

White-nose Syndrome in Michigan



Little brown bat from Mackinac Co., 3/24/14. Photo: J. Melotti, DNR-WDL.

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What is White-nose Syndrome (WNS)?

- Disease affecting hibernating colonial bats
- Named for the white fungus (*Pseudogymnoascus destructans*) that appears on the skin
- Associated with large die-offs of bats in eastern North America



Little brown bat with WNS, Dickinson Co., MI. Photo: A. Kurta, Eastern MI Univ.



WNS: Bats as hosts



- Long-lived: 10-30 years
- Longevity generally inversely related to ability to reproduce
 - MI bats typically raise only 1 or 2 pups/year
- Consequence is that bat populations are ill-equipped to absorb and recover from mass mortality



WNS: The host

All 5 colonial species native to MI known to be affected

- Little brown bat (*Myotis lucifugus*)
- Northern long-eared bat (*M. septentrionalis*)
- Indiana bat (*M. sodalis*; Fed. endangered)
- Eastern pipistrelle (*Perimyotis subflavus*)



- Big brown bat (*Eptesicus fuscus*)
- Susceptibility, progression differ by species and/or microclimate (Langwig et al., 2012, *Ecol. Lett.* 15:1050-1057)



WNS: The fungus

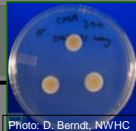


Photo: D. Berndt, NWHC

- *Pseudogymnoascus destructans* is proven causal agent (Lorch et al. 2012, *Nature* 480:376)
- Single genotype, introduced from Europe, in all likelihood by human transport, responsible for entire outbreak (Rajkumar et al., 2011, *Emerg. Infect. Dis.* 17:1273-1276)



WNS: The environment

- Colonial bat species hibernate where temperatures are close to, but above, freezing
- Such conditions are perfect for the growth and long term persistence of *P. destructans*

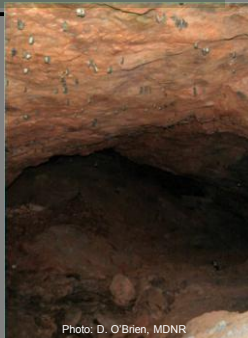
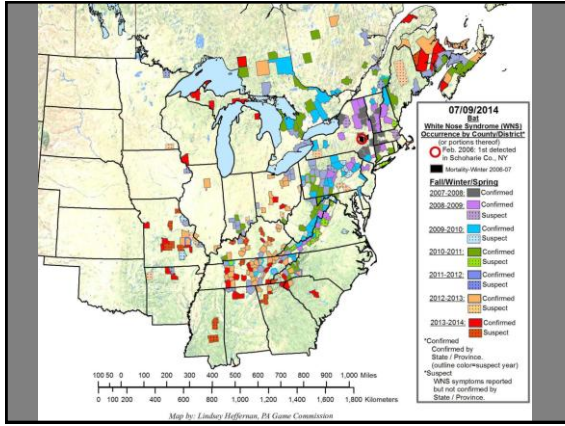
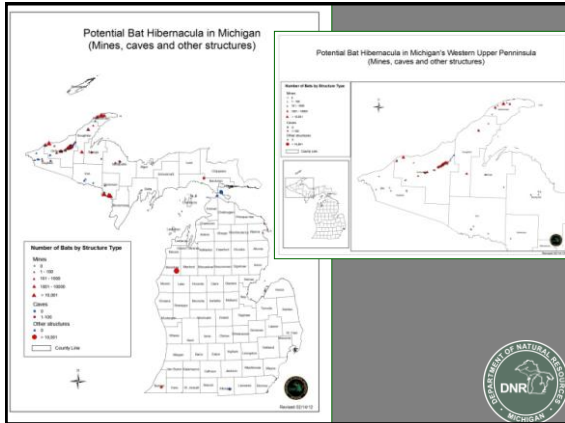


Photo: D. O'Brien, MDNR











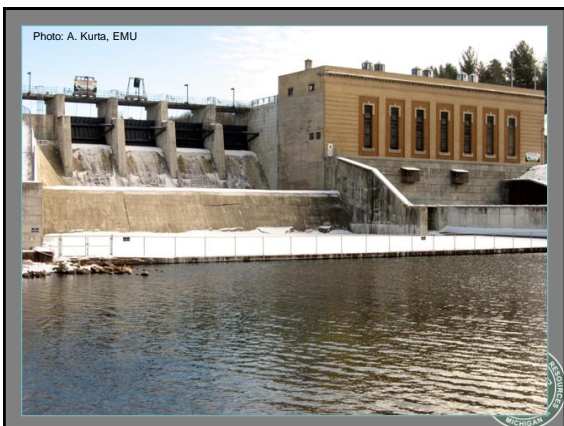


Table 1. Populations of hibernating bats in Michigan that exceed 500 individuals as of the latest available count or estimate. Assembled by A. Kurta on 1 May 2014.

Rank	Hibernaculum	Number of bats
1	Caledonia Mine complex	95,665
2	Millie Hill Mine	35,000-50,000
3	Adventure Mine	33,145
4	Iron Mountain Iron Mine	23,891
5	Tippy Dam	20,116
6	Norway Mine	19,979
7	Copper Falls Mine (including Owl Creek Falls)	18,089
8	Mead Mine	17,702
9	West Evergreen Mine	5,919
10	Burntshaw Mine	5,161
11	Nassau Mine	4,835
12	Quincy Mine	3,691
13	Seneca Mine	3,201
14	South Lake Mine	3,162
15	North Cliff Mine ^{1,2}	2,958
16	Lafayette Mine (East Shaft)	2,804
17	Windser Mine	2,762
18	Delaware Mine	2,591
19	Gunnaseac Adit	2,564
20	Beit Mine (North and South)	2,405
21	South Butte East Adit	1,969
22	Michigan A Shaft	1,610
23	Silver Mountain Mine ³	1,302
24	Adventure Adit	1,277
25	National Mine #7	964
26	Toledo Mine ⁴	836
27	Cushman Adit	825
28	Keel Ridge Shaft	784
29	Trader's Mine	695
30	Ohio (Tippock?) ²	654
TOTAL		283,743 ⁵



Photo: A. Kurta, EMU

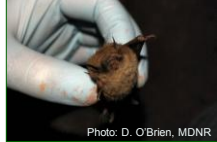


Photo: D. O'Brien, MDNR



¹No protection.
²The owner claims to have closed this mine and will not allow access to the property.

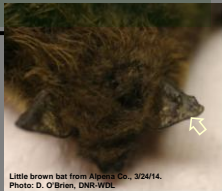
WNS: Transmission & spread

- **Bat-to-bat:**
 - Bats transmit fungus to each other by direct (**touching**) and indirect (**environmental contamination**) contact
 - Likely transport fungus to new sites during fall movements (**swarming**)
- **Human-assisted:**
 - Fungus contaminates clothing, boots and equipment of cavers, researchers and tourists who enter contaminated caves, mines
 - Humans move fungus to new sites



WNS: The Disease

- Fungus invades skin
 - Irritation
 - Alters ability to regulate water balance
- Bats repeatedly arouse from hibernation, use up stored fat more rapidly than normal (Reeder et al. 2012, PLoS One 7:10)
- Eventually arouse permanently in late winter before food (insects) available, starve (or die of metabolic dysfunction)



Little brown bat from Alpena Co., 3/24/14.
 Photo: D. O'Brien, DNR-WDC.



WNS: Ecological effects

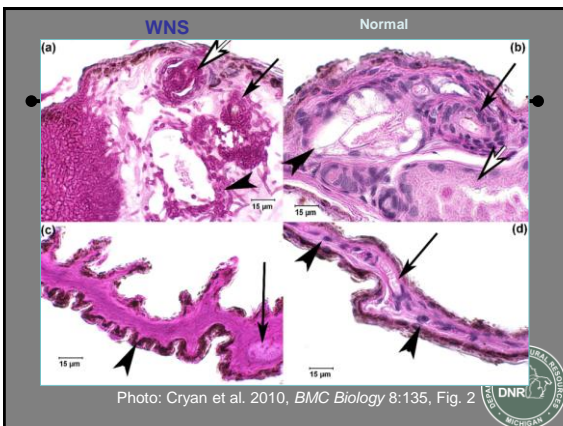
- Declines in summer abundance
 - 72%-78% reduction post WNS in MA (Brooks 2012, *Biodiversity Conserv.* 20:2537-2541) and NY (Dzal et al. 2011, *Biol. Lett.* 7:392-394)
- Estimated 660-1320 metric tons of insects (mostly crop and forest pests) may no longer be consumed in WNS areas (Boyles et al. 2011, *Science* 332:41-42)



Testing of WNS suspects

- Ongoing hibernacula surveillance by Dr. Al Kurta/Steve Smith, Eastern MI Univ.; collectors of all suspects
- Delivered to DNR Wildlife Disease Lab (WDL); examined and submitted for initial testing to MI State Univ. Diagnostic Center for Population and Animal Health (DCPAH)
- Suite of tests (polymerase chain reaction [PCR], fungal culture, histopathology) used
- Presumptive positives confirmed via same tests at National Wildlife Health Center (NWHC) in Madison, WI





Michigan WNS index cases

- Dickinson County (inactive iron ore mine)
 - Male Little Brown Bat (LBB) collected 2/20/14
 - Submitted for testing 2/27/14
 - Final DCPAH results 3/19/14
 - PCR positive for *P. d.* with DNA sequence confirmation
 - Histopathology consistent with WNS
 - Fungal culture negative for *P. destructans*
 - Shipped to NWHC 3/24/14
 - Confirmed PCR positive 3/28/14
 - Confirmed positive on histopathology 4/4/14
 - Fungal culture currently pending



MI WNS/*P. destructans* positive bats

- Mackinac County (privately-owned cave)
- Alpena County (inactive quarry)
 - LBB collected 3/22/14 (Alpena Co. [2 males, 1 female]) and 3/23/14 (Mackinac Co. [1 male])
 - Delivered 3/23/14, submitted for testing 3/24/14
 - DCPAH results as of 4/2/14
 - PCR positive for *P. destructans* in all four bats
 - Histopathology diagnostic for WNS (2 bats, 1 from each site) and consistent with WNS (2 bats, Alpena site)
 - Fungal culture for *P. destructans* pending
 - All four bats shipped to NWHC 4/1/14
 - All confirmed PCR positive 4/4/14
 - Histopath and fungal culture pending



WNS: So what now? The next steps

- Gate winter hibernacula to protect bats from human contamination/disturbance
 - 22 of the 27 largest hibernacula in the state (housing ~272,000 bats) already gated



WNS: So what now? The next steps

- Gate winter hibernacula to protect bats from human contamination/disturbance
 - 22 of the 27 largest hibernacula in the state (housing ~272,000 bats) already gated
- Land Use Order of the Director prohibiting entry to caves and abandoned mines within department-administered land and facilities



WNS: So what now? Next steps

- Outreach/education with partners
 - Bat ecology
 - Implementing decontamination to minimize human-assisted spread



The poster features a grid of bat species with their names and photos: Little Brown Bat, Northern Long-eared Bat, Evening Bat, Hoary Bat, Big Brown Bat, Tri-colored Bat or Eastern Pipistrelle, Tricolored Bat, Mexican Long-eared Bat, Evening Bat, Little Brown Bat, Hoary Bat, Silver-haired Bat, Indiana Bat, Red Bat, and Eastern Long-eared Bat. At the bottom, it says "Michigan's Brilliant Bats" and includes logos for DNR and Michigan's Wildlife Fund.

Michigan's Brilliant Bats

White-nose Syndrome in Bats

What does WNS do to bats?

How can you help bats?

- 1. Monitor bat hibernacula to avoid your property.
- 2. Follow the DNR's and other agencies' guidelines to reduce the spread of WNS.
- 3. Encourage the use of bat-friendly pest control methods.
- 4. Educating the public about bat ecology and conservation.
- 5. Encouraging the use of bat-friendly pest control methods.
- 6. Encouraging the use of bat-friendly pest control methods.


WNS: So what now? Next steps

- Outreach/education with partners
 - Bat ecology
 - Implementing decontamination to minimize human-assisted spread
- Continue winter hibernacula surveys with Dr. Al Kurta/Steve Smith, EMU
 - Discover/identify/monitor important hibernacula for conservation
 - Assess severity & spread of WNS, facilitate research



WNS: WNS & the public

- Signs of WNS the public will notice:
 - Bats flying during daytime or roosting on the outside of buildings **in winter**;
 - Bats having difficulty flying, especially **in winter**;
 - Large numbers of dying or dead bats, especially at the opening of a cave or mine **in winter**;
 - Hibernating bats with white fungus on their face or wings **during winter**;
 - Bats with scarred or misshapen wings or tails any time of year;
- Increased exposure of public to sick and dead bats (rabies exposure potentially a concern)



WNS: Management

- Culling unlikely to be effective due to high contact rates, multiple exposures, periodic movement (Hallam and McCracken 2011, *Conserv. Biol.* 25:189-194)
- Specific antifungals exist (Chaturvedi et al. 2012, *PLoS One*, 6,) but problematic delivery, effect on non-target organisms make use infeasible (Foley et al. 2011, *Conserv. Biol.* 25:223-231)
- Prevention of anthropogenic spread of limited value because of bat-to-bat transmission (witness Mammoth Cave NP)



WNS: Management

- Rehabilitation unlikely to play a meaningful role until populations critically endangered, if at all
 - Minimal effect at population level
 - Clinical therapies thus far ineffective (Meteyer et al., 2011, *J. Wildl. Dis.* 47(3):618-626) and safe methods of delivery as yet unavailable (Foley et al. 2011, *Conserv. Biol.* 25:223-231)
 - Perpetual unresolved issues: iatrogenic transmission, exposure to rabies, difficulty of captive propagation, inability to treat sufficient numbers, etc.
- Habitat conservation currently our best shot at post-WNS management



WNS: Management

Habitat conservation

- Assumes there are at least some less susceptible individuals, which current evidence supports (at least for some species) (Langwig et al., 2012, *Ecol. Lett.* 15:1050-1057)
- Two components
 - Conservation of important winter hibernacula from human disturbance
 - Conservation of summer roost habitat (dead trees with cavities, peeling bark, in riparian areas)





Photo: A. Kurta, EMU



Photo: A. Kurta, EMU



Photo: A. Kurta, EMU



Photo: A. Kurta, EMU



Photo: A. Kurta, EMU, In: Kurta, A., 2008. Bats of Michigan. Terre Haute, IN: Indiana State University Center for North American Bat Research and Conservation, Figure 54.



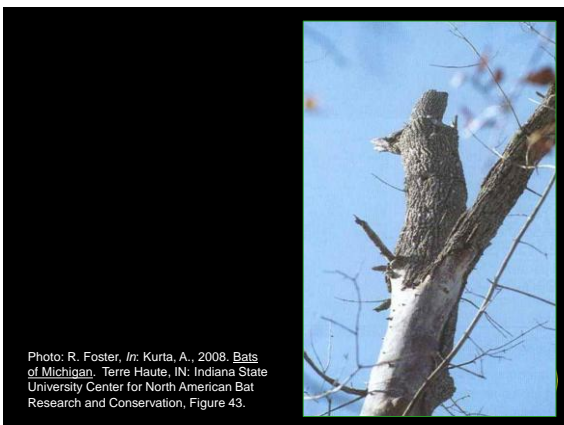


Photo: R. Foster, In: Kurta, A., 2008. Bats of Michigan. Terre Haute, IN: Indiana State University Center for North American Bat Research and Conservation, Figure 43.

MI WNS response plan

http://www.michigan.gov/documents/emergingdiseases/MichiganWNSPlanFINAL122010_342261_7.pdf

Healthy little brown bats, Dickinson Co. Photo: D. O'Brien, MDNR



Thank You

www.michigan.gov/wildlifediseases



BAT IDENTIFICATION STUDY

Julie Melotti
DNR Wildlife Disease Lab




BAT IDENTIFICATION STUDY

- Began in 2008
- 2007
 - Higher than normal submissions
 - Higher % positive
- Track bat submissions
 - Increase influenced by bats?
 - Or in response to increased press coverage?

Year	# Submitted	% Positive
2003	877	5.6
2004	547	6.8
2005	743	3.8
2006	1022	3.8
2007	1960	10.2
2008	1833	3.8
2009	1305	4.0
2010	1285	4.7
2011	1230	4.6
2012	1358	3.8
2013	1215	3.4

BAT IDENTIFICATION STUDY

- Examine all bats submitted to MDCH for rabies testing
 - Species
 - Age class (June through August 15)
 - Sex
- All negative bats examined at DNR WDL with Dr. Kurta
- All positive and unknown bats examined at MDCH by Dr. Kurta



MICHIGAN BATS

- 9 species
- All insectivorous
 - Major predators of nocturnal insects
 - Lactating female can consume body weight or greater in insects per night
 - Consume many agricultural pests
 - Mosquitoes are not a large portion of diet
- Long lived
 - Up to 30 years
- Reproduction
 - 1-2 offspring per year
- Best categorized by migratory behavior
 - Sedentary migrants
 - Regional migrants
 - Long distance migrants

MICHIGAN BATS

- Sedentary migrants
 - Short distances: 0-30 miles
 - Summer maternity colonies: man made structures
 - Winter hibernaculum: man made structures
- Big brown bat (*Eptesicus fuscus*)



MICHIGAN BATS

- Regional migrants
 - Moderate distances: < 300 miles
 - Summer maternity colonies: man made structures, trees
 - Winter hibernaculum: mines or caves
 - Migrate north or south depending on suitable underground hibernaculum
- Little brown bat (*Myotis lucifugus*)
- Northern long-eared bat (*Myotis septentrionalis*)
- Indiana bat (*Myotis sodalis*)
- Eastern pipistrelle (*Perimyotis subflavus*)



MICHIGAN BATS

- Long distance migrants
 - > 300 miles
 - Summer maternity colonies: trees
 - Winter hibernaculum: trees, caves, mines, buildings
- Silver haired bat (*Lasionycteris noctivagans*)
- Evening bat (*Nycticeius humeralis*)
- Eastern red bat (*Lasiurus borealis*)
- Hoary bat (*Lasiurus cinereus*)



BAT IDENTIFICATION STUDY: SPECIES

- From 2008-2013: 8,052 bats submitted
- Big brown bats: 94.2%
 - Nationwide: 74.5%
- Little brown bats: 4.6%
 - Nationwide: 12.4%

Bats by species submitted to MDCH for rabies testing: 2008-2013		
Species	Total	% Total
Big brown bat (<i>Eptesicus fuscus</i>)	7585	94.20%
Little brown bat (<i>Myotis lucifugus</i>)	368	4.57%
Red bat (<i>Lasiurus borealis</i>)	28	0.35%
Northern long-eared bat (<i>Myotis septentrionalis</i>)	19	0.24%
Silver-haired bat (<i>Lasioryctes noctivagans</i>)	17	0.21%
Myotis sp.	15	0.19%
Hoary bat (<i>Lasiurus cinereus</i>)	13	0.16%
Unknown	5	0.06%
Eastern pipistrelle (<i>Perimyotis subflavus</i>)	2	0.02%
Total	8052	

BIG BROWN BAT (*EPTESICUS FUSCUS*)

- Second largest bat in MI
- Found statewide
 - Most common species in the SLP
- Summer roosts
 - Maternity colonies: 5-150 adult females
 - Man made structures
 - 45% houses
 - 45% barns
 - 10% commercial buildings
 - Males roost alone
 - Under tree bark, behind shutters
 - Hibernaculum
 - Attic walls or external walls (often go unnoticed)
 - Some overwinter in mines in UP
- Roosts in locations highly visible to humans
- Form large colonies (as opposed to solitary roosting bats)
- Abundant in SLP
 - Greatest number of human inhabitants in the state



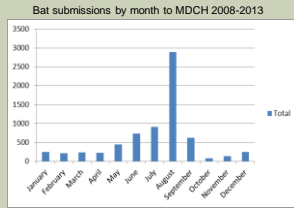
LITTLE BROWN BAT (*MYOTIS LUCIFUGUS*)

- Most common species in UP and upper northern half of LP
- Summer Roosts
 - Maternity colonies: 100-300 adult females
 - Man made structures: Barns, sheds, houses, cabins
 - Males roost in trees or buildings (sometimes in same structures used by females)
- Winter Hibernaculum
 - Caves/mines in large groups
- Species based on choice of summer roosts and large numbers in maternity colonies is conspicuous
- Not as frequently encountered
 - Smaller human populations where bat is abundant



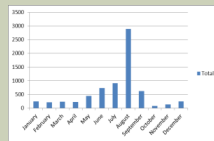
TEMPORAL PATTERNS

- Submissions lowest October - March
- Begin increasing in spring
- Peak in August
 - >40% all submissions



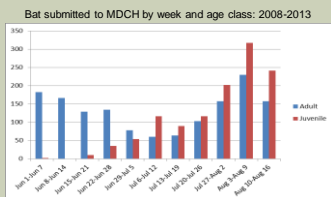
TEMPORAL PATTERNS: BAT BEHAVIOR

- Winter**
 - Bats in hibernation
- Spring**
 - Temperatures increase, insects available
 - Bats become active
- Summer**
 - Maternity colonies formed, young are born
 - Young weaned and attain flight at 3-5 weeks
- August peak in submissions**
 - Young bats begin flying
 - Inexperienced: will end up places adult bats would not
 - Maternity colonies and summer roosts break up
 - Increase in number of flying bats (largest number of the year) and movement
 - Human outdoor activity high
- Fall**
 - Temperatures decrease, insects less available
 - Activity declines
 - Preparing for hibernation



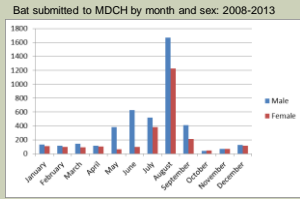
BAT IDENTIFICATION STUDY: AGE CLASS

- Young born in June
- Can distinguish juveniles from adults until mid-August
- Submission of juveniles higher after 1st week of July (55-65%)
 - More abundant
 - Learning to fly
 - Inexperienced flyers
 - Leave roost



BAT IDENTIFICATION STUDY: SEX

- Higher % of males vs females submitted
 - in May and June (~85%)



BAT IDENTIFICATION STUDY: SEX

- Kurta and Matson (1980) explored similar patterns of disproportionate ratios
 - 61:39 (M:F) from June 1975-Dec 1978
 - 62:38 (M:F) this study 2008-2013
- Examined and dismissed several hypotheses
 - Unequal sex ratio at birth
 - Latitudinal separation of sexes
 - Differences in roosting habits and maternal behavior
- Only hypothesis that fit was greater longevity of males

CONCLUSIONS

- Big brown bats account for the majority of submissions
- Largest number of submissions occur in August
 - Can anticipate higher call volume and contact with the public - plan ahead
- Submission of juveniles generally higher than adults
- Submission of males higher than females



BATS IN HOME



- May roost under siding, shingles or behind shutters
- Gain access through small openings near rooflines, gaps in siding, cracks along window frames, loose flashing, unscreened attic vents, poor fitting chimney caps
- Openings as small as ¼ to ¾" in length
- Usually 10' or higher off ground
- Once inside can move into attic, down walls, or into eaves

MI WILDLIFE CONSERVATION ORDER CHAPTER IX, SECTION 9.1 (4), 9.3 (2)

- Bats defined as a protected species, but can be taken if:
 - "...involved in a bat-human or bat-domestic animal exposure to rabies or other health hazard.
 - ...when creating a damage or nuisance problem on privately-owned property.
 - ...incidental to normal forest management activities..., closure of an abandoned mine..., demolition of a building...
 - ...to test for a wildlife disease...
 - ...to humane euthanize a bat...showing symptoms of a terminal disease..."
- Bats taken can only be held in captivity temporarily for public health reasons and must be humanely euthanized.

EVICTING BATS

- **Locate entrance**
 - Watch for activity ~ ½ hour before sunset
 - Station several people around perimeter of home
 - Continue to watch for activity ~ ½ - 1 hour after bats emerge
- **Install one way valves**
 - Allows exit but not reentry
 - PVC pipes, wire mesh or plastic mesh
 - Leave in place for several days
- **During process make sure living areas are bat proofed**
 - Seal any interior holes in walls and/or ceilings
 - Seal doors to attic and basement(draft guards)
- **Permanent exclusions**
 - Watch in evening to make sure bats done exiting
 - Check attic
 - Every potential entrance must be sealed
- **Online resources for evicting and excluding bats from home or call professional**



EVICTING BATS

- Avoid evicting in spring and summer
 - Spring
 - Stresses pregnant females and can affect reproductive success
 - June-July
 - Flightless young trapped inside
 - Will die slowly of starvation and dehydration
- Best time for exclusions is mid-August to September
 - All young are flying
 - Temperatures are warmer
 - Food is available

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Questions?

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Humane Euthanasia of Bats for Public Health Testing

Humane Euthanasia of Bats for Public Health Testing

- There are no published guidelines that address the humane euthanasia of bats specifically
- The American Veterinary Medical Association (AVMA) publishes and regularly updates 'Guidelines for Euthanasia of Animals' that addresses many species and categories of species
- Rabies Working Group (RWG) developed and published guidelines in 2008 based on AVMA recommendations
- AVMA updated their guidance in 2013
- The RWG is updating the 2008 document to reflect current AVMA guidelines

Euthanasia vs Humane Killing

- Euthanasia should minimize pain and distress prior to loss of consciousness, followed by cardiac or respiratory arrest and death
- Free-ranging animals may need to be killed quickly and efficiently in ways that don't fulfill these guidelines
- The priority for public health is to preserve the animal's brain for diagnostic rabies testing.

Major Points

- It is occasionally necessary for bats to be killed for public health testing when they have potentially exposed a person or unvaccinated pet to rabies.
- These guidelines outline the safest, most humane (when possible), and effective euthanasia techniques that result in a TESTABLE SPECIMEN for public health purposes.

Issues for Local Public Health

- LHDs are frequently contacted regarding potential rabies exposures due to bats, particularly in July/Aug
- Testing of the bat can prevent unnecessary rabies PEP for the exposed person(s) or euthanasia of a pet
- Citizens frequently collect bats that are still alive
- MDCH BOL cannot accept a live bat for testing
- Not all jurisdictions have associated animal control agencies
- LHD must provide a mechanism to have a bat euthanized
 - Trained LHD personnel
 - Arrangement with local shelter or humane society, veterinarian or nuisance wildlife control professional

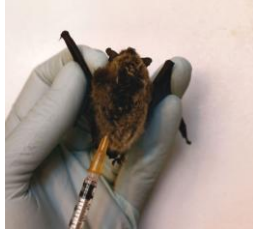
PRIORITY: TESTABLE SPECIMEN

Safety

- Personnel performing euthanasia of bats should be vaccinated against rabies.
- Personnel should be trained in the use of common euthanasia techniques.
- Personnel should wear appropriate protective equipment, depending on the method utilized. May include gloves, mask, and eye protection.
- If gaseous agents are used, proper ventilation and/or scavenging systems should be used.

Changes to Recommendations

- Thoracic compression is no longer considered humane in a sentient animal
- Ether is flammable and potentially explosive
- 70% Ethanol injection (0.5 ml) IP is a viable non-scheduled drug alternative to barbiturate euthanasia for small mammals
- Storing live bats at refrigerated temperatures (a cooler with ice, but not in direct contact with the ice) may reduce their activity level (induce torpor) and make them easier to manipulate for euthanasia.



Unacceptable Methods

- **Unacceptable Inhalation Agents:**
 - Exhaust fumes from an idling gasoline internal combustion engine (unacceptable due to production of additional gases leading to inadequate concentrations of CO gas and inadequate cooling of the gas)
 - Diethyl ether (flammable and explosive)
- **Unacceptable Physical Methods:**
 - Blunt force trauma (may destroy the brain)
 - Drowning (inhumane)
 - Gunshot (may destroy the brain)
 - Thoracic compression (inhumane, unless sedated or insentient)
 - Freezing (inhumane – formation of ice crystals on the skin and in tissues may cause pain or distress)
 - Cooling to induce torpor followed by freezing (inconsistent – torpid bats may awaken from torpor when subjected to freezing or subfreezing temperatures)

www.michigan.gov/rabies

Library tab: "Guidelines for Humane Euthanasia of Bats" PDF
