White-Nose Syndrome:
Current Status of the Disease and the Collaborative Response

Mike Armstrong, Jeremy Coleman, Jonathan Reichard, Christina Kocer, & Rich Geboy

US Fish and Wildlife Service

ASMR & ARRI Meeting

June 10, 2015
Overview of WNS

- A fungal disease of hibernating bats that continues to spread through North America
  - 26 states and 5 provinces confirmed
  - Evidence of causative fungus found in 2 additional states
- Disease caused by fungus *Pseudogymnoascus destructans* (*Pd*)
  - Grows at cold temperatures
  - Invasive pathogen, likely of foreign origin
- Mortality exceeds 90% for many sites and species
- Research continues to drive response
- Management:
  - Actions focused on containment and conservation
  - Multiple treatment options under investigation
Current Spread – 26 states, 5 Canadian Provinces

2006 - 2007

2006-07
BAT WHITE NOSE SYNDROME
Occurrence by County/District
(or portions thereof)

First detected Feb. 2006
Schoharie Co., NY

Fall/Winter/Spring
2006-07

Confirmed: Solid color
Suspect: Solid color with dots

Map by: Lindsey Heffernan, PA Game Commission
Current Spread – 26 states, 5 Canadian Provinces

2007 - 2008

2007-08
BAT WHITE NOSE SYNDROME
Occurrence by County/District
(or portions thereof)

First detected Feb. 2006
Schoharie Co., NY

Fall/Winter/Spring
- 2006-07
- 2007-08

Confirmed: Solid color
Suspect: Solid color with dots

Map by: Lindsey Heffernan, PA Game Commission
Current Spread – 26 states, 5 Canadian Provinces

2008 - 2009

2008-09
BAT WHITE NOSE SYNDROME
Occurrence by County/District
(or portions thereof)

First detected Feb. 2006
Schoharie Co., NY

Fall/Winter/Spring

2006-08
2008-09

Confirmed: Solid color
Suspect: Solid color with dots

Map by: Lindsey Heffernan, PA Game Commission
Current Spread – 26 states, 5 Canadian Provinces

2010 - 2011

2010-11
BAT WHITE NOSE SYNDROME
Occurrence by County/District
(or portions thereof)

First detected Feb. 2006
Schoharie Co., NY

Fall/Winter/Spring
- 2006-10
- 2010-11

Confirmed: Solid color
Suspect: Solid color with dots

Map by: Lindsey Heffernan, PA Game Commission
Current Spread – 26 states, 5 Canadian Provinces

2011 - 2012

2011-12
BAT WHITE NOSE SYNDROME
Occurrence by County/District
(or portions thereof)
First detected Feb. 2006
Schoharie Co., NY

Fall/Winter/Spring
- 2006-11
- 2011-12
Confirmed: Solid color
Suspect: Solid color with dots

Map by: Lindsey Heffernan, PA Game Commission
Current Spread – 26 states, 5 Canadian Provinces

2013 - 2014

2013-14

BAT WHITE NOSE SYNDROME
Occurrence by County/District
(or portions thereof)

First detected Feb. 2006
Schoharie Co., NY

Fall/Winter/Spring

- 2006-13
- 2013-14

Confirmed: Solid color
Suspect: Solid color with dots

Map by: Lindsey Heffernan, PA Game Commission
Current Spread – 26 states, 5 Canadian Provinces

2014 - 2015

04/17/2015

BAT WHITE NOSE SYNDROME
Occurrence by County/District
(or portions thereof)

First detected Feb. 2006
Schoharie Co., NY

Fall/Winter/Spring

- 2006-14
- 2014-15

Confirmed: Solid color
Suspect: Solid color with dots

Map by: Lindsey Heffernan, PA Game Commission
Seven Species Confirmed with WNS
(In North America)

Little brown bat *(Myotis lucifugus)*
(MYLU)

Northern long-eared bat* *(Myotis septentrionalis)* *(Perimyotis subflavus)*
(MYSE, PESU)

Tri-colored bat *(Myotis sodalis)*
(MYSO)

Eastern small-footed bat *(Myotis leibii)*
(MYLE)

Big brown bat *(Eptesicus fuscus)*
(EPFU)

Gray bat* *(Myotis grisescens)*
(MYGR)

Photos: Merlin Tuttle, Bat Conservation International
Additional species on which *Pd* has been detected

(In North America)

- **Southeastern bat**
  
  *(Myotis austroriparius)*

- **Virginia big-eared bat**
  
  *(Corynorhinus townsendii virginianus)*

- **Rafinesque's big-eared bat**
  
  *(Corynorhinus rafinesquii)*

- **Silver-haired bat**
  
  *(Lasionycteris noctivagans)*

- **Eastern red bat**
  
  *(Lasiurus borealis)*
WNS in Europe

- 13 species confirmed with Pd
- No mass mortality documented
- Long-term presence
- Considerable genetic variation
- North American Pd may have originated in western Europe

## Bat Populations in NY, PA, VT, VA, WV

from 42 hibernacula w/ 2+ yrs of mortality/WNS

<table>
<thead>
<tr>
<th>Species</th>
<th>Total change 2011 (Turner et al.)</th>
</tr>
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<tbody>
<tr>
<td>Little brown</td>
<td>-91%</td>
</tr>
<tr>
<td>Northern</td>
<td>-98%</td>
</tr>
<tr>
<td>Tricolored</td>
<td>-75%</td>
</tr>
<tr>
<td>Indiana</td>
<td>-72%</td>
</tr>
<tr>
<td>Small-footed</td>
<td>-12%</td>
</tr>
<tr>
<td>Big brown</td>
<td>-41%</td>
</tr>
<tr>
<td>Total</td>
<td>-88%</td>
</tr>
</tbody>
</table>
### Bat Populations in NY, PA, VT, VA, WV, CT, MA, MD, NC, NH, NJ, QC

from 42/149 hibernacula w/ 2+ yrs of mortality/WNS

<table>
<thead>
<tr>
<th>Species</th>
<th>Total change 2011 (Turner et al.)</th>
<th>Sum Pre-WNS</th>
<th>Sum Post-WNS</th>
<th>Total change 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little brown</td>
<td>-91%</td>
<td>600,595</td>
<td>76,968</td>
<td>-87%</td>
</tr>
<tr>
<td>Northern</td>
<td>-98%</td>
<td>4,412</td>
<td>196</td>
<td>-96%</td>
</tr>
<tr>
<td>Tricolored</td>
<td>-75%</td>
<td>16,826</td>
<td>4,224</td>
<td>-75%</td>
</tr>
<tr>
<td>Indiana</td>
<td>-72%</td>
<td>51,744</td>
<td>34,951</td>
<td>-32%</td>
</tr>
<tr>
<td>Small-footed</td>
<td>-12%</td>
<td>3,087</td>
<td>4,359**</td>
<td>+41%</td>
</tr>
<tr>
<td>Big brown</td>
<td>-41%</td>
<td>5,012</td>
<td>3,745</td>
<td>-25%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>-88%</strong></td>
<td><strong>681,677</strong></td>
<td><strong>124,442</strong></td>
<td><strong>-82%</strong></td>
</tr>
</tbody>
</table>

**increase of ~1,300 small-footed at a single site in NY**
### Bat Populations in the Midwest
from hibernacula w/ 3 yrs of mortality/WNS*

<table>
<thead>
<tr>
<th>Species</th>
<th>Ohio (36,541 bats, 2 sites)</th>
<th>Indiana (100,766 bats, 15 sites)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little brown</td>
<td>-97%</td>
<td>-80%</td>
</tr>
<tr>
<td>Tricolored</td>
<td>-98%</td>
<td>-45%</td>
</tr>
<tr>
<td>Northern</td>
<td>-90%</td>
<td>-60%</td>
</tr>
<tr>
<td>Indiana</td>
<td>-49%</td>
<td>-16%**</td>
</tr>
<tr>
<td>Big brown</td>
<td>-41%</td>
<td>+4%</td>
</tr>
</tbody>
</table>

**Winter of 2013-2014, preliminary analyses**

Data Courtesy: ODOW & IDNR, Jennifer Norris & Scott Johnson

* Decline estimated from winter of first WNS confirmation to most recent population count in sites with ≥3 years of WNS

** Biennial population census of larger caves not conducted in winter 2013 – 2014.
A Glimmer of Hope?

Little brown recaptures in MA, NH, and VT

<table>
<thead>
<tr>
<th>Number of winters survived</th>
<th>Summer in which the bat was last recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2009</td>
</tr>
<tr>
<td>1</td>
<td>34 (3)</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
</tr>
</tbody>
</table>

*Includes 1 adult male recaptured in Framingham, MA, on 12 July 2011.
**Includes 1 adult male recaptured in Milford, NH, on 17 July 2012.

<table>
<thead>
<tr>
<th>Condition</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnant</td>
<td>15 (2)</td>
<td>3 (3)</td>
<td>1 (1)</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>22 (6)</td>
</tr>
<tr>
<td>Lactating</td>
<td>9 (2)</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>-</td>
<td>21 (2)</td>
</tr>
<tr>
<td>Postlactating</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>7 (1)</td>
<td>-</td>
<td>2</td>
<td>14 (1)</td>
</tr>
</tbody>
</table>

New Research

Dynamics of fungal infection and transmission

- 6 bat species, 30 sites
- Peak transmission in the fall
- Peak fungal loads at end of winter
- Infection cleared in the summer

Management Implications – best time to apply a treatment is in early winter, when transmission rates are the highest

Treatment and Other Conservation Measures

Treatment and preventions under investigation:

- Probiotics
- Microbial derived compounds
- Mycovirus
- Vaccine development
- Other fungicides…

WNS Treatment Strategy Workshop – 2015

Other Conservation Measures:

- Cave advisory & Decontamination guidance
- Guidance Documents
  - NWCO, Rehab, Forest Management, & Bats and Bridges guidance documents
  - Captive management recommendations
- NABat report & implementation - baseline in non-WNS areas, trends over time in WNS areas
Managing WNS: A Tale of Two Plans

US National Plan
Purpose:
To guide the response of Federal, State, and Tribal agencies, and partners to WNS

Canadian National Plan
Purpose:
To organize Canada’s response to WNS, in collaboration with the US plan
Canadian WNS Organization Structure

- Bat Population Monitoring
  - T. W. G.
- Surveillance & Diagnostics
  - T. W. G.
- WNS Mitigation
  - T. W. G.
- Communications and Outreach
  - W. G.
- Data Management
  - W. G.
- Stakeholders
- Inter-agency WNS Committee
- US Action Plan
- Steering Committee
- Working groups
US Working Groups

Diagnostics – Anne Ballmann, USGS NWHC
  - Diagnostics protocols & case definitions

Disease Surveillance – Eric Britzke, DoD
  - National Surveillance Plan

Communications and Outreach - Catherine Hibbard, USFWS
  - National Communications Plan, Outreach, EduBat

Data and Technical Information Management – Laura Ellison, USGS FORT
  - Bat Population Database, Disease Tracking Database

Disease Management – Jonathan Reichard, USFWS (interim)
  - Decontamination, Cave Management Guidance, Treatment/Control

Etiological and Epidemiological Research – Sybill Amelon, USFS, NRS
  - Environmental Manipulations

Conservation and Recovery – Robyn Niver, USFWS
  - NaBat, Species and Habitat Recovery, Captive Management
Budget for WNS

- Agency spending, FY07-13: ~$40 million (USFWS, USGS, NPS, BLM, USFS, APHIS, DoD, ~40 states)

- USFWS total allocation, FY07-14: ~$27 million
  - USFWS grants through FY14: >$20 million

- USFWS research and state support in FY2015
  - $3.4 million
  - 4 grant opportunities
USFWS Funding & Support – FY2014

- $1.6 million for 8 Federal agency research projects
  Matched with $1.6 million by USGS, USFS, & NPS
- $1.9 million for 9 Research projects
- $1.3 million to 30 states for WNS capacity

Research targets:
- $d$ surveillance
- Treatment and control of $d$
- Understanding bat populations, pre- and post-WNS
- Bat physiology and immunology
- $d$ genetics, ecology, and pathogenicity
- Population monitoring, NABat
- Ecological Impacts
- Communications and Outreach
Future of WNS?

- Models predict continued spread
- All hibernating bat species potentially at risk
- Long-term impacts to bat population dynamics uncertain

Maher et al. 2012
Multi-Partner Collaboration
<table>
<thead>
<tr>
<th>Region</th>
<th>Coordinator</th>
<th>Email</th>
<th>Location</th>
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<tbody>
<tr>
<td>National</td>
<td>Jeremy Coleman</td>
<td><a href="mailto:Jeremy_Coleman@fws.gov">Jeremy_Coleman@fws.gov</a></td>
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<td>Nat’l Asst.</td>
<td>Jonathan Reichard</td>
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<td>Hadley, MA</td>
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<td>Nat’l Comm.</td>
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<tr>
<td>1</td>
<td>Don Campton</td>
<td><a href="mailto:Don_Campton@fws.gov">Don_Campton@fws.gov</a></td>
<td>Portland, OR</td>
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<td>2</td>
<td>Jennifer Smith-Castro</td>
<td><a href="mailto:Jennifer_Smith-Castro@fws.gov">Jennifer_Smith-Castro@fws.gov</a></td>
<td>Houston, TX</td>
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<td>3</td>
<td>Rich Geboy</td>
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<td>Bloomington, IN</td>
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<td>4</td>
<td>Mike Armstrong</td>
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<td>Frankfort, KY</td>
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<td>5</td>
<td>Christina Kocer</td>
<td><a href="mailto:Christina_Kocer@fws.gov">Christina_Kocer@fws.gov</a></td>
<td>Hadley, MA</td>
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<td>6</td>
<td>Chris Servheen</td>
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<td>7</td>
<td>Drew Crane</td>
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<td>8</td>
<td>Bronwyn Hogan</td>
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<td>Sacramento, CA</td>
</tr>
<tr>
<td>NWRS</td>
<td>Laura Eaton</td>
<td><a href="mailto:Laura_Eaton@fws.gov">Laura_Eaton@fws.gov</a></td>
<td>Newington, NH</td>
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