the past year. Although funding for research was severely limited, significant new discoveries were made regarding the condition and behavior of affected bats, bat-fungal interactions, and the fungus itself (which to date has not been confirmed as the causal agent). The fungus associated with WNS has been described and named as a new species—*Geomyces destructans* (Gargas et al. 2009). Much of the discussion focused on identifying uncertainties and research gaps concerning WNS.

Gaps were categorized and then prioritized through lively discussions and a series of votes by presenters. Prior to the group establishing priorities, John P. Hayes (Professor and Chair of the Department of Wildlife Ecology and Conservation at the University of Florida), gave a brief presentation on setting research priorities. The priorities, summarized in Table 2, include the following categories: Experimental research (field and laboratory), diagnostic tests (field and laboratory), surveillance and monitoring, epidemiology and modeling, and communication of results. Estimated costs were assigned to each proposed research gap. These costs are not included herein as they were subsequently revised and submitted by Thomas H. Kunz (Director of the Center for Ecology and Conservation Biology, Boston University), as his congressional testimony, "Proposed Budget for Research, Surveillance, and Management of WNS, FY10-14." These funding levels are summarized in Tables 3A (Budget Justification) and 3B (Proposed Budget). The final facilitated session identified the most critical conservation and management needs to prevent further spread, minimize harm, and maximize survival of the remaining bats (see Table 4). In the afternoon of day two, Thomas H. Kunz led a discussion on research and monitoring protocols as well as "best practices," based on ongoing collaborations of researchers and managers with the U.S. Fish and Wildlife Service. See Appendix B for the complete agenda.

A subsequent discussion focused on drafting a Consensus Statement on WNS, based on best available information. The statement reads:

> "White-nose Syndrome (WNS) 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 little brown myotis bats is staggering—equivalent to 694tons—emphasizing the extraordinary value of these bats to the normal function of both terrestrial and aquatic ecosystems. Establishment of a national comprehensive research program is urgently needed to identify underlying mechanisms causing WNS and to develop sound management solutions."

Information discussed at this meeting was incorporated into testimonies prepared and delivered by four of

the meeting participants (Merlin D. Tuttle, Scott Darling, Peter Youngbaer, and Thomas H. Kunz) before a joint oversight hearing entitled, "White-nose Syndrome: What is Killing Bats in the Northeast?" with the U.S. House Committee on Natural Resources, the Subcommittee on Insular Affairs, Oceans and Wildlife, and the Subcommittee on National Parks, Forests and Public Lands on June 4, 2009.

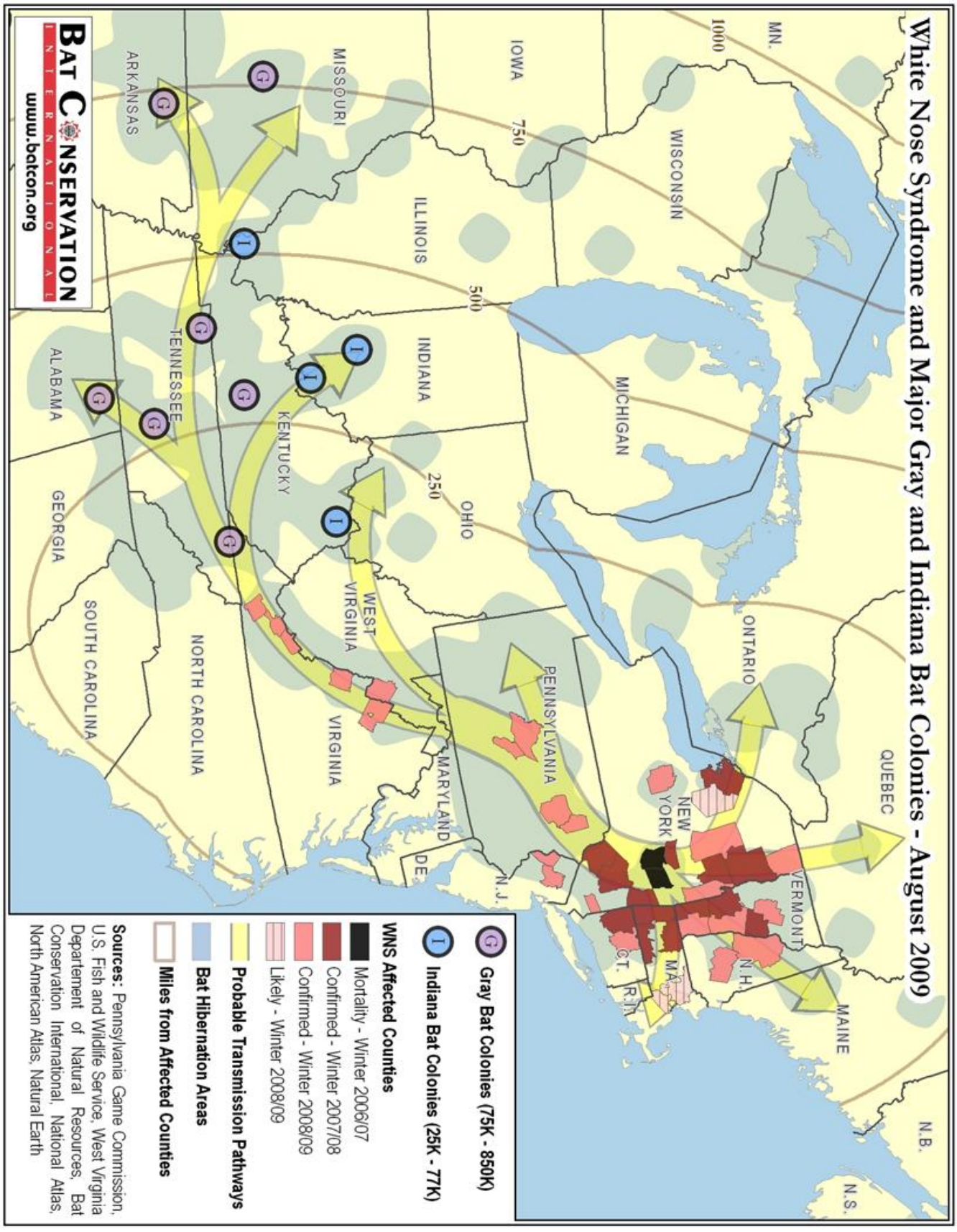

TABLE 1. WHAT DO WE KNOW ABOUT WNS?

[PLEASE NOTE THE DIFFERENT CATEGORIES BELOW: FACTS, PROBABILITY, AND SPECULATION]

	FUNGUS (NOT NECESSARILY CAUSAL AGENT)	BAT-FUNGUS INTERACTION (INFECTION/ENVIRONMENT)	BATS
FACTS	• Fungi of the genus *Geomyces* are natural components of cave ecosystems • *Geomyces destructans* is a newly described species • Growth of *G. destructans* depends on specific environmental conditions (it grows optimally at 5-14^{o}C). • *G. destructans* invades the skin of bats through hair follicles and sebaceous glands • *G. destructans* behaves like a pathogen, but needs to be verified by satisfying Koch's postulate • A morphologically identical fungus to the U.S. WNS-associated fungus grows on the skin of European bats • Genetically similar fungal isolates have been confirmed from several hibernacula in the northeastern U.S. • *G. destructans* can be killed by 10% bleach and 0.3% quarternary ammonium compounds	• *G. destructans* first documented in New York State in the winter of 2005-2006 (February 2006) • *G. destructans* is associated with WNS-related mortality • WNS has spread from the epicenter in New York State to eight other states in three years • Hundreds of thousands of hibernating cave bats in the northeastern U.S. have died from WNS during the past three years • WNS condition varies among hibernacula • Bat-to-bat transmission of *G. destructans* has been observed in laboratory tests • Presence of *G. destructans* can affect entire bat-cave ecosystems • WNS has strong parallels with other emerging diseases (e.g. death from chytrid fungus in frogs and colony collapse disorder in bees)	• Six species of hibernating bats in the northeastern U.S. have been affected by WNS • WNS affects each species differently. To date, colonies of the little brown myotis (*Myotis lucifugus*) have been most affected • Hundreds of thousands of bats have died from WNS in the northeastern U.S. • WNS has caused the most precipitous decline of hibernating bats in recorded history • WNS-affected bats experience premature depletion of fat reserves during hibernation • WNS-affected hibernating bats experience shorter torpor bouts (i.e. more frequent arousals) • WNS-affected bats show altered immune responses during hibernation • Wing damage (e.g. scarring and necrosis) is associated with WNS • Given what we know about the life histories of bats (e.g., low reproductive rates), recovery of populations to pre-WNS levels will take many years, if ever • WNS-affected bats sometimes fly outside hibernacula in mid-winter • WNS-related mortality at some hibernacula has exceeded 95% • No evidence of bacterial/viral infections in WNS-infected bats • WNS-associated mortality is spreading geographically mostly to the south and west of the original epicenter in New York State • WNS may also reduce reproductive success

TABLE 1 (Continued). WHAT DO WE KNOW ABOUT WNS?

	FUNGUS (NOT NECESSARILY CAUSAL AGENT)	BAT-FUNGUS INTERACTION (INFECTION/ENVIRONMENT)	BATS
PROBABILITY		• Differential susceptibility of hibernating bats to WNS appears to be associated with the microclimate of hibernacula • *G. destructans* persists in hibernating colonies/sites over multiple years • WNS appears to be dispersed by multiple vectors • Chitinase activity is low in WNS-affected hibernating bats	
SPECULATION		• *G. destructans* is a pathogen that directly causes mortality in hibernating bats	

TABLE 2. WHAT DO WE STILL NEED TO KNOW ABOUT WNS AND WHAT ARE THE PRIORITY RESEARCH GAPS AND UNCERTAINTIES (NEAR TERM)?

DIAMONDS (◆) REPRESENT SUPPORTING VOTES FROM AMONG 14 INVITED PRESENTERS

FIELD & LAB RESEARCH	DIAGNOSTICS FIELD & LAB STUDIES	SURVEILLANCE (ACTIVE) AND MONITORING	EPIDEMIOLOGY AND MODELING	COMMUNICATION	OTHER RESEARCH GAPS AND QUESTIONS IDENTIFIED
• Is *G. destructans* ubiquitous or a newly emerging fungus? ◆◆◆◆◆◆ • What is the natural history of *G. destructans living* on bats in caves and mines? • Can *G. destructans* persist in caves without bats? • What is the epidemiology of *G. destructans*? • Do hibernating bats have characteristics that make it possible for them to resist infection from *G. destructans* (e.g., can they mount an effective immune response?) ◆◆◆◆◆ • Does *G. destructans* actually kill bats or is it an opportunistic fungus? ◆◆◆◆◆ • How do WNS-affected bats behave during arousals? ◆◆	• What is mechanism of transmission of WNS? What constitutes an exposure? ◆◆◆◆◆ • Can WNS be transmitted by humans? • Is WNS spread by capturing and handling bats in spring, summer, or fall? • Can *G. destructans* be transported by people? If so, how? • Do spores of *G. destructans* survive outside cave/mine enviroments? ◆ • Can a rapid diagnostic test for WNS be developed? ◆◆	• Can bats survive exposure to WNS? ◆◆ • How can the spread of WNS be stopped or slowed? ◆◆ • Should biological control be an option? • Long-term surveillance of affected and unaffected sites is needed	• Can the dispersal of WNS be predicted? ◆◆◆ • What is the mechanism of fungal transmission? ◆ • Can WNS-affected bats survive?	• What role should federal/state agencies have in disseminating information about WNS? • A national framework is needed for sharing research information among scientists and wildlife managers • Transparency of information vs. publication rights of scientists should to be addressed • What resources are available to facilitate sharing	• Has climate change in the U.S. contributed to WNS? • Are some species less susceptible to infection from WNS? If so, why? • Should physical management be used to control WNS (e.g., temperature; light?) • Should biological agents be used to control WNS? • Should chemical treatment be used to control WNS? • Can bacterial infections cause WNS? • Can viral infections cause WNS? • Does WNS affect reproductive success of bats? • Does exposure to pesticides or other environmental con-taminants contribute to lowered resistance of bats to WNS? • Are hibernating bats from Europe resistant to infection from a related strain of *G. destructans*?

TABLE 2 (CONTINUED). WHAT DO WE STILL NEED TO KNOW ABOUT WNS AND WHAT ARE THE PRIORITY RESEARCH GAPS AND UNCERTAINTIES (NEAR TERM)?

FIELD & LAB RESEARCH	DIAGNOSTICS FIELD & LAB STUDIES	SURVEILLANCE (ACTIVE) AND MONITORING	EPIDEMIOLOGY AND MODELING	COMMUNICATION	OTHER RESEARCH GAPS AND QUESTIONS IDENTIFIED
• What proximate mechanisms underly increased arousal frequencies of WNS-affected bats? ◆ • Do all species affected by WNS have reduced torpor bouts? ◆ • Has *G. destructans* only been isolated from WNS-affected bats? ◆◆ • Do WNS-affected bats support distinct microbial assemblages? ◆ • Are the normal microbial assemblages on bats (skin, etc.) changed by WNS?					• Can roost sites contaminated with *G. destructans* be decontaminated to preserve natural cave ecosystems? • Can rapid mitigation strategies be developed to reduce or eliminate WNS? • Can the biodiversity of cave ecosystems be maintained without bats? • What is the progression of infection in WNS-affected bats? • At what stage of infection can WNS infection first be detected? • Are WNS-affected bats visibly infected in the first winter? • Does decreasing insect abundance affect the susceptibility of hibernating bats to WNS? • Does decreased dietary intake of polyunsaturated fatty acid (PUFA) increase susceptibility of hibernating bats to WNS? • Do changes in the composition of insect assemblages affect the quality of fat? • Is the transmission of *G. destructans* to hibernating bats a density-dependent phenomenon?

TABLE 3A. PROPOSED BUDGET JUSTIFICATION FOR RESEARCH, SURVEILLANCE, AND MANAGEMENT OF WNS (FY 2010-14)
(SUBMITTED TO JOINT HOUSE COMMITTEES ON JUNE 30, 2009)

RESEARCH CATEGORY	BRIEF SUMMARY
Determine mode of transmission of *Geomyces destructans*	Funds are needed to establish whether and how and in what form the fungus *G. destructans* is transmitted from bat to bat and from cave to cave. This information is critical for developing sound intervention and/or management strategies.
Document the origin, ecology, and distribution of *G. destructans*	Funds are needed to understand the ecology, origin and distribution of *G. destructans* in North America. This information is essential for understanding where, when, and how this fungus may have been introduced into the US, and how it its spread can be slowed or stopped.
Develop diagnostic tools for field identification of WNS	Funds are needed to develop field-based diagnostic tools for researchers to design reliable experiments with the knowledge that bats either are not or are infected—especially at early stages of infection—and for use by state and federal agency personnel for monitoring the spread of *G. destructans*.
Assessment of immune responses of bats with and without WNS	Funds are needed to compare the immune system of bats that are infected and unaffected by WNS. Thorough knowledge of the immune system of bats is critical for understanding the epidemiology of WNS and also for developing mitigation strategies.
Assess behavioral responses of bats with symptoms WNS	Funds are needed to assess the physiological responses of bats to infections from *G. destructans*. Knowledge of how bats respond behaviorally to infection from White-nose Syndrome (e.g. arouses more frequently than normal, emigrate from infected hibernacula, transmit fungal infections socially or by grooming) will be valuable for testing alternative hypotheses for the cause of frequent winter arousals and depletion of fat reserves.
Assess physiological responses of bats with symptoms of WNS	Funds are needed to quantify physiological responses of bats to infections from *G. destructans*, especially during hibernation. It is expected that this knowledge will lead to be better understanding of the underlying causes and consequences of infection from this fungus.
Assess epidemiology of WNS in the US	Funds are needed to develop epidemiological models of bats that have been exposed to *G. destructans*. Information needed for making this assessment includes timing and rates of infection, and rates of spread from single or multiple sites of origin. This information will be needed to affectively manage bat populations affected by WNS.
Assess demographic variables of bat species that are currently affected and unaffected by WNS	Funds are requested to collect demographic variables such as reproductive rates, growth rates, and survival rates of bats that are affected by and not affected by WNS. This information is essential for the development of population models (see below).
Develop demographic population models of bats at risk from WNS	Funds are requested for developing predictive models of species that are affected by WNS and rates of spread among affected species, based on demographic traits. This information is critical for developing sound management strategies.

TABLE 3A (CONTINUED). PROPOSED BUDGET JUSTIFICATION FOR RESEARCH, SURVEILLANCE, AND MANAGEMENT OF WNS FY10-14
(SUBMITTED TO CONGRESSIONAL COMMITTEES ON JUNE 30, 2009)

RESEARCH CATEGORY	BRIEF SUMMARY
Identify and develop mitigation and possible biocontrol strategies for managing WNS	Funds are requested to develop and test ecologically sound mitigation and biocontrol methods—including testing different decontaminants and developing a possible vaccine that can be deployed by wildlife managers.
Unknown/unexpected research needs	Contingency funds are requested to cover unexpected research needs that may be identified in the course of ongoing research.
Federal surveillance and monitoring	Funds are needed for federal agencies to protect wildlife by conducting surveillance and monitoring studies of critical hibernacula and summer roosts under their jurisdiction, both within and beyond the current distribution of WNS. This information will be critical for developing and implementing sound management strategies and for advising and assisting researchers on appropriate sites for field-based sampling and research.
State assistance for surveillance and monitoring	Funds are needed for state fish and wildlife agencies to conduct surveillance and monitoring of critical hibernacula and summer roosts, both within and beyond the current distribution of WNS. This information will be critical for developing and implementing sound management strategies and for advising and assisting researchers on appropriate sites for field-based sampling and research.
Coordination and disease management	Funds are requested for state and federal agencies responsible for wildlife diseases to manage these resources to help reduce adverse impacts of WNS on hibernating bats using adaptive management strategies throughout the known and expected range of WNS.
Conferences and communication	Funds will be used to convene one WNS Conference each year and one Webinar meeting each year, and for outreach and communications related to WNS.

TABLE 3B. PROPOSED BUDGET FOR RESEARCH, SURVEILLANCE, AND MANAGEMENT OF WNS FY10-14
(SUBMITTED TO CONGRESSIONAL COMMITTEES ON JUNE 30, 2009 BY THOMAS H. KUNZ)

Funding Categories Research	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Mode of Fungal Transmission	600,000	150,000	150,000	150,000	150,000	1,200,000
Origin, Ecology and Distribution of *Geomyces destructans*	600,000	150,000	150,000	150,000	150,000	1,200,000
Development of Diagnostic Tools						
Genetic	300,000	75,000	75,000	75,000	75,000	600,000
Colorimetric	500,000	250,000	75,000	75,000	75,000	975,000
Immune Responses	500,000	250,000	100,000	75,000	75,000	1,000,000
Behavior and Physiology	500,000	250,000	250,000	250,000	250,000	1,500,000
Epidemiology	500,000	200,000	200,000	200,000	200,000	1,300,000
Demography	500,000	200,000	200,000	200,000	200,000	1,300,000
Population Modeling	500,000	250,000	250,000	250,000	250,000	1,500,000
Mitigation and Biocontrol	6,000,000	1,000,000	1,000,000	1,000,000	1,000,000	10,000,000
Unknown/unexpected needs	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	7,500,000
SUBTOTAL (RESEARCH)	**12,000,000**	**4,275,000**	**3,950,000**	**3,925,000**	**3,925,000**	**28,075,000**
Surveillance and Monitoring						
Federal Agencies (USFWS, USGS, USFS, NPS)	2,790,000	2,790,000	2,790,000	2,790,000	2,790,000	13,950,000
State Fish & Wildlife Agencies	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	6,250,000
SUBTOTAL (SURVEILLANCE)	**4,040,000**	**4,040,000**	**4,040,000**	**4,040,000**	**4,040,000**	**20,200,000**
Coordination and Disease Management						
Federal Agencies **	700,000	700,000	700,000	700,000	700,000	3,500,000
State Fish & Wildlife Agencies	750,000	750,000	750,000	750,000	750,000	3,750,000
SUBTOTAL (MANAGEMENT)	**1,450,000**	**1,450,000**	**1,450,000**	**1,450,000**	**1,450,000**	**7,250,000**
Communication and Information Exchange						
Annual Meetings	60,000	60,000	60,000	60,000	60,000	300,000
Communication and Outreach	10,000	10,000	10,000	10,000	10,000	50,000
SUBTOTAL (OTHER)	**70,000**	**70,000**	**70,000**	**70,000**	**70,000**	**350,000**
TOTAL BUDGET NEEDS	**17,560,000**	**9,835,000**	**9,510,000**	**9,485,000**	**9,485,000**	**55,875,000**

Footnotes

*This budget does not include indirect costs, which varies among agencies and academic institutions from 26-67% of modified direct costs. Modified direct costs include all project costs except equipment.

**Federal agencies who are not represented by this budget: DOE, DOD, EPA, NIH, NSF, USDA

TABLE 4. WHAT ARE THE PRIORITY CONSERVATION/MANAGEMENT CONCERNS?

PREVENT SPREAD OF WNS: MINIMIZE HARM AND MAXIMIZE SURVIVAL

DIAMONDS (◆) REPRESENT SUPPORTING VOTES FROM AMONG 14 INVITED PRESENTERS

CONSERVATION	CONSERVATION AND MANAGEMENT	MANAGEMENT
• Maintain viable wild populations ◆◆◆◆◆◆◆◆ • Avoid damaging existing ecosystems with mitigation strategies and exercise caution in the treatment of caves ◆◆◆◆◆ • Protect the survivors; avoid non-essential disturbance and minimize disturbance of already stressed bats ◆◆◆◆◆ • Prevent spread to hibernating animals other than bats ◆◆◆ • Test viability of strategies/adaptive management ◆	• Sources of funding ◆◆◆◆ • Develop transparency between research and management ◆◆◆◆ • Involve stakeholders in decision making ◆◆◆ • Coordinate management responses to WNS (strong leadership) ◆ • Prevent natural spread • Educate/regulate: i.e., permits, science studies, community caves, caving classes, decontamination • Manage forests to benefit bats; roost trees, canopy gap, upland water sources, open understory • Establish and standardize bat monitoring protocols throughout the Eastern U.S. to assess impacts of WNS	• Develop appropriate response to new/disjunct epicenters of WNS ◆◆◆ • Assess potential impacts of WNS on show-caves and cave ecosystems (4000 people employed) ◆◆ • Develop separate management strategies for each of the various regions affected or potentially affected by WNS. • Determine whether cave closures is an effective means of slowing the spread of WNS ◆◆ • Develop guidelines to prevent human spread ◆ • Determine whether existing monitoring protocols contribute to spread of WNS ◆ • Establish whether existing decontamination procedures are effective • Grant matches should not be required, though they are useful initiatives • Inform the FWS Structured Decision Making (SDM) process related to WNS • Identify key criteria for determining cave/mine closure/opening • Public relations issues – Determine how experts and managers can best communicate with different stakeholders

Appendix A. Participant List

* Participated via conference call; ** Invited presenter; + Invited participant.

****Thomas Aley**
President and Senior Hydrogeologist
Ozark Underground Laboratory, Inc.
1572 Aley Lane
Protem, MO 65733
Phone: 417/785-4289
Email: taley@ozarkundergroundlab.com

****Hazel Barton**
Associate Professor
Department of Biological Sciences
Northern Kentucky University
SC 204D Nunn Drive
Highland Heights, KY 41076
Phone: 859/572-5303
Email: bartonh@nku.edu

***Anne Ballmann**
Diagnostic Microbiologist
6006 Schroeder Road
Madison, WI 53711-6223
Phone: 608/270-2466
Email: aballmann@usgs.gov

+Mylea Bayless
Conservation Biologist
Bat Conservation International
500 N. Capital of Texas Highway
Building 1, Suite 200
Austin, TX 78746
Phone: 512/327-9721
Email: mbayless@batcon.org

***David Blehert**
Diagnostic Microbiologist
6006 Schroeder Road
Madison, WI 53711-6223
Phone: 608/270-2466
Email: dblehert@usgs.gov

+Eric Britzke
Research Wildlife Biologist
Research and Development Center/
EE-E US Army Corps of Engineers
3909 Halls Ferry Road
Vicksburg, MS 39180
Phone: 601/634-3641
Email: Eric.R.Britzke@usace.army.mil

+Cal Butchkoski
Nongame Biologist
Wildlife Diversity Section
RR 1, Box 172
Petersburg, PA 16669-9435
Phone: 814/667-3685
Email: cbutchkosk@state.pa.us

+Kevin Castle
Wildlife Veterinarian
National Park Service
Biological Resource Management Division
1201 Oakridge Drive, Suite 200
Fort Collins, CO 80525
Phone: 970/267-2162
Email: Kevin_Castle@nps.gov

+Jeremy Coleman
Wildlife Biologist
U.S. Fish and Wildlife Service
New York Field Office
3817 Luker Road
Cortland, New York 13045
Phone: 607/753-9334
Email: Jeremy_Coleman@fws.gov

****Paul Cryan**
Research Biologist
Fort Collins Science Center
2150 Centre Avenue, Bldg C
Fort Collins, CO 80525
Phone: 970/226-9389
Email: cryanp@usgs.gov

+Chris Dobony
Fish and Wildlife Biologist
Fort Drum, Natural Resources Branch
85 First Street West, IMNE-DRM-PWE
Fort Drum, NY 13602-5097
Phone: 315/772-4999
Email: chris.dobony@us.army.mil

+Joe DuChamp
Competitive SWG WNS Project Manager
Department of Biology
Indiana University of Pennsylvania
975 Oakland Avenue
Indiana, PA 15705-1081
Phone: 765/412-8777
Email: duchampwns@gmail.com

****Craig Frank**
Associate Professor
Department of Biological Sciences
Fordham University
Louis Calder Center
53 Whipporwill Road
Armont, NY 10504
Phone: 914/273-3078 x14
Email: frank@fordham.edu

****John Hayes**
Professor and Chair of the
Department of Wildlife Ecology and Conservation
University of Florida
Institute of Food and Agricultural Sciences
PO Box 110430
Gainesville, FL 32611-0430
Phone: 352/846-0552
Email: hayesj@ufl.edu

****Al Hicks**
Mammal Specialist
Endangered Species Unit
New York State Department of
Environmental Conservation
625 Broadway, 5th Floor
Albany, NY 12233-4754
Phone: 518/402-8854
Email: achicks@gw.dec.state.ny.us

+Dennis Krusac
Endangered Species Specialist
USDA Forest Service Region 8 (Southern)
1720 Peachtree Street Northwest
Suite 816 N
Atlanta, GA 30309-2441
Phone: 404/347-4338
Email: dkrusac@fs.fed.us

****Thomas Kunz**
Professor of Biology
Boston University
Department of Biology
5 Cummington Street
Boston, MA 02215-2406
Phone: 617/353-2474
Email: kunz@bu.edu

+Mike Lacki
Professor and Interim Chair
Department of Forestry
University of Kentucky
214 T.P. Cooper Building
Lexington, KY 40546-0073
Phone: 859/257-8571
Email: mlacki@uky.edu

+Bob Locke
Director of Publications
Bat Conservation International
500 N. Capital of Texas Highway
Building 1, Suite 200
Austin, TX 78746
Phone: 512/327-9721
Email: rlocke@batcon.org

****Gary McCracken**
Professor and Department Head
Department of Ecology and
Evolutionary Biology
569 Dabney Hall
University of Tennessee
Knoxville, TN 37996-1610
Phone: 865/974-2371
Email: gmccrack@utk.edu

****DeeAnn Reeder**
Assistant Professor
Department of Biology
Bucknell University
701 Moore Avenue
Lewisburg, PA 17837
Phone: 570/577-1208
Email: dreeder@bucknell.edu

+Rick Reynolds
Biologist
Virginia Dept. Department of
Game and Inland Fisheries
Post Office Box 996
Verona, VA 22482-0996
Phone: 540/248-9386
Email: Rick.Reynolds@dgif.virginia.gov

****Alison Robbins**
Adjunct Professor
Tufts University School of Veterinary Medicine
65 Arrowhead Road
Concord, MA 01742
Phone: 617/663-9082
Email: alison.robbins@tufts.edu

+Brooke Slack
Wildlife Biologist
Kentucky Department of Fish
and Wildlife Resources
#1 Sportsman's Lane
Frankfort, KY 40601
Phone: 502/564-7109 x4573
Email: brooke.slack@ky.gov

***Ward Stone**
Wildlife Pathologist
New York State Department
of Environmental Conservation
Wildlife Resources Center
108 Game Farm Road
Delmar, New York 12054
Phone: 518/478-2203
Email: wbstone@gw.dec.state.ny.us

****Merlin Tuttle**
Executive Director & Founder
Bat Conservation International
P.O. Box 162603
Austin, TX 78716
Phone: 512/327-9721
Email: mtuttle@batcon.org

+Dave Waldien
Co-Director of Programs
Bat Conservation International
500 N. Capital of Texas Highway
Building 1, Suite 200
Austin, TX 78746
Phone: 512/327-9721
Email: dwaldien@batcon.org

+Peter Youngbaer
WNS Liaison
National Speleological Society
2813 Cave Avenue
Huntsville, AL 35810-4431
Phone: 802/272-3802
Alt. Phone: 802/454-7752
Email: wnsliaison@caves

Meeting Facilitation and Coordination

Bonnie Ram
Planning Committee and Facilitator
Energetics Incorporated
901 D Street, SW, Suite 100
Washington, DC 20024
Phone: 202/406-4112
Email:bram@energetics.com

Wendy Wallace
Meeting Planner and Scribe
Energetics Incorporated
901 D Street, SW, Suite 100
Washington, DC 20024
Phone: 202/406-4112
Email:bram@energetics.com

Dianne Odegard
Executive Assistant
Bat Conservation International
500 N. Capital of Texas Highway
Building 1, Suite 200
Austin, TX 78746
Phone: 512/327-9721
Email: dodegard@batcon.org

Appendix B. Agenda

White-nose Syndrome
Science Strategy Meeting II

Organizers:
Bat Conservation International and Boston University
Radisson Hotel, Austin, Texas
May 27-28, 2009

OVERARCHING GOAL

The primary goals of the White-nose Syndrome (WNS) Science Strategy Meeting II are to evaluate the seriousness of the crisis and achieve consensus on next research and conservation priorities. Recommended priorities and protocols that result from the meeting are intended to advance our understanding of bat mortality associated with WNS, slow or prevent its spread and ensure the viability of surviving bat populations.

Purpose of this Meeting

- Discuss the status of current knowledge about the syndrome as well as critical research gaps
- Reach consensus on the seriousness of WNS threat
- Identify short-term research and monitoring activities (by season) to address priority research gaps and build the evidence base
- Discuss appropriate research protocols going forward
- Recommend research, monitoring and conservation priorities

Final Products

- Proceedings based on Energetics notes and results of the facilitated sessions (Presenters will review and approve final draft)
- One-page summary statement of scientists' consensus on the above items
- Distribution of results with web site postings (e.g., BCI, BU, USFWS, NASBR, NPS, NSS, and USGS.)

Reading Materials

1. Final proceedings from WNS Scientific Strategy Meeting I (Albany 2008)
2. Thomas H. Kunz et al. Draft Manuscript
3. One-page summary papers from scientists (not to be published).

DAY 1 WEDNESDAY, MAY 27, 2009

8:00-8:15	Welcome and Introductions, **Merlin Tuttle**, Bat Conservation International (BCI)
8:15-8:30	Facilitator Overview and Introductions, **Bonnie Ram**, Energetics Incorporated
8:30-8:45	Syndrome History and Overview: **Al Hicks**, New York State Department of Environmental Conservation--Bat Ecology
8:45-9:00	**Merlin Tuttle**, Bat Conservation International, Hibernation and Migration
9:00-9:15	**Thomas Kunz**, Boston University, Physiological Ecology and Immunology
9:15-9:30	**Craig Frank**, Fordham University, Hibernation Physiology
9:30-9:45	**DeeAnn Reeder**, Bucknell University, Physiology and Immunology
9:45-10:00	Questions and Answers, **Bonnie Ram**
10:00-10:15	BREAK
10:15-10:30	**Hazel Barton,** Northern Kentucky University, Microbial Ecology of Caves
10:30-10:45	**Tom Aley,** Ozark Underground laboratory, Cave Ecosystems
10:45-11:00	**Ward Stone,** New York State Dept. of Environmental Conservation**,** Experimental Microbiology
11:00-11:15	Questions and Answers, **Bonnie Ram**
11:15-11:30	**David Blehert,** USGS National Wildlife Health Center, Experimental Mycology
11:30-11:45	**Gary McCracken,** University of Tennessee**,** Modeling Approaches
11:45-12;00	**Alison Robbins,** Tufts University**,** Epidemiology
12:00-12:15	**Paul Cryan**, US Geological Survey (USGS) Fort Collins Science Center, Control and mitigation of WNS in the face of uncertainty
12:15-12:30	Questions and Answers, **Bonnie Ram**
12:30-1:30	LUNCH
1:30-2:45	Facilitated Discussion, **Bonnie Ram**—What do we know about WNS?
2:45-3:15	BREAK
3:15-4:30	Facilitated Discussion, **Bonnie Ram**—What do we still need to know about WNS/ Research Gaps?

4:30-5:15	Facilitated Discussion, **Bonnie Ram and John Hayes**—Based on what we still need to know, what are our highest research priorities?
5:15	ADJOURN

DAY 2 THURSDAY, MAY 28, 2009

8:30-9:00	Recap of results from Day 1 and agenda review for Day 2, **Bonnie Ram**
9:00-10:15	Facilitated Discussion, **Bonnie Ram**—Moving toward consensus on the severity of WNS threat to bats and ecosystem health
10:15-10:30	BREAK
10:30-12:00	Facilitated Discussion, **Bonnie Ram**—What are the priority conservation/management concerns?
12:00-1:00	LUNCH
1:00-1:30	Facilitated Discussion, **Bonnie Ram** (continued)—Discussion about the priority votes for conservation/management concerns
1:30-3:00	Facilitated Discussion, **Bonnie Ram**—What are "best practices" in research protocols and monitoring going forward?
3:00-3:30	BREAK
3:30-4:15	Facilitated Discussion, **Thomas Kunz—**What are the estimated costs of addressing the priority research gaps?
4:15-4:30	Key Messages for the Congressional Hearing, **Merlin Tuttle**
4:30	ADJOURN

Appendix C. Current References on White-nose Syndrome

Blehert, D., A.C. Hicks, M. Behr, C.U. Meteyer, B.M. Berlowski-Zier, E.L. Buckles, J.T.H. Coleman, S.R. Darling, A. Gargas, R. Niver, J.C. Okoniewski, R.J. Rudd, and W.B. Stone. 2009. Bat White-nose Syndrome : an emerging fungal pathogen? *Science* **323**, 227.

Boyles, J.G., and C.K.R. Willis. 2009. Could localized warm areas inside cold caves reduce mortality of hibernating bats affected by White-nose Syndrome ? *Frontiers in Ecology and the Environment*. doi: 10.1890/080187.

Frick, W.F., D.S. Reynolds, and T.H. Kunz. 2009. Influence of climate and reproductive timing on demography of little brown myotis (*Myotis lucifugus*). *Journal of Animal Ecology* (in press).

Gargas, A., M.T. Trest, M. Christensen, T.J. Volk, and D.S. Blehert. 2009. *Geomyces destructans* sp. nov. associated with bat white-nose sydrome. *Mycotaxon* **108**, 147-154.

Meteyer, C.U., E.L. Buckles, D.S. Blehert, A.C. Hicks, D.E. Green, V. Shearn-Bochsler, N.J. Thomas, A. Gargas, and M.J. Behr. 2009. Histopathologic criteria to confirm White-nose Syndrome in bats. *Journal of Veterinary Diagnostic Investigation* **21**, 411-414.

Reichard, J.D., and T.H. Kunz. 2009. White-nose Syndrome inflicts lasting injuries to the wings of little brown myotis (*Myotis lucifugus*). *Acta Chiropterologica* (in press).