Up and away: Creating a monitoring program for bats at Qw’xwulwis/Cable Bay

ES 471/ER 412: Galiano Island Field School Design Project

Students Sophia Basanta, Max Pietrzyk, and Andraya Stuart

Abstract/Executive Summary

This report outlines a bat monitoring plan for Galiano Island, created by the 2024 Advanced Principles and Practices of Ecological Restoration field school students at the request of the Galiano Conservancy Association (GCA). The primary aim is to establish a monitoring framework to gather baseline data on bat populations, addressing the critical need for systematic data collection on vocalizing animal communities in protected areas. The monitoring plan is implemented at Qw'xwulwis Cable Bay, a protected area on Galiano Island managed by the GCA. This area was selected due to its ecological significance and the historical context provided by the island's Indigenous heritage and past land use. The plan draws on existing monitoring programs, including the North American Bat Monitoring Program (NaBat) and Bat Conservation International (BCI) protocols, adapting their methodologies to suit the local context. As a pilot project, acoustic monitoring was conducted using an SM4BAT detector from June 27th to 29th and July 3rd to 8th, 2024. 491 sound files were collected during the first period and 1372 during the second period. Analysis identified 11 species, with California myotis (*Myotis californicus)* and Long-eared myotis (*Myotis evotis*) being the most recorded species. These results provide a foundational understanding of the bat population at Qw'xwulwis Cable Bay and highlight the species diversity in this habitat.

Table of Contents

ER 412 GALIANO CONSERVANCY RESTORATION DESIGN PROJECT

Territorial Acknowledgement

The property described in this report (DL 64) is located within the traditional, unceded, and shared territory of the Penelakut, Hwlitsum, and other Hul'qumi'num-speaking Indigenous peoples of the Salish Sea, as well as the ceded territory of the Tsawwassen First Nation.

1.0 Introduction

This wildlife-ecological restoration project was generated at the request of the Galiano Conservancy Association (GCA) by students in the University of Victoria School of Environmental Studies' 2024 Advanced Principles and Practices of Ecological Restoration field school. The report proposes a route forward for bat monitoring by the GCA.

Goals

I. Present a workable monitoring plan for bats on Galiano Island that can be applied by the GCA across protected areas to establish baseline measures of bat populations.
II. Respond to a gap in existing literature that calls for more robust frameworks for monitoring vocalizing bat communities.

Objectives

I. Consolidate bat literature relevant to Galiano Island
II. Conduct a pilot project for bat population surveys
III. Formulate comprehensive protocols for future bat monitoring endeavours

2.0 Background

In 2017/18, Freida Weinert conducted a study monitoring Bat, or Chiroptera, populations at Laughlin Lake for the GCA. However, since this initial report, there has been minimal follow-up and continued research on understanding bat populations on Galiano Island. This project aspires to initiate future endeavours in monitoring bat populations. In 2023, the GCA commenced a bird acoustic monitoring program, focusing on the Western Screech-Owl (*Megascops kennicottii*), at Qw'xwulwis Cable Bay and Quadra Hill (Figure 1). Despite this progress, questions persist regarding the presence of bats and the most effective methods for monitoring their populations. Implementing bat monitoring would begin filling current gaps in biodiversity data and contribute to broader ecological studies and conservation efforts. Understanding bat activity and distribution is crucial given their roles in insect population control and pollination. Therefore, developing and deploying effective monitoring techniques is essential for informed conservation management and ecological research.

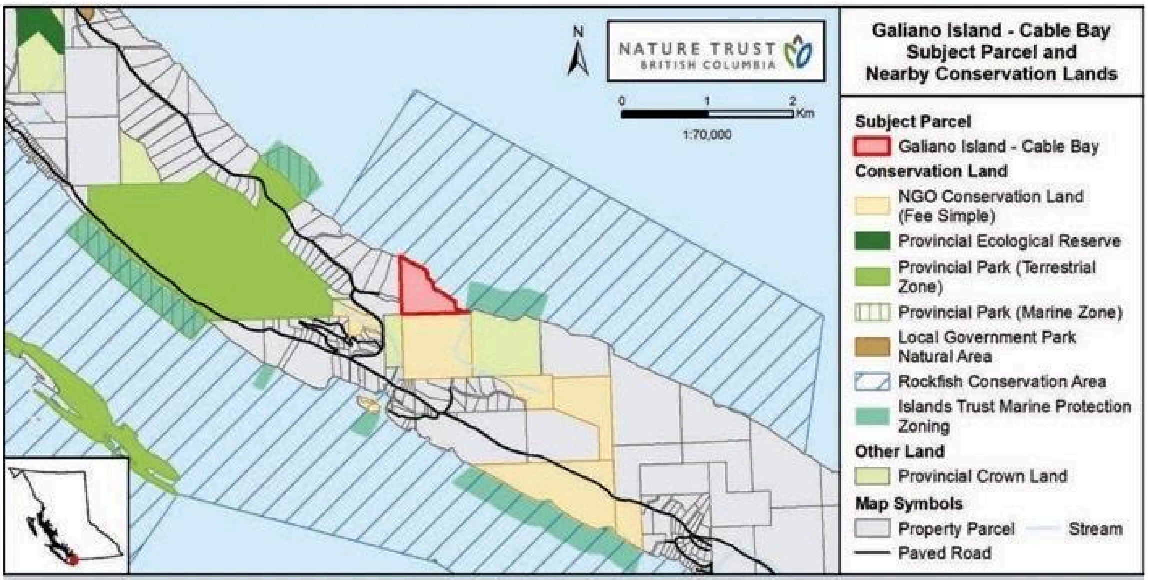


Figure 1. *Qw'xwulwis Cable Bay, the red polygon, in the Context of Adjacent Conservation Lands*

In this section, we explore the ecological importance of bats, explain passive acoustic monitoring and best practices for its deployment, discuss the current threats to bat populations and highlight the need for ongoing monitoring. We provide an overview of the Qw'xwulwis Cable Bay site to support the development of ongoing monitoring efforts. As an orienting approach to our work, we took the time to understand how Galiano Island's history necessitates our presence on the land and the present land-based relationships between community members, local Indigenous peoples, and organizations. This project aspires to transcend traditional quantitative methods by reimagining ecological restoration as a community-oriented, reconciliatory practice. We seek to integrate scientific monitoring with a holistic understanding of environmental and socio-cultural interconnectedness.

2.1 Why Bats?

Understanding and conserving bat populations in British Columbia, particularly on Galiano Island, is crucial due to their significant ecological roles and ongoing threats (Gili & Rolando, 2024). Bats maintain ecosystem balances and biodiversity through pest control, pollination, and seed dispersal (Kunz et al., 2011; Boyles et al., 2011). Despite their importance, bat populations are increasingly threatened by habitat loss, climate change, emerging diseases such as White-Nose Syndrome (WNS), and anthropogenic pressures, including the expansion of wind energy infrastructure (Frick et al., 2010; Thogmartin et al., 2013). These threats endanger both bat populations and the health of ecosystems that rely on their ecological services (Ghanem & Voigt, 2012). Focusing on bat conservation efforts is essential for safeguarding their well-being and preserving the environmental integrity of places like Galiano Island, where bats play indispensable roles in maintaining healthy ecosystems (Frick, Kingston & Flanders, 2020).

Bats serve as key bioindicators of ecosystem health, owing to their diverse taxonomy and functional roles (Jones, 2009). They contribute significantly to ecosystem services such as seed dispersal and insect suppression through foraging activities, essential for sustaining healthy ecosystems (Kunz et al., 2011). For example, bat guano plays a crucial role in nitrogen cycling, enriching soil fertility and enhancing nutrient distribution, which supports plant growth and overall ecosystem productivity (Boyles et al., 2011). The accumulation of guano also fosters the development of microbial communities, including fungi, bacteria, and lichens, and sustains organisms across various trophic levels, such as arthropods (Polis et al., 1997). In addition, bats contribute to agricultural balances. For example, the endangered little brown bat (*Myotis lucifugus*) consumes 600 insects per hour, providing pest management services worth over 3.7 billion dollars annually in the United States (Parks Canada Agency, 2023).

Bats' taxonomic stability facilitates the monitoring of population trends and the assessment of global environmental impacts (Boyles et al., 2011; Fenton et al., 1992). Insectivorous bats, sensitive to pesticides and toxins, are indicators of fluctuations in prey populations, as their abundance is closely linked to toxin prevalence (Hutson et al., 2001).

Declines in bat populations function as early warning signals of broader ecosystem disturbances (Jones et al., 2009). This emphasizes the need for comprehensive monitoring programs that track bat populations, leveraging their bioindicator status to inform conservation strategies and environmental policies (Jones et al., 2009).

2.2 What is Passive Acoustic Monitoring?

Passive acoustic monitoring (PAM) uses specialized ultrasonic detectors to record bat echolocation calls, making it a valuable tool for studying bats and other vocalizing animals (Ross, 2023). Recent advancements have made PAM equipment more affordable and portable, with modern units offering programmability and extended battery life for long-term data collection across diverse sites and habitats (Browning et al., 2017; Heinicke et al., 2015; Campos-Cerqueira & Aide, 2016). These technological improvements allow for comprehensive archival of recordings, enabling deployment by staff with limited expertise and subsequent analysis by specialists. Wildlife Acoustics' "Song Meter" recorders are frequently used in PAM, including by the GCA for monitoring bird populations. The collected audio is analyzed with machine learning algorithms to identify specific bat species based on their echolocation calls. PAM is increasingly integrated into multi-method monitoring programs such as NABat (Rodhouse et al., 2019).

2.3 Passive Acoustic Monitoring Best Practices

To enhance the detection of bat echolocation calls, it is essential to deploy monitors in habitats preferred by the target species, which will optimize both the quantity and quality of recordings (Fraser et al., 2020). In British Columbia's Coastal Douglas-fir zone, ideal habitats include diverse tree species, dense canopy cover, and features such as snags and dead-standing trees, which provide suitable roosting sites (Loeb et al., 2015). Site selection should consider proximity to water sources, forest edges, established roosting sites, and topographical features like elevation, that influence bat activity and foraging behaviour (Fraser et al., 2020). Clutter—obstacles like tree branches, leaves, or water surfaces—affect sound transmission and recording quality. Detectors positioned away from such clutter generally capture more calls due to reduced sound reflections (Patriquin et al., 2003; Weller & Zabel, 2002). Bats produce shorter, higher-frequency echolocation calls in cluttered environments to navigate effectively (Broders, Findlay & Zheng, 2004; Wund, 2006). To minimize disturbances and enhance monitoring efficacy, sites should be situated away from major roads and urban centers.

Environmental factors such as temperature, humidity, and weather conditions play a crucial role in the effectiveness of bat monitoring, as they impact echolocation and overall monitoring success (Goerlitz, 2018). Most bat species prefer high relative humidity, though specific preferences can vary (Erickson & West, 2002). Still or slow-moving freshwater sources are important foraging areas, meeting bats' dietary needs and enhancing habitat suitability (Thomas et al., 2021). Elevation and topography affect microclimatic conditions and insect availability, influencing bat distribution and behaviour (Perry, 2012). Monitoring is most effective under favourable weather conditions, such as warm evenings with minimal wind, which improves the likelihood of detecting bat echolocation calls (Loeb et al., 2015).

2.4 Threats to Bats

Bats have faced significant population declines over recent decades, with around 18 percent of global bat species classified as threatened by the IUCN (Frick et al., 2020). Bats' unique life history traits exacerbate declines linked to human activities, such as land development and habitat altercation (Festa et al., 2023; Put et al., 2019). Despite conservation efforts, climate change is expected to reduce reproductive success among insectivorous bats, as rapid environmental changes outpace their ability to adapt (Adams, 2010; Festa et al., 2023). Additional threats include habitat loss, water quality decline, intensified agriculture, wind turbine fatalities, disease outbreaks, pesticide use, and overhunting (Jones et al., 2009).

The spread of White-Nose Syndrome (WNS) poses a significant threat to bat populations (Cheng et al., 2021). This disease, caused by the fungus Pseudogymnoascus destructans, colonizes the epidermis and dermis of bats' ears, wings, and muzzles during hibernation (Hiolski, 2018). The infection increases bats' metabolic rates, leading to severe energy depletion, starvation, and ultimately, death (Hammerson et al., 2017; Weinert, 2018; Warnecke et al., 2013). Since 2006, WNS has killed millions of bats across 31 U.S. states and five Canadian provinces, causing declines in local populations (Adams & Pederson, 2013; Environment Canada, 2015). In WNS-affected areas, other threats have an amplified impact due to the already reduced bat populations, compromising their survival and recovery efforts. (Frick et al., 2010; Langwig et al., 2017). There is uncertainty about WNS's potential spread to British Columbia's Gulf Islands, owing to the region's distinct bat ecology (Weinert, 2018).

2.5 Bats of Concern

In Canada, bat species face varying levels of conservation concern, with some recognized as endangered under the Species at Risk Act (SARA) and others at risk provincially in British Columbia. Federally endangered species include the little brown myotis (*Myotis lucifugus*), Northern myotis (*Myotis septentrionalis*), and tri-coloured bat (*Perimyotis subflavus*), all primarily threatened by WNS (Environment Canada, 2015; SARA, 2009). The little brown bat is particularly vulnerable, with about 50% of its global range in Canada (Environment Canada, 2015). Models predict its functional extirpation, meaning population levels could drop too low to sustain the species (Environment Canada, 2015). In response, the Government of Canada prioritizes the implementation of standardized monitoring protocols and the establishment of baseline population levels to combat these declines (Environment Canada, 2015).

Blue-listed species in British Columbia are considered at risk but not as threatened as those under SARA (Government of British Columbia, 2023). The Fringed Myotis, blue-listed since 1988, has seen limited conservation action due to insufficient data (COSEWIC, 2004). Increased research and monitoring are needed to enhance conservation efforts. Conversely, the Hoary Bat, also blue-listed, faces a population decline of over 50% in three generations, primarily due to wind energy facilities (COSEWIC, 2023). Species not listed under SARA or provincial categories are generally considered stable and not at significant risk.

2.6 Need for Monitoring

Monitoring the population trends of bats is essential due to the numerous environmental threats they face (Festa et al., 2023). To reliably track bat populations using their ultrasonic calls, we need to standardize monitoring protocols, data management, and analytical methods (Jones et al., 2013). This standardization will ensure the accuracy and consistency of data, which in turn supports effective conservation strategies and enhances our understanding of bat populations and their responses to environmental challenges (Stahlschmidt, & Brühl, 2012). Existing monitoring protocols provide a guide for future ventures.

Bat monitoring protocols are integral to multinational conservation programs like the North American Bat Monitoring Program (NaBat) and organizations like Bat Conservation International (BCI). These protocols, implemented across North America, are used by entities like Parks Canada in partnership with the Canadian Wildlife Health Cooperative and the United States National Park Service (Reichert et al., 2021). They ensure effective bat conservation by collecting critical data and enhancing our understanding of bat ecology, informing conservation strategies regionally and internationally (Reichert et al, 2021).

The NaBat Project is a comprehensive, large-scale initiative established in 2015 to monitor bat populations across North America. This collaborative effort involves federal and state agencies, non-profit organizations, and research institutions. It aims to provide standardized and detailed data on bat species. The project focuses on informing conservation strategies, standardizing monitoring practices, and mitigating threats like habitat loss and WNS.

Bat Conservation International, a leading NGO dedicated to bat conservation, is recognized for its comprehensive monitoring protocols and global influence (Bat Conservation International, 2024a). BCI facilitates participation in NaBat through multiple hubs, partnering with federal agencies, nations, state agencies, and local conservation organizations to ensure capacity (Bat Conservation International, 2024b). Their protocols include standardized survey methods like acoustic monitoring and physical capture techniques like mist-netting and harp traps for detailed species information (Bat Conservation International, 2024b). Given the diverse life histories and behaviours of North American bats—ranging from colonial roosters to solitary tree bats, migratory species to year-round residents, and varying echolocation call intensities—the choice of method varies by species and season (Loeb et al., 2015). This approach ensures that monitoring efforts are effectively adapted to the specific ecological contexts of bat populations, as exemplified by the Western Bat Conservation Program of Wildlife Conservation Society Canada's application of NaBat protocols in British Columbia (Loeb et al., 2015).

The Western Bat Conservation Program of Wildlife Conservation Society (WCS) Canada monitors bat species diversity and distribution to support long-term conservation in Western Canada (Wildlife Conservation Society, n.d.). Their work includes applying NaBat protocols in British Columbia, focusing on hibernation sites through the BatCaver Program, and long-term monitoring of sentinel roosts with the BC Community Bat Program. Since 2016, WCS has conducted comprehensive baseline assessments every five years across twelve grid cells using acoustic bat detectors to capture echolocation calls, identify species, and measure activity levels. This sampling covers Vancouver Island and the Fraser Valley, involving volunteer biologists (Community Bat Programs of BC, n.d.; Wildlife Conservation Society, n.d.).WCS also uses climate loggers, fungal samples, roost loggers, remote bat detectors, and other biological samples to investigate cave and mine use, establish baseline diversity, and monitor the potential impacts of WNS (Wildlife Conservation Society, n.d). Systematic hibernation site surveys and public outreach efforts further enhance understanding of overwintering bat behaviours and support regional conservation initiatives (Wildlife Conservation Society, n.d.).

BC's Community Bat Program, a volunteer-oriented monitoring program based on individual observations, is the central province-wide monitoring program for bats (BC Community Bat Program, 2023). Data collection involves the repeated tracking of bats exiting roost sites – exit counts – designated by the province in guidance with regional coordinators (BC Community Bat Program, 2023). While previous monitoring confirms the presence of California myotis, big brown bat, long-eared myotis, Townsend's big-eared bat, and long-legged myotis across the Gulf Islands as of 2023, the report fails to distinguish among the Gulf Islands (BC Community Bat Program, 2023). Nonetheless, this program proves significant as a potential guide for community integration into monitoring protocols and cultivating a broader look into species abundance records, lending itself to future restoration approaches. In collaboration with the BC Community Bat Program, Mayne Conservancy has undertaken place-based monitoring (Dunn, 2024). The GCA is considering how they, too, might approach bat monitoring, alongside fellow Gulf Island partners.

On the local scale, in 2018, Frieda Weinert used passive acoustic monitoring to survey bat populations at Laughlin Lake on Galiano Island, offering a localized perspective distinct from the BC Annual Bat Count. Conducted from May to September 2017, Weinert's study involved installing an acoustic bat monitor on a stake to gather baseline data on bat presence and assess the effects of temperature, insect biomass, and time of night on bat activity (2018). This study aimed to fill a regional research gap. While it supported some findings of the BC Bat Program—confirming species including the silver-haired bat, hoary Bat, Western small-footed myotis, Yuma myotis, and Brazilian free-tailed bats on Galiano Island—it did not detect

Townsend's big-eared bat and long-legged myotis (Weinert, 2018). These discrepancies may stem from differences in monitoring techniques, though conclusive evidence is lacking. Weinert's (2018) research underscores the value of place-based monitoring in capturing local ecological dynamics.

In addition to international, national, and regional monitoring programs, local involvement monitors and evaluates bat populations. Despite a lack of pre-existing data, local community members have identified bats on the platform iNaturalist, a social network dedicated to exchanging biodiversity information, across five different periods. Observations range from as far back as eight years ago, with a sighting of a genus Myotis bat, to as recently as ten months ago, with an observation of a family Vespertilionidae bat (Figure 2) (iNaturalist, n.d.). Furthermore, citizen science is gaining prominence in bat monitoring, particularly through volunteer monitors. This grassroots involvement enhances data collection while fostering a greater public awareness and appreciation of bat conservation efforts (Greving et al., 2022).

Figure 2. *Map of iNaturalist Bat Observations on Galiano Island*

2.7 The Qw'xwulwis Cable Bay Site

Qw’xwulwis Cable Bay, on the northeastern shoreline of Galiano, is a 26.5-hectare traditional site for the Hwlitsum, Penelakut, and other Hul’qumi’num-speaking peoples. Meaning “the action of paddling”, Qw’xwulwis Cable Bay was historically a bustling harbour rich with marine resources (halibut, lingcod, rock cod, shellfish, and seals). The area faced low levels of historical logging but was recently rezoned for six residential subdivisions (Miltner, 2022). However, in 2022, conservation-minded landowners withheld the sale of the property until it could be bought for conservation purposes. It is now owned by the Nature Trust of British Columbia and managed by the GCA (Miltner, 2022). Qw’xwulwis Cable Bay contributes to the expanding conservation network of over 500 hectares across Galiano Island. This protected area includes ecologically diverse coastal Douglas fir forests, mature and young, and a kilometre-long stretch of rocky coastal outcrop shoreline. The maturity of forests on Galiano Island is depicted in Figure 3. It is a vital habitat for overwintering birds, including buffleheads, harlequins, loons, grebes, goldeneyes, mergansers, scoters, geese, ducks, and gulls. The nutrient-rich waters also provide ideal nurseries for juvenile fish, further supporting the island’s diverse marine ecosystem (Miltner, 2022).

Figure 3. *Map of Galiano Island Indicating Forest Maturity and Protected Areas*

3.0 Methodology

3.1 Consultation with the Galiano Conservancy Association

This project grew from consultations with the Galiano Conservancy Association (GCA), particularly with staff members Becca Gray and Sofia Silverman, Executive Director, Chessi Miltner, and Restoration Coordinator, Adam Huggins. In these discussions, the GCA's future desire to monitor bat populations at Qw'xwulwis Cable Bay, in line with their management agreement with the Nature Trust of British Columbia, was highlighted (Figure 2). Moreover, staff emphasized the potential future application of these monitoring protocols across other GCA properties, including the Millard Learning Centre wetlands, Great Beaver Swamp, and Quadra Hill. This expanded scope underscores the GCA's commitment to comprehensive ecological stewardship, including restoration and diverse habitat protection. Consequently, this project emerged as a preliminary step, equipping GCA staff with the tools and methodologies to implement effective bat monitoring protocols.

3.2 Site Selection

We placed the bat box on a red alder tree approximately 65 inches above the ground. This selection point is characterized by a smaller wetland with expansive open spaces, decaying trees, and gaps in canopy coverage (Figure 4). The site has an understory of sword fern (*Polystichum munitum*), ocean spray (*Holodiscus discolor*), salal (*Gaultheria shallon*), and an overstory of Western red cedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), red alder (*Alnus rubra*) and Bigleaf maple (*Acer macrophyllum*). Consideration included how Qw'xwulwis Cable Bay features two distinct Douglas-fir ecosystems – complex ecological communities (Figure 5).

Figure 4. *Acoustic Monitoring Box Surroundings*

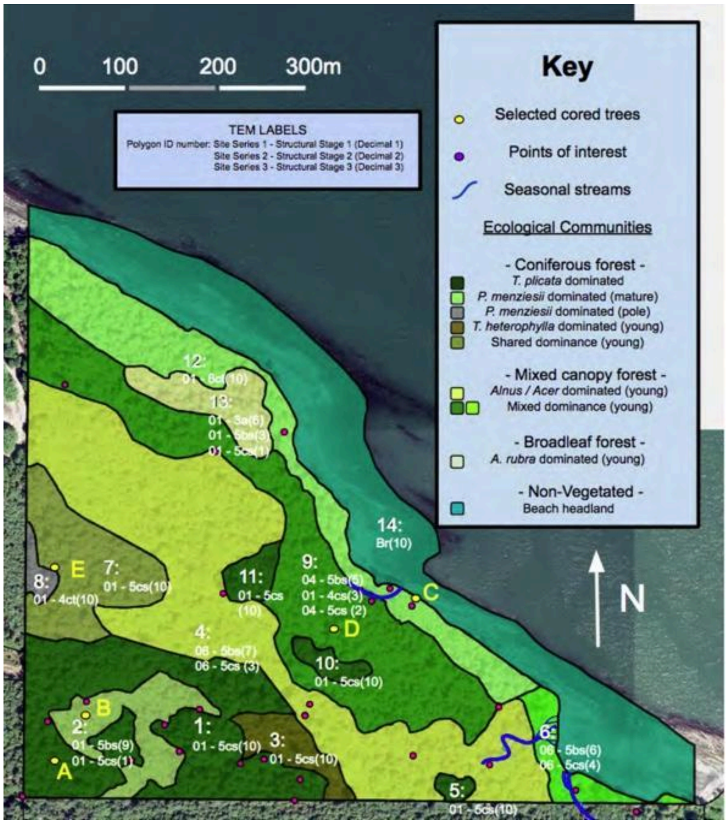


Figure 5. *Ecological Community Map of Qw'xwulwis Cable Bay*

3.3 Passive Acoustic Monitoring

To record bats, we used a Song Meter SM4BAT released by Wildlife Acoustics in September 2017 and their omnidirectional external A2 Acoustic Microphone, provided by the GCA. The Song Meter includes an advanced schedule mode (used in our scheduling of monitoring periods), comprehensive latitude and longitude settings, internal temperature values, and improved accessibility features for easier user access. However, this model does not include WAV compression for increased storage space, additional labelling features, or a response to logistical manufacturing errors. These advancements are available through firmware updates. Additional limitations extend to the device's battery life, storage capacity, and reliability.

Other monitors, such as Avisoft, produce more reliable data due to their increased frequency range – the spatial range within which the monitor can detect bat echolocation calls. In one study SM4BAT detected 40-50% of the calls detected by Avisoft due to a discrepancy in the frequency ranges (Adams et al., 2012). The frequency of the 115kHz impulses was higher than what the SM4BAT could detect, hence it was not picked up by the model (Adams et al., 2012). However, recent models of the SM4BAT have higher sampling frequencies, thus, they can detect higher-frequency signals (Adams et al., 2012). Although it has limitations, SM4BAT is a sufficient monitor for the aims and objectives of this project.

3.4 Data Collection

The SM4BAT was attached to a red alder tree at eye level, at approximately (-123.4891°, 48.9496°), as displayed in Figure 6 and Figure 7. The detector was installed on June 27th and removed on June 29th, 2024. Further, Becca Gray reinstalled the monitor to record from July 3rd to July 8th, 2024.

The acoustic detector was set to full spectrum mode to capture a high-resolution account of time, frequency, amplitude, and multiple-frequency content. Full-spectrum techniques preserve all the call recording's amplitude and frequency data (Walters et al., 2012). It was set to record from 15 minutes before sunset until 15 minutes after sunrise (Weinert, 2018). These decisions were made due to bat activity being the most prevalent from dusk to dawn and to ensure the best quality of recording possible.

Figure 6. *PAM Device Attached to the Red Alder Tree*

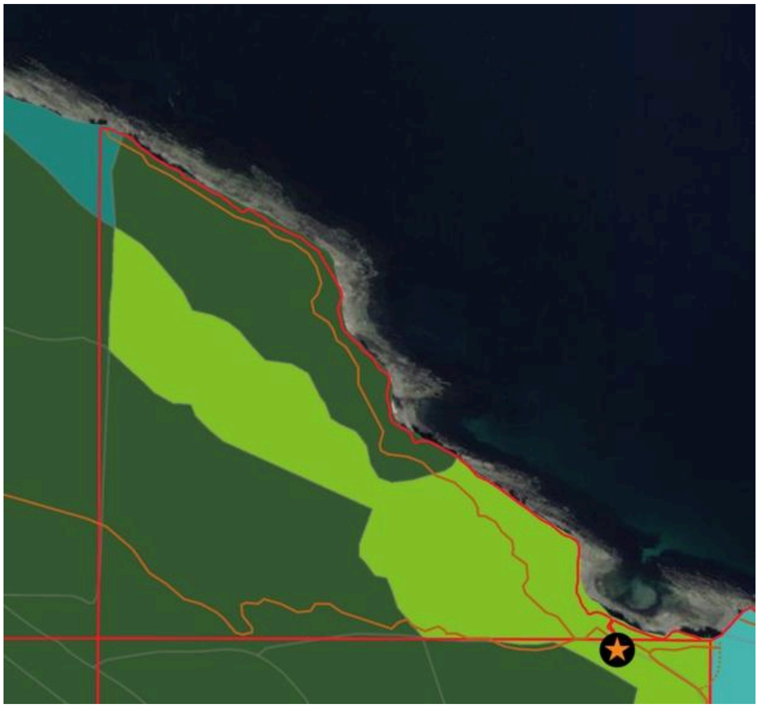


Figure 7. *ArcGIS Map of Qw'xwulwis Cable Bay created by our team in collaboration with the GCA. The black circle with a yellow star in its center indicates the placement of the acoustic monitoring box.*

3.5 Data Analysis

We acquired a free trial of the Kaleidoscope Pro Analysis Software (KP) to analyze our bat recording data due to accessibility and cost. KP is an acoustic software program created to explore acoustic and ultrasonic recordings. It is designed to filter ambient noise that is incongruent with bat signals. The software uses an algorithm to compare individual and series of echolocation pulses against a standardized bat species database to identify bat species. The result of this auto-identification is a "match ratio," which indicates the accuracy and confidence of the classification. In this project, we set the classifier threshold to 0 Balanced (Neutral) to enhance model reliability. A balanced setting minimizes false positives and negatives, avoiding biases towards either detecting the species (liberal) or avoiding false detections (conservative). In addition, practitioners suggest manually reviewing each call to ensure a reliable dataset for statistical analysis and results (Weinert, 2018).

We conducted two analyses:

1. **Provincially-Specified Species Analysis:** This analysis focused on bats in British Columbia, Canada, while considering the broader North American context.
2. **Regional Species Analysis:** This analysis considered bats across North America without locale specifications.

Our primary output, with data from both monitoring periods, follows the provincially-specified species analysis. We also conducted a regional analysis to check for any additional species identifications. All numerical data, except for the additional species IDs identified in the regional analysis, is derived from the provincial analysis. By using both analyses, we gain a more thorough understanding. The provincial analysis focuses on a specific area, refining species identification; the regional analysis helps identify any additional species and addresses potential errors in auto-classification by comparing results across a broader dataset.

While auto-classification is a valuable tool, it is subject to error. For example, KP has misidentified bat calls as NoID due to overlapping calls (Rydell et al., 2017). In addition, the software only provides uncalibrated confidence measures, which raises concerns about its reliability and accuracy. The primary confidence metric is the classification margin—an uncalibrated score only interpretable relative to each species; higher values indicate greater confidence. KP attributes misidentifications to clutter, echo, background noise, overlapping calls, and reliance on call shape. To ensure accuracy, practitioners often perform manual validation and create confidence intervals with KP data (Bolker et al., 2009). Sonobat is an alternative device with fewer false negative identifications(Perea & Tena, 2020). Existing literature does not specify the probability threshold needed to ensure confidence or provide numerical values for the output of acoustic software that accurately reflects measurement precision.

Using the data generated by KP from both monitoring periods, we transferred the bat identification results into tables and manually calculated the cumulative days (out of 9) each bat was recorded and the total time each bat was identified as active in the area. While this process invites room for human error due to the volume of data, results were cross-checked to ensure accuracy. Despite having access to the data, our novice-level bat identification skills prevented us from manually reviewing the bat calls, limiting the statistical significance of our findings. Since the goal of this project is not to produce statistically significant data but to inform future protocols as beginners navigate the field, this limitation is of lesser concern. Nonetheless, it provides valuable insights for our discussion.

4.0 Results

Acoustic monitoring was conducted at Qw’xwulwis Cable Bay for two periods over seven nights, from June 27th to 29th and from July 3rd to the 8th, using an SM4BAT detector. Of 491 recorded sound files from the first period, Kaleidoscope software identified 78 sound files (15.9%) as bat calls of specific species, 109 sound files (22.2%) as bat calls without specific species identification (NoID), and 302 sound files (61.5%) as background noises (NOISE). In comparison, from the second period, KP identified 730 (53.1%) sound files as bat calls of specific species, 381 sound files (27.7%) as bat calls without specific species identification (NoID), and 261 sound files (19.0%) as background noises (NOISE). Calls detected by KP with a match ratio of 0.5 or greater (refer to section 3.5) were manually examined and assigned to species.

Q: What species were monitored at Qw'xwulwis Cable Bay?

Electronic identification with the provincially-specified analysis recognized 11 species (Table 1) recorded over 9 days. During the same period, our regional investigation found three more species, for a total of 14 species (Table 2).

Table 1. *Bat Species Identified in Qw'xwulwis Cable Bay (With Provincial Specification)*

Scientific Name	**Common Name**	**Abbreviation**	**Status**
Myotis lucifugus	Little brown myotis	MYOLUC	Endangered (SARA); BC Blue List
Myotis septentrionalis	Northern myotis	MYOSEP	Endangered (SARA); BC Blue List
Lasiurus cinereus	Hoary bat	LASCIN	BC Blue List
Myotis ciliolabrum	Western small-footed myotis	MYOCIL	BC Blue List
Myotis yumanensis	Yuma myotis	MYOYUM	BC Blue List
Myotis thysanodes	Fringed myotis	MYOTHY	BC Blue List
Eptesicus fuscus	Big brown bat	EPTFUS	Not at Risk
Myotis californicus	California myotis	MYOCAL	Not at Risk
Lasionycteris noctivagans	Silver-haired bat	LASNOC	Not at Risk
Myotis evotis	Long-eared myotis	MYOEVO	Not at risk

Myotis volans	Long-legged myotis	MYOVOL	Not at Risk

Table 2. *Additional Bat Species Identified in Qw'xwulwis Cable Bay (Without Specification)*

Scientific Name	**Common Name**	**Abbreviation**	**Status**
Myotis sodalis	Indiana myotis	MYOSOD	Near Threatened (IUCN 3.1)
Myotis austroriparius	Southeastern myotis	MYOAUS	Least Concern (IUCN 3.1)
Myotis velifer	Cave myotis	MYOVEL	Least Concern (IUCN 3.1)

As shown in Table 2, "minute activity" refers to the total number of minutes a specific bat was active across the recorded days. The table presents the minute activity for each identified bat species over nine monitoring nights/days, noting that not all species were present every night.

Notable abundances include the presence of *Myotis lucifugus* (MYOLUC) and *Myotis septentrionalis* (MYOSEP), federally recognized species by the Species at Risk Act (SARA) as endangered. MYOLUC was recorded in 3.557 minutes across six nights. MYOSEP was recorded in 0.906 minutes across three nights. This is notable considering the status of these species.

BC's blue-listed endangered species *Lasiurus cinereus* (LASCIN), *Myotis ciliolabrum* (MYOCIL), *Myotis thysanodes* (MYOTHY) and, *Myotis yumanensis* (MYOYUM) were also recorded. LASCIN and MYOCIL appeared in both periods, with respective total minute activities of 0.1603 over two days and 9.762 over nine days. On the other hand, observations of MYOTHY were restricted to the second monitoring period, accounting for 0.179 minutes of activity over three days. The third most recorded species was *Myotis yumanensis* (MYOYUM), present seven of the nine days, with a total minute activity of 12.753.

Additional not-at-risk observed species include *Eptesicus fuscus* (EPTFUS), *Lasionycteris noctivagans* (LASNOC), *Myotis calfornicus* (MYOCAL), *Myotis evotis* (MYOEVO) and Myotis volans (MYOVOL). EPTFUS and LASNOC were only observed in the second monitoring period over two nights, with respective total minute activities of 0.215 and 0.291—a similar temporal range. Similarly, MYOYOL was observed over seven nights, with respective total minute activities of 11.828. The bat species with the highest relative abundance at Cable Bay were MYOCAL and MYOEVO, with total minute activities of 35.004 and 28.898, respectively. MYOCAL and MYOEVO were both present on all nine days.

The regional analysis identified three additional species: *Myotis sodalis* (MYOSOD), *Myotis austroriparius* (MYOAUS) *and Myotis velifer* (MYOVEL). The International Union for Conservation of Nature lists MYOSOD as Near threatened, and MYOAUS and MYOVEL as Least Concern (IUCN, n.d.). Near Threatened species may be vulnerable to endangerment soon but do not currently qualify for the threatened status (IUCN, 2024). Species of Least Concern are of less concern than those threatened (IUCN, 2024). MYOSOD was observed in both monitoring periods for 0.305 minutes across three days. MYOAUS was recorded over five days for 2.328 minutes. MYOVEL was recorded over two days for 0.2371 minutes.

The margin scores for auto-identifications across all species data reveal a spectrum of confidence levels, indicating varying degrees of certainty in these species-specific identifications. The lowest overall score in the dataset is 0.072 (MYOEVO) and the highest is 0.875 (MYOYUM). We did not compile all margin scores due to the abundance of data; each call identification has an associated margin score. To illustrate a species-specific example, MYOSEP's margin scores were 0.291, 0.292, 0.319, 0.315, 0.259, and 0.344, illustrating different levels of confidence:

- 0.259 indicates the least confidence.
- 0.291 and 0.292 suggest moderate confidence.
- 0.315 and 0.319 show slightly higher confidence.
- 0.344 indicates the greatest confidence.

These scores demonstrate low to moderate confidence compared to the mean of 0.474, calculated from the above maximum and minimum margin scores. Although there is moderate confidence in detecting MYOSEP, the uncalibrated nature of these scores means they should be viewed as relative indicators of confidence rather than definitive proof of detection. Additionally, MYOLUC has relatively low margin scores, with a maximum of 0.242, a minimum of 0.0814 and a mean of 0.144.

Table 3. *Presence, Days Recorded, and Total Minute-Activity of Bat Species in Qw'xwulwis Cable Bay* listed from federally endangered by SARA, to provincially Blue-listed, to not at risk.

Abbreviation	Days recorded	Total minute-activity	Status
MYOLUC	6	**3.557**	Endangered (SARA); BC Blue List
MYOSEP	3	**0.906**	Endangered (SARA); BC Blue List
LASCIN	2	**0.1603**	BC Blue List
MYOCIL	9	**9.762**	BC Blue List
MYOTHY	3	**0.179**	BC Blue List
MYOYUM	7	**12.753**	BC Blue List
EPTFUS	2	**0.215**	Not at Risk
LASNOC	2	**0.291**	Not at Risk
MYOCAL	9	**35.004**	Not at Risk
MYOEVO	9	**28.898**	Not at Risk
MYOVOL	7	**11.828**	Not at Risk
MYOSOD	3	**0.305**	Near threatened*

MYOAUS	5	**2.328**	Least Concern*
MYOVEL	2	**0.2371**	Least Concern*

* Conservation status assessments are from the IUCN as Canadian records do not exist

5.0 Discussion

In alignment with our primary objective of developing a practical bat monitoring plan for the Galiano Conservancy Association (GCA) to establish baseline bat population measures in protected areas, our results provide insights into key indicators that inform effective monitoring protocols. This discussion will explore the implications of our findings, highlighting the critical elements necessary for the successful implementation and standardization of bat monitoring efforts: consultation, site selection, timing, detection methods, data collection, data analysis, ethical considerations, and collaboration and community engagement. By examining the core indicators identified, we aim to enhance understanding and application of monitoring protocols, thereby contributing to the broader conservation efforts for bat populations.

5.1 Consultation

Consulting and conversing with the GCA provided a thorough understanding of the project's needs and direction and established connections supporting ongoing monitoring efforts. While developing baseline data does not necessarily require consultation by the GCA, such awareness is necessary for other organizations seeking to collect data while ensuring respectful relationships with local Nations and community members.

5.2 Site Selection

Identifying an optimal site for passive acoustic monitoring of bats within Qw'xwulwis Cable Bay requires a rigorous and systematic site selection protocol. When selecting sites for monitoring, we recommend that the GCA place the monitors near edge habitats, close to water, and in woodland interiors as such features ensure good survey coverage (Collins, 2023). If the GCA continues monitoring at Qw'xwulwis Cable Bay, it would be advisable to track two consecutive areas: young and mature forests. This approach will help reveal how species abundance varies with historical land use changes. We recommend placing an acoustic bat monitor in the northern section of Cable Bay to ensure monitoring of more mature first cover.

Other GCA properties for future monitoring could include the Millard Learning Center wetlands, the Great Beaver Swamp, and Quadra Hill. The GCA's "Cedars for the Next Century" wetland project would be a prominent example of alignment with bat needs. It would be valuable to learn if the recently created wetland supports bat populations.

We recommended placing detectors at a sufficient distance and orienting them away from clutter sources (Patriquin et al., 2003). This approach helps minimize echoes and reduces the impact of clutter on bat behaviour and sound quality (Weller and Zabel, 2002). Omnidirectional microphones, such as the one we deployed, require a greater set-back distance due to conflicting errors due to clutter.

5.3 Frequency & Timing

We recommend conducting surveys during the summer active period before young bats become volant–capable of flight. Bat activity and species detectability peak in July and August, making these periods optimal (Weinert, 2018). Detectors should run continuously for at least four nights under ideal weather conditions: warm temperatures, low wind speeds, and minimal rainfall. Warmer temperatures and longer daylight hours coincide with heightened foraging and reproductive activities among bat populations. These months also align with the maternity season for many bat species, increasing the chances of detecting maternal colonies and facilitating comprehensive population assessments. Focusing surveys on these conditions maximizes the recording of bat echolocation calls and provides insights into seasonal variations in bat behaviour and population dynamics.

According to extensive research, including our studies, the optimal time for monitoring bat activity is between dusk and dawn. More specifically, initiating recordings approximately 15 minutes before dawn and continuing until 15 minutes after dusk significantly enhances the probability of detecting bat echolocation calls. These twilight periods are characterized by increased bat activity as they emerge from their roosts to forage at dusk and return at dawn. Researchers can improve the accuracy and comprehensiveness of bat population assessments and behavioural studies by strategically timing the deployment of acoustic monitors to encompass these critical windows of heightened bat activity. Additionally, extended-duration surveys enhance the likelihood of bats encountering detectors during survey periods.

5.4 Detection Methods

Various bat detectors can continuously record echolocation calls, and selecting the appropriate method is crucial for an effective monitoring program. Acoustic monitoring is non-invasive and allows continuous data collection, which is beneficial under time and resource constraints. However, long-term use of stationary sensors can be costly due to maintenance and frequent data retrieval, whereas mobile monitors offer more flexibility. Solar-powered sensor networks could address battery replacement issues and improve efficiency (Aide et al., 2013).

The Galiano Conservancy Association's current Passive Acoustic Monitoring (PAM) equipment is suitable for initial data collection at Qw'xwulwis Cable Bay. However, logistical challenges arise in covering the entire property, such as relocating the monitor throughout the property to capture variations in habitat and their influence on bat presence and abundance. To scale up monitoring efforts, we recommend:

1. **Deployment of Multiple PAM Devices:** This will improve coverage and mitigate the limitations of relocating equipment.
2. **Integration of Advanced Technology:** Advanced devices like Avisoft monitors can enhance data accuracy despite their higher cost (Adams et al., 2012); their advanced capabilities could justify the investment for a larger-scale monitoring effort.
3. **Utilization of Sensor Networks:** Solar-powered sensors can reduce maintenance and ensure continuous data collection (Aide et al., 2013).
4. **Data Integration and Analysis:** Advanced software, such as Sonobat, can help manage and interpret large volumes of data more effectively (Perea & Tena, 2020). This can improve the precision of species identification and habitat assessment.
5. **Collaboration and Funding:** Partnering with other conservation organizations or research institutions can provide additional resources and expertise. Securing funding will support equipment acquisition and expanded monitoring.

Our study tentatively identified the little brown bat and Northern myotis, both endangered species under SARA, with the Northern myotis not previously recorded on Galiano Island. Despite low confidence in these detections, the findings are significant due to the critical conservation status of these species. The presence of even small numbers underscores the need for ongoing monitoring and further investigation to confirm their presence and assess their habitat use, highlighting the importance of continued conservation efforts in the area. We recommend confirming whether or not they are present and continuing monitoring to gain a deeper understanding of their habitat preferences and ecological requirements. If confirmed, federal jurisdiction exists over the legal protection of these species, fostering the potential for greater resources and protection of surrounding ecological communities. We also recommend evaluating the presence and status of other at-risk species in the study area to ensure a comprehensive approach to biodiversity conservation and habitat management on Galiano Island, particularly given the data deficiencies surrounding the fringed myotis and their tentative presence.

5.5 Data Analysis

Numerous data analysis programs are available for processing acoustic data. Due to constraints in expertise and time, manual identification was not feasible, leading us to rely on the precision and efficiency of Kaleidoscope software for data analysis. This software quickly identified bat species based on their echolocation calls, ensuring robust results despite our limitations in manual processing capabilities; however, limitations nonetheless arose.

The PAM analysis software is widely acknowledged for its reliability in processing bat acoustic data. However, researchers have highlighted a preference for using the SonoBat bat call analysis software over Kaleidoscope due to concerns regarding the potential erroneous discarding of bat calls by the latter, which could lead to inaccurate representations of bat activity (Goodwin & Gillam, 2021; Perea & Tena, 2020). This distinction underscores the importance of selecting robust software tools that accurately identify and classify bat echolocation calls, ensuring precise data interpretation in ecological studies. Due to resource constraints, we opted to deploy Kaleidoscope for our analysis. We recommend that the GCA explore the feasibility of utilizing SonoBat as an alternative software solution (Perea & Tena, 2020). This exploration could address concerns regarding the accurate detection and classification of bat calls, ensuring more reliable data outputs for ecological research and monitoring purposes (Goodwin & Gillam, 2021).

Manual verification and the construction of confidence intervals increased the accuracy and reliability of PAM software identifications. Although resource-intensive, manual verification allows for a detailed review of acoustic recordings by experts to validate species identifications and ensure data quality. This process includes verifying difficult-to-distinguish species and confirming outliers that may not fit typical identification patterns. In addition to manual verification, rigorous calibration and validation procedures for acoustic monitoring equipment can improve accuracy and reliability. If GCA continues to use Kaleidoscope, we recommend the configuration of a confidence interval measure through Wald tests or other means (Bolker et al., 2009).

5.6 Collaboration & Community Engagement

Effective bat monitoring programs face significant challenges in balancing local engagement with stakeholder buy-in while maintaining rigorous scientific standards, quality control, and coordination. This dual requirement is challenging due to bats' high mobility and diverse ecological needs amidst increasing threats. Our study began to integrate these challenges, employing scientific measures while redirecting our project to local knowledge from the GCA. In addition, the North American Bat Monitoring Program provides another example of these challenges, integrating science with regional monitoring. Moreover, local, place-based knowledge is essential to collaboration and community engagement, especially when ensuring the longevity of restoration projects (Wickham et al., 2022).

Potential strategies for engaging the community with the GCA for bat monitoring include initiatives fostering awareness and participation. For example, potential routes include educational programs focused on bat ecology and conservation, organized night walks designed to facilitate experiential learning opportunities, and volunteer sessions training community members in bat monitoring techniques. These activities promote understanding of local bat populations and empower community members to actively contribute to monitoring efforts, thereby enhancing the sustainability and effectiveness of conservation initiatives within the GCA region.

Outreach efforts should, whenever possible, center around local Indigenous knowledge and perspectives from the Penelakut, Hwlitsum and Tsawwassen First Nations, and other Hul'qumi'num-speaking communities. This approach ensures that partnerships and conservation efforts are respectful and culturally sensitive (Wickham et al., 2022). Engagement might vary depending on existing relationships, ranging from personal connections to other outreach methods. For example, the GCA could organize an Indigenous-led workshop to explore how knowledge exchange between Indigenous communities and restoration ecologists can be effectively facilitated. A key goal of this workshop may be to develop a set of "shared principles" to guide ongoing efforts, ensuring Indigenous leadership and fostering greater equity in restoration initiatives (Robinson et al., 2021). Building capacity within these communities is crucial for the sustainability of restoration projects (McFarlane et al., 2024).

5.7 Considerations for Bat-Focused Ecological Restoration

Ensuring the long-term viability of bat species necessitates the establishment of a comprehensive plan for habitat restoration based on the ongoing acquisition of data. Specific recommendations for habitat ecosystem restoration tailored to the local socio-economic and ecological context are essential. Moreover, the emergence of secure funding grants offers a promising outlook for the future trajectory of bat-focused ecological restoration (Bat Conservation International, 2024c).

Restoring lost or degraded wetlands is a significant contemporary conservation challenge for bat populations, particularly for endangered species such as the little-brown bat and Northern myotis, which rely heavily on wetlands for foraging (Environment Canada, 2015). Bat-focused restoration efforts include reinstating wetlands and optimizing habitats to support bat populations. For example, enhancing riparian buffers by expanding native vegetation can improve water quality and increase insect abundance (Ober & Hayes, 2008). Such improvements are associated with increased acoustic activity of insectivorous bats, providing increased feeding opportunities (Vasko et al., 2024).

Protecting undisturbed feeding areas is crucial for reducing the risk of bats contracting viruses, as it minimizes human contact and ensures adequate food availability (Plowright et al., 2024). Key restoration activities include the preservation of snags, ditch plugging, and tree planting (Vasko et al., 2024). Additionally, prescribed fire regimes are increasingly utilized as a management tool to enhance bat habitat, particularly in response to the growing frequency and severity of wildfires, which negatively impact bats (Loeb & Blakey, 2021).

Restoring bat roosting sites is crucial for bat-focused ecological restoration. In forested areas, preserving or replicating features typical of old-growth forests can enhance habitats for bat species. Essential elements include retaining dead-standing trees, maintaining tree cavities, fostering a diverse canopy structure, and ensuring an uncluttered understory with occasional dense shrub clusters (Carr, Weatherall & Jones, 2020). In cases where habitats are disturbed, creating bat boxes may be considered. However, these should be viewed as temporary measures to mitigate the exclusion from existing roosts or as a substitute for lost natural roosting sites, versus long-term solutions (BC Community Bat Program, 2019; Rudderham, 2023).

6.0 Recommendations

1. While our project allowed for a case study at Cable Bay, we suggest extending the bat monitoring plan to other GCA properties of involvement: Millard Learning Center wetlands, the Great Beaver Swamp, and Quadra Hill.
2. In addition to creating a baseline of bat populations on protected land, with a focus on the little brown bat and Northern myotis on Galiano Island, we propose that the GCA partner with the North American Bat Monitoring Project (NABat). To participate in data collection, the GCA must create an account with NABat and select a Generalized Random Tessellation Stratified design (GRTS) cell. NABat divides North America into cells; each cell delineated by NABat has an area of 10km by 10km. Within the 100 km2 cell, four 5km by 5km quadrants exist. At least two of the four quadrants are surveyed to create a viable dataset.

   Stationary acoustic surveys are NABat's primary approach to bat population monitoring. The standardized recording scheme includes a two-second trigger window and a maximum file length of 15 seconds. For optimal monitoring time, acoustic monitoring systems should be stationed during the summer before the young bats can fly. To ensure efficacy, each survey location requires a yearly sample. Each sample must be taken over at least four consecutive nights and run from 15 minutes before sunset to 15 minutes after sunrise. We suggest the purchase of a second passive acoustic monitoring device for optimal monitoring.

3. Depending on the GCA’s budget and capacity, we suggest buying an additional Song Meter SM4BAT FS Ultrasonic Recorder retailing for $999.00 USD, the Song Meter Mini Bat 2 AA retailing for $749.00 USD or the Avisoft UltrasoundGate 116 for $2950.00 USD. In addition to the secondary bat recorder, we suggest the GCA purchase the SonoBat Year One License as an analysis software superior to Kaleidoscope Pro Analysis Software. The first installment of the SonoBat 30 North America will cost $384.00 USD.
4. It is important to recognize that site selection is a multi-year commitment and requires the knowledge of professional biologists. We suggest that the GCA involve knowledgeable individuals in determining survey locations.
5. In addition to participating in the North American Bat Monitoring Program, we suggest the GCA participate in the BC Annual Bat Count organized by the Community Bat Projects of BC. As a registered society, the Habitat Acquisition Trust partners with Community Bat Projects of BC to facilitate a community-run annual bat count (HAT, 2024). The conservancy can register as a volunteer and collect valuable data from June to July and July to August.

Acknowledgments

We would like to extend our heartfelt thanks to Chessi Miltner, Adam Huggins, Becca Gray, Sofia Silverman and GCA's GIS technician for their invaluable contributions to this project. Their expertise in bat biology, ecological restoration, and wildlife monitoring has been instrumental in developing and implementing our bat monitoring protocols. Their dedication and willingness to share their knowledge have enriched our understanding of local ecosystems and strengthened our commitment to conservation efforts on Galiano Island and beyond. Their collaboration underscores the importance of interdisciplinary cooperation in advancing scientific research and promoting sustainable environmental practices within the GCA.

We would also like to thank Eric Higgs and Emma Street for their willingness to share their expertise, continued support, and passion for ecological restoration and wildlife ecology.

References

About Galiano | Galiano Island Chamber of Commerce. (n.d.). https://galianoisland.com/visitor-information/about-galiano

About Galiano Island. Galiano Island Life Real Estate. https://galianoislandlife.com/about-galiano-island.html

Adams, R.A. (2010). Bat reproduction declines when conditions mimic climate change projections for western North America. *Ecology*, 91(8), 2437–2445. https://doi.org/10.1890/09-0091.1

Aide, T. M., Corrada-Bravo, C., Campos-Cerqueira, M., Milan, C., Vega, G., & Alvarez, R. (2013). Real-time bioacoustics monitoring and automated species identification. *PeerJ (San Francisco, CA)*, 1, e103-. https://doi.org/10.7717/peerj.103

Bat Conservation International. (2024a). https://www.batcon.org/

Bat Conservation International. (2024b). *North American Bat Monitoring Program.* https://www.batcon.org/our-work/research-and-scalable-solutions/north-america-bat-monitoring-program/?gad_source=1&gclid=CjwKCAjw7s20BhBFEiwABVIMrb7A5z2l9pvwT_Kozk8HN7EKjTmsaP_TnUYuKXBHYFCsvSCvU6FqkRoCbscQAvD_BwE

Bat Conservation International. (2024c). *BCI announces 2024 student scholar awards, Advancing Global Bat Research*. https://www.batcon.org/press/bci-announces-2024-student-scholar-awards-advancing-global-bat-research/

BC Community Bat Program. (2019). *Best Management Practices for Bat Boxes in British Columbia.* https://www.bcbats.ca/attachments/BMPS-for-Bat-Boxes-in-BC-2019.pdf

Beattie, I., Schofer, D., McGregor, G., Lee, M. J., Lee, L. K. F., Himsworth, C. G., & Byers, K. A. (2022). An investigation of bat mortality in British Columbia, Canada. Canadian Journal of Zoology, 100(7), 464–473. https://doi.org/10.1139/cjz-2021-0230

Bolker, B. M., Brooks, M. E., Clark, C. J., Geange, S. W., Poulsen, J. R., Stevens, M. H. H., & White, J.-S. S. (2009). Generalized linear mixed models: a practical guide for ecology and evolution. *Trends in Ecology & Evolution (Amsterdam)*, *24*(3), 127–135. https://doi.org/10.1016/j.tree.2008.10.008

Boyles, J. G., Cryan, P. M., McCracken, G. F., & Kunz, T. H. (2011). Economic Importance of Bats in Agriculture. Science (American Association for the Advancement of Science), 332(6025), 41–42. https://doi.org/10.1126/science.1201366

Britzke, E. R., Gillam, E. H., & Murray, K. L. (2013). Current state of understanding of ultrasonic detectors for the study of bat ecology. *Acta Theriologica*, 58(2), 109–117. https://doi.org/10.1007/s13364-013-0131-3

Broders, H. G., Findlay, C. S., & Zheng, L. (2004). EFFECTS OF CLUTTER ON ECHOLOCATION CALL STRUCTURE OF MYOTIS SEPTENTRIONALIS AND M. LUCIFUGUS. J*ournal of Mammalogy*, 85(2), 273–281. https://doi.org/10.1644/BWG-102

Carr, A., Weatherall, A., & Jones, G. (2020). The effects of thinning management on bats and their insect prey in temperate broadleaved woodland. *Forest Ecology and Management*, *457*, 117682-. https://doi.org/10.1016/j.foreco.2019.117682

Cheng, T. L., Reichard, J. D., Coleman, J. T. H., Weller, T. J., Thogmartin, W. E., Reichert, B. E., Bennett, A. B., Broders, H. G., Campbell, J., Etchison, K., Feller, D. J., Geboy, R., Hemberger, T., Herzog, C., Hicks, A. C., Houghton, S., Humber, J., Kath, J. A., King, R. A., … Frick, W. F. (2021). The scope and severity of white‐nose syndrome on hibernating bats in North America. *Conservation Biology*, *35*(5), 1586–1597. https://doi.org/10.1111/cobi.13739

Collins, J. (2023). *Bat Surveys for Professional Ecologists: Good Practice Guidelines* (4th edition). The Bat Conservation Trust.

Community Bat Programs of BC. (2023, September 29). *Na Bat Monitoring Program*. BC BATS. https://bcbats.ca/got-bats/na-bat-monitoring-program/

COSEWIC. (2004). *COSEWIC assessment and update status report on the fringed bat Myotis thysanodes in Canada.* Committee on the Status of Endangered Wildlife in Canada. Ottawa, 26.

COSEWIC. (2023). *COSEWIC assessment and status report on the Hoary Bat Lasiurus cinereus, Eastern Red Bat Lasiurus borealis and Silver-haired Bat, Lasionycteris noctivagans, in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, 100.

de Torrez, E.C.B., Wallrichs, M.A., Ober, H.K. and McCleery, R.A. 2017. Mobile acoustic transects miss rare bat species: implications of survey method and spatiotemporal sampling for monitoring bats. *PeerJ* 5. doi: 10.7717/peerj.3940.

Dunn, M. (2024, May 5). *Becoming a bat-friendly community - could Mayne Island be such a community?* Mayne Island Conservancy. https://mayneconservancy.ca/becoming-a-bat-friendly-community-could-mayne-island-be-such-a-community/

Environment Canada. (2015). Recovery Strategy for Little Brown Myotis (Myotis lucifugus), Northern Myotis (Myotis septentrionalis), and Tri-colored Bat (Perimyotis subflavus) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. ix + 110 pp.

Erickson, J. L., & West, S. D. (2002). The Influence of Regional Climate and Nightly Weather Conditions on Activity Patterns of Insectivorous Bats. *Acta Chiropterologica*, *4*(1), 17–24. https://doi.org/10.3161/001.004.0103

Fenton, M. B., Swanepoel, C. M., Brigham, R. M., Cebek, J., & Hickey, M. B. C. (1990). Foraging behavior and prey selection by large slit-faced bats (Nycteris grandis; Chiroptera: Nycteridae). *Biotropica*, 2-8.

Fenton, M. B., Acharya, L., Audet, D., Hickey, M. B. C., Merriman, C., Obrist, M. K., Syme, D. M., & Adkins, B. (1992). Phyllostomid Bats (Chiroptera: Phyllostomidae) as Indicators of Habitat Disruption in the Neotropics. *Biotropica*, *24*(3), 440–446. https://doi.org/10.2307/2388615

Festa, F., Ancillotto, L., Santini, L., Pacifici, M., Rocha, R., Toshkova, N., Amorim, F., Benítez‐López, A., Domer, A., Hamidović, D., Kramer‐Schadt, S., Mathews, F., Radchuk, V., Rebelo, H., Ruczynski, I., Solem, E., Tsoar, A., Russo, D., & Razgour, O. (2023). Bat responses to climate change: a systematic review. *Biological Reviews of the Cambridge Philosophical Society,* 98(1), 19–33. https://doi.org/10.1111/brv.12893

Fraser, E. E., Silvis, R., Brigham, R. M., & Czenze, Z. J. (2020). Bat Echolocation Research: A handbook for planning and conducting acoustic studies. Second Edition. *Bat Conservation International.* Austin, Texas, USA.

Frick, W. F., Pollock, J. F., Hicks, A. C., Langwig, K. E., Reynolds, D. S., Turner, G. G., Butchkoski, C. M., & Kunz, T. H. (2010). Emerging Disease Causes Regional Population Collapse of a Common North American Bat Species. *Science (American Association for the Advancement of Science)*, *329*(5992), 679–682. https://doi.org/10.1126/science.1188594

Frick, W. F., Kingston, T., & Flanders, J. (2020). A review of the major threats and challenges to global bat conservation. *Annals of the New York Academy of Sciences*, 1469(1), 5–25. https://doi.org/10.1111/nyas.14045

Fukui, D. A. I., Murakami, M., Nakano, S., & Aoi, T. (2006). Effect of emergent aquatic insects on bat foraging in a riparian forest. *Journal of Animal Ecology*, *75*(6), 1252-1258.

Galiano Museum. Galiano Museum Society. (n.d.). https://galianomuseum.ca/?s=Galiano

Galiano Island history. Gulf Islands Guide. (2009, October 28).

Galiano Island. The Canadian Encyclopedia. (2006, November 21). https://www.thecanadianencyclopedia.ca/en/article/galiano-island#:~:text=of%20the%20islands.-,Galiano%20Island%2C%205787%20ha%2C%20is%20one%20of%20BC’s%20GULF%20ISLANDS,island%20for%20several%20thousand%20years

Ghanem, S. J., & Voigt, C. C. (2012). Chapter 7 - Increasing Awareness of Ecosystem Services Provided by Bats. *Advances in the Study of Behavior*, 44, 279–302. https://doi.org/10.1016/B978-0-12-394288-3.00007-1

Gibb, R., Browning, E., Glover‐Kapfer, P., Jones, K. E., & Börger, L. (2019). Emerging opportunities and challenges for passive acoustics in ecological assessment and monitoring. Methods in Ecology and Evolution, 10(2), 169–185. https://doi.org/10.1111/2041-210X.13101

Goerlitz, H. R. (2018). Weather conditions determine attenuation and speed of sound: Environmental limitations for monitoring and analyzing bat echolocation. *Ecology and Evolution*, *8*(10), 5090–5100. https://doi.org/10.1002/ece3.4088

Goodwin, K. R., & Gillam, E. H. (2021). Testing Accuracy and Agreement among Multiple Versions of Automated Bat Call Classification Software. *Wildlife Society Bulletin* (2011), 45(4), 690–705. https://doi.org/10.1002/wsb.1235

Government of British Columbia. (2023, November 8). *Red, Blue & Yellow lists*. Province of British Columbia. https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/conservation-data-centre/explore-cdc-data/red-blue-yellow-lists

Greving, H., Bruckermann, T., Schumann, A., Straka, T. M., Lewanzik, D., Voigt-Heucke, S. L., Marggraf, L., Lorenz, J., Brandt, M., Voigt, C. C., Harms, U., & Kimmerle, J. (2022). Improving attitudes and knowledge in a citizen science project about urban bat ecology. *Ecology and Society*, *27*(2), 24-. https://doi.org/10.5751/ES-13272-270224

Habitat Acquisition Trust. (2024) Bats on Vancouver Island. https://hat.bc.ca/bats

Hammerson, G. A., Kling, M., Harkness, M., Ormes, M., & Young, B. E. (2017). Strong geographic and temporal patterns in conservation status of North American bats. Biological Conservation, 212, 144–152. https://doi.org/10.1016/j.biocon.2017.05.025

Hiolski, E. (2018). Battling a Deadly Bat Fungus. *ACS Central Science*, *4*(3), 308–311. https://doi.org/10.1021/acscentsci.8b00153

Hutson A. M., Mickleburgh S. P., & Racey P. A. (2001). Microchiropteran Bats: Global Status Survey and Conservation Action Plan. Gland, Switzerland: IUCN/SSC chiroptera specialist group, IUCN. http://doi.org/10.2305/IUCN.CH.2001.SSC-AP.1.en

INaturalist. (n.d.) *Observations of Order Chiroptera Across Galiano Island.* https://www.inaturalist.org/observations?place_id=94935&taxon_id=40268

IUCN. (n.d.). *The IUCN Red List of Threatened Species*. IUCN Red List of Threatened Species. https://www.iucnredlist.org/fr

IUCN Standards and Petitions Committee. (2024). *Guidelines for Using the IUCN Red List Categories and Criteria*. IUCN, 16. https://www.iucnredlist.org/documents/RedListGuidelines.pdf.

Jones, G., Jacobs, D. S., Kunz, T. H., Willig, M. R., & Racey, P. A. (2009). Carpe noctem: the importance of bats as bioindicators. Endang Species Res 8:93-115. https://doi.org/10.3354/esr00182

Jones, K. E., Russ, J. A., Bashta, A., Bilhari, Z., Catto, C., Csősz, I., Gorbachev, A., Győrfi, P., Hughes, A., Ivashkiv, I., Koryagina, N., Kurali, A., Langton, S., Collen, A., Margiean, G., Pandourski, I., Parsons, S., Prokofev, I., Szodoray‐Paradi, A., … Zavarzin, O. (2013).

Indicator Bats Program: A System for the Global Acoustic Monitoring of Bats. In *Biodiversity Monitoring and Conservation* (pp. 211–247). Wiley‐Blackwell. https://doi.org/10.1002/9781118490747.ch10

Kellner, M., & Rodriguez de la Vega, P. (2023). Annual Bat Count (2012-2023). *British Columbia Community Bat Program.* https://bcbats.ca/attachments/Annual-Bat-Count-Report-2023_24.pdf

Kunz, T. H., Braun de Torrez, E., Bauer, D., Lobova, T., & Fleming, T. H. (2011). Ecosystem services provided by bats. Annals of the New York Academy of Sciences, 1223(1), 1–38. https://doi.org/10.1111/j.1749-6632.2011.06004.x

Langwig, K. E., Hoyt, J. R., Parise, K. L., Frick, W. F., Foster, J. T., & Kilpatrick, A. M. (2017). Resistance in persisting bat populations after white-nose syndrome invasion. *Philosophical Transactions of the Royal Society of London. Series B. Biological Sciences*, *372*(1712), 20160044–20160044. https://doi.org/10.1098/rstb.2016.0044

Loeb, S. C., Rodhouse, T. J., Ellision, L. E., Lausen, C. L., Reichard, J. D., Irvine, K. M., Ingersoll, T. E., Coleman, J. T. H., Thogmartin, W. E., Sauer, J. R., Francis, C. M., Bayless, M. L., Stanley, T. R., & Johnson, D. H. (2015). A plan for the North American Bat Monitoring Program (NABat). *Department of Agriculture Forest Service.* https://doi.org/10.2737/SRS-GTR-208

Loeb, S. C., & Blakey, R. V. (2021). Bats and fire: a global review. *Fire Ecology*, *17*(1). https://doi.org/10.1186/s42408-021-00109-0

Matthäus, L., Kugelschafter, K., & Fietz, J. (2023). Influence of ambient temperature on the phenology of the greater mouse‐eared bat (Myotis myotis). *Ecology and Evolution*, 13(5), e10081-n/a. https://doi.org/10.1002/ece3.10081

McFarlane, K., Wallace, K. J., Shanahan, D. F., & Clapcott, J. E. (2024). Working together to scale ecosystem restoration: collective approaches to community action in Aotearoa New Zealand. *Ecology and Society*, *29*(2), 17-. https://doi.org/10.5751/ES-15152-290217

Mickleburgh, S. P., Hutson, A. M., & Racey, P. A. (2002). A review of the global conservation status of bats. *Oryx*, *36*(1), 18–34. doi:10.1017/S0030605302000054

Miltner, C. (2024, January 18). *Biodiversity Hotspot saved through Conservation Partnership*. Galiano Conservancy. https://galianoconservancy.ca/news/cable-bay/

NABat. (2018). North American Bat Monitoring Program. https://www.nabatmonitoring.org/

Neuweiler, G. (1989). Foraging ecology and audition in echolocating bats. *Trends in ecology & evolution*, *4*(6), 160-166.

Ober, H. K., & Hayes, J. P. (2008). Influence of Vegetation on Bat Use of Riparian Areas at Multiple Spatial Scales. *The Journal of Wildlife Management*, *72*(2), 396–404. https://doi.org/10.2193/2007-193

Park, K.J. Mitigating the impacts of agriculture on biodiversity: bats and their potential role as bioindicators. *Mamm Biol* **80**, 191–204 (2015). https://doi-org.ezproxy.library.uvic.ca/10.1016/j.mambio.2014.10.004

Parks Canada Agency. (2023, December 22). *Making life better for bats and people in Canada.* Nature and science. https://parks.canada.ca/nature/science/especes-species/chauve-souris-canada-bats

Patriquin, K. J., & Robert M. R. Barclay. (2003). Foraging by Bats in Cleared, Thinned and Unharvested Boreal Forest. *The Journal of Applied Ecology*, 40(4), 646–657. https://doi.org/10.1046/j.1365-2664.2003.00831.x

Perea, S., & Tena, E. (2020). Different bat detectors and processing software… Same results? *Journal of Bat Research & Conservation*, 13(1), 4—8. https://doi.org/10.14709/BarbJ.13.1.2020.01

Perry, R. W. (2013). A review of factors affecting cave climates for hibernating bats in temperate North America. *Environmental Reviews*, 21(1), 28–39. https://doi.org/10.1139/er-2012-0042

Plowright, R. K., Ahmed, A. N., Coulson, T., Crowther, T. W., Ejotre, I., Faust, C. L., Frick, W. F., Hudson, P. J., Kingston, T., Nameer, P. O., O'Mara, M. T., Peel, A. J., Possingham, H., Razgour, O., Reeder, D. M., Ruiz-Aravena, M., Simmons, N. B., Srinivas, P. N., Tabor, G. M., … Keeley, A. T. H. (2024). Ecological countermeasures to prevent pathogen spillover and subsequent pandemics. *Nature Communications*, *15*(1), 2577–2577. https://doi.org/10.1038/s41467-024-46151-9

Polis, G. A., Anderson, W. B., & Holt, R. D. (1997). TOWARD AN INTEGRATION OF LANDSCAPE AND FOOD WEB ECOLOGY: The Dynamics of Spatially Subsidized

Food Webs. *Annual Review of Ecology and Systematics*, *28*(1), 289–316. https://doi.org/10.1146/annurev.ecolsys.28.1.289

Protected lands. Galiano Conservancy. (2024, May 10). https://galianoconservancy.ca/land-stewardship/protected-lands/

Put, J. E., Fahrig, L., & Mitchell, G. W. (2019). Bats respond negatively to increases in the amount and homogenization of agricultural land cover. Landscape Ecology, 34(8), 1889–1903. https://doi.org/10.1007/s10980-019-00855-2

Reichert, B. E., Bayless, M., Cheng, T. L., Coleman, J. T. H., Francis, C. M., Frick, W. F., Gotthold, B. S., Irvine, K. M., Lausen, C., Li, H., Loeb, S. C., Reichard, J. D., Rodhouse, T. J., Segers, J. L., Siemers, J. L., Thogmartin, W. E., & Weller, T. J. (2021). NABat: A top-down, bottom-up solution to collaborative continental-scale monitoring. *Ambio*, *50*(4), 901–913. https://doi.org/10.1007/s13280-020-01411-y

Robinson, J. M., Gellie, N., MacCarthy, D., Mills, J. G., O'Donnell, K., & Redvers, N. (2021). Traditional ecological knowledge in restoration ecology: a call to listen deeply, to engage with, and respect Indigenous voices. *Restoration Ecology*, *29*(4). https://doi.org/10.1111/rec.13381

Ross, S.-J., O'Connell, D. P., Deichmann, J. L., Desjonquères, C., Gasc, A., Phillips, J. N., Sethi, S. S., Wood, C. M., & Burivalova, Z. (2023). Passive acoustic monitoring provides a fresh perspective on fundamental ecological questions. *Functional Ecology*, 37, 959–975. https://doi.org/10.1111/1365-2435.14275

Rudderham, R. (2023). *Maternal Bat Roost Habitat Enhancement Project in Mystic Vale, Victoria, BC.* University of Victoria. https://journals.uvic.ca/index.php/ecorestoration/article/view/21994

Russo, D., & Jones, G. (2015). Bats as bioindicators: an introduction. *Mammalian Biology : Zeitschrift Für Säugetierkunde*, *80*(3), 157–158. https://doi.org/10.1016/j.mambio.2015.03.005

Rydell, J., Nyman, S., Eklöf, J., Jones, G., & Russo, D. (2017). Testing the performances of automated identification of bat echolocation calls: A request for prudence. *Ecological Indicators*, *78*, 416–420. https://doi.org/10.1016/j.ecolind.2017.03.023

Species at Risk Act (SARA), Revised Statutes of Canada (2009, c. C-29). https://laws.justice.gc.ca/eng/acts/s-15.3/

Schnitzler, H. U., & Kalko, E. K. (2001). Echolocation by insect-eating bats: we define four distinct functional groups of bats and find differences in signal structure that correlate with the typical echolocation tasks faced by each group. *Bioscience*, *51*(7), 557-569.

Sherwin, H. A., Montgomery, W. I., & Lundy, M. G. (2013). The impact and implications of climate change for bats. *Mammal Review*, 43(3), 171–182. https://doi.org/10.1111/j.1365-2907.2012.00214.x

Stahlschmidt, P., & Brühl, C. A. (2012). Bats as bioindicators – the need of a standardized method for acoustic bat activity surveys. *Methods in Ecology and Evolution*, 3(3), 503–508. https://doi.org/10.1111/j.2041-210X.2012.00188.x

The Story of Galiano Island. Galiano story - Margaret Griffiths. http://galianostory.com/OVERVIEW.HTM

Thogmartin, W. E., Sanders-Reed, C. A., Szymanski, J. A., McKann, P. C., Pruitt, L., King, R. A., Runge, M. C., & Russell, R. E. (2013). White-nose syndrome is likely to extirpate the endangered Indiana bat over large parts of its range. *Biological Conservation*, *160*, 162–172. https://doi.org/10.1016/j.biocon.2013.01.010

Thomas, D. W. (1988). The distribution of bats in different ages of Douglas-fir forests. *The Journal of Wildlife Management*, 619-626.

Thomas, J. P., Kukka, P. M., Benjamin, J. E., Barclay, R. M. R., Johnson, C. J., Schmiegelow, F. K. A., & Jung, T. S. (2021). Foraging habitat drives the distribution of an endangered bat in an urbanizing boreal landscape. *Ecosphere (Washington, D.C)*, *12*(3). https://doi.org/10.1002/ecs2.3457

Thomas, R. J., & Davison, S. P. (2022). Seasonal swarming behavior of Myotis bats revealed by integrated monitoring, involving passive acoustic monitoring with automated analysis, trapping, and video monitoring. *Ecology and Evolution*, 12(9), e9344-n/a. https://doi.org/10.1002/ece3.9344

Vasko, V., Gaultier, S. P., Blomberg, A., Lilley, T. M., Norrdahl, K., & Brommer, J. E. (2024). Restoration of boreal wetlands increases bat activity. *Restoration Ecology*, *32*(4). https://doi.org/10.1111/rec.14099

Voigt, C. C. (2016). *Bats in the Anthropocene: Conservation of Bats in a Changing World* (C. C. Voigt & Tigga. Kingston, Eds.; 1st ed. 2016.). Springer Nature. https://doi.org/10.1007/978-3-319-25220-9

Walters, C. L., Freeman, R., Collen, A., Dietz, C., Fenton, M. B., Jones, G., Obrist, M. K., Puechmaille, S. J., Sattler, T., Siemers, B. M., Parsons, S., & Jones, K. E. (2012). A continental-scale tool for acoustic identification of European bats. *The Journal of Applied Ecology*, *49*(5), 1064–1074. https://doi.org/10.1111/j.1365-2664.2012.02182.x

Warnecke, L., Turner, J. M., Bollinger, T. K., Misra, V., Cryan, P. M., Blehert, D. S., Wibbelt, G., & Willis, C. K. R. (2013). Pathophysiology of white-nose syndrome in bats: a mechanistic model linking wing damage to mortality. *Biology Letters* (2005), 9(4), 20130177–20130177. https://doi.org/10.1098/rsbl.2013.0177

Wildlife Conservation Society. (n.d.). *Our work to Save Bats Inventory & Monitoring.* WCS Bats. https://wcsbats.ca/monitoring

Weller, T. J., & Zabel, C. J. (2002). Variation in Bat Detections due to Detector Orientation in a Forest. *Wildlife Society Bulletin*, 30(3), 922–930.

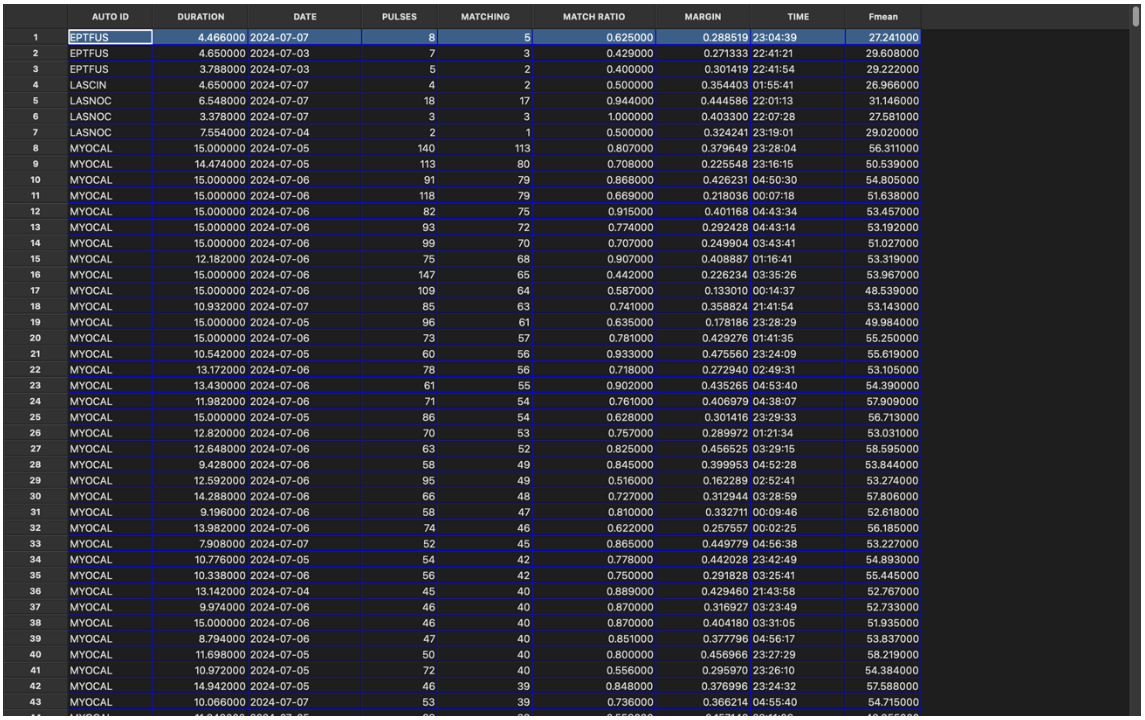
Wickham, S., Augustine, S., Forney, A., Mathews, D., Shackelford, N., Walkus, J., & Trant, A. (2022). Incorporating place-based values into ecological restoration. *Ecology and Society*, *27*(3), 32-. https://doi.org/10.5751/ES-13370-270332

Wund, M. A. (2006). Variation in the Echolocation Calls of Little Brown Bats (Myotis lucifugus) in Response to Different Habitats. *The American Midland Naturalist*, 156(1), 99–108. https://doi.org/10.1674/0003-0031(2006)156[99:VITECO]2.0.CO;2

8.0 Appendix A

A sample of the audio recordings collected by the GCA’s PAM device at Qw’xwulwis Cable Bay is included in Table 4. This table is an illustrative sample of the total data collected.

Table 4. *A screenshot of the Kaleidoscope software depicting each bat species identified in the Cable Bay site. Each sample (row) contains information concerning the bat identified. The row is distinguished by nine columns: auto ID (acronym), duration of call, date, # of pulses, match ratio, margin of error, time, and Fmean value.*



	AUTO ID	DURATION	DATE	PULSES	MATCHING	MATCH RATIO	MARGIN	TIME	Fmean
1	EPTFUS	4.466000	2024-07-07	8	5	0.625000	0.288519	23:04:39	27.241000
2	EPTFUS	4.650000	2024-07-03	7	3	0.429000	0.271333	22:41:21	29.608000
3	EPTFUS	3.788000	2024-07-03	5	2	0.400000	0.301419	22:41:54	29.222000
4	LASCIN	4.650000	2024-07-07	4	2	0.500000	0.354403	01:55:41	26.966000
5	LASNOC	6.548000	2024-07-07	18	17	0.944000	0.444586	22:01:13	31.146000
6	LASNOC	3.378000	2024-07-07	3	3	1.000000	0.403300	22:07:28	27.581000
7	LASNOC	7.554000	2024-07-04	2	1	0.500000	0.324241	23:19:01	29.020000
8	MYOCAL	15.000000	2024-07-05	140	113	0.807000	0.379649	23:28:04	56.311000
9	MYOCAL	14.474000	2024-07-05	113	80	0.708000	0.225548	23:16:15	50.539000
10	MYOCAL	15.000000	2024-07-06	91	79	0.868000	0.426231	04:50:30	54.805000
11	MYOCAL	15.000000	2024-07-06	118	79	0.669000	0.218036	00:07:18	51.638000
12	MYOCAL	15.000000	2024-07-06	82	75	0.915000	0.401168	04:43:34	53.457000
13	MYOCAL	15.000000	2024-07-06	93	72	0.774000	0.292428	04:43:14	53.192000
14	MYOCAL	15.000000	2024-07-06	99	70	0.707000	0.249904	03:43:41	51.027000
15	MYOCAL	12.182000	2024-07-06	75	68	0.907000	0.408887	01:16:41	53.319000
16	MYOCAL	15.000000	2024-07-06	147	65	0.442000	0.226234	03:35:26	53.967000
17	MYOCAL	15.000000	2024-07-06	109	64	0.587000	0.133010	00:14:37	48.539000
18	MYOCAL	10.932000	2024-07-07	85	63	0.741000	0.358824	21:41:54	53.143000
19	MYOCAL	15.000000	2024-07-05	96	61	0.635000	0.178186	23:28:29	49.984000
20	MYOCAL	15.000000	2024-07-06	73	57	0.781000	0.429276	01:41:35	55.250000
21	MYOCAL	10.542000	2024-07-05	60	56	0.933000	0.475560	23:24:09	55.619000
22	MYOCAL	13.172000	2024-07-06	78	56	0.718000	0.272940	02:49:31	53.105000
23	MYOCAL	13.430000	2024-07-06	61	55	0.902000	0.435265	04:53:40	54.390000
24	MYOCAL	11.982000	2024-07-06	71	54	0.761000	0.406979	04:38:07	57.909000
25	MYOCAL	15.000000	2024-07-05	86	54	0.628000	0.301416	23:29:33	56.713000
26	MYOCAL	12.820000	2024-07-06	70	53	0.757000	0.289972	01:21:34	53.031000
27	MYOCAL	12.648000	2024-07-06	63	52	0.825000	0.456525	03:29:15	58.595000
28	MYOCAL	9.428000	2024-07-06	58	49	0.845000	0.399953	04:52:28	53.844000
29	MYOCAL	12.592000	2024-07-06	95	49	0.516000	0.162289	02:52:41	53.274000
30	MYOCAL	14.288000	2024-07-06	66	48	0.727000	0.312944	03:28:59	57.806000
31	MYOCAL	9.196000	2024-07-06	58	47	0.810000	0.332711	00:09:46	52.618000
32	MYOCAL	13.982000	2024-07-06	74	46	0.622000	0.257557	00:02:25	56.185000
33	MYOCAL	7.908000	2024-07-07	52	45	0.865000	0.449779	04:56:38	53.227000
34	MYOCAL	10.776000	2024-07-05	54	42	0.778000	0.442028	23:42:49	54.893000
35	MYOCAL	10.338000	2024-07-06	56	42	0.750000	0.291828	03:25:41	55.445000
36	MYOCAL	13.142000	2024-07-04	45	40	0.889000	0.429460	21:43:58	52.767000
37	MYOCAL	9.974000	2024-07-06	46	40	0.870000	0.316927	03:23:49	52.733000
38	MYOCAL	15.000000	2024-07-06	46	40	0.870000	0.404180	03:31:05	51.935000
39	MYOCAL	8.794000	2024-07-06	47	40	0.851000	0.377796	04:56:17	53.837000
40	MYOCAL	11.698000	2024-07-05	50	40	0.800000	0.456966	23:27:29	58.219000
41	MYOCAL	10.972000	2024-07-05	72	40	0.556000	0.295970	23:26:10	54.384000
42	MYOCAL	14.942000	2024-07-05	46	39	0.848000	0.376996	23:24:32	57.588000
43	MYOCAL	10.066000	2024-07-07	53	39	0.736000	0.366214	04:55:40	54.715000