ALBERTA BAT AMBASSADOR GUIDE

Ideas for Bat Conservation Outreach

WCS CANADA

ALBERTA COMMUNITY BAT PROGRAM

Last Updated

March 20, 2025

The Bat Ambassador logo (designed by Safiya Rasheed).

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FORWARD

About Wildlife Conservation Society Canada's Alberta Community Bat Program

The Alberta Community Bat Program (ACBP) is a program of Wildlife Conservation Society Canada (WCS Canada). The ACBP was initiated in 2015 in collaboration with Alberta Environment and Parks (now Environment and Protected Areas), along with the Alberta Bat Action Team (a group of volunteers consisting of government biologists, environmental consultants, university students and faculty, and environmental organizations with interest in bat conservation). The ACBP was modeled after highly successful community bat programs in British Columbia (e.g., www.bcbats.ca) and continues to work closely with counterparts in B.C. for the development of program materials, including the Bat Ambassador Program. Community bat programs in B.C., as well as Bat Action Teams in both B.C. and Alberta, have been instrumental in creating science-based guidelines and best practices widely used by government, industry and conservation groups in both provinces.

The Alberta Community Bat Program (ACBP) was established with the mission to protect Alberta's bats. The program works to achieve this by raising awareness of bat conservation issues, helping residents manage bats in buildings, and collecting valuable data needed to monitor and better understand bats in the province (through monitoring, research, community science, and partnering with other organizations).

This guidebook was initially developed as support material for an Alberta Bat Ambassador Training Program (2019) but has been updated to create a resource that any educator can use to support teaching and outreach for bat conservation. The Alberta Education Curriculum has historically included topics on hibernation, small mammals and flying things, echolocation and a study of biodiversity across Alberta's natural regions. This guidebook provides material that may be used for lesson development and teaching. We are happy to support teachers with materials that can be used to educate students about bats and the conservation issues they face.

What is a "Bat Ambassador"?

A *bat ambassador* is a passionate advocate for bat conservation who raises awareness about the ecological importance of bats, educates others about their role in ecosystems, and promotes actions to protect bat populations and habitats. Bat ambassadors engage with communities, dispel myths, support research, and encourage sustainable practices to ensure bats thrive for generations to come.

Bat *experts* can spend years, if not decades, studying and learning about bats. But Bat *Ambassadors* can include people who share an interest and passion for bats and who want to share that passion and interest with others. This training resource has been created to support both learning and teaching about bats and their habitats to further our bat program conservation goals. These include:

Goals

1. Create "Bat Ambassadors" by providing guidance and resources to Teachers, Park Interpreters, Biologists, and Naturalists who are interested in science communication and education specifically targeting bats and bat conservation (#BatSciComm).
2. Increase awareness of the Alberta Community Bat Program and the program's goals (for Outreach, Education, Monitoring and Research).
3. Promote bat conservation and awareness of the current status of our Alberta bat species and Canadian/North American bat species.
4. Share a list of key talking points to drive bat conservation, correct misconceptions about bats, and improve public perceptions of bats.
5. Improve management of bat populations in Alberta and elsewhere across North America.

This guidebook includes:

1. An introduction to the Bat Ambassador Program.
2. Outline of goals of the program.
3. Expectations for Bat Ambassadors.
4. Key communications points for bat conservation with background information.
5. Descriptions of actions that can be taken to support bat conservation.
6. Information on bat ecology with explanations and examples to use to easily explain key points to others.
7. Suggestions for activities and crafts.
8. Suggestions on how to run a bat walk.

TIP

There are numerous resources on our webpage (www.albertabats.ca/resources) that can be downloaded, shared, and used for education and outreach. Please reach out if you need photos and videos to support your programming. For videos, be sure to see our YouTube channel (www.youtube.com/albertabats). There are many available photos on iNaturalist that have a Creative Commons license, including by a photographer we have worked with over the last several years: www.inaturalist.org/observations?place_id=6834&taxon_id=40268&user_id=jasonheadley.

The Bat Ambassador Training Program (BATP)

The Bat Ambassador Training Program (BATP) has been developed to assist groups already involved in science communication to deliver key messages about bat conservation, improve the public's understanding and appreciation of bats, encourage bat-friendly management, and highlight some of the priorities of the Alberta Community Bat Program (ACBP).

Expectations of Bat Ambassadors

1. Speak to what you know—inform yourself before teaching others and admit when you do not know the answer. Consider taking our online training course: training.canadabats.org.
2. Use this guidebook to help learn about bats and how to convey bat conservation messaging. Don't be afraid to incorporate other materials from trusted sources and to share your experience with others.
3. Make sure public safety is a priority and ensure you have all necessary permissions and permits for the activity you are undertaking. Ensure you have appropriate liability insurance coverage.
4. Act professionally to encourage others to appreciate our shared mission.
5. Promote the importance of biodiversity and wildlife conservation.
6. Acknowledging the assistance of the Alberta Community Bat Program and the Bat Ambassador Training Program. However, please do not represent yourself as a volunteer (or staff) of WCS Canada or the Alberta Community Bat Program unless a formal volunteer agreement or contract is in place.

Be Professional:
Bat Ambassadors come from diverse backgrounds with varied experience. They are expected to learn about bats and conservation issues continually to engage the public knowledgeably. Ambassadors should always be respectful, representing the program professionally. Their role is to advocate for bats and foster long-term support for conservation.

Note:
Not everyone feels positively about bats, and some may share negative or fearful experiences. Remain calm, non-judgmental, and provide factual information. Education is often the best way to help people understand and support bat conservation.

COMMUNICATIONS: THE TOP FIVE THREATS TO BATS IN CANADA

To keep our messaging focused, this guidebook will target the top threats to bats in Canada which include:

1. **White-Nose Syndrome (WNS)**: A devastating fungal disease that has killed millions of bats in North America, especially affecting hibernating species. It disrupts their winter rest, leading to fatal energy depletion.
2. **Wind Turbines**: While green energy is vital, wind turbines pose a direct threat to bats through collisions and barotrauma (pressure-induced lung damage), affecting migratory and non-migratory species alike.
3. **Habitat Loss and Fragmentation**: As forests and wetlands are cleared or altered, bats lose crucial roosting and foraging sites, making it harder for them to survive and reproduce.
4. **Insect Prey Population Declines**: Insect prey declines are affecting aerial insectivores globally. Pesticides reduce insect prey availability and may directly harm bats through bioaccumulation of toxins, weakening their immune systems and affecting reproductive health and development.
5. **Climate Change**: Shifting temperatures and altered precipitation patterns impact bat hibernation cycles, food availability, and habitat ranges, creating challenges for bat survival.

Efforts to mitigate these threats include disease research, habitat conservation, safe wind turbine technology, and pesticide regulation

COMMUNICATIONS: KEY CONSERVATION ACTIONS

One of the Alberta Bat Program's key messages is that "Bats Need Friends". But how can people be a "good bat friend"? The public can play a critical role in bat conservation in Canada through several impactful actions:

1) **Support Bat-Friendly Habitats**: Preserve natural habitats like forests and wetlands, which provide bats with food and roosting sites.
    - Plant native vegetation to support insect populations, giving bats a steady food source.
    - Turn off yard lights in summer. Create dark areas. Minimize lighting.
    - Plant shelterbelts, hedges and/or tree rows to create habitat connectivity on the landscape (e.g., between roosting and foraging habitat in areas that have been cleared because some bat species will not cross open spaces).
    - Reduce hazards around our communities (e.g., outdoor cats, uncovered rain barrels, ducts or chimneys without proper caps, etc.).
    - Advocate for beneficial practices for agriculture targeted to support bats.
2) **Install Bat Houses Only Where Appropriate**: Providing safe roosting spots by installing bat houses can help bats find shelter, especially when they are excluded from buildings or in situations where

natural roosting options have been lost. We recommend reviewing the Summary Brochure for the Best Management Practices for Bat Houses in the USA and Canada as well as the Alberta Bat House Guidebook.

Key points include:

- Bat houses mainly help Little Brown Myotis and Big Brown Bats, which are the same species that commonly occupy buildings. Most other species will not use them.
- Install multiple boxes and ensure there are a range of temperature conditions (sunny, partial sun and shade). Create "roost areas" where they can move around to find the best conditions.
- Use large multi-chambered designs (single-chambered designs are most likely to overheat)
- Avoid installing bat boxes in natural areas. Most bat species do not roost in bat houses and may rely on natural areas for roosting habitat. Attracting bat-house roosting species into these areas will have unpredictable consequences for the overall bat community.

3) **Educate and Advocate**: Raising awareness about bats' ecological importance and their challenges helps combat misconceptions and promote conservation. Share information with your community and advocate for protective policies (e.g., habitat protection).

- Advocate for safe practices when they are around bats. Emphasize the importance of not touching bats. Rabies is a deadly virus that is spread through bites (or scratches). It is easily prevented by not touching bats. If a bat must be moved to a safe location, then it should be done by an adult who is wearing leather gloves to protect against bites.
- If someone is bitten (or possibly bitten) by a bat, then it is important that they seek medical attention. Avoid giving specific medial advice; instead, direct people to immediately consult with a qualified health care provider (Health Link at 8-1-1 is a good starting place).
- Let people know that rabies is rare (fewer than 1% of free-flying bats have rabies), but those accessible to people (i.e., on the ground) are much more likely to have rabies. Rabies is found at low levels throughout the province.
- Do not show angry or aggressive images of bats. Avoid images of bats barring their teeth. Do not use photos of vampire bats or flying foxes to depict Alberta bat species (this is a surprisingly common mistake).

4) **Limit Pesticide Use**: Avoid using pesticides in gardens and near bat habitats, as these chemicals harm bats and their insect prey, weakening local ecosystems.

- If used, pesticides should be targeted, minimizing amounts used, and avoiding contact with non-target areas.
- Advocate for the use of the Alberta Bat Program's "Beneficial Management Practices for Bats: Bat-friendly Farming" (albertabats.ca/resources).

5) **Donate or Volunteer**: Support organizations dedicated to bat research, conservation, and public education. Donations fund essential programs, while volunteering aids monitoring and habitat restoration efforts.

    - Support fund-raising campaigns for bat conservation by either directly participating or indirectly through promotion of the event to communities.

By taking these steps, the public can significantly contribute to preserving Canada's bat populations and their habitats.

COMMUNICATIONS: KEY INFORMATION RESOURCES

Alberta Bats Website

The Alberta Bats website can be found at www.albertabats.ca and has been set up to not only update the public on the latest developments within the program but to provide information resources on key issues. There are also a series of guidebooks that are free to download. The website provides links to wildlife rehabilitators and resource links to trusted conservation partners.

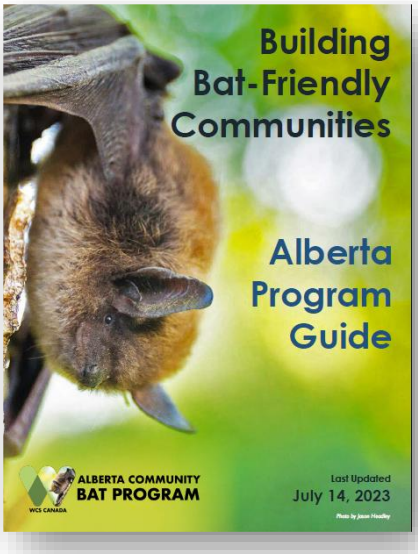
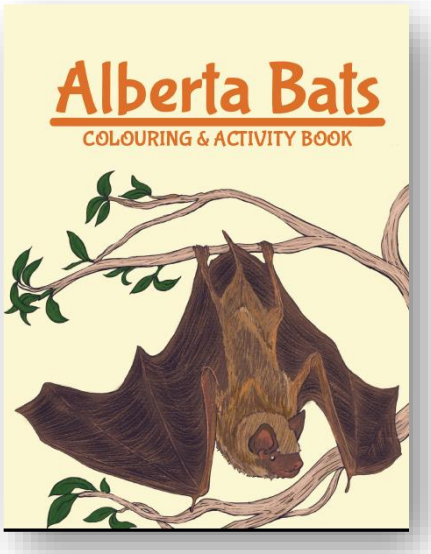
Bat-friendly Communities Guidebook

The Alberta Community Bat Program developed a Guidebook with suggestions on what people can do to make their backyards or communities more bat-friendly. The document is available as a free download on our website www.albertabats.ca/resources.

The guidebook provides key elements that are needed to create a "bat-friendly community". These are a) information on how to protect both bats and their habitats; b) information on backyard hazards and ways to improve or create habitat for bats; and c) information about our Alberta bat species that can be provided to the community.

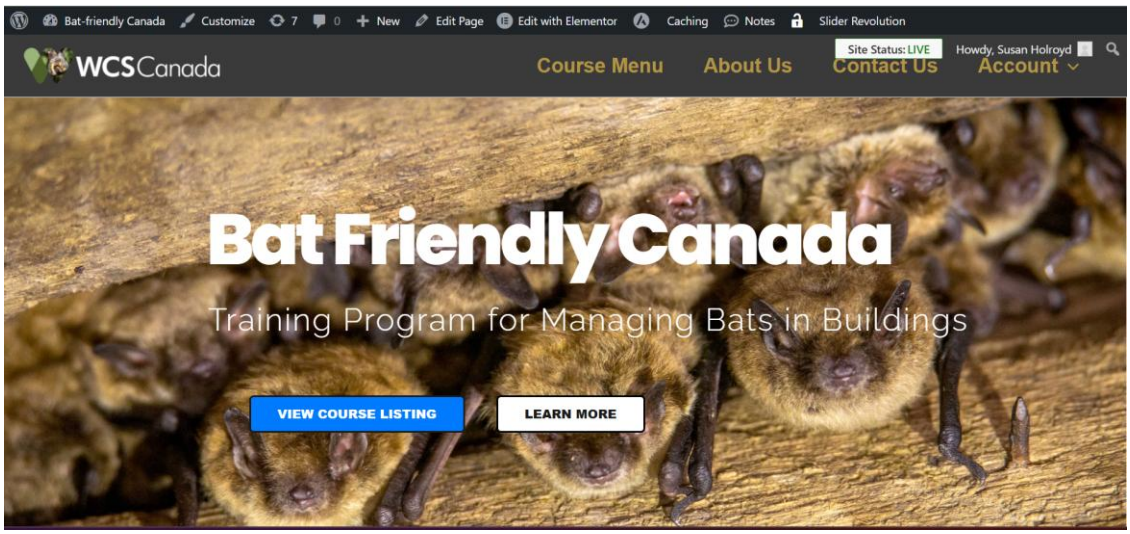
Alberta Bats Activity and Colouring Book

This free PDF is available on the Alberta Bats website (www.albertabats.ca/resources) and is a great resource for teachers and educators looking to enhance bat-related lessons. The activity book includes word puzzles, mazes and colouring pages, along with great information about bats. You are welcome to print pages from the booklet to support your education and outreach activities.

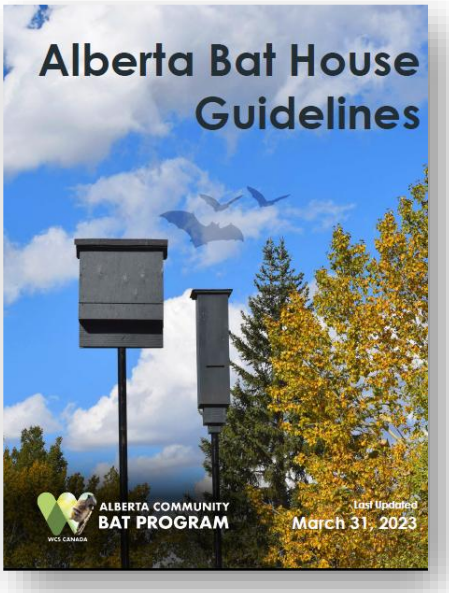
	
Alberta Community Bat Program's "Building Bat Friendly Communities" Guidebook for anyone needing information on how improve or manage bat habitat in their backyards or in their communities.	*Alberta Bats Activity and Colouring Book is a made in Alberta resource created in cooperation with the Government of Alberta and the Alberta Community Bat Program.*

Online Training Platform

Alberta Bats has developed on online training platform with courses aimed at supporting bat conservation. There is a comprehensive course targeting “Managing Bats in Buildings” and another course focused on natural history for bat enthusiasts “Alberta Bats”.



Other Key Resources on the Alberta Bats website

	
Alberta Community Bat Program's Alberta Bat House Guidelines resource provides information on the design, installation, and management of artificial roost features such as bat houses (see www.albertabats.ca).	*Beneficial Management Practices for Bats: Bat-Friendly Farming is a made in Alberta resource created for the Alberta farming industry (see www.albertabats.ca).*

ALBERTA COMMUNITY BAT PROGRAM: COMMUNITY SCIENCE PROJECT

What is it?

- The community science project was initiated by the Alberta Community Bat Program (ACBP) in 2016. Details and protocols are available on our website at www.albertabats.ca/communityscience
- The public are asked to submit an observation report on known bat roosts, including roost location, roost type, history of roost, physical characteristics of the roost, and estimated colony size using data sheets provided. The complete protocol is outlined in detail on the Alberta Bats website.
- Participants are encouraged to conduct two or more colony counts each year, but reports of the roost are encouraged regardless of whether ongoing monitoring is planned.
- A guano sample is requested, in addition to the report, so that the species can be determined using DNA barcoding.
- Data submitted is used to build a long-term database that can be used for population monitoring, research, and (potentially) recovery actions.
- A form is available to facilitate reporting of random observations that may have conservation value (see: www.albertabats.ca/communityscience).

Preliminary Results

The Community Science project supports research and monitoring initiatives in Alberta. Among other outcomes, this is helping us to better understand how bats are using habitats, monitor population changes, and track the spread of diseases like white-nose syndrome. Some of the results to date include:

- Little Brown Myotis and Big Brown Bats are the primary species being found using building roosts and bat houses in Alberta. Most reported roosts (about 85%) were used by Little Brown Myotis, a federally listed endangered species.
- Many of the reported roosts were used by maternity colonies; one species (Big Brown Bat) was also observed overwintering in buildings in and around Edmonton.
- Roost reports were concentrated near areas of the province with higher human population density; however, work by our local conservation partners is helping to fill in some gaps in rural areas around the province.
- We now know that Long-eared Myotis occur along the Peace River in NW Alberta.

To learn more, visit www.albertabats.ca/communityscience.

The Alberta Community Bat Program would like Bat Ambassadors to actively promote participation by the public in our community science program!

BAT BASICS

Biodiversity

"Biodiversity" = "all of the genes, species and ecosystems of a region"

Number of Species (province, country, globally)

Bats are an important part of the world's biodiversity. Almost ¼ of all mammals are bats. There are 1,487 different species of bats on the planet (and counting!), although about nine of those are already extinct. Alberta has NINE bat species. British Columbia has 15 bat species (the most of any province). Across Canada, we have 17 confirmed species of bats (three of these are migratory; the rest live year-

Figure. Alberta's nine bat species, (top row) Silver-haired Bat (JH), Western Small-footed Myotis (CO), Red Bat (CO); (middle row) Little Brown Myotis (JH), Long-legged Myotis (CO), Big Brown Bat (SAE); (bottom row), Northern Myotis (MWH), Hoary Bat (JH), Long-eared Myotis (CL). JH= Jason Headley, CO= Cory Olson, SAE= Sebastian A. Echeverri, MWH= Milkweedhunter from iNaturalist/CC, CL= Cori Lausen.

round in Canada). There are an additional four bat species that are considered “accidental” (because they have only a single point of capture or have only been heard using bat detectors).

Range maps for Alberta Bat species can be found at https://www.albertabats.ca/batprofiles.

Table 1. Alberta bat occurrences by municipality and Natural Region (red highlight indicates the two species currently listed as Provincially and Federally Endangered).

Bat Common Name	Bat Scientific Name	General Status in Alberta[1]	Status in Canada[2]	Municipality								Alberta Natural Region					
				Fort McMurray	Peace River	Edmonton	Red Deer	Calgary	Lethbridge	Medicine Hat	Crows Nest Pass	Boreal	Canadian Shield	Foothills	Grasslands	Parkland	Rocky Mountain
Long-legged Myotis	*Myotis volans*	Undetermined			X			X	X	X	X	X	X	X	X	X	X
Northern Myotis	*Myotis septentrionalis*	May be at risk	Endangered (SARA S1)	X	X	X	X					X	X	X		X	X
Western Small-footed Myotis	*Myotis ciliolabrum*	Sensitive							X	X					X	X	
Long-eared Myotis	*Myotis evotis*	Secure			X		X	X	X	X	X	X		X	X	X	X
Little Brown Myotis	*Myotis lucifugus*	May be at risk	Endangered (SARA S1)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Big Brown Bat	*Eptesicus fuscus*	Secure		?	X	X	X	X	X	X	X	X	X	X	X	X	X
Hoary Bat	*Lasiurus cinereus*	Sensitive	Endangered (COSEWIC)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Silver-haired Bat	*Lasionycteris noctivagans*	Sensitive	Endangered (COSEWIC)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red Bat	*Lasiurus borealis*	Sensitive	Endangered (COSEWIC)	X	X	X	X	X	X	X	X	X	X	X	X	X	X

[1] Based on 2020 general status. We expect the status of Hoary Bats, Eastern Red Bats, and Silver-haired Bats to change under the 2025 update.

*[2] **COSEWIC (Committee on the Status of Endangered Wildlife in Canada) assessed the three migratory species as Endangered but have not yet been listed under Schedule 1 of the Species at Risk Act.*

Table 2. All Canadian bat species by province/territory

Common Name	Scientific Name			Province/Territory										
		Alberta	British Columbia	Saskatchewan	Manitoba	Ontario	Quebec	New Brunswick	Nova Scotia	Prince Edward	Newfoundland and Labrador	Yukon	Nunavut	Northwest
Pallid Bat	*Antrozous pallidus*		X											
Townsend's Big-eared Bat	*Corynorhinus townsendii*		X											
Big Brown Bat	*Eptesicus fuscus*	X	X	X	X	X	X	X						
Spotted Bat	*Euderma maculatum*		X											
Silver-haired Bat	*Lasionycteris noctivagans*	X	X	X	X	X	X	X	X					
Eastern Red Bat	*Lasiurus borealis*	X	X	X	X	X	X	X	X					
Hoary Bat	*Lasiurus cinereus*	X	X	X	X	X	X	X	X				X	X
California Myotis	*Myotis californicus*	?	X											
Western Small-footed Myotis	*Myotis ciliolabrum*	X	X	X										
Long-eared Myotis	*Myotis evotis*	X	X	X										
~~Keen's Myotis~~[1]	~~*Myotis keenii*~~													
Little Brown Myotis	*Myotis lucifugus*	X	X	X	X	X	X	X	X	X	X	X		X
Northern Myotis	*Myotis septentrionalis*	X	X	X	X	X	X	X	X		X	X		X
Fringed Myotis	*Myotis thysanodes*		X											
Long-legged Myotis	*Myotis volans*	X	X											
Yuma Myotis	*Myotis yumanensis*		X											
Tri-colored Bat	*Perimyotis subflavus*					X	X	X	X					
Eastern Small-footed Myotis	*Myotis leibii*					X	X							
Evening Bat	*Nycticeius humeralis*					?								
Brazilian Free-tailed Bat	*Tadarida brasiliensis*		?											
Big Free-tailed Bat	*Nyctinomops macrotis*		Acc											
Canyon Bat	*Parastrellus hesperus*		?											
TOTAL BAT SPECIES (Accepted) 17		9	15	8	6	8	8	7	6	1	2	2	1	3
Total (including accidentals and unverified) 21		10	18			9								

[1] Keen's Myotis now officially merged with Long-eared Myotis as a single species Myotis evotis.

THREATS TO BATS

We have addressed five key current threats to bat populations. This section aims to:

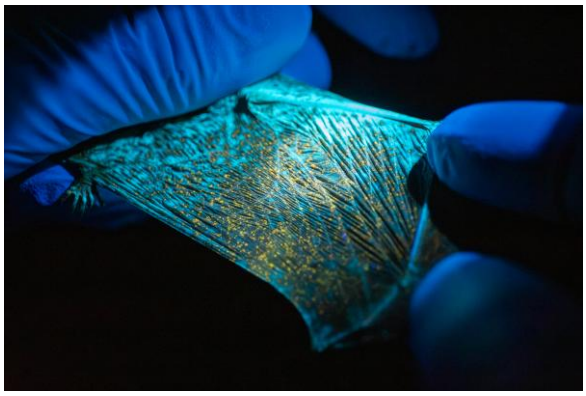
- Outline and explain the threat and how it affects bats.
- Clearly list practical and attainable actions the average person can take to help address these threats to bats.

The average person will not be able to take all of these actions, but every action is a small step that helps meet a goal. Collectively, society can make small changes that lead to significant and positive outcomes. The Bat Program has been asked, “What can I do to be a good bat friend?” Use this section to help give direction to people who want to take real steps towards change. In 2024, the United States Geological Service (USGS) created a report on “The State of North American Bats”. This is an excellent overview with some sobering statistics. Bat Conservation International created an interactive brochure on the report https://digital.batcon.org/state-of-the-bats-report/2023-report/ which is a great resource summarizing the report. In summary: 52% of bat species in North America are at-risk. The threats include the five that we highlight here.

Threats

Threat A: White-nose syndrome

White-nose syndrome (WNS) is a lethal fungal disease affecting North America's hibernating bat species. Millions of bat deaths have been recorded across North American since 2006, when a fungal pathogen *Pseudogymnoascus destructans* (Pd) was observed on hibernating bats. Pd has affected some bat species more than others. Little Brown Myotis, Northern Myotis and Tri-colored Bats were listed Federally as Endangered in 2014 because of the threat of WNS after populations declined over 90%. WNS is considered one of the worst wildlife epidemics ever observed in North America.



Signs of Pd on a bat wing; fungal growth fluoresces orange under a UV light. Photo: Jason Headley.

Pseudogymnoascus destructans (Pd) is a cold-loving fungus that thrives in cold, damp places, infecting hibernating bats by growing as a white fuzz on their skin, wings, and tails. This fungal growth disrupts hibernation, causing bats to awaken early and deplete essential fat reserves. Consequently, infected bats may emerge prematurely from hibernation sites in winter, often leading to starvation.

White-nose syndrome is devastating to bats largely due to their unique hibernation physiology. During hibernation, bats' body temperature, metabolism, and immune response all drop to conserve energy. This suppression of immune function allows the cold-loving fungus *Pd* to thrive on their skin. The infection causes dehydration, which forces bats to wake mid-winter in search of water and food, but since no insects are available, they often starve. Piles of dead bats have been found outside caves in eastern North America. In Alberta, the fungus was detected in 2021, with the first infected bats found in 2024 near Dinosaur Provincial Park. The Alberta Community Bat Program and provincial biologists are actively monitoring its spread.

The impact of white-nose syndrome (WNS) on western bat populations is still unknown. Although fungal spores have been detected on some western species, their effect on populations hasn't been fully assessed. Some species, like Silver-haired Bats, seem resistant to infection but may carry spores into hibernation sites, potentially spreading the disease to more

Bats in a hibernation site exhibiting tell-tale signs of White-nose Syndrome. Indiana bats (*Myotis sodalis*), New York State. Photo: Al Hicks.

vulnerable bats. *Pd* is hardy and can survive in infected caves even without bats, growing on organic material and posing a risk to any new bats entering the site.

There are two phases that populations of bats typically experience as white-nose syndrome spreads to new areas. First, detections of the spores of Pd are identified, but bats may not yet exhibit the disease. Second, bats emerging from hibernation may show signs of actual infections (the fungus has grown into wing tissues or other skin tissue, wings may have holes or scarring). Within particular provinces or states, there may be areas where populations are severely affected or lost, while neighbouring counties may still support bat populations. Geographic patterns of infection have been shown to have "patchy" distributions, which is why decontamination protocols persist, even after white-nose syndrome has been detected.

Table 3 Western bat species affected by white-nose syndrome, list A includes bats observed with the disease, list B includes bats that have been observed with the fungal spores but no lesions or infections (information from www.whitenosesyndrome.org curated by the US Fish and Wildlife Service).

Western bat species identified with white-nose syndrome:	Western bat species identified as "Pd Positive" but have yet to exhibit the disease:
• Big Brown Bat (*Eptesicus fuscus*) • Little Brown Myotis (*Myotis lucifugus*) • Long-legged Myotis (*Myotis volans*) • Northern Myotis (*Myotis septentrionalis*)**threatened* • Yuma Myotis (*Myotis yumanensis*) • Long-eared Myotis (*Myotis evotis*) • Fringed Myotis (*Myotis thysanodes*)	• Eastern red bat (*Lasiurus borealis*) • Hoary Bat (*Lasiurus cinereus*) • Mexican free-tailed bat * *(Tadarida brasiliensis)* • Silver-haired bat (*Lasionycteris noctivagans*) • Townsend's big-eared bat (*Corynorhinus townsendii*) • Western small-footed myotis *(Myotis ciliolabrum)* • Canyon Bat (*Parastrellus hesperus*)

The survival of bat species may hinge on their ability to develop immunity to *Pd*. Western bats might be less vulnerable to white-nose syndrome (WNS) than eastern species due to their preference for crevice habitats over large cave systems, which limits their congregation in high-density groups. However, monitoring these crevices is challenging since few hibernation sites are known. Recent research by the Alberta Community Bat Program found significant winter bat activity near crevices along Alberta's Badlands, suggesting these areas may be critical hibernation sites. Continued research is needed to identify and protect these key habitats and to understand the dynamics of the disease in our western bat populations. Work is ongoing.

White-nose Syndrome (WNS) was first identified in New York during the winter of 2006–2007. Up-to-date maps of the disease spread are available on the U.S. Fish and Wildlife Service website and the Canadian Wildlife Health Cooperative (CWHC) website, which runs the Bat Health Program in coordination with the federal government.

WNS is primarily spread through bat-to-bat contact or indirectly through contaminated environments. However, initial spread and ongoing transmission are also attributed to people unknowingly carrying fungal spores on clothing, boots, or equipment. Decontamination protocols for entering bat habitats, including summer roosts and caves, are regularly updated on the above-listed sites to reflect new findings, such as that spores remain viable year-round and can persist in bat guano.

While North America's bat populations are highly susceptible to WNS, *Pseudogymnoascus destructans* is also found in Europe, where it has not caused similar mortality, possibly due to historical exposure that allowed European bats to develop resistance. However, North American bats face ongoing risks of population declines and potential extirpations due to this disease. Theories of the origins of white-nose syndrome in North America have not been scientifically confirmed (and it may be impossible to confirm) however there are a few theories on how it got here. First, is the "muddy boots" hypothesis. Perhaps a caver from Europe came over to the USA with dirty boots contaminated with the fungal spores of Pd and left some behind in an underground hibernation site used by bats. The spores flourished and infected resident bats and the story starts from there. A second hypothesis is that an infected European bat flew into a shipping container and was transported across the Atlantic, disembarked somewhere along the St. Lawrence seaway and flew to a site in upper New York state where it found a hibernation refuge where it shared the fungal spores on its wings with the native bats in the cave. Again, the spores grew and flourished, and bats continue to spread the fungal spores from bat to bat across the continent. There are other hypotheses that involve the transport of contaminated soils from Europe to America – but again, none of these hypotheses have been proven. But we do know that the fungus originated in Europe, and it is here to stay as it can survive in cold, damp places growing on any organic material.

Disease Spread

Alarmingly, in the spring of 2016, white-nose syndrome showed up in Washington state which represented a leap of over 2,000km for the disease as Pd had only been tracked as far west as the Midwest states. The disease normally has jumped about 250km each year. The theory is that an eastern infected little brown bat caught a ride heading west either in a transport truck or rolled up in the awning or patio umbrella of a camper. Once across the country it flew off and started hanging out with Washington bats. We now have a "Stowaway Bat" campaign to remind campers and truckers to check their vehicles for bats to avoid extra travel companions and to help reduce the spread of the fungal spores. There is a poster developed by the CWHC that you can use (and modify) for your own use. Find it here https://www.cwhc-rcsf.ca/bat_health_resources.php .

Solutions from science:

- Biologists found that UV light will kill the fungus; however, this is not a broad-scale solution to treating the disease.

- Researchers in several parts of North America are working on developing a "probiotic" cocktail to apply on bats to fight the fungus naturally. Bats have naturally-occurring species of fungi and bacteria that grow on their wings and in their fur. These micro-organisms can produce

secondary compounds that kill or outcompete the invasive *Pd* fungus. Biologists have been swabbing bats to obtain "natural fungi and bacteria", taking them back to the lab and growing the cultures in petri dishes. The first trials on wintering bats have just begun in the past year. Results are pending but they look promising. More information on this project can be found on our WCS Canada Western Bat Team website www.wcsbats.ca.

- Researchers have also been working on a vaccine to give bats immunity to the fungal infection, but this is still in development stages.

- Limiting spread by decontaminating exposed equipment and clothing is key. Researchers have been examining the effectiveness of different decontamination protocols. These have been updated as newer/better protocols have arisen.

- The "fat bat hypothesis" indicates that bats have a better chance of surviving a WNS infection if they go into hibernation good and fat. Ensuring that bats have plenty of insect prey through the protection of habitats that produce lots of insects may be a key strategy to help bat populations be resilient in the face of this disease.

What can people do?

- Specifically, to limit the spread of the disease there are a couple of things that people can do. First, anyone who goes into underground habitats (such as caves or mines) should follow the latest decontamination guidelines to prevent further spread of the fungus. Equipment that has been used underground in areas with WNS should not be used in areas that are currently free of the disease.

- Campers and long-haul truckers should check their vehicles for unsuspecting passengers. Use the "Bats Astray" poster (https://www.cwhc-rcsf.ca/bat_health_resources.php) to communicate this message to others.

- Do not ship bat guano across the country and limit the local movement of guano to 10 kilometres or less. Especially when guano originates from areas with WNS. The fungal spores can remain active for several weeks in spring after bats come out of hibernation. It is unclear if this has been a route of transmission, but it a risk that can be managed.

- If you are conducting a bat exclusion from a building, request that pest control operators use appropriate white-nose syndrome decontamination procedures to minimize the risk of spreading fungal spores from one roost to another.

- Support bat foraging habitats by creating insect-friendly areas and ensuring they are accessible to bats. Limit outdoor lighting at night, connect roosting and foraging spaces, and consider the "Bat-Friendly Communities Guidebook" at (www.albertabats.ca/resources) for practical backyard tips. Reduce pesticide use, keep summer yards dark, and plant native plants to attract insects and help local bat populations.

Threat B: Habitat Loss and Fragmentation

Urban and resource development often reduces natural bat habitats, especially roosting trees but foraging habitats for bats can also become seriously degraded by human actions. The Alberta Community Bat Program's "Bat-Friendly Communities" guidebook provides tips for supporting bats, including tree planting, retaining tree stubs, and adding native shrubs to encourage insect prey. Creating accessible water sources can also benefit bats in dry areas.

Habitats for bats may be fragmented or degraded by a) forest clearing, b) building dams or affecting wetlands or c) as a result of ALAN (artificial lighting at night). Photos: CANVA.

Stable bat populations depend on:

- **High-quality summer roosting habitats.**
- **Foraging and drinking water access** (supported by healthy riparian and wetland areas).
- **Connectivity between habitats** (as some bats avoid open gaps over 10 meters).
- **Undisturbed hibernation sites** over winter.

Habitat loss and degradation from forestry, mining, agriculture, land reclamation, and wetland changes limits roosting, foraging, and access to water for bats. Effective bat conservation often depends on protecting existing habitats, as reestablishing complex features like old trees can take decades. When natural habitat is lost, creative solutions, such as installing artificial roosts, may be needed temporarily, although natural habitat retention is preferable.

Some bats, like Little Brown Myotis and Big Brown Bats, frequently roost in rural structures like barns and cabins. When renovations or demolitions affect these buildings, bat houses can provide alternative roosts, but these structures do not benefit all bat species that may occur in an area. Habitat fragmentation is another challenge, as gaps over 10 meters wide, like roads or breaks in hedgerows, can isolate bat populations of some species.

For more detailed guidance, see Alberta's free bat conservation resources: *Managing Bats in Buildings* and *Building Homes for Bats* at albertabats.ca.

What can people do?

Here are several impactful ways the public can help reduce bat habitat loss and degradation:

- **Protect and Restore Native Vegetation**: Planting native trees, shrubs, and plants supports insect populations, providing a natural food source for bats and other wildlife. Keeping older trees and snags intact can help preserve essential roosting spots for bats.
- **Install Bat Houses**: Where natural roosts are limited, installing well-designed bat houses can provide safe shelter, especially in areas where buildings or other roosting structures are being removed or renovated. Bat houses offer an accessible alternative habitat that can also reduce bats' competition for natural roosts. However bat houses tend to benefit only a few bat species and their use should be targeted and intentional.
- **Limit Outdoor Lighting**: Reducing artificial lighting, especially near foraging and roosting sites, creates bat-friendly areas by maintaining the natural dark environment bats need for hunting and navigation. Use warm, low-intensity lights and motion sensors where lighting is essential.
- **Support and Advocate for Habitat Conservation**: Engage in local conservation efforts, advocate for policies that protect natural habitats, and support organizations that work on bat conservation. Getting involved at the community level can have a direct positive impact on habitat quality and availability.
- **Reduce Pesticide Use**: Avoiding or reducing pesticides in yards and gardens helps maintain insect populations that serve as a food source for bats. Opting for natural pest control methods contributes to a healthier ecosystem overall.
- **Provide Access to Clean Water Sources**: If feasible, install a safe water source, such as a small pond or water feature, which can attract bats and provide essential hydration, especially in dry regions.
- **Promote Awareness**: Educate others about the importance of bats and their habitats. Hosting or attending bat-related educational events can increase community interest in bat conservation.

For more details and practical advice, resources like the “Bat-Friendly Communities Guidebook” by Alberta Bats (available on albertabats.ca) offer valuable insights for community and individual efforts to support bat habitats.

Threat C: Wind Energy

Impact of Wind Turbines on Bats:

Wind turbines have significant negative effects on bat populations, with the threat expected to grow as wind energy capacity expands exponentially by 2050.

In Canada and the USA, wind turbines have killed over one million bats across 28 species. Migratory species like Hoary Bats (*Lasiurus cinereus*), Eastern Red Bats (*Lasiurus borealis*), and Silver-haired Bats (*Lasionycteris noctivagans*) are most affected. These species were classified as "endangered" in Canada in 2023 by COSEWIC (the Committee on the Status of Endangered Wildlife in Canada), primarily due to high mortality rates at wind farms.

Projections suggest that hoary bat populations could decline by 50% by 2050 without immediate action to reduce fatalities at wind energy facilities. Extinction of Hoary Bats has also been projected if action is not taken.

Types of Wind Energy Sites:

- **Onshore** (land, >3 km from coast), **nearshore** (<3 km from coast or <10 km offshore), **offshore** (>10 km from land).

Onshore wind (land, >3 km from coast).

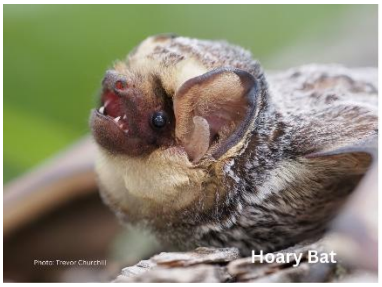
Nearshore wind (<3 km from coast or <10 km offshore).

Offshore wind development (>10 km from land).

Wind energy facilities can be developed as a line of turbines, or in an array and are usually installed in sites that have high, persistent wind. However, changes in technology have improved the profitability of establishing wind developments in areas of lower wind, a fact that is contributing to the increased growth and widespread distribution of new wind energy sites.

Bat Fatalities:

- It is estimated that the combined total number of bats killed in Canada and the USA at wind energy sites totals approximately one million bats each year and these are mainly migratory species like **Hoary Bat, Red Bat, and Silver-Haired Bat**.
- Deaths peak in late summer during the fall during migration (a period lasting about six weeks).
- Most bat deaths occur on warm nights with low wind and no rain during the six week migration window.



Three Main Causes of Bat Deaths:

1. **Direct Mortality** results when bats are either hit by the turning blades of the wind turbine or because of barotrauma. Bats are most often killed when rotors are moving at slow speeds. Many bats are killed by being struck by the turbine blades. Others experience barotrauma. The fast-moving tips of wind turbines, reaching speeds of up to 240 km/h, create a low-pressure zone around them. When bats enter this zone, the sudden pressure change causes their lungs to expand, rupturing blood vessels and tissues, leading to their swift death.
2. **Habitat loss:** wind facilities built in forested areas will require forest clearing. Loss of trees and tree roosts for bats during the breeding season may result in direct mortality of colonies; removal of appropriate tree roosts outside of the breeding season may limit available roosting habitat for bats if forests are not managed to retain a variable stand structure. Removal of rock features suitable for roosting bats may also impact local bat populations. Crevices in rock outcrops and cliffs can provide important long-term roosting habitat for bats in both summer and winter.
3. **Loss or degradation of foraging and drinking habitat**: any construction activity or development that changes drainage patterns or results in the loss or degradation of riparian areas can negatively affect bats. Wind energy facilities consist of not only the turbine site but networks of roads for access which all require construction that can affect the surrounding landscape. Open water may be critical resource for bats, especially in dry ecological areas.

Mitigation Efforts:

1. **Pre-Construction Studies:**

    - Bat surveys to avoid high activity areas but may not predict post-construction mortality accurately due to the attraction effect of turbines.

Pre-construction studies are surveys for bats and bat habitat in areas that are proposed to develop wind energy are surveyed for bats before development occurs. This informs the developers in choosing a site that is not characterized by high levels of bat activity in the fall and not located near high quality bat habitat (e.g., large, open water, bat roosting habitat, or a hibernaculum). Pros: it does offer some insight about the area. Cons: hoary bats often do not echolocate while migrating and these surveys heavily rely on passive acoustic detection (bat detectors are set out on tall towers to record any bat activity during the night for several weeks in the fall). Also, a con is that pre-construction surveys do not seem to perform well at predicting post-construction bat mortality

(possibly because the turbines themselves result in attracting bats due to their physical presence on the landscape).

2. **Post-Construction Monitoring:**

    - Random searches for dead bats can trigger mitigation actions like increased cut-in wind speeds to reduce bat deaths.

Post-construction monitoring occurs during the fall migration season, with random turbines in each development area methodically surveyed for dead bats every few days. Pros: detection of dead bats will initiate further mitigation action. Cons: random searches mean that not every turbine is checked and there is high variability in the number of kills at each turbine; small bat bodies are quickly scavenged by crows, ravens, magpies and beetles (which means searchers may miss bodies); bat bodies are often difficult to find, even in an open landscape like prairie grasslands (even more so in forested or shrub habitats); also a con is that once built, it is unlikely that turbines are removed for many years.

Hoary Bats have high levels of documented fatalities at wind developments. Photo: Paul Cryan.

3. **Technological Solutions:**

    - Techniques like feathering turbine blades at low wind speeds, **UV reflective paint**, and **high-frequency sound deterrents** are being tested, with some reductions in fatalities observed.

Mitigation initiated if dead bats are found include using minimum “cut-in” speeds that lock the entire turbine/rotor in place until windspeeds are high enough to efficiently generate power (used especially on nights with low windspeeds as this is when many bat deaths are observed and especially on nights when the front of low-pressure system passes through the development area during the fall migration period); and “feathering” the blades of the offending turbine.

“SMART” curtailment is a new technology that involves using acoustic detection systems to listen for bat activity in the area of the turbines at night. When bats are detected, curtailment occurs. This system attempts to both reduce bat deaths and minimize the expense of mitigation to the wind industry.

Other industry methods developed to reduce bat mortality include painting rotors with UV reflective paint to make them more “visible” to bats; strategic lighting to warn bats that rotors are present; and most recently, playing very loud, high frequency sound to warn/repel bats from the area. It is unclear if any of these methods are truly effective although some have resulted in a small reduction in bat deaths. **I**t remains to be seen if these mitigation efforts are enough to protect bat populations in the face of exponential growth of wind energy facilities across North America and an uneven playing field of regulations.

What can people do?

- **Community Involvement:**
    - Support and encourage **research** and demand better mitigation strategies.
    - Be vocal about choosing appropriate sites for wind energy developments to minimize impacts to bats and support policy recommendations to protect bats.
- **Policy Recommendations:**
    - **Curtail turbines below 5.0 m/s** during high-risk periods to reduce fatalities by 50-80%. This curtailment speed is a source of contention. Higher curtailment speeds help reduce the fatality rate but stopping the turbines at higher wind speeds means that the industry incurs higher energy/profit losses. Deploy and monitor the effectiveness of SMART curtailment systems that incorporate bat detection systems to trigger turbine shutdowns when bats are nearby.
    - Site turbines **away from bat habitats** such as migration routes and hibernacula. In many places there are recommendations for siting but without good information on migration routes, timing of migration, and the expected variability in these factors (mostly due to changing environmental conditions) means that these recommendations could be improved.
    - **Establish setback distances** from geographic features known to be used as migratory corridors by bats. In Alberta, the east slopes of the Rocky Mountains funnel bats towards southern destinations. Research from Saskatchewan clearly identified rivers and 2-5km on either side of river corridors as migratory highways for bats. Large natural areas and ridgelines are also known to create pathways for migratory bats.

Further Reading:

- www.albertabats.ca/wind, Alberta Environment, CANWEA, BC Bat Management Guidelines

Threat D: Insect Prey Population Declines & Bat Health

Possibly one of the most alarming things to have been brought to light in the past decade is the decline in insect populations world-wide. 40% of insect species are in decline. In North America half of all lepidoptera (moths/butterflies) and beetle species are in decline with 1/3 threatened with extinction. Half of all bee and ant species are threatened and 63% of caddisfly species are threatened (possibly because their aquatic larval forms are at a higher risk from polluted waters from development).

There has been no single reason found for insect declines – but there are several factors that contribute to their demise. First the biggest reason is from habitat changes. Loss of habitat from urbanization and conversion of natural habitats to agriculture. The loss of the small family farms has meant the loss of hedgerows, open pastures and weedy areas that supported insect fauna. Drawing down swamps and wetlands to increase land availability has also impacted insect production (especially those with aquatic larval forms). Pesticide use such as herbicides, fungicides and pesticides all contribute to loss of insects and their habitats. Climate change also affects insect abundance and may cause the timing of bat activity to desynchronize with insect emergence. Drought, extremes in weather patterns and changes in the frequency and duration of extreme weather events all affects natural populations. And lastly, invasive species, parasites and disease all contribute to insect losses.

A recent report by Bird Studies Canada found that aerial insectivorous bird populations had declined by 42%. Birds are much easier to monitor than bats. The birds that consume daytime flying insects share the same "guild" with the aerial insectivorous bats. We have no reason to think that bats have not seen similar population declines. It's concerning but on the other hand, any conservation measures that benefit bats will benefit insect-eating birds as well.

Where have all the bugs gone? Illustration by Jan Kunz (via Jonathan Kolby on Linkedin)

What can people do?

- *Stop using pesticides on lawns and gardens. Use organic treatments and spot treatments for pest insect issues.*
- *Buy organic fruit and vegetables when possible.*
- *Plant native plants, trees and shrubs; converting lawn to natural habitat would have a huge impact in urban centres.*
- *Put water out for bees! Bird bath-type structures filled with pebbles will allow access to water for small insects without the risk of drowning.*
- *Promote local community projects to conserve wetlands and wild habitats. One such project in the city of Calgary involved planting a central boulevard strip with native grasses and wildflowers. The result was a significant increase in the abundance and diversity of insects in the area, including a rare bumble bee species! Small acts an have big effects.*

Threat E: Climate Change

Climate change may affect levels of bat activity and bat numbers. Extreme weather patterns, especially drought but also extreme heat, cold, and precipitation; increasing storm intensities; and sea level rise can directly affect bats and the habitats they depend on. Lactating female bats are very sensitive to the availability of water resources for drinking. Declines in available water during times of drought can cause lower bat reproductive success and population decline. Even a diminished water output from a small stream may impact a local bat population, especially in areas with few watering holes for bats. Biologists in Europe found that in dry regions, bats fly long distances to find water and have very large home ranges. Drought conditions brought on by climate change may force bats to fly even farther which increases their daily energetic costs.

Bat reproduction and hibernation are both closely tied to environmental temperatures and conditions. Timing of hibernation in autumn and emergence in spring (with subsequent initiation of pregnancy) is dependent upon cues from temperature and weather. The effects of these changes on bat population sizes is not known or if there are species specific effects from such changes.

Because bats are sensitive to environmental change, they may act as early warning indicators of the large-scale ecological effects of climate change, especially in western North America. Bat biologists have advocated for the implementation of a global network for monitoring bat populations allowing the use of bats as bio-indicators of ecosystem changes around the planet.

What can people do?

Here are some practical and attainable actions individuals can take to reduce their ecological footprint and combat climate change:

Reduce Energy Use

- **Switch to energy-efficient appliances**: Opt for LED bulbs, energy-efficient refrigerators, and other certified devices.
- **Unplug electronics**: Turn off and unplug devices when not in use to save power. Unplug charging plugs from the wall when done charging devices.
- **Use renewable energy**: Install solar panels or choose green energy options if available through your utility provider.
- **Adjust your thermostat**: Lower heating in winter and reduce air conditioning use in summer.

Change Transportation Habits

- **Drive less**: Walk, bike, carpool, or use public transport.
- **Use fuel-efficient vehicles**: Switch to a hybrid or electric vehicle if possible.
- **Plan efficiently**: Combine trips to reduce driving frequency.

Adopt a Sustainable Diet

- **Reduce meat consumption**: Especially red meat, as livestock farming is a major source of greenhouse gases.
- **Buy local and seasonal food**: This reduces emissions from long-distance transportation.
- **Cut food waste**: Plan meals, store food properly, and compost leftovers.

Consume Wisely

- **Buy less**: Avoid unnecessary purchases and prioritize quality over quantity.
- **Choose eco-friendly products**: Look for sustainable, recycled, or upcycled goods.
- **Reuse and repair**: Extend the life of items instead of replacing them.

Conserve Water

- **Fix leaks**: A dripping faucet wastes water and energy.
- **Install water-saving devices**: Use low-flow showerheads and toilets.
- **Reduce hot water use**: Wash clothes in cold water and take shorter showers.

Reduce Waste

- **Recycle properly**: Follow local guidelines for sorting waste.
- **Avoid single-use plastics**: Use reusable bags, bottles, and containers.
- **Compost**: Turn organic waste into nutrient-rich soil for gardens.

Support Reforestation and Green Spaces

- **Plant trees**: In your yard or as part of community projects.
- **Support green initiatives**: Donate to or volunteer with organizations focused on reforestation and conservation.

Advocate and Educate

- **Vote for climate-conscious leaders**: Support policies and candidates prioritizing renewable energy and sustainability.
- **Spread awareness**: Share information and encourage others to adopt eco-friendly habits.
- **Participate in local climate initiatives**: Join clean-up drives, environmental groups, or climate action campaigns.

Offset Your Carbon Footprint

- **Invest in carbon offsets**: Support projects that reduce or capture greenhouse gas emissions.
- **Support renewable energy**: Contribute to programs advancing wind, solar, or other clean energy technologies.

Even small, consistent actions can add up to make a significant impact over time.

Check out the Alberta Community Bat Program Guidebook on "Bat-Friendly Communities" and implement some of the suggestions for bats www.albertabats.ca.

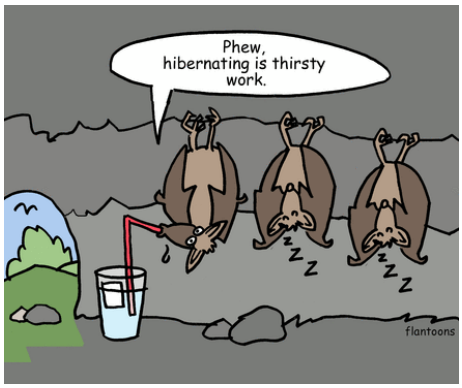
ECOLOGY OF BATS

Most people do not have a good understanding of basic bat biology. Bats are kind of weird and unless you have an issue with bats in a building or you are the kind of person that is really keen on wildlife, it is not surprising that the average person would have no bat knowledge. Don't be surprised if you are repeating very basic messaging like, "Bats are mammals." "Canadian bats only eat insects; we don't have fruit bats here." Or truly amazing people with bat facts like, "Bats have incredibly long lifespans. We have a 7-gram Little Brown Myotis in Alberta that was determined to be 39 years old from banding records!" (Honestly, that is a pretty great bat fact!)

Understanding some bat basics is a key part of doing bat education. This guidebook presents some very basic information with examples and suggestions on how to explain this information simply to the public. But this is not an exhaustive resource. Bat biologists learn new and sometimes truly amazing things about bats every year. Keep reading and keep learning. Even the most seasoned bat expert is doing the exact same thing!

All About Bat Life Cycles

Hibernation



Thirsty hibernating bats. (Illustration: Flantoons, creative commons).

In Alberta, bats enter hibernation in late fall (typically by mid- to late October). We know of just a handful of cave sites where bats hibernate, and these sites contain only a few thousand bats. The largest cave hibernaculum in Alberta has fewer than 2000 visible bats during winter counts. We suspect that most of our bats are hibernating in deep crevices that are located under the frost line in rock faces or other sites. The Alberta Badlands provide hibernation habitat for bats in the deep erosion crevices along the riverbanks in this zone. But we really don't know exactly where most of our bats hibernate in Alberta!

Bats are TRUE HIBERNATORS. During hibernation, bats drop their body temperature to the temperature of the environment. They choose sites that are above freezing, generally around 0-9C. The analogy is that they are looking for sites that are like your refrigerator, not the freezer! Temperatures need to be stable and cold, and the environment needs to be humid, or bats can become dehydrated (forcing them to wake and seek water).

When bats are not hibernating, their resting heart rate is about 120 beats per minute. During flight, that heart rate may soar to up to 1000 beats per minute! During hibernation, their heart rate slows to about 5 beats per minute.

Fun Fact: Bears don't truly hibernate! Unlike "true hibernators" that lower their body temperature close to the surrounding air, bears only reduce their temperature slightly. This mild energy-saving state, called "carnivore lethargy," keeps them warm enough to avoid costly rewarming, letting them rest through winter without fully shutting down.

Activity: *Place your hand on your chest and tap it at the resting heart rate of a bat (so about 2x every second). Now increase the heart rate to flying heart rate (about 16 times per second!). Now decrease the heart rate to hibernation heart rate (about once every 12 seconds).*

https://nyaspubs.onlinelibrary.wiley.com/doi/10.1111/nyas.15225

During hibernation, bats also lower their metabolic rate (which is the rate at which they use energy). They don't eat during winter (because there are no flying insects available in winter!). They survive on the fat stores they accumulate just prior to hibernation. A 16g big brown bat may put on 8-10g of fat in the fall. Bats do wake during hibernation, but only 10-15% of this period is spent awake. Surprisingly, they spend almost 85% of their stored energy reserves to power the re-warming for these awake periods! The reason bats wake up is to have a pee (rid the body of wastes) and to get a drink of water! Dehydration is a problem when hibernating.

They also reduce their breathing rate to once every few minutes. And their immune system function is depressed during hibernation. White-nose syndrome infected bats need to wake from hibernation to fight the fungal infection. Waking uses up additional, valuable and limited fat stores. Ultimately, too much waking can lead to starvation and death for bats.

Important Message: *It is critical that bats remain undisturbed during winter hibernation sites. Never enter a bat hibernaculum in winter. Bat hibernation sites are critical habitats and should always be a priority for protection. Anyone entering underground sites used by bats should employ the latest white-*

Little brown myotis hibernating in an Alberta cave (oldest record for this species from this site is 39 years from a band record). Photo: Cory Olson.

Emergence

Bats come out of hibernation in spring when temperatures are consistently warm, and insects become active. This varies from year to year, so there is no set date. When females wake from hibernation, that is the time when they ovulate. Sperm that was stored overwinter (they a have specialized uterus that keeps sperm viable for fertilization) fertilizes the egg and pregnancy starts soon after the females wake. Males are efficient at mating with everybody and anybody in a hibernation site, so all females are potentially mothers when they wake (we are not yet sure about mating systems for migratory bats though). Successful

pregnancy depends on whether a female has enough body mass or can gain enough body mass in spring to support a pregnancy. If they are too thin and in poor condition, the embryo will be resorbed. Almost all our Alberta bats have only one pup per summer. Big browns have twins (but less than 10% of the time). Hoary bats will give birth to twins; red bats are known to have litters of four, but we know almost nothing about what red bats do in Alberta (they are quite rare). Pregnant females of most species (except hoary and red bats) band together and form "maternity" colonies. Size of colonies may vary with species. Little brown myotis may form small colonies (less that 25) or very large colonies of more than 1000 bats. Once they give birth, the colonies are often referred to as "nursery" colonies. Males and non-pregnant females have few energy demands and nothing to do but hunt and sleep. They choose roost sites that are cool so they can use torpor daily as a way of saving energy. Females with young choose much warmer roosts to reduce the expense of keeping babies warm. Warm babies grow faster than babies in cold sites. Nursery colonies are often 37-40C in the daytime!

Newborn myotis pup. Bat babies are often born hairless, pink, with eyes closed and large feet. Photo: Christian Gronau.

Birth

Bat pups are HUGE compared to their mother's body weight. At birth, they range from 25-30% of their mother's mass. Most species are born pink and hairless with their eyes closed but with very large feet that they use to hold on in the roost. Some females will carry their pups with them, but most of the time they will leave their pups behind in the roost when they leave at night to forage for insects. Bat gestation periods are around 40 days, but this can be longer if they use torpor while pregnant. Torpor is like hibernation (they lower their body temperature, breathing rate, heart rate and metabolic rate) but they use it over short periods to save energy (usually if the weather is cold or raining and there are no insects available). If a pregnant bat uses torpor, it will slow the fetal growth rate which will extend the length of the gestation period!

Fun Fact: *Put the size of a bat pup in human terms. A human baby that is 30% of its mother's body weight would weigh in at around 30-40lbs at birth!*

Fledging

Baby bats reach adult size at around 4 weeks of age but still need to figure out how to fly and how to hunt on their own. Bats are mammals and the mothers feed their babies milk. At the time of fledging, the mothers are feeding the equivalent of an Olympic athlete! Pups are relying on their mothers for food but burning huge amounts of energy while they learn to fly. This is called the period of "peak lactation". At this time, the mothers may be eating one and a half times their weight in insects each night, just to keep up with the energy demand from their pups! Shortly after fledging occurs, the nursery colonies begin to disperse. Everybody now has the job of eating as much as they can to get ready for winter hibernation.

Key Information: *Pups often start fledging around mid-July to August. They often are poor fliers and either get tired or crash-land away from the roost. It is this time of year that these youngsters may be found either on the ground or in weird roost sites (on the sides of buildings) or sometimes they will end up inside houses! These little bats just need a bit of help. Using thick leather gloves and a cardboard box, an adult can gently move a stranded bat to a safe spot (they need to be up high so they can take off again). Putting the bat in an open pillowcase and pinning it to a tree will protect the bat from birds and still let them climb out on their own and take off safely.* **Never handle bats with your bare hands!**

Bat Anatomy

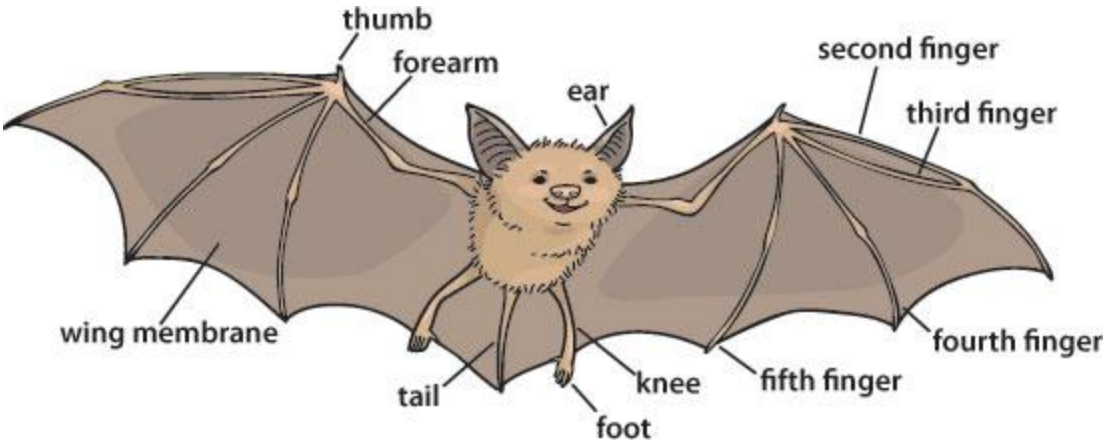


Illustration: creative commons.

Wings

Bats belong to the order Chiroptera which literally means
"Hand-wing". All our Alberta bats have simple wings and tails with a tail membrane. The small claw that sticks out above the wing is the bat's thumb. The other four fingers are elongated with membrane between the fingers. The fourth finger (the "pinkie" finger) has wing membrane that stretches from the tip of the finger to the bat's ankle. Hunting bats may sweep insects up into their wing membranes or in their tail membrane and reach down (while flying) to pick out the captured bug (they will curl their tail up like a little bucket). The result is often twists, turns and somersaults in the air. Bats are truly "acro**bat**ic"!

Activity: *Have everyone put their arms out to their sides with bent elbows and spread their fingers wide like a bat wing with their thumbs up. Show a photo of a bat wing and point out the arm, elbow, wrist, thumb and fingers as well as the feet and tail membrane. Flap like a bat! Ask them to imagine that their fingers were so long that they touched the ground and that their thumbs could wiggle and they use them for climbing.*

Feet

Bat feet are actually on backwards! Well backwards to us. They are rotated 180 degrees from our own feet and have a tendon system that allows them to hold on to things with their feet effortlessly. Normally, in a human hand, we must contract a muscle that pulls on a tendon that pulls your hand closed. Bats have tendons that are attached to their body, so when they are holding on with their feet, the weight of their bodies pull on the tendon and cause their feet to contract and grip. This is how bats can still hang on when they are sleeping or hibernating! They don't have to exert force to contract their gripping feet, however, they do have to contract muscles to release their grip.

Ears

Ears are an important bat body part. Because they navigate the night skies using echolocation, bat ears have evolved to capture sounds and there is huge variability in bat ear structure across different bat groups. Canadian bats have ears that range from being relatively small and rounded (like hoary bats) to quite large (such as the Townsend's big-eared bat or the Long-eared Myotis) to massive for their body size (such as the Spotted Bat that has the largest ears for its body size of any bat species!). Ear size and shape is often a reflection of the type of echolocation call that bat uses. "Whispering" bats that use very quiet echolocation calls often have larger ears to better hear the echoes of their own calls. Spotted bats have an unusually low frequency call (low voice) so they need a bigger "satellite dish" type ear to capture those long wave lengths. Aside from differences in the shape of the outside part of the ear (the "pinnae") bats also have another prominent ear structure known as the "tragus" that looks like a little "mini ear" inside its big ear. We humans have a tragus (and lately it has been a popular spot for piercing), but it is not well developed as it is in bats. This interior structure is also variable amongst bat groups. Sound captured by the ear will bounce off the pinnae and hit the back of the tragus and then is reflected into the bats ear canal to be processed by its brain. This additional information is used to determine where objects are located vertically (up and down) in front of the bat as it flies. It is just another specialized feature they have for analyzing their echoes from their echolocation calls.

Hoary bat (rounded ears, round short tragus), our largest Canadian bat species, likely widespread in Alberta. Photo: Jared Hobbs

Big Brown Bat (short, slightly pointed ears, small tragus); common bat species in Alberta. Photo: Jared Hobbs

Townsend's Big-eared Bat (very large ears that can fold backwards like a ram's horn, longer pointed tragus); in Canada this species is only found in British Columbia. Photo: Cori Lausen

Noses

Alberta bats belong to the family Vespertilionidae or the “Vesper bats”. All our bats are considered “plain-nosed” bats because they have no special structures. Our bats call by projecting sound out their mouths. Not true though for several other bat families which support what is known as a “nose-leaf”. These special structures evolved to help disperse sound because leaf-nosed bats send their echolocation calls out through their noses! Spear-nosed bats and horseshoe bats all sport a nose-leaf. The common vampire bat (*Desmodus rotundus*) also has a modified nose-leaf that is equipped with a special array of infrared radiation sensors that allow it to detect hot spots on their prey where blood runs close to the surface of the skin. So far, only pit vipers have been found to have this ability. The nose-leaf is also important in identifying some species of bats.

Golden Bat (Mimon bennettii) a spear-nosed bat (South and Central America); not found in Alberta. Photo: Cory Olson

Little Brown Myotis (North America) plain-nosed bat; a common species in Alberta but currently listed Federally as Endangered. Photo: Cory Olson

Common Vampire Bat (Desmodus rotundus) with modified nose-leaf (South and Central America); not found in Alberta. Photo: Cory Olson

For more information see:

Vampire bats turn down the heat sensors to hunt.
https://www.nature.com/news/2011/110803/full/news.2011.454.html

Noseleaves. https://animaldiversity.org/collections/mammal_anatomy/noseleaves/

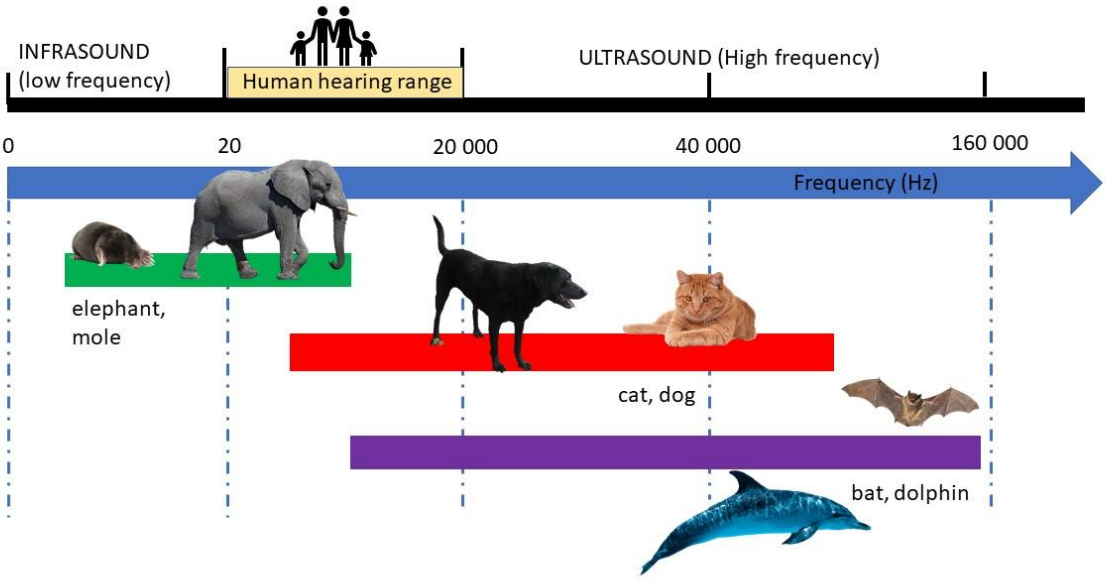
Echolocation

Hearing and Sound

Bats navigate their night world using “echolocation”. Just as the word implies, they locate objects in space by listening for rebounding echoes of their very loud, high frequency calls. We cannot hear bats echolocating. Their calls are at such a high frequency that they are above the hearing range for humans. Cats and dogs can hear them though, so if you catch your pet staring at the night sky in summer, they aren’t crazy – they may be listening to the bats flying and calling as they pass by!

Bats use a frequency range of around 20,000 Hertz (Hz) up to 150,000 Hz. The range of human hearing is around 20 to 20,000 Hz. Younger people with sharp ears can sometimes hear bats that echolocate at the lower portions of their range (i.e., around 20,000 Hz) and the sounds are very high pitched. As we age, we lose the ability to hear these high frequency sounds. Humans cannot hear infrasound either; these are the very, very, low frequency sounds used by species such as elephants and moles for communication. These low frequency sounds travel long distances.

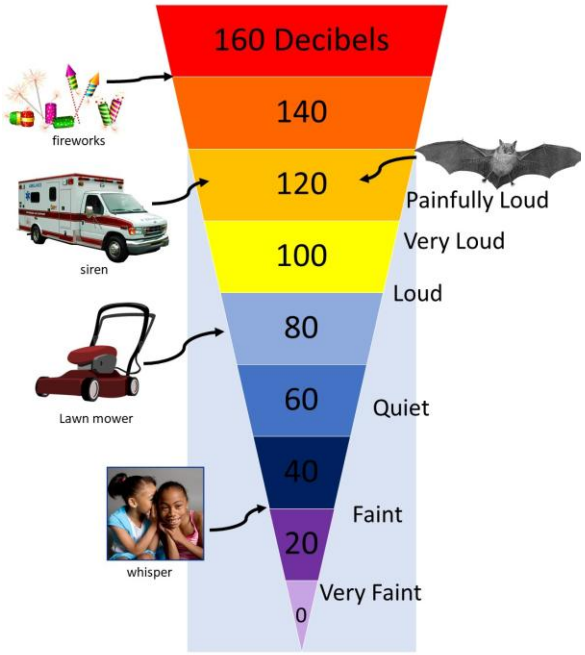
There is one Canadian bat species that has a very atypical, low frequency call (for a bat) that is audible to the unaided human ear and that is the Spotted Bat (Euderma maculatum) from the Okanagan Valley of British Columbia. If you camp in the south Okanagan you might hear a strange “click-click, click-click” sound over your head at night. Those aren’t weird birds but rather the calls of spotted bats. Their calls range from 9,000-12,000 Hz and they have evolved really large ears just to be able to hear their own call echoes (lower frequency sound has much larger wavelengths, their ears are like a large satellite dish). In fact, spotted bats have the largest ears for their body size of any of the bat species. They even generate



Hearing range of humans compared to several animal groups including bats.

some lift from their ears during flight they are that large! If you would like to seek out the spotted bat, you won't be able to see them, they roost in steep cliffs in very high locations. But you could listen for them. Near Gallagher Lake in British Columbia there are some steep cliffs with spotted bats. At around a half hour past sunset, sit near the cliffs and listen for their calls and you will hear them as they leave for their evening hunt.

To hear our Alberta bat species, you would need a "bat detector", which is a device with a microphone that captures the bat's calls, divides the sound and slows it down so we can hear the call with our ears. (See below for a general discussion on bat detectors).



Typical intensities of common sounds in decibels (dBs).

Fun Fact: *Interestingly, we can't hear bats echolocating, but your dog and cat can! The hearing ranges of both cats and dogs runs very high and overlaps with the frequency of bat calls.*

Bats are very loud with calls measured as high as 120 decibels (dB) which is louder than a symphony orchestra. If had a bat echolocating 10 centimetres from your ear, it would be like having a smoke detector go off beside your head! They are that loud. Fortunately, we can't hear them, or our summer nights would be very noisy.

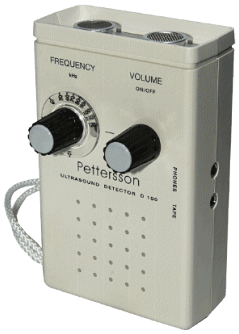
Sound intensity is a measure of how loud a sound is and biologists measure this in "decibels" (Db).

Activities:

1. **"Slinky Echolocator"** – (this exercise gives a "visual" of how sound travels from the bat, bounces off an object and travels back again). Pick one person to be the bat and another to be the moth. Maybe choose a couple of "trees" or "shrubs" as well. Have the bat hold the slinky up near their face. Have them yell, "click, click, click, click" as you pull the slinky out towards the "tree" (i.e., the traveling sound waves of their echolocation call) then walk the slinky back towards the bat (representing the returning echo). (Nope, not an insect! That's a tree!). "Echolocate" in the search phase a couple of more times with the slinky until your bat "finds" the moth. You can have the bat move towards the moth and increase the repetition rate of the "clicks" as the bat attacks the moth. (Demonstrates sound waves bouncing off objects; search phase of hunting and feeding buzz phase of hunting). You could even give the moth "ears" and allow them to try to evade the bat when they hear the bat echolocation calls.
2. **"Bouncing sound waves"** – demonstrate how sound bounces back to bats by having everyone cup their hands in front of their faces and making a "puh" p-sound. The air from the puh sound

will bounce back into their faces – much like how sound waves bounce off objects in front of echolocating bats.

Bat Detectors (models and detector basics)



Tunable detector (shown is the Pettersson D-100 from Sweden). These units are tuned into a single frequency to detect bats. Microphones are located on top. Second knob adjusts volume. Price: abt $300CA

ANABAT SD2 detector from Australia. Records all sound frequencies at once. These units are often used in scientific monitoring (data can be recorded and downloaded later for analysis). Price: abt $2000CA

Songmeter SM4BAT detector from the US (Wildlife Acoustics). A full-spectrum detector that can be left out to record passively with later download and analysis of data. This model often used in scientic monitoring; comes with a waterproof casing. Price: abt $1500CA (with microphone/cables/accessories)

Echometer Touch detector (shown is the model for naturalists, Wildlife Acoustics, USA). This unit records all frequencies at once (full-spectrum); free downloadable software will give both audio and visual displays of the calls and auto-ID function will identify the bat species calling. The most affordable model is $170CA

There are a few more models of bat detectors available, but the ones pictured above are among the more common ones that may be used to detect bats. They range in their ability to detect bats and manage data recording. Type of sound file required is also a feature that is considered when choosing a bat detector. For a naturalist just looking to listen to bats and figure out what kinds of bats live in their area, the Echometer Touch unit is very practical and is the best priced detector available at the moment that uses a very decent microphone. There are some questions about the reliability of the software that is used to identify bat species. There are options when setting up your Echometer Touch and associated software that allows you to restrict the "known" species in your area so that you don't seem to be detecting Myotis species only found in Britain! Bat calls can be very similar in frequency and structure across some species, and some bat groups cannot be reliably differentiated using auto-classification software. Grouping bats into "general" groups (e.g., silver-haired bat/big brown bat; little brown myotis/eastern red bat/northern myotis/long-legged myotis/western small-footed myotis) may be a more accurate representation of data unless reviewed by an expert.

For actual long-term scientific monitoring of bats, the full-spectrum detectors are better than the tunable detectors. Data analysis can be complex because auto-classification is often unreliable, and most data sets will require some degree of evaluation by an expert who can identify bat species by their

call files to compare with the results given by the auto-ID program. Specific training in call identification is required.

Diet

Diets of Canadian Bats

All the bat species in Canada eat insects (insectivores). There is variation in diet based on bat species—some species are moth specialists, others favour beetles. Larger bat species tend to eat large insects; smaller bats tend to eat smaller bugs (such as midges and mosquitoes). Any insect flying at the same time as a hunting bat is fair game to be consumed!

Insect groups eaten by bats (starting from upper right corner, left to right): first row – June bug beetle, Potato beetle, moth; second row – caddisfly, mayfly, lacewing; third row – midge, mosquito, fly (Photos: creative commons).

Traditionally, bat diets were determined by sorting through fecal pellets of bats and identifying insect groups to larger orders. Current methodologies include DNA analysis that allows a more specific determination of the insect groups in their diet (depending on the reference samples of insect DNA available). Bat specialists always assumed that bats eat mosquitoes but recent work using DNA has determined that both Little Brown Myotis and Big Brown Bats do, in fact, consume a considerable number of mosquitoes as part of their regular diet!

The impact of bats on insect populations should not be underestimated. Because bats are consuming the flying adult forms of many moths and beetles, they are removing adult, egg-laying individuals that

A colony of 1000 Myotis bats will eat 17,500 moths/night = 7 kg/night. In 2 months, these bats could eat over 1 million moths. Top photo: Jared Hobbs, Bottom photo: Emily Owens, Natural Resources Canada.

could be responsible for laying thousands of eggs that hatch into caterpillar forms that do the most damage to many crops. Bats consume pest insect species recognized by both the agricultural and forestry industries.

Recent diet analyses conducted by the Alberta Bat Program has found that Long-eared Myotis were eating crickets and grasshoppers! Long-eared Myotis are a gleaning species, which means they fly slowly and pick insects up off of surfaces. These bats are exceptional as not all bats would be able to capture insects that are resting on the ground or on the surfaces of vegetation.

Amounts of Insects Consumed

Bats consume huge numbers of insects. Most will eat their own weight in bugs in a night. Females with young bats that are just learning to fly and hunt on their own will still be nursing those babies; those moms can eat more than their own weight in insects in a night just to keep up with the energy demand!

Some calculations:

- A colony of 150 big brown bats can consume enough adult cucumber beetles in one summer to prevent egg-laying that would produce 33 million of their root-worm larvae, a major pest of corn.
- The 20 million bats that live in Bracken Cave, near Austin, Texas eat over 200 tons of insects each night. The Bracken Cave colony represents the largest concentration of mammals on the planet!
- One little brown bat can eat up to 2500-5000 mosquito-sized insects in one night!

- The economic importance of bats to the US agricultural industry is huge. On average, the estimate is that the value of insect control by bats is worth about $22.9 billion per year (with a range of $3.7 to 53 billion/year). Their estimate was that one million bats could be consuming from 660-1,320 tons of insects each summer.

Migratory Red Bat in flight. Photo: M. Brock Fenton.

Flight Distances

Bats are capable of amazing flight distances. Our three migratory species (Hoary bat, Red bat and Silver-haired bat) fly thousands of kilometres when moving between their summer breeding habitat and their wintering areas. Hoary and Red bats in Alberta likely fly to the southern USA but could range as far as Mexico or Central America, although we are not exactly sure where they winter. Silver-haired bats may also fly south, or perhaps some head west and hibernate in BC. Recent monitoring found them heading west through the mountain passes from Alberta into British Columbia in late fall. We think Silver-haired bats make a long-distance migratory flight (in this case maybe hundreds of kilometres) before they find a site where they hibernate for winter. Radio-telemetry technology capable of satellite tracking is still not small enough to attach to a bat (radio and battery weight would exceed the acceptable load to attach to a bat). Current radio-tags for bats are as small as 0.3 grams but the detection range is only a couple of kilometres in best conditions. Tracking flying bats is tricky because they can fly fast and overland whereas human trackers (requiring a vehicle to keep up) are limited to road systems. Bats can be out of range very quickly.

Our hibernating bats, even the smallest ones, are also capable of long-distance movements between summer and winter roost habitats. Little brown myotis have been found moving 500 kilometres between sites in Alberta. Even daily short-range flyers (Table 3) such as Northern Myotis have been recorded moving over 100 kilometres between their summer and winter habitats.

Flight distances given in Table 3 are averages taken from numerous studies that examined the daily movements of bats making foraging flights away from their summer roost. Hoary bats and big brown bats followed using radio-telemetry in Alberta and Manitoba made flights of 25 kilometres away from their roosts, flying the entire night and then returning to their roost at dawn (with a minimum total flight distance of 50km). Radio-telemetry work with little brown myotis in Washington state found bats

In Alberta, two long-eared myotis banded in Tolman were recaptured at Cadomin Cave (about 321km away); one big brown bat banded in Medicine Hat was recaptured in Stony Plain (about 448km away); and one little brown myotis banded in Warner was recaptured in Stony Plain (about 487 km away!).

flying a total of 15 kilometres in an evening as part of a large loop-route that included a large water body for drinking and shallow wetlands where they spent time hunting for insects.

Table 3. Average distances flown away from their day roost by night-foraging western bat species. Almost all these bat species will fly the same distance to return to their day-roost.

Short-range flyers (generally 1 kilometre or less, but can range up to 5 or 6 kilometres)	
7 species	Western-small Footed Myotis Long-eared Myotis, Northern Myotis, Long-legged Myotis (British Columbia bats: Pallid Bat, Fringed Myotis, California Myotis)
Mid-range flyers (often more than 2 kilometres and generally around 5–8 kilometres)	
4 species	Little Brown Myotis, Red Bat, (British Columbia bats: Townsend's Big-eared Bat, Yuma Myotis)
Long-range flyers (generally 10 kilometres or more but ranging up to 25 kilometres)	
4 species	Hoary Bat, Big Brown Bat, Silver-haired Bat, (British Columbia bat: Spotted Bat)

Wing shapes reflect flight abilities. Long-narrow wings are good for fast, direct flights. Short-wide wings are better for quick turns and sometimes even hovering. Bats like the Hoary bat need to take-off from an elevated position as they can't get enough lift to get off the ground. But bats like the Pallid bat or Townsend's Big-eared bat can take off from the ground with a bit of a hop up into the air because they can generate so much lift with their wide wings. Little bats like Western small-footed (and Eastern small-footed, *photo below*) have short-wide wings that allow these bats to fly in "cluttered" environments with lots of shrubs and branches in the way. They can also make very tight turns and can use very small (1-metre square) water sources for drinking. Hoary bats are not good at tight turns and need water sources with a straight flyway of up 30 metres long for drinking!

Hoary bat (*Lasiurus cinereus*) with long narrow wings for fast, direct flight; poor manoeverability but capable of long, sustained flights. Photo: Brock Fenton.

Eastern small-footed myotis (*Myotis leibii*) from Ontario, a small myotis with short rounded wings for quick flights and high manoeverability. Photo: Brock Fenton.

Pallid bat (*Antrozous pallidus*) from the south Okanagan, British Columbia. Wings are very wide which allows for very slow flights and maximum lift (these bats can take off from the ground). Photo: Jared Hobbs.

Types of Roosts Used by Bats

Many people think bats roost in caves year-round but that is not the case. Caves, mines and deep rock crevices are important for bats in winter as hibernation sites (because they provide stable, cold temperatures above freezing and high relative humidity) but they are almost always too cold for summer roosts. Large bat colonies in summer are almost always “maternity colonies” composed of mothers and their pups. Mothers are looking for very warm sites that keep pups warm and growing fast (a warm site also means that the mother doesn’t have to spend energy keeping baby warm). Living in a group that cuddles also generates heat that helps pups grow. And some bat species will have a couple of females stay behind at night to “babysit” their friends’ pups during the period of nightly insect hunting (although we are not clear on how common this happens with Alberta bats). Maternity colonies are often composed of related individuals with moms and their female pups from previous years all roosting together. Because bats are such long-lived animals (with lifespans of up to 40 years for some species; Alberta has the North American record for a little brown myotis that was found to be 39 years old through band records) these groups form very tight social bonds. We are still just starting to understand colony behaviours, but we suspect that these groups also hunt together and maybe move together to winter sites (but we really don’t know for sure).

Maternity roosts can occur in a variety of natural and human-constructed features. Types of roosts used can be specific to the bat species in question. Not all bats will use buildings or bat houses. Many rely on tree hollows or other spaces created by tree defects (cracks, spaces beneath peeling bark, within furrows of very deep bark). Other bat species may use only rock crevices (cliff faces, rock outcrops, mudstone areas of riverbanks). And a few bat species will roost in all these types of roosts. Males and non-reproductive females will often be found roosting singly or in very small groups of just a couple of bats. Males and non-reproductive females have virtually no energy demands during summer, so they just eat and then find a cool place to sleep where they can use daily torpor and with as little effort as possible.

A single myotis bat roosting on the outside wall of a home under the eaves. Likely a male, because it is roosting alone, this is also a typical location for a night-roost. Photo: Karen Bennett.

People often report bats roosting against the outside of their houses, under eaves and out of the wind; but this often only happens for short periods during the night. These types of roosts are known as “night-roosts”. We are still unclear on the exact functions of a night-roost, but we do know that most species do this for a couple of hours after their first bout of hunting at night. With full bellies, bats hang up in a warm spot out of the wind with their friends, groom, digest bugs, poop (a LOT of pooping going on) and cuddle with their neighbours. This may be an important social behaviour as well. The only evidence the next morning is often a scattering of bat guano on the wall and on the ground beneath the roost. Bat guano is an excellent plant fertilizer (very high in nitrogen, it is considered a specialty fertilizer). Aside from simply sweeping up the guano in the morning, residents can set up a planter beneath these types of roosts that will catch the guano. A wall-mounted version can work well in some

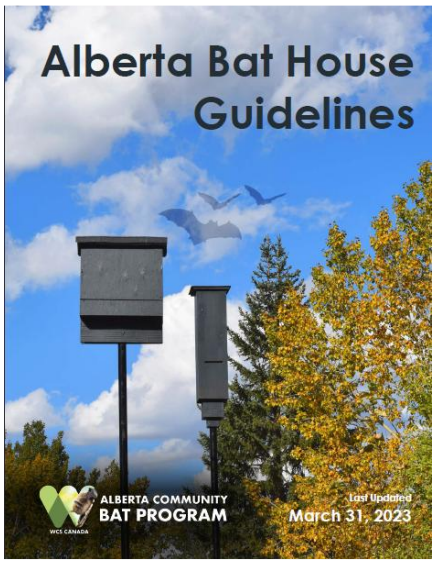
locations. We encourage residents to welcome these nightly guests as they do no harm and having a safe place to night-roost is important for local bat populations.

Bat houses

Four-chambered nursery box for bats; designed for maternity colonies; this is the easiest model to build and the one we recommend (www.albertabats.ca for free plans). Photo: Cory Olson.

Rocket box-type bat house; also multi-chambered; more difficult to build and more expensive; unclear if bats prefer this model. Photo: Cory Olson.

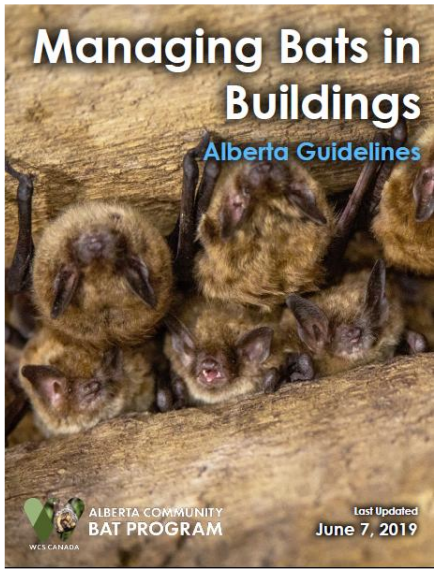
Bat "condo" is a condominium-style bat house; for very large groups of bats; suitable for sites with large colonies that need to be excluded; houses 1,000 bats or more. Photo: Cory Olson.



Alberta Community Bat Program's "Building Better Bat Houses" Guidebook available for anyone wanting information on building, installing or managing bat houses.

Interest in bat houses has increased substantially in the past few years. It seems like an easy fix for the "bat conservation problem" (i.e., declining populations from various threats). The truth is that bat houses may be effective for only a few Alberta bat species. Primarily Little Brown Myotis and Big Brown Bats will benefit from bat houses (but this is okay because Little Browns are currently listed as Federally Endangered due to white-nose syndrome). Long-legged Myotis may also use bat houses, but we have yet to find any in boxes in Alberta, although we do know of a couple colonies in buildings. Five of our nine bat species use natural roosting habitat, so bat houses are not going to help them. But bat houses are a great tool to introduce people to bats and to get them excited and supportive of bat conservation.

People should be warned about purchasing bat houses that are not suitable for bats. There is concern that single chamber boxes can overheat and may leave young, flightless bats with no escape from the heat, resulting in a death-trap. Very small bat houses may be cute but are not likely to be functional. Our current recommendation is to use the four-chambered nursery box plans available for free on our website www.albertabats.ca. These can be built with about $40 worth of materials but require some special preparation of the interior roosting panels (they need to be scored to increase roost grip for young bats). Our Guidebook "Building Homes for Bats" talks about where to install your bat house and HOW to install your bat house. The outsides of bat houses are often stained (not painted) black but in very hot regions, a lighter colour may be needed to prevent temperatures in the box from spiking above 40C (which is too hot for bats for prolonged periods and may lead to heat-related deaths). Rot-resistant woods, like cedar, do not necessarily need to be treated. Some colonies of some bat species also like to move around between several roosts. We are just learning how bats use bat houses, but it might be advisable to set up a few boxes in different locations for your bats (if you have the space) or cooperate with neighbours to get them involved in bat conservation. Current research on bat house use in both Alberta and BC is ongoing and we may see updates to recommendations. Both provinces have ongoing "community science" projects that involve homeowners who have roosts (in buildings, bat houses or natural roosts) counting bats and registering locations. Information on this project is available for Alberta at www.albertabats.ca (for BC see www.bcbats.ca).



Alberta Community Bat Program's "Bats in Buildings" Guidebook for anyone needing information on how to manage a bat roost in a building in a bat-friendly way.

Bats in Buildings

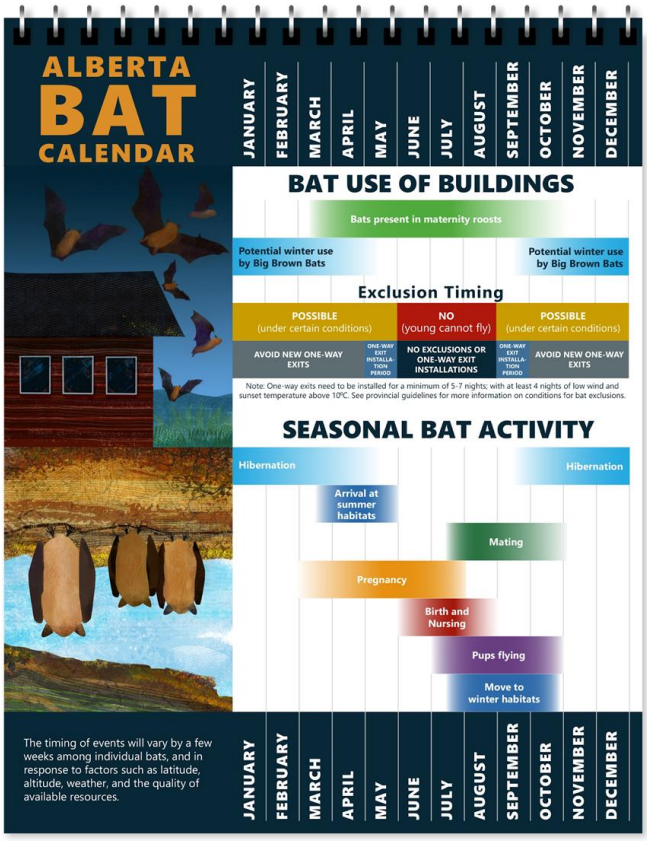
The Alberta Community Bat Program has a great Guidebook available as a resource for anyone with bats in a building (available for free download at www.albertabats.ca). Bat colonies can be kept in buildings

occupied by humans if the two groups stay in their own spaces. Bats do not chew or dig holes, they don't bring in nesting material, so they do not create a fire hazard or destroy things. Bats do poop a lot, and they will urinate in their roosts, both can cause a significant smell if left unattended. Humans can manage the mess by cleaning out their attics (after the bats have left to hibernate), sealing up spaces where bats might move into human living spaces, laying down plastic sheeting to catch future guano and making a schedule of clean up every year or two (depending on the size of the colony).

Managing a colony will diminish the chance of damage from excess guano accumulation. Humans sharing spaces with bats should also ensure that their pets are up to date with their inoculations and that all residents (especially young ones) are clear that bats are not to be handled (especially with bare hands).

When a bat colony cannot stay in a building (or if the building is to be demolished), there are specific timing windows when evictions and exclusions should be conducted. Bat-friendly exclusions involve waiting until bats have left the building in late fall and subsequent renovations or exclusions occur between late fall and early spring. Mid-summer, maternity colonies are full of mothers and flightless pups that are quite vulnerable.

Natural Roosts and Behaviour



Timing is everything when a building-owner is committed to a "bat-friendly" exclusion. See the Guidebook for more details.

Western bat species (from Alberta and British Columbia) can be lumped together based on the types of roosts they will use and the way they move around the landscape. This is especially useful for management purposes, but this also helps conceptualize differences and similarity among bat species. Specialist bats who will only use one type of roost may be more vulnerable to habitat change or loss. Bats that will use many types of roosts exhibit behavioural flexibility, which is something that is in their favour when facing threats like climate change or habitat loss.

Habitat connectivity can be an issue for some bat species. Those bats that will not cross open gaps (some bat species may be sensitive to open areas of as small as 10 metres) may find themselves restricted in their movements. This can cause problems if either food or roosting habitat is limited.

Table 4. Types of nursery roosts used by western bat species (Alberta and British Columbia), typical movement habits.

	Bat Species	Nursery Roost type	Foraging & Movement Habits
ROCK ROOSTS	Spotted bat, Pallid Bat, Western Small-footed Myotis, and Canyon Bat	Uses rock roosts only; cliffs, rock outcrops, boulder fields, erosion crevices in riverbanks (mudstone)	All species will fly in open habitats (crosses gaps easily).
TREE ROOSTS	Hoary bat	Solitary (a single female with pups); roosts on small twigs in open foliage; requires tall trees (generally, 15 meters+) with open space below to "drop and fly".	Uses older, tall, mature trees with open canopy, flies in open habitats. (Note: preferred tree height is variable; often chooses the tallest tree available; open understory is essential).
	Silver-haired bat	Roosts only in trees (old-growth or mature, old-seral)	Forages in open habitats, including above the canopy of closed forests (crosses large gaps easily)
	Northern Myotis		**Forages along edges or in interior forest habitat (sensitive to fragmentation)**
ROCK OR TREE ROOSTS	Big brown bat, Little Brown Myotis, Yuma Myotis, Long-legged Myotis, Fringed Myotis	Roosts in either rock-type roosts and/or old-growth, mature, old-seral tree roosts. Often roost in buildings.	Forages in open habitats (crosses large gaps easily)
	California Myotis, Long-eared Myotis		**Forages along edges or in interior forest habitat (sensitive to fragmentation)**
	Townsend's Big-eared Bat	Roosts in very large tree cavities (like hollow western red cedar), shallow cave formations, and buildings	Prefers roosts with large entry points that allow them to fly into the roost; roosting bats are in the open; building roosts may require specific conservation strategy; roosts in wide open locations within roosts, easy to locate and identify.

Bat roost trees can occur in a variety of tree species if spaces exist for bats to hide (hollows, cracks, crevices, under peeling bark); large diameter trees with some type of defect are preferred but bats may use large old stumps if conditions are suitable. (Photos: Cory Olson).

Table 5. Types of bat roosts.

Roost Type	Definition
Ephemeral roost	A bat roost in a feature where the characteristics important to bats (e.g., microclimate) may change quickly and/or unpredictably (lasting short durations); for example, an area under sloughing tree bark.
Permanent roost	A roost that is available for bat use over many years and has suitable characteristics (e.g., microclimate, access) that remain stable over time. Examples of permanent roosts include caves, cliffs, mines, bridges, buildings, and large hollow trees of a slow-decaying species.
Night-roost	A roost where bats rest at night between foraging bouts. Bats may roost singly or in groups.
Day-roost	A roost where bats rest during the day in spring/summer/autumn. Day-roost types include maternity roosts, bachelor roosts, and mixed male/non-reproductive female/yearling groups. Use of a specific day-roost may be seasonal or variable within a season.
Maternity roost	A roost used outside the winter period by adult females that are capable of reproduction.
Nursery roost	A roost where females congregate to give birth and raise their young. A nursery roost is a type of maternity roost.
Bachelor roost	A roost used by one or more males during the day.
Fall migratory rest stop	A roost used by bats during migration between summer and winter habitats.
Winter hibernation roost	A site where one or more bats hibernate in winter (hibernacula [plural]). A given hibernaculum may be used by bats for only part of the winter and may not be used every winter.

Bat nursery roosts in rock features can occur in a variety of formations such as cliff faces, rock outcrops, split boulders, stacked rock, and talus slopes. (Photos of roosts: top, crevices in hoodoos, Cory Olson, left, cliff face illustrating a roost area with multiple roost sites in rock crevices, Mandy Kellner; bottom right, crevices under rocks in a boulder field provide bat roosts, Doug Burles).

Bat-Watching & Listening

Watching

Where are the best spots to watch bats? It is difficult to see them in flight once it gets very dark but for a half an hour just after the sun sets, the light is usually good enough to see bats in flight if they are around. The first thing bats do when they leave their hot, summer day-roost is to fly to a drinking water source such as a pond or lake with an area of clear, still water. Bats drink while in flight, skimming the surface and dipping their chin and tongues into the water to lap up a drink. Positioning yourself near this type of waterbody at sunset is a good strategy for bat-watching. Alternately, if you know of a roost site with bats, watch at sunset for an hour and count the bats exiting. If you record the information and use one of the Alberta Community Bat Program Roost Count data sheets, you can report your counts to us and be a part of our community science program!

Some people will throw pebbles in the air around bats and watch them dive at them (they will think they are insects) but to be bat-friendly, please use something soft, like raisins because pebbles can knock their teeth out! And they need their teeth!

Listening
Alberta Bats has created bat "kits" for each public library region as a pilot program in 2025. Each kit will include an ultrasonic bat detector and supporting information on how to use the unit and understand the output. These will be on loan at the discretion of participating libraries. Our conservation partner with the Waterton Biosphere Region has a similar project (participating libraries are in Cardston and Pincher Creek).

BAT ACTIVITIES AND CRAFTS

How to Run a Bat Walk

- Ideal group size:
  Depends on the number of bat detectors available for sharing. Ideally, it is good to have one detector for every 3-5 people. Groups of about 25 are easiest to handle but 50 could be managed with some assistance to manage the group.
- Control group size using an event management service (such as Eventbrite which is free for non-profit use).
- Types of detectors to use:
  The Echo-meter Touch units with a tablet are the most popular (because of the visual display and the auto-ID feature) but any type of bat detector will work.
- Number of detectors needed: depends on the group size.
- Timing: Set up the walk based on official sunset time. Bats will start flying within 30 minutes past sunset. Give time for people to arrive and 20-30 minutes for an introductory talk. Set arrival time for participants about an hour and a half before sunset (especially if bat interpretive materials are set out for viewing beforehand). The walk itself can be about an hour or so. If you set up a black-light

Counting bats exiting a roost. Photo: Cory Olson.

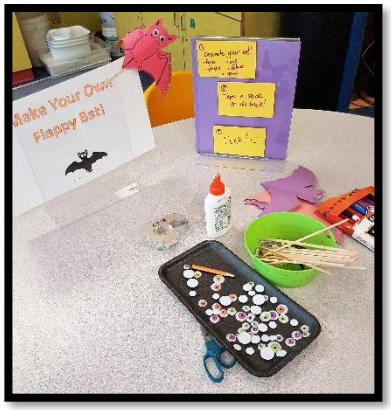
Sitting by a pond watching for bats at sunset. Photo: creative commons.

and sheet to attract moths and night-flying insects, count on another 10-20 minutes for everyone to look at this as well. Packing up will take a half an hour or so. Do not be discouraged if bats take some time to arrive – if there is not a roost nearby, or if a site is too open, it may take 30-60 minutes for bat activity to really pick up.

- Introductory talk:
    - Start with a welcome,
    - Explain the plan for the evening,
    - Introduce the Alberta Community Bat Program and its objectives (pointing out the website and social media platforms),
    - Talk about the number of bat species in Alberta and the number of bat species expected in your area,
    - Bat ecology,
    - Echolocation and how the detectors work,
    - Conservation concerns for bats,
    - Why bats are important and what the average person can do to help conserve Alberta bats.
- Can have display material set up as well
- Set up a white sheet with a black light and check out the local insect fauna after the walk
- Ask attendees to bring a flashlight and dress appropriately (it is often much colder after sunset)
- Sign-in – Sign-out may be useful, so you don't lose anyone, it is good to have a couple of helpers to ensure everyone is accounted for
- Walk and stop at strategic spots and just listen for bats

Bat Crafts

- **Flappy bats**
    - Use the template provided in the Appendix 1, trace your bats and cut them out ahead of time (tip: fold your paper in four, fold the bat template in half and trace half the bat along the fold line, with heavy scissors, you can cut through at least three pieces of construction paper at a time, this will generate six cut-outs per cut, use children's construction paper (regular size, lots of colours)
    - Provide coloured markers or pencils for decorating and details
    - Optional: buy some googly eyes and self-adhesive "gems" from the dollar store for decorating
    - Use flat, wooden stir sticks and tape them to the back of your flappy bat (*no name brand from Superstore works well)
    - Include a simple sign with instructions and a sample "flappy bat" (most kids can take this on themselves without much supervision – it is a quick and popular craft)



Flappy bats are a great, easy bat-craft that most kids can manage on their own or with just a little supervision from parents.

Pre-cut a stack of "bats" using the template attached in appendix 1. Cut sheets of adhesive stickers up into strips to limit consumption.

Create a sign with simple instructions and keep an sample "flappy bat" handy.

Pinecone bats

- Collect some pinecones (preferably open, large cones)
- Cut out a set of bat wings (Appendix 2 for template; may adjust size if needed)
- Inset wings into the cone
- Decorate the flat part of the cone with googly eyes and cut-outs of a bat nose and teeth
- Cut out ears and attach with glue
- Cone can be strung up using fishing line or a piece of yarn

Pinecone bats.

- **Bat Masks**
  - Print onto card stock
  - Cut out ahead of time
  - Use string or yarn to use as a mask tie
  - Decorate with coloured pencils, markers, self-adhesive stickers/crystals

Bat masks printed on cardstock.

- **Do Not Disturb signs**
    - It is important to not disturb bats, especially during hibernation
    - Cut out a rectangle from cardboard (old cereal boxes made with stiff cardboard work well); or find some pre-cut rectangular pieces of plain cardboard (such as large gift tags)
    - Cover the cardboard in paper (plain or coloured paper; use a glue stick)
    - Write “Do Not Disturb” “Bats Sleeping”
    - Use bat stamps, coloured markers or pencils, stickers to decorate
    - Punch a hole in the top and tie on a loop of string or yarn

- **Clothespin Bats**
    - A simple craft using clothespins painted black and two bat silhouettes that are glued or stapled along the edge of the bat wing and glued to the clothespin.
    - Use a one-hole punch to make the eye holes.
    - An easy craft that requires little supervision.

Top photo: “Do not disturb” signs, bottom photo: clothespin bats. All simple crafts that simply require preparation of materials beforehand.

Bat Games

- **Bat and Moth Game:**
    - With a large group
    - Pick one “moth” and one “bat”
    - Form a large circle
    - Blindfold the bat
    - Give the moth a shaker (any kind of noise maker)
    - When the bat “calls” the moth must respond with an “echo” (shake the shaker)
    - Have the bat find the moth inside the circle!

- **Bug Hunting:**
    - pretend they are all little bats have them fly" over to "catch" plastic bugs off a wall
    - give them paper cups to be their "bat ears" so they can hear better
    - talk about the kinds of bugs bats eat

- **Surprise Dinner:**
    - Have a cloth bag with an assortment of plastic bugs in it
    - Get the kids to reach in and pull out a bug
    - Talk about the kinds of bugs that bats eat

- **How many?**
    - Estimates are that little brown myotis can eat 600 insects (or more) in an hour
    - Count out 600 M&Ms to show the number of insects eaten; fill and label a jar to exhibit the "bat food".

Bat House Building Workshops

Tips on how to run a bat house building workshop:

- Ask them to bring their own power tools (drill with specific bit size for screwing in wood screws)
- Precut all the wood into "kits" following the plans available on the website www.albertabats.ca
- If you are staining boxes – bring appropriate clothes (it's often easier to have them stain it at home)
- Have a hand-out ready for post-build reference re: how to install and where to install bat house and information on the community science program – how to report your bat box and counts
- Advise that they should also use caulking to seal any of the seams from the outside (to keep it both watertight and reduce cooling from air leaks)
- Discuss all the parts of the box and how it all works (interior panels roughed give little bats better grip on the inside of the box), the piece at the bottom hangs out for a landing pad for the bats and then they crawl inside, the vents on either side of the box to give the bats a "cool" area to hang out if it gets too hot, the large holes in the inside panels allow bats to move from one compartment to the next from inside the box, roof is slanted to drain rainwater (some people add roofing material to their boxes, such as a tin or copper sheet).
- Talk about how to hang up a box (different ways to attach depending on whether you are installing it on a pole or a building)
- Discuss the importance of internal temperatures (needs to be quite warm, 37C range but not spiking over 40C or it can cause heat deaths); stable, warm temperatures over night are ideal

Four-chambered nursery boxes are the easiest to build as part of a workshop and the model best suited for Alberta bats (based on current information).

Pre-cut kits mean the workshop is for box assembly. Costs of materials for this box style is about $40 (not including labour). Use weather purpose screws on the outside of the box.

Make sure you have lots of electric drills handy for assembly.

ADDITIONAL RESOURCES

Alberta Community Bat Program homepage www.albertabats.ca

Alberta Environment: Bats https://www.alberta.ca/bats.aspx

Best Management Practices for Bats in British Columbia, Chapter 1: Introduction to Bats (covers both BC and Alberta bat species)
http://a100.gov.bc.ca/pub/eirs/viewDocumentDetail.do?fromStatic=true&repository=BDP&documentId=12460

Got Bats? BC Community Bat Program www.bcbats.ca

Bat Conservation International www.batcon.org

White-nose Syndrome US Fish and Wildlife Service www.whitenosesyndrome.org

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GLOSSARY

Acoustic survey/echolocation survey: a method of detecting bats using an ultrasonic bat detector. Detectors may be handheld (active surveys) or connected to an electronic system (passive surveys) for long periods of recording independent of human observation.

Adit: (mining term) a horizontal mine passage driven from the surface.

Bat detector: any device used to render the ultrasonic calls of a bat audible to the human ear. Popular models include the EMTouch (Wildlife Acoustics) that can be plugged into tablets or smartphones. The EMTouch uses software that will give the user both an audio call and a visual display of the call on the device screen. Automatic identification software will give a bat ID as the call is detected, however, there can be a significant amount of error in identification depending on the reference calls used and how well defined the detector settings are adjusted for the geographical region being surveyed.

Bachelor roost: a roost used by one or more males during the day

Cave: a natural cavity in the earth that connects with the surface, contains a zone of at least partial darkness, and is large enough to admit a human. For bats, this term also includes any natural extensions, such as crevices, sinkholes, pits, or any other openings, that contribute to the functioning of the cave system.

Crevice: a narrow crack or opening, or a fissure or a cleft, not large enough to admit a human. In addition to using caves, bats may roost in crevices and other cracks or surface openings within caves, in rocks, in rock outcrops, and on exposed cliff faces.

Curtailment: (applies to wind turbines used to generate electricity**)** limiting the supply of electricity during conditions when it would normally be supplied. Accomplished by cutting-out the generator from the grid and/or feathering the turbine blades.

Cut-in speed: (applies to wind turbines used to generate electricity**)** the wind speed at which the turbines produce electricity. Some turbine blades will continue to spin even when no electricity is produced.

Day-roost: a roost where bats rest during the day in spring/summer/autumn. Day-roost types include maternity roosts, bachelor roosts, and mixed male/non-reproductive female/yearling groups. Use of a specific day-roost may be seasonal or variable within a season.

Echolocation: the orientation system used by bats which consists of bats generating sounds high frequency sounds and listening to their returning echoes to locate obstacles and prey.

Ephemeral roost: a bat roost in a feature where the characteristics important to bats (e.g., microclimate) may change quickly and/or unpredictably. For example, a roost might be found in an area under sloughing tree bark that falls off the tree in only a few seasons and/or the microclimate under the bark may change significantly depending on the widening of the space under the bark or partial bark removal.

Feathering of the blades: (applies to wind turbines used to generate electricity**)** adjusting the angle of the rotor blade parallel to the wind or turning the whole unit out of the wind to slow or stop blade rotation.

Fertilization: the impregnation of the egg by the male sperm cell.

Flyway: any corridor used by bats commuting between roosting and foraging areas. Flyways make excellent sites for capturing bats in mist-nets and harp-traps; often delimited by physical structures such as vegetation or buildings.

Forage: to hunt for food.

Gestation period: the length of a pregnancy; the time from fertilization until the birth of the fetus. This period may vary depending on the environmental conditions experienced by the pregnant female in spring (torpor use during cold/wet weather will slow fetal growth and lengthen the gestation period). Generally, though, it is 5-6 weeks.

Gleaner: a bat that can capture prey on the leaves and twigs of vegetation or on the ground.

Harp-trap: a specialized trap designed exclusively for capturing bats.

Hibernaculum: a site where one or more bats hibernate in winter (hibernacula [plural]). A specific hibernaculum may be used by bats only part of the winter and may not be used every winter.

Hibernation: a state of lethargy characterized by a reduction in body temperature and metabolic rate.

Inventory: a single enumeration of an ecological system; generally carried either as a basis for estimating potential yield or to establish a benchmark. An inventory may act as one point in time in a monitoring program. Ecological inventories may be more comprehensive and spatially/temporally discrete than monitoring activities.

Lactation: the period of milk production by female mammals nursing young.

Maternity colony: an aggregation of females in spring, summer, or autumn. The colony may include pregnant females (may not be visibly pregnant early in the season), lactating females with or without young-of-the-year, or post-reproductive females. A maternity colony may consist of a group of females within a single maternity roost (e.g., building, cave), or a group of females roosting singly or in small groups in close proximity and maintaining a long-term social relationship, adhering to the fission-fusion model (e.g., in crevices within a cliff or boulder field, in a forest stand under sloughing bark of trees). A roost used by such a colony is called a maternity roost.

Maternity roost: a roost used outside of the winter period by adult females that are capable of reproduction.

Mitigation: measures implemented to control, reduce, or eliminate a potential adverse impact of a project, including restorative measures.

Monitoring: repeated, systematic measurements done with a specific purpose in mind. Monitoring is focused on measurements over time in order to detect the change toward, or away from, a stated standard or objective. Monitoring is part of the cycle of assessment and evaluation that is linked to management activities.

Nacelle: the part of the wind turbine on top of the tower that houses the controlling electronics and machinery of the turbine, including the gear box, drive shaft and blade controls.

Nocturnal: active at night.

Night-roost: a roost where bats rest at night between foraging bouts. Bats may roost singly or congregate.

Nursery colony: a type of maternity colony containing mainly nursing adults with young (summer), or an aggregation of mainly volant pups (late summer/early autumn). A roost used by such a colony is called a nursery roost (C. Lausen, pers. comm.).

Nursery roost: a roost where females congregate to give birth and raise their young. A nursery roost is a type of maternity roost.

Ovulation: maturation and release of the egg before fertilization.

Parturition: birth.

Permanent roost: a roost that is available for bat use over many years and has suitable characteristics (e.g., microclimate, access) that remain stable over time. Examples of permanent roosts include caves, cliffs, mines, bridges, buildings, and large hollow trees of a slow-decaying species, such as western redcedar (*Thuja plicata*).

Portal: the entrance to an adit or tunnel.

Pup: a bat born during the current year.

Resident bat species: species that move relatively short distances between summer and winter habitat, compared to migratory species, which travel long distances (> 1000 kilometres).

Riparian area: three-dimensional ecotones of interaction that include terrestrial and aquatic ecosystems. They extend down into the groundwater, up above the canopy, outward across the floodplain, up the near-slopes that drain to the water, laterally into the terrestrial ecosystem, and along the water course at a variable width.

Roost: a daytime retreat or night-time resting place.

Shaft: a vertical mine opening from the surface may also apply to cave systems.

Significant bat roost:

- any hibernaculum or swarming site.
- a roost used by a nursery colony of a listed species (any number of individuals), or a nursery roost used by more than six females of other species (can include mixed species groups).
- a roost used by a maternity colony of listed species (any number of bats), or a maternity roost used by more than four females of other species (can include mixed species groups).
- any permanent type day-roost used by a male or a non-reproductive female of a listed species, or > 10 males/non-reproductive females/juveniles of other species (can include mixed species groups).

- any night-roost used by a listed species or > 10 bats of other species (can include mixed species groups).
- any regularly used roost of a species listed under Schedule 1 of the *Species at Risk Act* (any number of individuals); or
- any other roost deemed significant by an experienced bat biologist.

Stewardship: caring for the land and associated resources so that healthy ecosystems can be passed on to future generations.

Swarming: behaviour associated with nocturnal flights that are made through potential hibernacula by aggregations of bats in late summer or autumn.

Torpor: a short-term (daily) state of inactivity achieved by lowering the body temperature and reducing the metabolic rate in order to conserve energy.

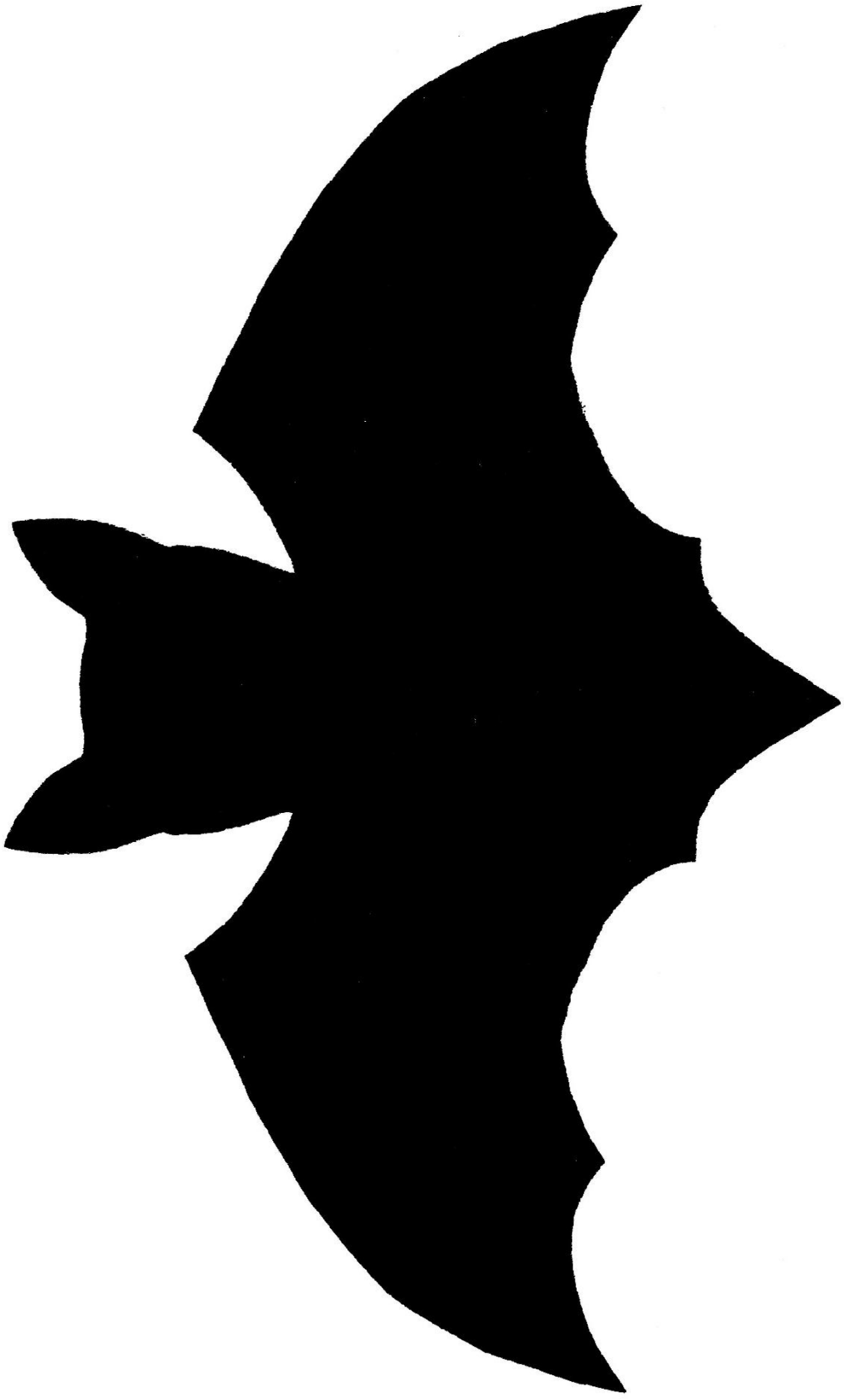
Tunnel: a horizontal mine passage that is open at both ends.

Volant: capable of flying.

Yearling: a bat born in the previous reproductive year.

Young-of-the-year: a bat born during the current reproductive year.

APPENDIX 1. FLAPPY BAT TEMPLATE



APPENDIX 2. WINGS FOR PINECONE BATS