



CONSERVATION & MANAGEMENT OF DECLINING BAT POPULATIONS IN EASTERN FORESTS

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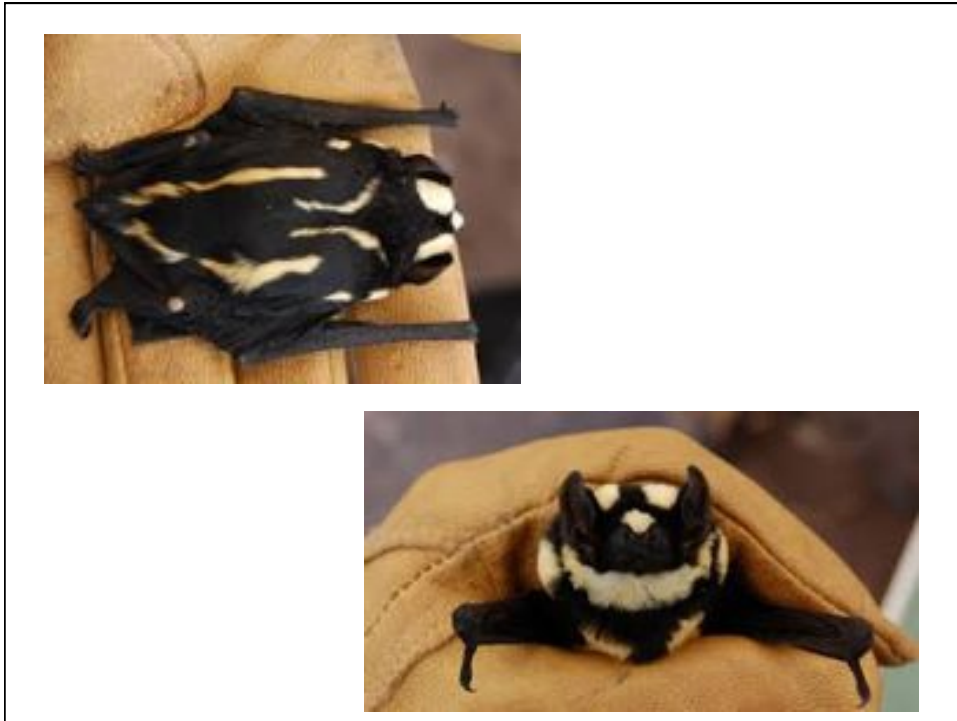
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Flight Plan

- 1. Why bats are important/why you need to care.**
- 2. Threats to bats**
- 3. What can managers to do?**
- 4. Monitoring bat populations at local and regional/continental scales**

Importance of Bats



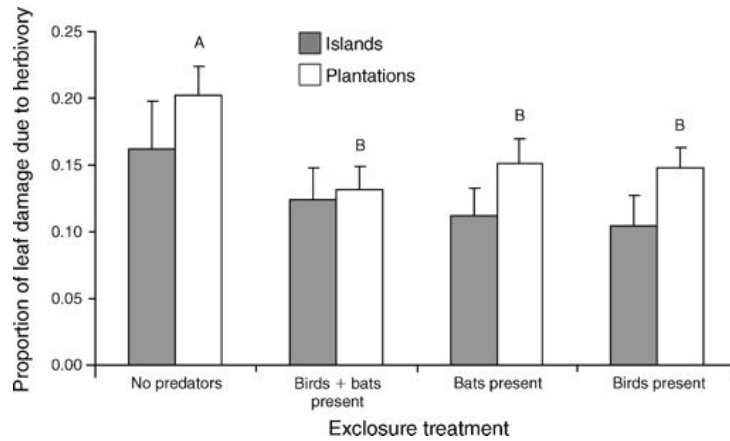


Insect Predators

- 70% bats worldwide
- ~ 95% US bats



Impact of Bats in Tropical Systems



Morrison & Lindell 2012

Impacts of Bats in US Agricultural Systems

Table 1. Value of pest control service provided by the Brazilian free-tailed bat (*Tadarida brasiliensis*) in the Winter Garden region of south-central Texas

Cost or value	Low egg/larvae survival	Reference case	High egg/larvae survival
Avoided crop damage	\$121	\$638	\$1519
Avoided pesticide cost (private)	\$0	\$100	\$200
Avoided pesticide cost (social)	\$0	\$3	\$6
Total annual value	\$121	\$741	\$1725

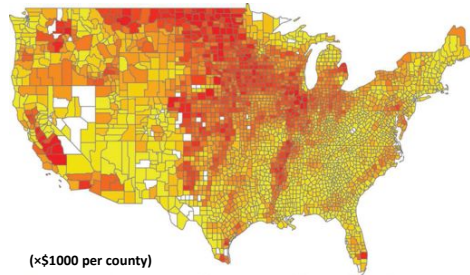
Units are thousands of \$US unless otherwise noted.

Cleveland et al. 2006

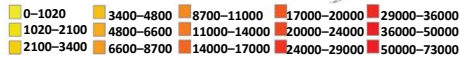


Impacts of Bats in US Agricultural Systems

= ~\$23 Billion US-Wide



(×\$1000 per county)



Boyles et al. 2011

Other Ecological & Economic Services

- Pollination
- Seed dispersal
 - ~550 plants in neotropics
- Nutrient cycling
 - Hotspot hypothesis
- Tourism
- Medical research



Legal Status

- Eastern US
– 4 Federally Listed



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Legal Status

- **Eastern US**
 - 4 Federally Listed
 - 1 Proposed Endangered



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Threats

- **Chronic**
- **New**

Major 20th Century Threats

- Habitat loss & fragmentation



Major 20th Century Threats

- Cave & Mine Disturbance/Destruction



Major 20th Century Threats

- **Toxicants and pollutants**
 - Water
 - Pesticides
 - Heavy metals
 - Light pollution
 - LED's
 - Roads/traffic



Major 21st Century Threats



Wind Energy Related Mortality

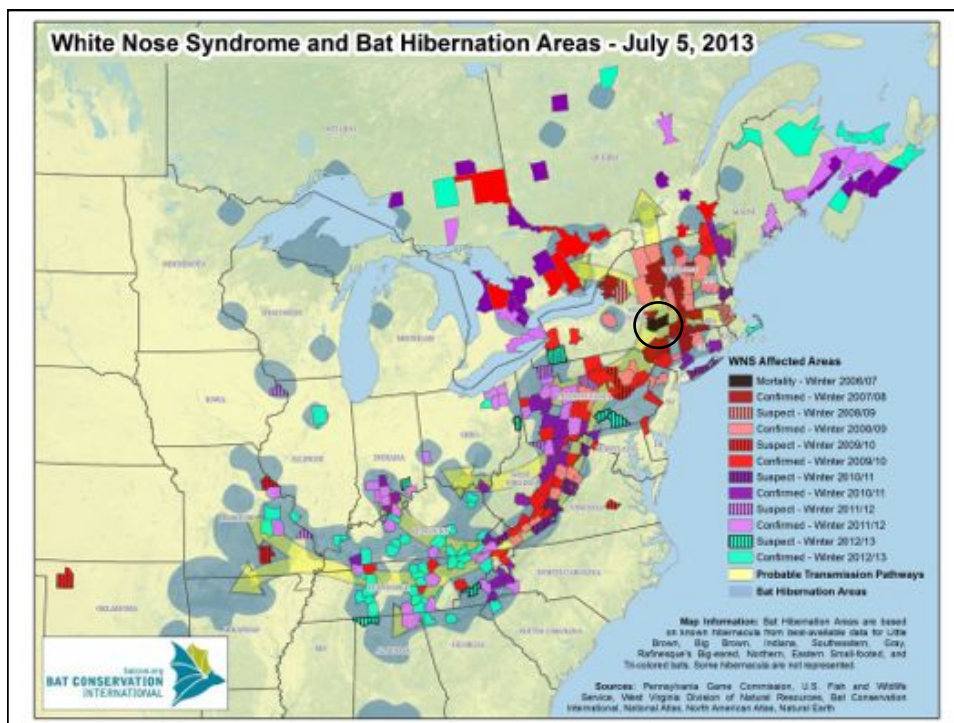
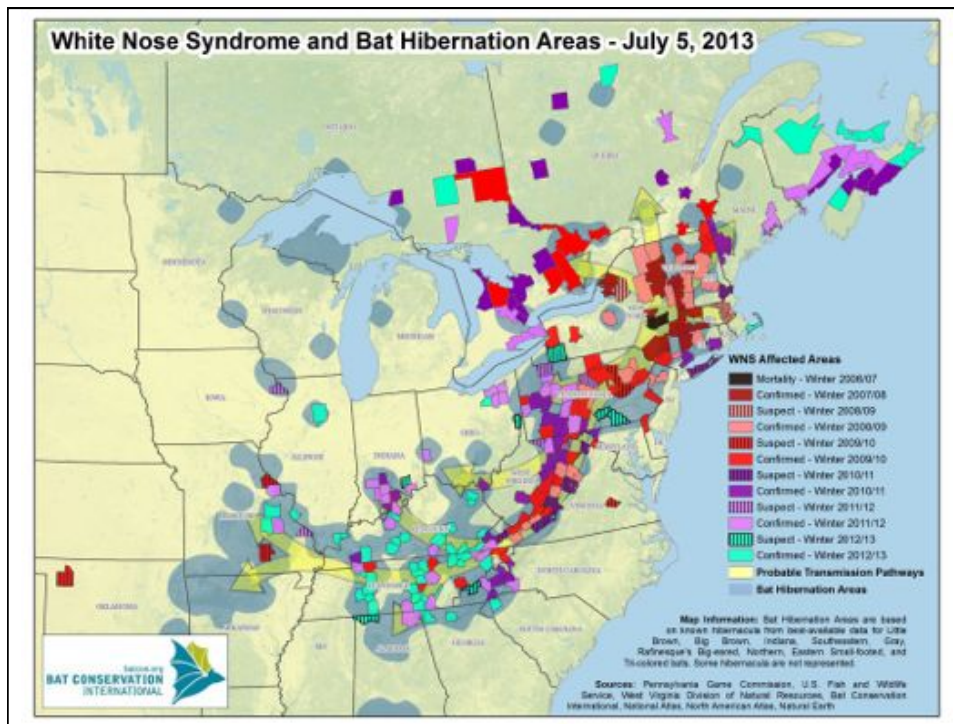
- Fall Migration
- Collisions
- Barotrauma
- Mid-Atlantic 2020
 - Kunz et al. (2007)
 - 33,000-60,000 bats/yr
- Nationwide 2012
 - Smallwood (2013)
 - 880,000 bat/yr



Major 21st Century Threats

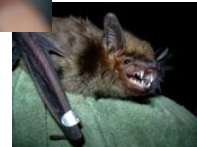
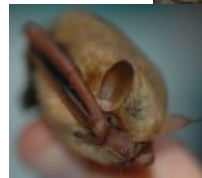
- White-nose Syndrome



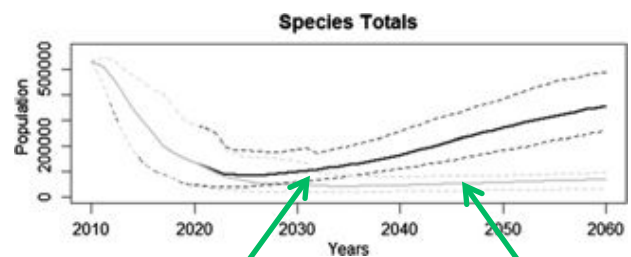


WNS Effects

- 5-6 million bats dead
- Little brown bats (-91%)
- Northern long-eared bats (-98%)
- Small-footed bats (-12%)
- Indiana bat (-72%)
- Tri-colored bat (-75%)
- Big brown bat (-41%)



Indiana Bats

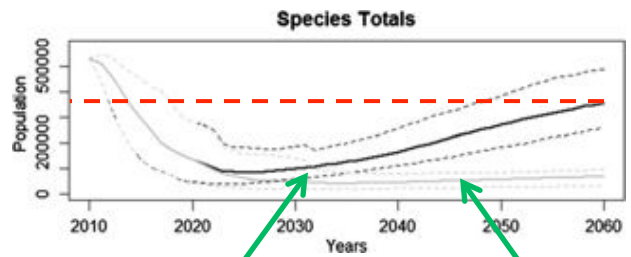


Acquired Immunity

Persistent Influence

Thogmartin et al. 2013

Indiana Bats

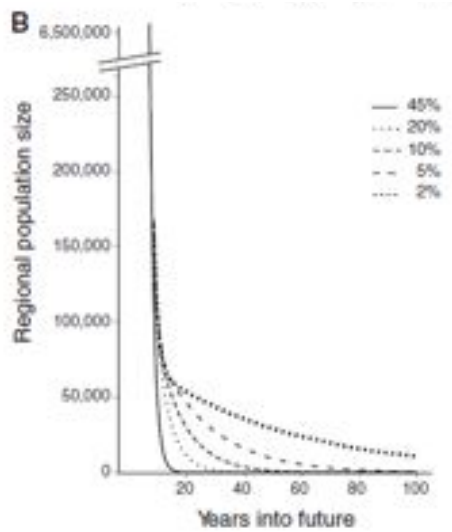


Acquired Immunity

Persistent Influence

Thogmartin et al. 2013

Little Brown Bats



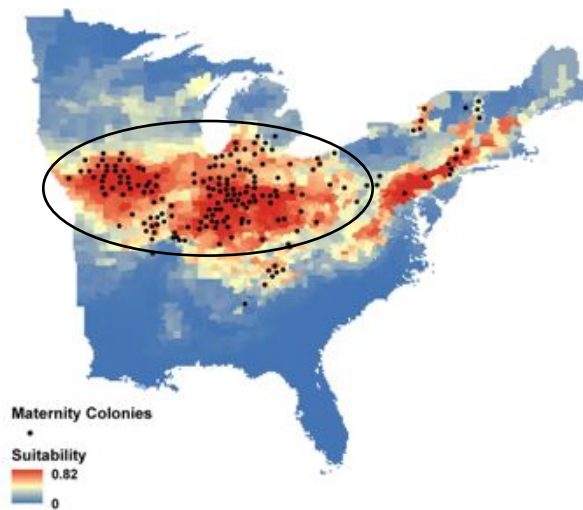
Frick et al. 2010

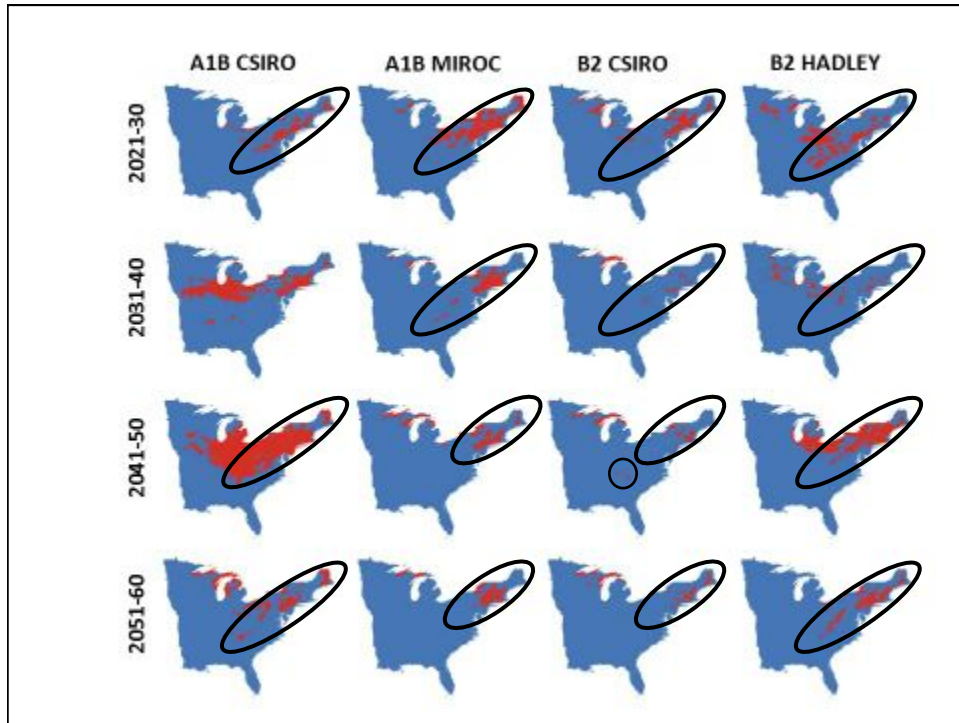
Climate Change

- Range contractions?
- Range expansions?

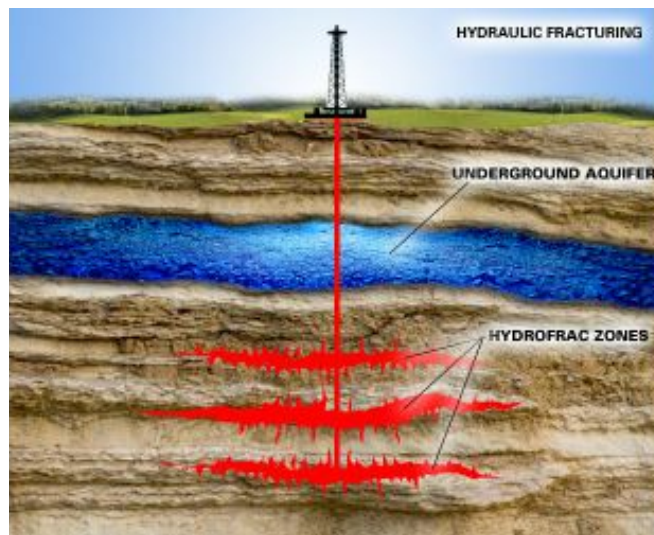


Current Distribution





21st Century Threats



What's A Manager To Do?



- 1. Figure out what bats require**
- 2. Figure out how you can provide those requirements**
- 3. Figure out how you can eliminate or decrease threats**

Basic Requirements

- **A place to live**
 - i.e., roosts
- **A place to eat**
 - i.e., foraging habitat and food
- **A place to drink**
 - i.e., easy access to clean water

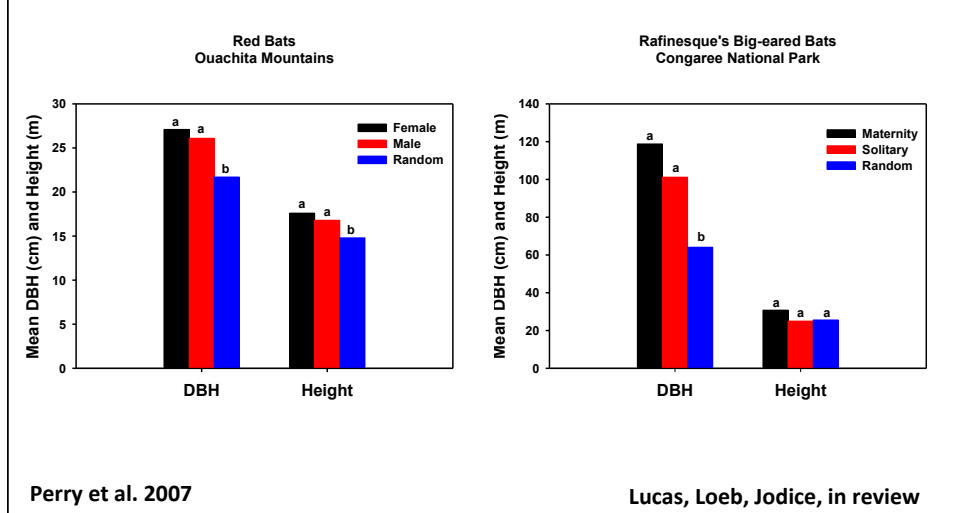


A Place to Rest

- **“Cave Bats”**
- **“Tree Bats”**



Management Strategies Live Trees



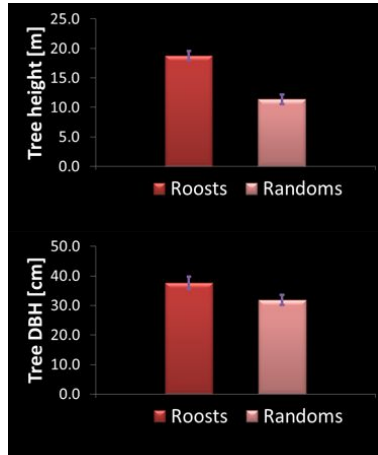
Management Strategies Live Trees

- Large trees
- Mature forests
- Maintain damaged trees
- Artificial cavities?



Management Strategies Snags

Indiana Bats – Southern Appalachians



O'Keefe & Loeb, unpub. data

Management Strategies Snags

- **Maintain large snags**
 - Safety considerations
 - Small snags also used
- **Snag clusters**
- **Create snags?**



Prescribed Fire Effects?



Prescribe Fire Effects Winter Burns - Litter Roosts

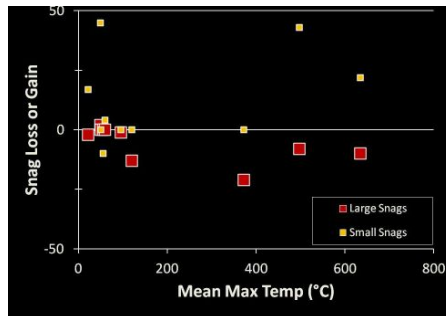
- **Winter Prescribed burns**
 - Red bat response time ↓
 - ↑ temp
 - ↑ wind speed
 - Smoke as cue
 - **Roost in trees**
 - Higher temp
 - **Recommendation**
 - ≥ 10 °C (50 °F) time of burn



Hein et al. 2005, Scesny 2006, Layne 2009

Prescribed Fire Effects Winter or Summer - Snags

- Does fire destroy snags?
- Does fire create snags?
- GSMNP, NF



O'Keefe & Loeb, unpublished data



Prescribed Fire Effects Roosting Habitat

- Bats select roosts in burned habitat
 - Evening bats (Boyles & Aubry 2006)
 - Northern long-eared bats (Johnson et al. 2009, Lacki et al. 2009)
- Opens canopy
 - Increase solar radiation

Prescribed Fire Effects Spring/Summer Burns

- Prescribed fire may benefit habitat
- But, may have short-term direct effects
 - Avoid post-emergence burns
 - More likely to torpor
 - Depleted fat reserves
 - Avoid late-pregnancy/early lactation

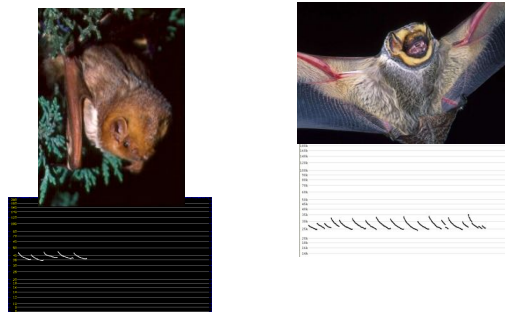
Foraging Habitat

- Adaptation to clutter

Clutter
Adapted



Open
Adapted

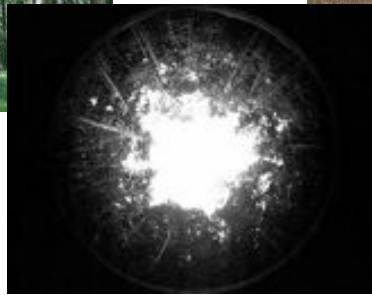


Forest Habitats

Mature Forest

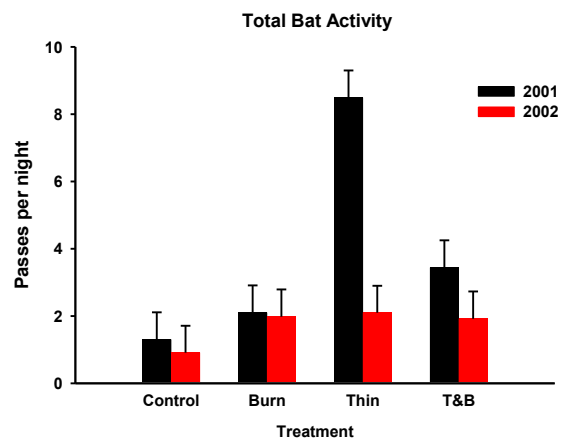


Openings & Edges



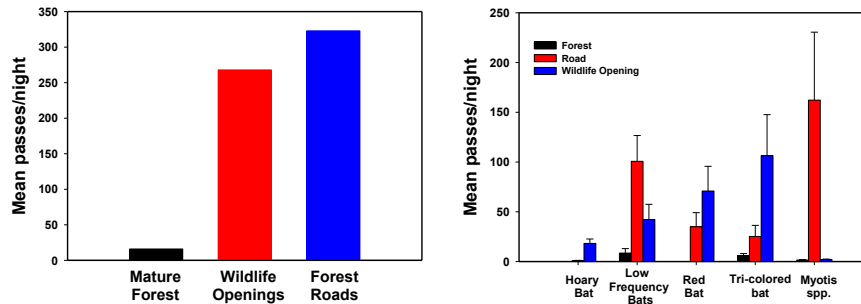
Canopy Gaps

Effects of Forest Management on Bat Activity



Loeb & Waldrop 2008

Effects of Forest Management on Bat Activity



Loeb & O'Keefe 2011

Management Strategies Forest Habitats

- **Maintain mature forest**
- **Reduce Clutter**
 - Thinning
 - Prescribed fire
- **Create or maintain small gaps**
- **Maintain early successional habitat and edges**

Riparian Habitats

- **Maintain open flight corridors**
- **Maintain large trees**
 - Roosts
 - Predator protection

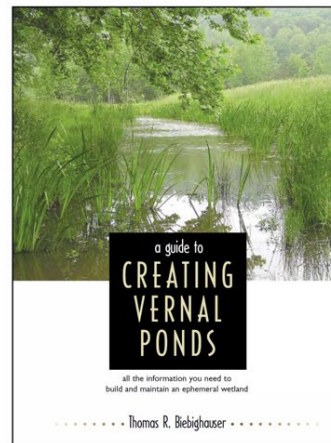


Drinking Water

- **Dependence on water varies**
 - Species
 - Habitats
- **May also be important Ca source**
- **Rich in insect prey**

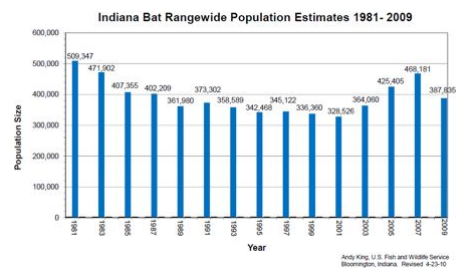
Drinking Water Constructed ponds

- Benefits other wildlife
- May increase in importance with climate change



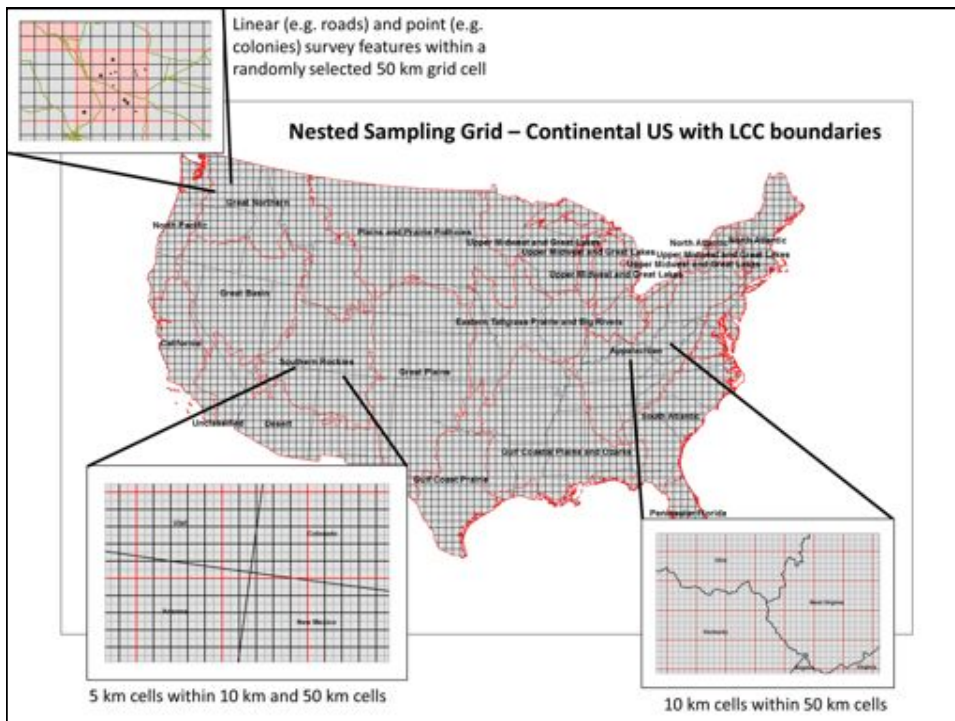
Monitoring

- Are threatened bats continuing to decline?
- Are other species declining?
 - Early warning system
- Are bat distributions changing?
- Is our management effective?

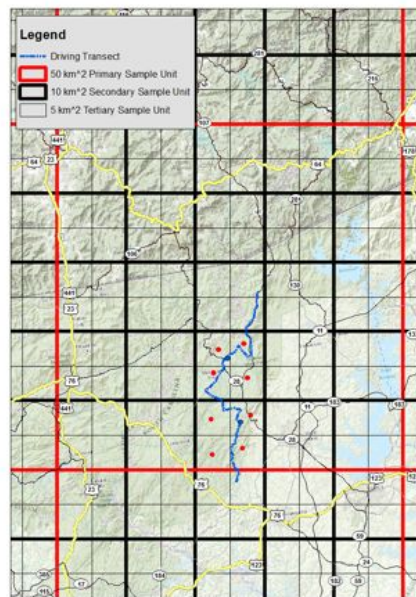
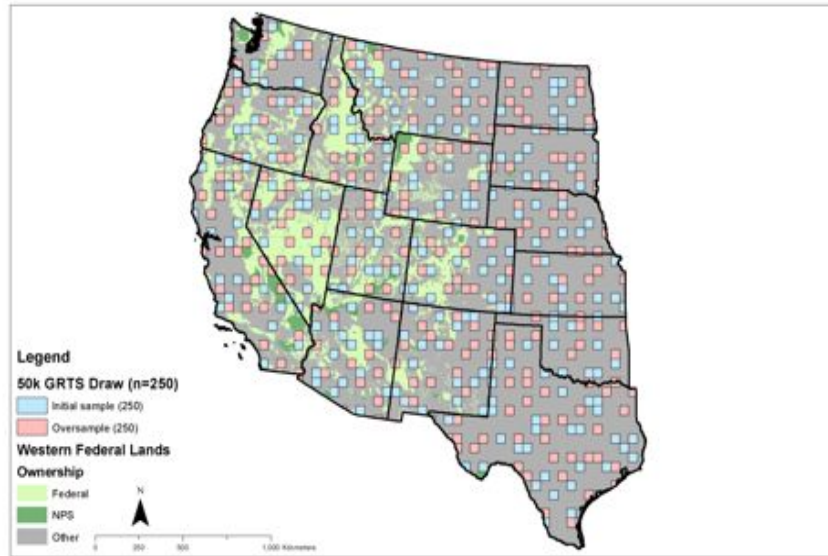


North American Bat Monitoring Initiative (NABat)

- **Interagency/International Effort**
 - US, Canada, Mexico
 - 45 bat spp common to all 3
- **Scalable sampling protocol**
 - Site to continental
- **Methods**
 - Colony Counts
 - Acoustic driving transects
 - Acoustic point samples



Example Draw



NABat Program Vision

- **National/International Coordinator**
- **Analyst**
- **Database**
 - Bat Population Data (BPD) Project
 - USGS Fort Collins
 - <http://my.usgs.gov/bpd>
- **Products:**
 - Annual & multi-annual “State of North American Bats”



Questions?