University of British Columbia

Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Human-Wildlife Conflict Management at UBC

A case study using bats

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Executive Summary

This case study examines the university response to the presence of a bat roost in a campus building. The bats species present in the roost have a Blue-list designation by the province due to the new threat of white-nose syndrome in western Canada. This case study serves as an opportunity to examine University response to human-wildlife conflict, and how to best support vulnerable mammal species living on campus through urban development and climate change.

Recommendations:

1. Adopt a proactive approach to human-wildlife conflict.
    a. Currently EcoPest is on the 'front lines' of human-wildlife conflict management on campus. While they certainly play an important role in responding to 'pest' species in campus buildings, shifting to a **preventative and proactive model** may be more effective in preventing future human-wildlife conflicts.
    b. Support for facilities and maintenance to inspect all older campus buildings for small holes, aging siding and fascia, and similar areas that allow wildlife to enter buildings.
    c. Building and maintaining naturalistic landscapes. Often, wildlife chooses to inhabit human structures due to the lack of their natural roosting or denning areas like mature or hollow trees. The **maintenance of mature trees** and preservation of dead or hollow trees where possible often provides critical habitat for wildlife species such as bats.
    d. In addition to mature trees, the addition and maintenance of **naturalistic water sources** will be critical in supporting vulnerable bat species in the future. These water sources support diverse insect communities, vital prey for bats and other species. Current climate change scenarios predict longer drought periods, making these water sources critical for biodiversity and climate resilience. Daylighting streams and adding naturalistic ponds to campus would also provide cultural ecosystem services.
2. Monitor the effectiveness of bat exclusion.
    a. Providing bat boxes may or may not be an effective way to encourage the bats to abandon their current roost. **Non-invasive monitoring** of both the bat boxes and the current roost site should be conducted in order to evaluate the effectiveness of the exclusion efforts.
    b. Non-invasive monitoring (e.g., dusk emergence surveys, acoustic monitoring) provides an excellent **teaching opportunity** for students involved in a summer field ecology or biodiversity course.
3. Mammal diversity baseline.
    a. Currently there is a **paucity of data** on mammals occupying campus. Two UBC researchers, Sarah Benson-Amram and Kristen Walker, conduct camera trapping on campus, but camera traps are not always effective for detecting small, arboreal, or flighted mammal species like bats.
    b. Support for mammal biodiversity efforts, such as iNaturalist projects, BioBlitz, and even small-mammal trapping should be considered. These offer excellent teaching opportunities for students, especially those enrolled in field ecology or mammalogy courses.

1. Introduction

1.1 Research topic

The current biodiversity crisis is being exacerbated by global urban expansion. Urbanization results in loss of wildlife habitat and can exacerbate the effects of climate change via the urban heat island effect. Additionally, as urbanization expands, wildlife and humans will be brought into closer proximity to one another. This applies to the UBC campus, which is in the process of urban growth. UBC thus has a unique opportunity to become a leader in sustainable urban growth that supports vulnerable wildlife through urbanization, land-use changes and predicted climate change scenarios. As urban spaces encroach on wildlife habitat, there will be increased overlap between wildlife and people, which can lead to human-wildlife conflict. Human-wildlife conflict is defined as negative interactions between humans and wildlife, and includes transmission of zoonotic disease, interference with agricultural crops and livestock, and property damage. Human-wildlife conflicts can range in severity from large mammals like bears killing humans or livestock, to mice and rats being 'pests' in indoor spaces. A current conundrum of urban development is how to provide refugia for wildlife to support biodiversity and climate change resilience, while promoting human-wildlife coexistence and preventing human-wildlife conflicts. This case study examines how UBC policy currently approaches human-wildlife conflict using exclusion efforts of two vulnerable bat species, (*Myotis lucifugus*) and Yuma myotis (*Myotis yumanensis*).

1.2 Research relevance

As campus continues to grow both in land use and population, the frequency of human-wildlife interactions on campus will continue to increase. Sustainable development of UBC campus will need to take the prevention of human-wildlife conflict into consideration. Generally, a proactive approach to landscape design and facilities maintenance will yield the best results in promoting human-wildlife coexistence. UBC has a unique opportunity to be a leader in urban development that takes human-wildlife coexistence into account. By completing a case study of a current incident of human-wildlife conflict involving a vulnerable mammal species on campus, we can identify the holes in policy that need to be addressed. Further, it will be critical for urban areas such as the UBC campus to provide refugia for vulnerable species.

1.3 Project purpose, goals and objectives

- Identify mammal species-at-risk on campus and associated climate risks and vulnerabilities.
- Identify best practices/procedures UBC land-use planners and developers can follow in order to comply with provincial endangered/vulnerable species legislation through climate emergency.
- Complete a case study to understand the needs of promoting wildlife coexistence on campus.

2. Methodology and methods

An iNaturalist project was created to aggregate community scientists reports of mammals on UBC campus. The iNaturalist project can be found at: https://www.inaturalist.org/projects/ubc-ibios-collaboratory-campus-biodiversity

The Blue list of species was accessed via the BC Conservation Data Center (CDC). Following the acquisition of mammal data from the CDC, all species on the Blue list were cross-referenced with historical ranges of each species. The Blue list was reduced to species whose range would include UBC campus. Then, the CDC iMap system

was used to investigate whether any Blue list species were known to occur on UBC grounds (*B.C. Conservation Data Centre: CDC IMap*, 2023). Following the confirmation of two bat species presence on UBC campus, interviews and personal communications were conducted with several stakeholders involved in exclusion of the bats from their current roost in a campus building. A literature review was conducted to understand best practices for bat exclusion, and how to support bat species on campus in future. Maps were created using ArcGIS Pro to highlight the foraging ranges and water sources on campus valuable for support bat colonies.

3. Results

Results from iNaturalist reports yielded little information on vulnerable (Blue-listed) species on campus (Figure 1). The most common mammal species observed on campus between 2015-2022 was Eastern grey squirrels (*Sciurus carolinensis*). Several species that are Blue-listed by BC have a range that encompasses UBC's Vancouver campus (Table 1). However, the majority of these species have likely been extirpated from campus and the surrounding lands, or data of their current ranges are not publicly available, with the exception of two bat species: little brown and Yuma myotis (Table 1).

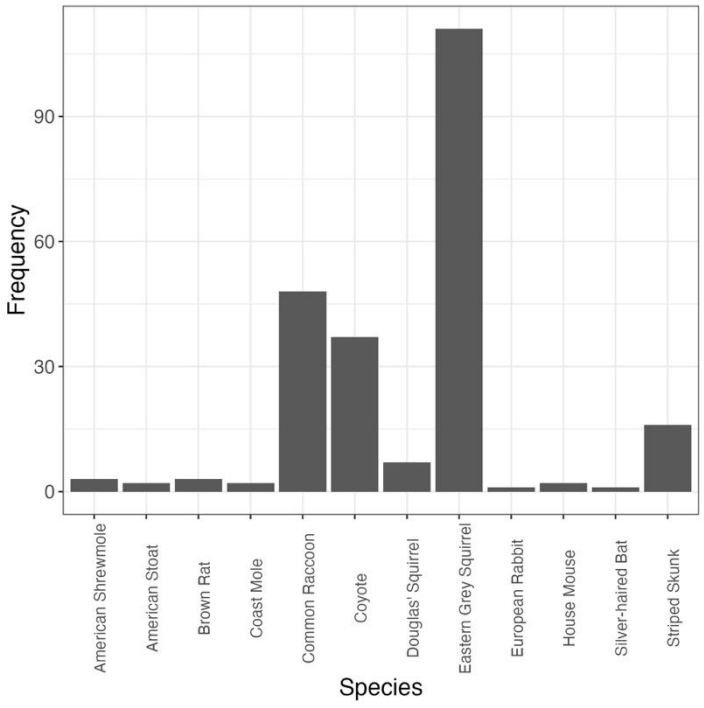

Figure 1. Wildlife sightings on UBC campus that were reported to iNaturalist. Observations were recorded from 2015-2022

Table 1. Species that are Blue listed (vulnerable, but not currently Endangered, Threatened, or Extirpated) or Red listed (candidates for Endangered, Threatened, or Extirpated list) by British Columbia. Provincial S Ranks: S1 = critically imperiled; S2 = imperiled, S3 = special concern, vulnerable to extirpation or extinction; S4 = apparently secure; S5 = abundant.

Scientific Name	English Name	Provincial SRank (Date of Evaluation)	BC List	Notes
Lasiurus cinereus	Hoary Bat	S3S4 (2022)	Blue	Data unavailable.

Myotis lucifugus	Little Brown Myotis	S3S4 (2022)	Blue	Likely roosting on campus.
Sorex rohweri	Olympic Shrew	S2 (2015)	Red	Only known occurrences are in Chilliwack.
Sorex bendirii	Pacific Water Shrew	S2 (2015)	Red	Last known occurrence/collection at UBC in 1973 – likely extirpated from area (CDC Map 12/1/22).
Myodes gapperi galei; Myodes gapperi occidentalis	Southern Red-backed Vole, galei and occidentalis	S3S4 (2006)	Blue	Data unavailable.
Corynorhinus townsendii	Townsend's Big-eared Bat	S3 (2022)	Blue	Only known occurrences mapped are from 1940s -- Fisherman's Cove and near Hope.
Sorex trowbridgii	Trowbridge's Shrew	S3 (2015)	Blue	Occurrence in Pacific Spirit Park 50 years ago -- likely extirpated from area (CDC Map 12/1/22).
Myotis yumanensis	Yuma Myotis	S3 (2022)	Blue	Maybe roosting on campus.

Bats have been found to be roosting in Old Auditorium Annex Offices (Figures 2 and 3). The bats were originally reported to EcoPest, UBC's pest management contractor, by people working in this building (Krystin, EcoPest technician, pers. comm.). Acoustic monitoring completed by Matt Mitchell suggests that the bats occupying the building are likely little brown myotis (*Myotis lucifugus*) and/or Yuma myotis (*Myotis yumanensis*) (Matt Mitchell, pers. comm.) These species often roost together, forming fission-fusion societies at their roosts, and it is difficult to discriminate between the two species using vocalizations and observations alone (Rensel et al., 2022). Guano samples from the roost site have been given to BC Bats for species determination via genetic analysis, and the results of the testing suggest that both little brown myotis and Yuma myotis are currently present at the roost (D. Dagenais, pers. comm.). Both species were designated Blue (vulnerable) in 2022. While the population of both species in BC is likely currently stable, white-nose syndrome (WNS), caused by the fungal pathogen *Pseudogymnoascus destructans* has been affecting bat populations in Eastern Canada, leading to an urgent need to protect these species in Western provinces that still have viable populations (Committee on the Status of Endangered Wildlife in Canada, 2013). White-nose syndrome was also recently detected in Grand Forks, BC, in April 2023 (BC Ministry of Forests, 2023). This fungus is a threat to all bat species in North America. The fungus disrupts bats' hibernation physiology, leading the bats to awaken from torpor and become more active than normal during winter hibernation. This depletes bats' winter fat reserves, leading them to starve or dehydrate. The threat of white nose syndrome led to BC Blue-listing little brown and Yuma myotis, due to the need to proactively support healthy populations of these species.

Water sources, especially open and naturalistic lakes and ponds, are important to survival of little brown and Yuma myotis. These water sources are important not only for hydration, but also support aquatic insect populations, which make up a large portion of the bats' diets (Table 2). Both species will forage above water and shrub layers on banks, catching flying insects. This punctuates the importance of the water sources nearby the current roost site, especially if they hold complex riparian areas that allow bats to rest and roost during foraging. The most likely foraging site near the current roost is the pond in Nitobe Garden (Figure 2). The complex

landscaping and diversity of plant life in this area likely supports numerous insect species, making it an easier source of food for foraging bats nearby their roost site. However, both Yuma and little brown myotis will fly anywhere from 2-5 km nightly to access foraging sites. This distance includes all of UBC campus and Pacific Spirit Park (Figure 3), and there are likely to be other foraging sites located within these areas. In particular, the pond at the UBC Botanical Garden is another site likely to support a variety of insect species to support a robust maternal bat colony.

Table 2. Little brown myotis and Yuma myotis foraging preferences. Reproduced from BC Ministry of Environment (2016).

Species	**Diet** (Aquatic insects[1] shown in italics, taxonomic groups are listed in order of frequency in diet composition studies)	**Foraging Mode**	**Reference** (D = diet; M = foraging mode)
Little Brown Myotis	*Midges, mosquitoes, mayflies (Ephemeroptera), flies (Diptera),* beetles (Coleoptera)[2], *caddisflies (Trichoptera),* lacewings (Neuroptera), Hymenoptera, and moths (Lepidoptera).	Aerial; nimble flyer, above water; above shrub layer	Belwood and Fenton 1976 (D); Anthony and Kunz 1977 (D); Fenton et al. 1980 (M); Herd and Fenton 1983 (DM); Saunders and Barclay 1992 (DM); Whitaker and Lawhead 1992 (D); Rainey 1998 (D); Burles et al (2008); Clare et al. 2011(D)
Yuma Myotis	Moths (Lepidoptera), *midges, mosquitoes, caddisflies (Trichoptera), flies (Diptera)*, and small beetles (Coleoptera).	Aerial; similar to Little Brown Myotis	Fenton et al. 1980 (M); Herd and Fenton 1983 (DM); Brigham et al. 1992 (D); Bogan et al. 1998a (D)

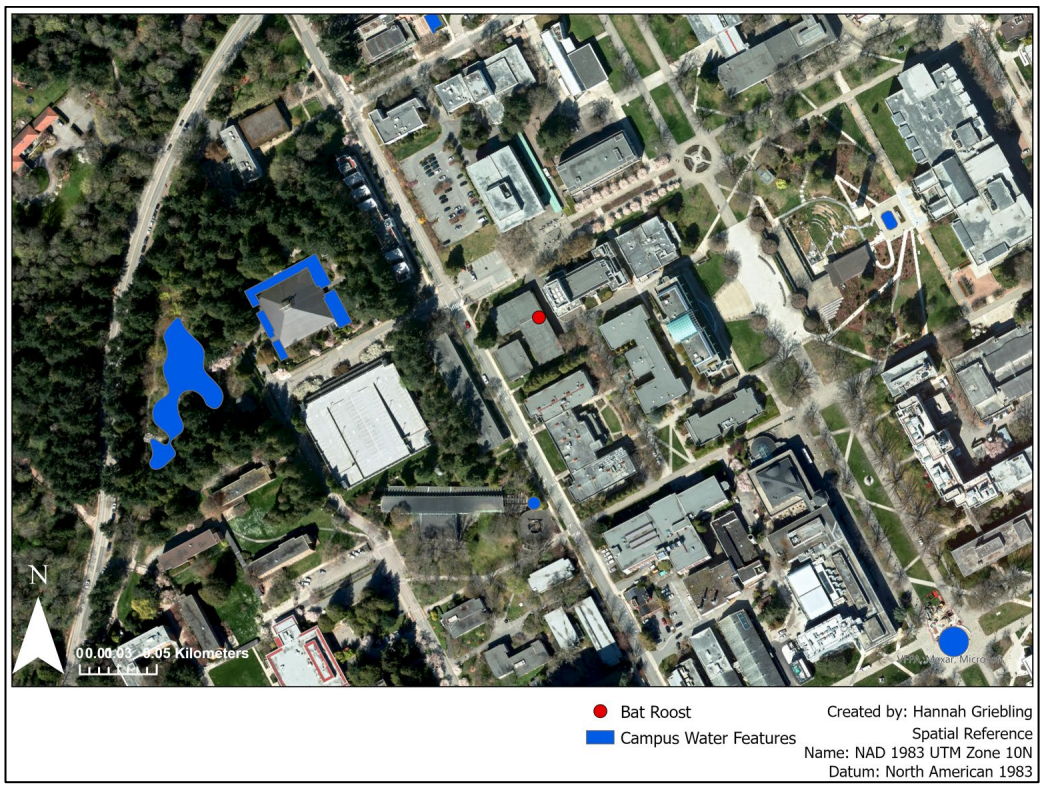

Figure 2. Map of UBC campus showing the current bat roost site (red dot) and campus water features in the closest vicinity to the roost.

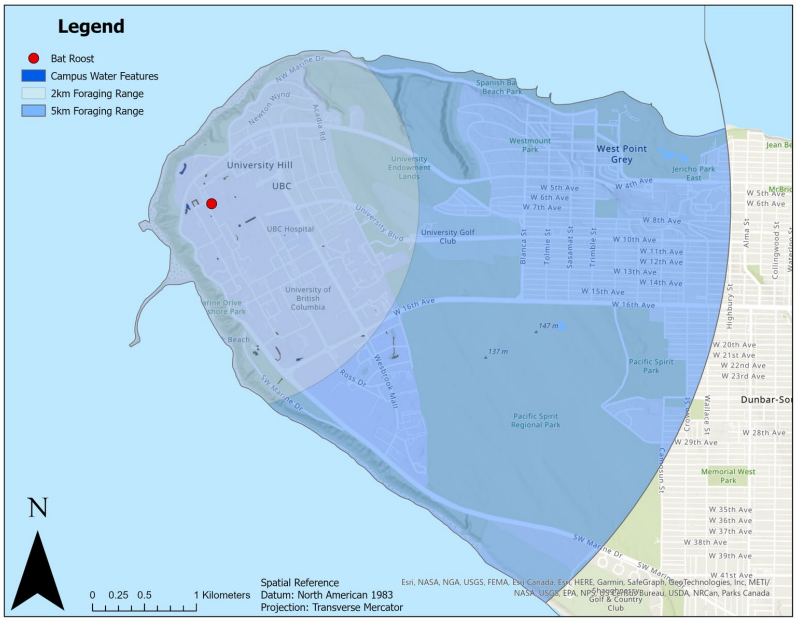

Figure 3. Map showing the current bat roost site (red dot) and the 2-5km foraging ranges for these species. The bats may travel away from campus as needed to forage in other areas.

4. Discussion

Addressing Current Conflict

The current plan to address the presence of the bat roost in the Old Auditorium Annex Office Building is to construct bat boxes in the summer of 2023. Following construction of the boxes the bats will be evicted from their current roost by closing any holes or patching siding the bats have been roosting in. British Columbia's Wildlife Act protects all bat species in BC from being killed, wounded, trapped, or transported (BC Ministry of Environment, 2016). Installation of bat boxes should be close to water sources to encourage the bats to move to the bat boxes that are near foraging areas. An area with trees to provide potential additional roost sites and shade could also encourage the bats to move to the bat boxes. Ongoing acoustic monitoring of the current roost and the newly installed bat boxes will be completed in order to confirm whether the bats migrate to the new site. Following successful migration of the bats to the bat boxes, the bat boxes will require minimal maintenance. However, yearly cleaning of any guano that has accumulated under the bat box is recommended by BC Bats.

Currently, there is a gap in UBC policy regarding who will be responsible for installation or maintenance of the bat box; however, it is likely that facilities will play a role in the installation of the boxes. It is important to note that, due to the risk of WNS and zoonotic disease, only trained professionals familiar with biosafety procedures concerning bats should access the bat box if bats are present. However, this should not be necessary unless more detailed monitoring of the box is needed.

While the bats are being encouraged to move to the bat boxes it could be beneficial to provide education on bats to the occupants of the Old Auditorium Office Annex. Since the bat roost was originally reported by someone working in the building to Facilities/EcoPest due to the build up of guano, it may be pertinent to

educate people working in the building on the low risk of rabies and histoplasmosis, the efforts currently being undertaken to exclude the bats from the Office, and the important ecosystem services that bats provide. BC Bats may be able to do a site visit to discuss any concerns with people working in the Office.

Preventing Future Conflicts

Prevention is often worth a pound of cure in human-wildlife conflicts. Existing buildings, especially older buildings, should be regularly inspected for holes or weak spots in siding, fascia, roofing, and any holes found should be immediately repaired. Bats can squeeze through holes as small as 0.75 x 0.75 inches, and will often roost under siding shingles as this replicates their natural roosts under peeling tree bark. Screens should also be installed on windows to limit wildlife access, including species other than bats. Proactively identifying and cleaning guano deposits may remove potential sources of conflict.

Additionally, providing adequate natural habitat is critical to preventing human-wildlife conflict and support of bat populations on campus in the future. The potential emerging UBC Nature Positive Guidelines guiding future campus development should include recommendations to maintain as many mature trees on campus as possible. In the wild, bats will roost in tree hollows or under the peeling bark of mature trees, and leaving these potential roost sites will encourage bats to roost in trees rather than buildings. Future campus development should strive to leave mature trees intact, and keep hollow trees intact when they do not threaten the safety of pedestrians.

Climate Change Resilience

Providing adequate bat habitat on campus will not only limit potential future conflicts, but could serve to mitigate the effects of climate change on campus. For example, maintaining large, mature trees on campus not only provides roost sites for bats, but will aid in carbon sequestration and provide shade during future rising temperatures. In Vancouver, climate change is predicted to increase the length and severity of droughts. Maintenance of campus water features, especially naturalistic ponds like the ones in Nitobe and the UBC Botanical Gardens, will become more essential as climate change progresses. Increases in drought severity and rising temperatures will lead to more rapid evaporation of ponds and lakes. This not only limits water sources for animals, but evaporation and rising water temperatures can lead to ponds and lakes becoming hypoxic. Disruptions in dissolved oxygen levels can greatly impact the health of waterways, leading to die offs of aquatic animals and vegetation. Monitoring and maintenance of the water quality of campus ponds, lakes, and water features will be critical in maintaining these valuable habitats in the future. Further, planted vegetation in riparian areas should take climate scenarios into consideration. For example, trees or tall vegetation can be planted to provide shade for waterways, serving to limit evaporation and rising water temperatures. Vegetation complexity in riparian areas is also important for supporting a variety of insect species that provide food for bat species. Plantings near other campus water features (e.g., fountains) should be installed or maintained to provide habitat for insect species. The addition of new naturalistic water features to campus should be considered as campus is developed along Nature Positive Guidelines. Adding more naturalistic water features would provide additional habitat for a multitude of species, and would increase climate resilience on campus by providing critical water sources in times of drought. Daylighting streams or adding ponds to new developed areas on campus should be seriously considered.

Climate change and subsequent warming temperatures may actually provide a ‘rescue effect’ for WNS in British Columbia (McClure et al., 2022). The fungus that causes WNS thrives in cool environments, which is one reason why it successfully infiltrates bat hibernacula. However, warmer temperatures resulting from climate change may be too late to shield many colonies from WNS. Indeed, McClure et al. projected that little brown bat populations in the Vancouver/Lower Mainland area will decline in all climate and WNS scenarios modeled with current data. This punctuates the need to support the current colony roosting on campus, as maintaining healthy bat populations will be critical for the survival of little brown and Yuma myotis. While warming temperatures may benefit bats in some cases, care should still be taken to ensure that the newly installed bat boxes receive adequate shade so that the temperatures inside the bat boxes do not reach high levels during the heat of summer. Placing the bat boxes in partial shade and maintaining the surrounding trees will be important to regulating temperatures inside the bat boxes, especially as climate change leads to rising average temperatures. Little brown bats prefer to roost in boxes that have ~8-10°C ambient temperature, with normal temperature gradients (Brittingham & Williams, 2000). In future, temperature

monitoring using remote data loggers (e.g., iButtons) may be pertinent to ensure the bat boxes are maintaining appropriate ambient temperatures.

5. Recommendations

5.1 Recommendations for action and implementation

- Immediate Recommendations
  - Education for people working in the building with current roost on the risks and safety of living alongside bats
    - Rabies and histoplasmosis – risks are minimal
    - BC Bats may have educational opportunities
  - Monitor roost site and re-confirm bat presence Spring and Summer 2023
  - Permitting for bat box
  - Installation of bat box – ideally near water sources close to current roost (e.g., Nitobe Garden)
  - Exclusion of bats from current roost in Fall 2023
  - Monitor usage/migration to bat box following exclusion (Matt Mitchell)
  - Annual maintenance/cleaning of area surrounding bat box while taking the appropriate measures to limit potential spread of white-nose syndrome
    - Not currently assigned - clarify whether this falls under Facilities, SEEDs, or neither.
    - Anyone maintaining the inside structure of the bat box should don appropriate PPE to limit spread of WNS and risk of zoonotic disease
    - Generally, the only maintenance needed is an annual clean up of guano that may accumulate on the ground at the bat box site (BC Bats.
- Long-Term Recommendations
  - Maintenance of older campus buildings
    - Find/fill any small holes or cracks in building fascia and siding
    - Installation of screens over windows on campus buildings, especially older buildings, to limit potential bat entrances
  - Installation of bat boxes across campus, especially near water features
  - Maintenance of campus water features bats likely use for foraging
  - Continuing education of human-bat conflict
  - Annual, continued monitoring bat boxes on campus for usage
    - Ideally done in summer months
    - Bat counts done at dusk emergence
    - Acoustic monitoring (Matt Mitchell)
    - Currently unassigned, but can consider:
      - Summer field ecology students
      - Mammalogy students
      - SEEDs volunteers
- Policy Recommendations
  - Potential Emerging Nature Positive Guidelines
    - Maintenance and preservation of mature trees that bats will use as refugia/roosts

- Maintenance and preservation of more natural water features in Nitobe and Botanical Gardens
- Consider the addition of natural water features, such as ponds and streams, to improve climate resilience and support wildlife occupying campus
- Continuation of eliminating the use of pesticides on campus, especially in areas of water features bats and other species may forage
    - Current policy limits pesticide and herbicide use to rare exceptions related to public health or special landscape elements. Maintenance of this policy is essential
    - Eliminating pesticide use increases the likelihood of healthy insect populations that can support bat colonies. Healthy bat colonies will then help control the insect/pest populations on campus

- Facilities and Maintenance
    - Currently there is a lack of specification of who/what department is responsible for handling human-wildlife conflicts, especially with vulnerable species like bats. EcoPest technicians are the 'front line' for pest control on campus
    - Building maintenance (e.g., patching any holes, maintaining roofs and siding, trimming vegetation/branches), especially on older buildings, is important to limit access points for animals to enter buildings
    - Installing screens on windows important for limiting animal access to buildings
    - Cleaning guano
        - The conflict with bats discussed in this report was originally reported due to the presence of guano at the roost
        - Cleaning the guano on the side/outside of building, while not disturbing the bats, could be a viable solution to coexisting with the bat roost at Old Auditorium Annex, especially if exclusion efforts are unsuccessful

€ Climate Change Resilience

- Maintenance and addition of natural water features (ponds and streams)
    - Droughts are expected to increase in length and severity, limiting access to hydration and food sources
    - High temperatures can lead to increased evaporation rates and disruption of water temperature and oxygenation, greatly impacting pond and stream health
    - Addition of naturalistic water features would provide additional habitat, foraging sources, and insect biodiversity.
- Provide any installed bat boxes with ample shade to maintain appropriate temperatures within the boxes with consideration of high temperature predictions
- Climate change and white-nose syndrome
    - Climate change and subsequent warming temperatures may offer 'rescue' from WNS. But may arrive too late for many hibernacula.
    - *M. lucifugus* populations are projected to decline in Vancouver under most climactic and WNS scenarios

5.2 Recommendations for future research

- Mammal biodiversity baseline
  - Currently there is a paucity of data on mammal diversity on campus
  - Sarah Benson-Amram (Zoology/Forestry) and Kristen Walker (AWP) are two researchers who have ongoing camera trapping efforts on campus
    - Camera traps are not always suitable for capturing presence of small mammals or arboreal mammals. Small mammal trapping and monitoring on campus may lead to more insights of mammal diversity on UBC lands, and is especially important for detecting Blue-list species such as shrews and voles (Table 1)
    - Offering a mammalogy course or summer field ecology course may allow for opportunities for monitoring mammal diversity on campus

- Bat roost presence/absence across campus
  - Ongoing monitoring of known roosts and identifying more roosts on campus
  - In addition to the roost discussed here, there are reports that bats are occupying a building on South campus and the bat boxes installed by Beaty Biodviersity Museum
  - Students of a mammalogy or summer field course could be involved in monitoring known roosts by engaging in emergence counts
  - Ongoing acoustic monitoring by Matt Mitchell et al.

- Bat colony health on campus
  - Monitoring temperatures in bat boxes using remote data loggers (iButtons)
  - Monitoring for presence of white-nose syndrome
  - Monitoring invertebrate species diversity (prey abundance) on campus
    - Comparisons of naturalistic vs. non-naturalistic water features

References

B.C. Conservation Data Centre: CDC iMap. (2023). [Web application]. Province of British Columbia. https://maps.gov.bc.ca/ess/hm/cdc/

BC Ministry of Environment. (2016). In *Best Management Practices Guidelines for Bats in British Columbia. Chapter 1. Introduction To Bats of British Columbia* (p. 108). BC Ministry of Environment.

BC Ministry of Forests. (2023, April 3). *Bat fungus that causes white nose syndrome detected in B.C. | BC Gov News*. https://news.gov.bc.ca/releases/2023FOR0019-000426

Brittingham, M. C., & Williams, L. M. (2000). Bat Boxes as Alternative Roosts for Displaced Bat Maternity Colonies. *Wildlife Society Bulletin (1973-2006)*, *28*(1), 197–207.

Committee on the Status of Endangered Wildlife in Canada. (2013). *COSEWIC Assessment and Status Report on Little Brown Myotis, Northern Myotis, and Tri-Colored Bat*. Ottawa. www.registrelep-sararegistry.gc.ca/default_e.cfm

McClure, M. L., Hranac, C. R., Haase, C. G., McGinnis, S., Dickson, B. G., Hayman, D. T. S., McGuire, L. P., Lausen, C. L., Plowright, R. K., Fuller, N., & Olson, S. H. (2022). Projecting the compound effects of climate change and white-nose syndrome on North American bat species. *Climate Change Ecology*, *3*, 100047. https://doi.org/10.1016/j.ecochg.2021.100047

Rensel, L. J., Hodges, K. E., & Lausen, C. L. (2022). Maternity colony social structure of myotis in British Columbia, Canada. *Behavioral Ecology and Sociobiology*, *76*(12), 159. https://doi.org/10.1007/s00265-022-03265-8