Impacts of the Barrington Lake Wildfire in Shelburne County, Nova Scotia, on Bat (Chiroptera) Activity

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CRediT authorship contribution statement

SG – statistical analyses, report writing; LP – data collection, data curation, data analyses, writing – editing & review; SC – data curation, data analyses; JP – data curation

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This report is written for the Nova Scotia Department of Natural Resources (NS DNR). The goal of this work was to assess the impacts of the Barrington Lake wildfire (2023) in Shelburne County, Nova Scotia, on bats by analysing acoustic data collected opportunistically before and after the wildfire.

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Abstract

Wildfires play important ecological roles with respect to landscape succession and nutrient cycling. As such, some wildlife benefit from fire disturbance. However, wildfire risk, severity, and spread are increasing worldwide due to climate change. Paired with the on-going biodiversity crisis, understanding the impacts that fire can have on wildlife is of increasing importance. Bats (Chiroptera) have become a particular taxon of interest in recent years due to many species being listed or assessed as endangered in many parts of their geographic range, including Maritime Canada. The impact of fire on bats depends on several factors, but mixed findings and species-specific responses have been documented elsewhere. The goal of our work was to assess the impact of the Barrington Lake wildfire, the largest wildfire recorded in Nova Scotia, on the bat community. Using acoustic data opportunistically collected pre- and post-fire, we compared changes in bat activity at a burned site and two unburned sites. Overall, the increase in bat activity was significantly greater post-fire at the burned site. Overall activity is mainly driven by common species, who in our study included species groupings for *Myotis* bats and high-frequency bats. For both of these acoustic categories, the increase in bat activity post-fire was significantly higher at the burned site. We note that the little brown bat (*M. lucifugus*) is the most abundant bat in our system and is most likely the driving force of our findings for overall and common bat activity. We were limited in our ability to concretely explore rarer species and species with few acoustic detections. Given this, we strongly recommend exerting caution when generalizing positive findings to other bats, particular rarer species and species who cannot be reliably identified acoustically. Wildfires, while being a beneficial ecosystem disturbance, have become more severe and can completely burn through habitat, impacting already vulnerable bat species. We suggest repeated and structured monitoring to better understand longer-term impacts of severe wildfires on bat activity and habitat suitability for bats and other wildlife.

Highlights

- Bat activity increased over time, but the increase was significantly greater at a wildfire-impacted site
- 40kHz *Myotis* bat activity ("40kMyo") increased significantly more at a wildfire-impacted site, though this finding is most likely reflective of one species, *Myotis lucifugus*
- High-frequency bat activity ("HighF") activity increased significantly more at a wildfire-impacted site
- Concrete inferences on the impact of wildfire on rarer and lesser-sampled species could not be made
- Changes in landscape structure and consequent prey abundance likely drive bat response

Introduction

Fires play important roles in ecosystems, contributing to nutrient cycling, structural landscape changes, and more, that influence ecosystem communities (Certini, 2005; Pausas & Keeley, 2019; Thom & Seidl, 2016). Fire is a beneficial disturbance in many areas, and fire suppression can have significant consequences for ecosystem health (Pausas & Keeley, 2019). However, the increasing pervasiveness, frequency, and severity of wildfires over recent years, largely owing to climate change and global warming (Flannigan et al., 2009; Halofsky et al., 2020), have resulted in devastating losses of wildlife (Baltzer et al., 2025; Kelly et al., 2020; Reiner, 2020). The impacts of wildfires on wildlife are complex: several factors such as species-specific behaviour, vegetation structure, habitat complexity, fire severity and spread, and more, contribute to how wildlife may be affected by fire. With wildfire risk continuing to rise, understanding its impact on biodiversity is becoming increasingly important.

The Barrington Lake wildfire began 26 May 2023 and is considered the largest wildfire in Nova Scotian history. While the fire was started by human cause, the environmental conditions linked to fire ignition and propagation are still linked to changing climate and global warming, with land generally becoming more susceptible to fires and other ecological disturbances (Coogan et al., 2019). Between the fire's start on 26 May 2023 and full extinguishment 26 July 2023, an estimated 23,379 hectares of land were burned, dozens of structures destroyed, and thousands of civilians had been evacuated from their homes. Beyond the immediate human and structural toll, the Barrington Lake wildfire fundamentally altered the regional landscape, acting as a catalyst for habitat reorganization for wildlife. Among the wildlife who may be impacted by these landscape-level changes are bats (Chiroptera), who have been of great interest in recent years due to their endangered status in Canada.

Bats play critical ecological roles worldwide; in temperate regions such as Maritime Canada, bats contribute greatly to insect and agricultural pest control (Boyles et al., 2011; Maine & Boyles, 2015). Significant bat declines in North America over the past two decades have also been linked to declines in human health (Frank, 2024; Medcalfe et al., 2025), predicted to be primarily due to increased insecticide, particularly in agricultural settings (Frank, 2024). How bats contribute to human-related issues, and ultimately the roles bats play in ecosystems, drive us to further our knowledge into assessing factors that influence bat activity.

Bat activity in response to fire, like for many other taxa, is complex. Some species appear to benefit, especially in fire-prone systems (Blakey et al., 2019; Steel et al., 2019). One way that fire alters vegetation structure is by creating more edge habitat, which for many bats is beneficial for foraging activities, leading to increased bat activity in the short-term (Burns et al., 2019; Smith & Gehrt,

2010). The overall reduction of vegetative clutter promotes more suitable habitat for bats adapted to more open-habitat, such as larger-bodied bats (Blakey et al., 2019). Fire can also create more suitable roosting habitat (Baldwin et al., 2023; Harper et al., 2016). For species adapted to cluttered or sheltered habitats, however, the loss of vegetative complexity may result in unsuitable habitat, thereby reducing activity (Blakey et al., 2019).

It is important to note however that many studies on the impact of fire are conducted in fire-prone systems with controlled or prescribed burns (e.g., Boyles & Aubrey, 2006; Lacki et al., 2009; Taillie et al., 2021). Since wildfires are an increasing risk, both in terms of frequency and severity (Halofsky et al., 2020), prior findings may not be reflected in larger and more severe fires (Loeb & Blakey, 2021). For example, in a boreal forest in Canada, a severe wildfire did not result in the formation of suitable foraging or roosting habitat and bat activity declined significantly (Jung, 2020). In the Canadian Rocky Mountains following the Kenow wildfire, most species responded negatively and saw significant declines in activity (Low et al., 2024), including species previously documented to respond positively to prescribed fires. With uncontrolled and severe wildfires, particularly in the immediate stages post-fire, habitat can be completely burned through. Severity and completeness of the burn often dictate cascading factors such as the rate of nutrient cycling, vegetative succession, colonization of insect populations, and consequent habitat use of higher-level fauna. Additionally, study-specific factors such as, but not limited to, geography, topography, and vegetative diversity all play a role in determining animal response to disturbance, including bat response to fire (Loeb & Blakey, 2021). As such, it is important to conduct these studies at the localities in which they may occur to obtain detailed information on local populations.

Goal & aim

The goal of this work is to report on the impacts of the Barrington Lake wildfire on bat activity using acoustic data that were opportunistically collected prior to and following the wildfire.

Methods

Study area

The study area (Figure 1) encompassed land corresponding to Landscapes 9-11[a] of the Natural Landscapes of Nova Scotia (Government of Nova Scotia, 2002). These landscapes include several water bodies such as rivers and large lakes, barren/semi-barren unforested habitats, and encompass forested habitat such as Acadian coniferous forests and boreal coastal forests. Tree species encountered in the area include red spruce (*Picea rubens*), black spruce (*P. mariana*), white spruce

[a] See landscapes map at https://novascotia.ca/nse/protectedareas/naturalland.asp

(*P. glauca*), eastern hemlock (*Tsuga canadensis*), balsam fir (*Abies balsama*), white pine (*Pinus strobus*), and red oak (*Quercus rubra*).

Study species – bats of Nova Scotia

There are records for seven bat species in Nova Scotia (Table 1; Van Zyll de Jong, 1985): the little brown bat (*Myotis lucifugus;* MYLU), the northern long-eared bat (*M. septentrionalis*; MYSE), the tri-colored bat (*Perimyotis subflavus;* PESU), the hoary bat (*Lasiurus cinereus;* LACI), the eastern red bat (*L. borealis;* LABO), the silver-haired bat (*Lasionycteris noctivagans*; LANO) and the big brown bat (*Eptesicus fuscus;* EPFU). The little brown, northern long-eared, and tri-colored bat are resident species that can be found in the province throughout the year, spending the winter period hibernating in caves and abandoned mines. The hoary, eastern red, and silver-haired bats are long-distance migrating species that migrate southward for the winter period but can be found in the province from late-spring to early fall. Big brown bats are more abundant westward in the Maritimes, and while they are not typically considered a resident species in Nova Scotia, there have been increasing observations of these bats in recent years (McAlpine et al., 2024). Big brown bats have also been observed hibernating in buildings in the Maritimes, specifically New Brunswick (McAlpine et al., 2002). Natural summer roosts of each of these species can be found in forested habitats. The little brown, northern long-eared, and silver-haired bats roost in cavities and crevices of trees (live, dead, or decaying, i.e., snags). The hoary, eastern red, and tri-colored bats roost in foliage. Tri-colored bats of Nova Scotia are considered to be a disjunct population, one reason being their unique lichen-roosting behaviour as they preferentially roost in old man's beard lichens (*Usnea* sp., Poissant et al., 2010).

With the exception of big brown bats, each of the species here has been assessed endangered. The hibernating species (MYLU, MYSE, PESU) are listed as provincially and federally endangered, greatly owing to disease-induced mortality, specifically White-Nose Syndrome (WNS; COSEWIC, 2013; Frick et al., 2015; Government of Nova Scotia, 2017). The long-distance migrating species have recently been assessed as federally endangered owing to wind turbine mortality (COSEWIC, 2023). Given the status and overall declining trends of bats, monitoring these animals, particularly after disturbance events such as wildfires, has become of increasing interest and importance.

Table 1. Bats of Nova Scotia, their characteristic acoustic frequencies (F_c), and their typical roosting and foraging habitats in the active season.

Scientific name	Common name	Typical F_c[a]	Roost structure(s)	Foraging strategy
Myotis lucifugus	Little brown bat	35 – 40 kHz	Cavity/bark, human-made structures	Edge (Nelson & Gillam, 2017; Saunders & Barclay, 1992)
Myotis septentrionalis	Northern long-eared bat	35 – 40 kHz	Cavity/bark	Covered (e.g., within forests and forest-covered areas) (Henderson & Broders, 2008)
Perimyotis subflavus	Tri-colored bat	40 – 45 Khz	Foliage[b]	Open (Carter et al., 1999; Van Zyll de Jong, 1985)
Eptesicus fuscus	Big brown bat	25 – 30 kHz	Cavity/bark, human-made structures	Edge (Brigham, 1991)
Lasionycteris noctivagans	Silver-haired bat	25 – 30 kHz	Cavity/bark, human-made structures	Edge (Barclay, 1986)
Lasiurus borealis	Eastern red bat	30 – 40 kHz	Foliage	Edge, Open (Amelon et al., 2014; Beilke et al., 2023)
Lasiurus cinereus	Hoary bat	15 – 30 kHz	Foliage	Open (Barclay, 1986)

a – McBurney & Segers, 2021

b – Specific roosting habitat varies across geographic range but foliage-roosting is mostly observed for this species (McCoshum et al., 2023). Observations in Maritime Canada also show primarily foliage-roosting behaviour, but in southwest Nova Scotia preferred roosts tend to be in clumps of *Usnea* lichens (Poissant et al., 2010)

Acoustic surveys

Pre-fire baseline data (2018) were collected as part of an independent research project based on species distribution monitoring for PESU and post-WNS monitoring of at-risk bats (Farrow & Broders, 2011; Phinney, 2020). For these data, Autonomous Recording Units (ARUs) used were Wildlife Acoustics SM4 Bat-FS detectors with SMM-U2 Ultrasonic Microphones. ARUs were deployed from 30 June 2018 to 3 July 2018, resulting in three survey nights (June 30, July 1, July 2) for each of three sites surveyed (S17, S18, S20). Detectors were scheduled to begin recording

at 19:00 until 7:00, encompassing sunset and sunrise. Microphones were positioned 6m high on aluminum poles and positioned in a manner to avoid environmental clutter (e.g., trees, canopy, bushes), which allowed for better call detection and quality, and reduced acoustic noise (Weller & Zabel, 2002). For specific ARU details at each site and recording settings, see Supplementary Table S1.

Post-fire data were collected between 23 June and 9 July 2025, resulting in 16 nights surveyed for each site. These data were collected at the same sites as 2018 baseline data. GPS accuracy was within 3m, so ARUs for post-fire surveys were placed within 3m of the original recording placement. For these data, we replicated the methods for 2018 data collection, using the same brand of equipment, equipment placement, nightly recording schedule, and audio settings (Table S1).

Baseline data and replicated post-fire data collection occurred at three survey sites: S17, S18, and S20. For these sites, S17 was within the Barrington Lake Wildlife burn boundary, and is hereafter referred to as our "burned" site. The other two sites, S18 and S20, were outside of the burn boundary, hereafter referred to as our "unburned" sites. S18 and S20 are our control sites, whereas S17 is our impacted site (Figure 1).

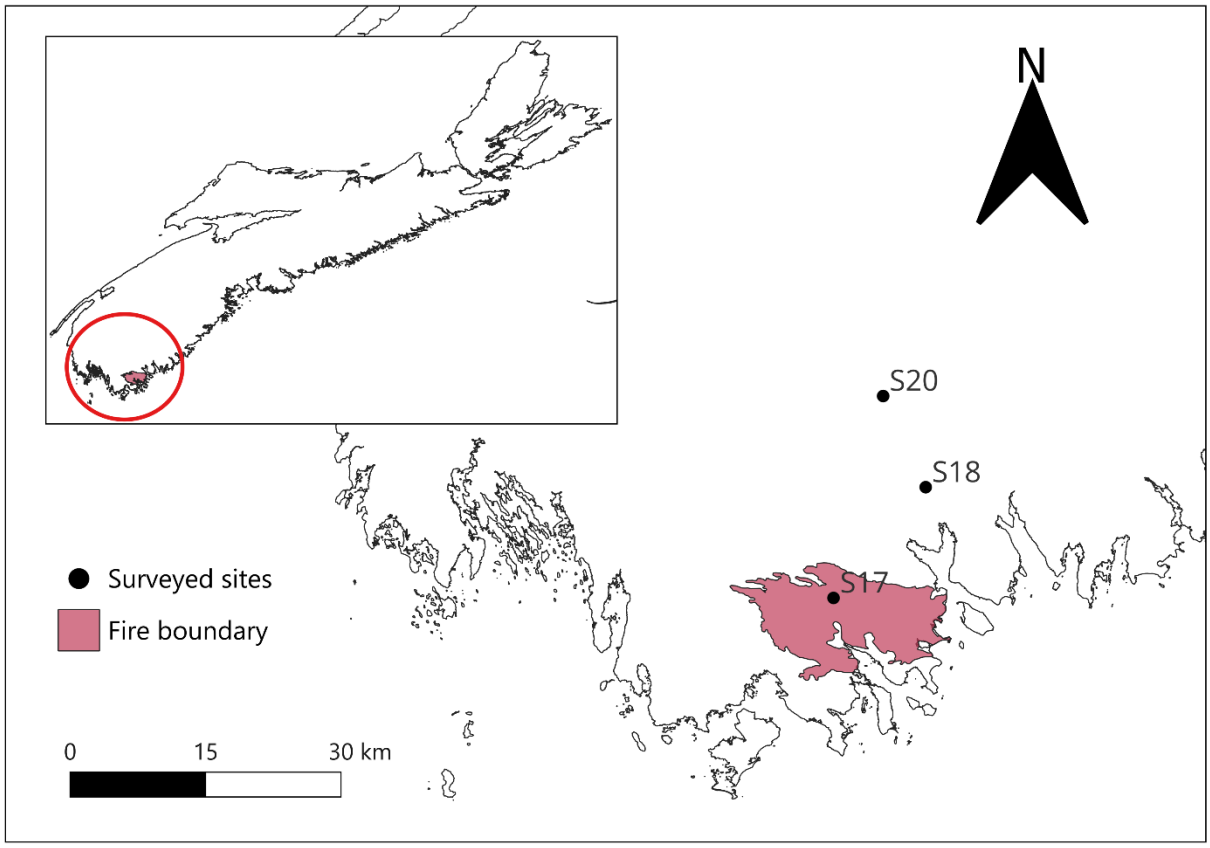

Figure 1. Acoustic survey sites and area impacted by the 2023 Barrington Lake wildfire. Pre-fire surveys were conducted in 2018, and post-fire surveys in 2025.

Species identification & acoustic categories

Acoustic data were processed using Kaleidoscope pro v5.7.0 for the 2025 data and v5.8.1 for the 2018 data and both using classifier v5.7.0 (Wildlife Acoustics) to filter the data by differentiating potential bat activity from noise, and to organize data by species vocal signatures. Changes in Kaleidoscope pro from version to 5.7.0 to 5.8.1 did not impact our analysis (see Release Notes). As baseline data had initially been processed using an older version of the Kaleidoscope program (v.5.1.9), we reprocessed baseline data using the updated software to ensure consistency in automatic identification of files classified as bats versus noise. Processing settings included a minimum of three pulses, frequency between 15-120kHz, pulse length of 1-500ms, and advanced signal processing.

From the resulting acoustic data, species or species groups can often be identified (Fenton & Bell, 1981). For manual species identification, we followed the latest identification guide by the

Canadian Wildlife Health Cooperative (CWHC; McBurney & Segers, 2021). As per this guide, we only identified a file as a bat pass if at least three zero-crossing echolocation calls were detected. Additionally, we also did not review files automatically identified by as NOISE by Kaleidoscope Pro. We identified species or species-groups where possible. If species identification was not possible, we classified detections to higher taxonomic levels or species groupings. Acoustic identification categories for bats included the following: 40kMyo (40kHz range *Myotis* species), MYLU (*Myotis lucifugus*), MYSE (*Myotis septentrionalis*), PESU (*Perimyotis subflavus*), LABO (*Lasiurus borealis*), LABOPESU (*Lasiurus borealis* / *Perimyotis subflavus*), LACI (*Lasiurus cinereus*), LANO (*Lasionycteris noctivagans*), EPFULANO (*Eptesicus fuscus* / *Lasionycteris noctivagans*), HighF (high frequency bat, ≥ 35 kHz); LowF (low frequency bat, 15– 30 kHz), and NoID (unidentified bat call). The number of files generated by the ARU that were further processed and classified is used as a measure of activity.

Environmental data

We obtained weather data from Shelburne Sandy Point weather station (Climate ID: 8205130; Environment and Climate Change Canada) as it was nearest to our survey sites. Weather variables can influence bat activity and consequently the likelihood of acoustic detection (Gorman et al., 2021; Perks & Goodenough, 2020). Temperature, wind, and precipitation are among these weather variables, so we focused on these factors. We calculated mean temperature (°C), mean wind speed (km/h), and total precipitation amount (mm) for each night, using weather data corresponding to when the ARUs were programmed to record (19:00 to 7:00).

Analyses

All statistical analyses were completed in R v.4.4.2 (R Core Team, 2024). Where data were deficient or where resolution was too coarse for specific statistical analyses, we present the findings descriptively. As we were interested in bat activity, we filtered out all files identified as NOISE from our analyses.

Overall bat activity

Our first question was: what were the impacts of the fire on overall bat activity? From preliminary analyses, our data were most suited to a negative binomial distribution so we fit generalized linear mixed models (GLMMs) to this distribution using the glmm package in R (Brooks et al., 2017). Our baseline model involved the number of bat files as our dependent variable, and the interaction between period (pre- or post-fire) and treatment (burned or unburned) as our independent variables, resulting in a before-after control-impact (BACI) design. We incorporated Site ID as a random effect to account for natural variation between sites independent of fire treatment.

We then assessed various candidate models that incorporated combinations of weather variables as covariates. For these climatic variables, we ended up excluding consideration of total precipitation amount for analyses as very few nights surveyed had any precipitation recorded. For mean temperature and mean wind speed, we scaled these variables (mean = 0, SD = 1) to ensure that they were appropriately incorporated into our candidate models. For assessing our models and determining which were plausible candidates, we used the DHARMa package (Hartig, 2016) to verify statistical assumptions statistical assumptions of residual uniformity, residual distribution and variance structure. To determine the most suitable model for our analysis, we used the Akaike Information Criterion (AIC; where a lower AIC corresponds to a better-suited model) and considered model parsimony, opting for models with fewer parameters if they were within a reasonable AIC of the best model ($\Delta AIC < 2$). Upon selection of our final model, we assessed model-estimated means using the emmeans package (Lenth et al., 2024) to determine the statistical significance and effect size of period and treatment on mean activity.

Species-specific responses

To assess the impact of wildfire on specific species, we first focused on species categories that were sufficiently sampled (hereafter referred to as "common species" for analyses) to make stronger and more appropriate inferences. Our criteria for common species were informed by preliminary data analysis and existing knowledge of general abundance of the study system. Our criteria for common species included species who had: ≥10 detections in each survey period, detections in each treatment type, and detections at multiple (≥2) sites or on multiple (≥2) nights. Representation in each treatment type was necessary to understand the interaction between survey period and treatment (i.e., our BACI interaction). Additionally, having detections at multiple sites and nights is more likely to represent resident or regular users of the surveyed areas rather than transient individuals. For these species, we adopted a similar statistical approach as we did for overall bat activity. Specifically, we developed models that incorporated combinations of climatic covariates, and selected models as candidates if statistical assumptions were met. For each species, we used the glmmTMB package (Brooks et al., 2017) to make generalized linear models with negative binomial distributions. For climatic variables, we again considered scaled temperature and scaled wind speed as possible covariates. To determine which model to proceed with for each species from the candidate models, we considered the AIC value and model parsimony.

For species with relatively few detections, we aimed to evaluate potential wildfire effects without fully excluding them from analysis. For these species, we focused on detection probability rather than magnitude of activity. Low detection frequencies can limit statistical inference, particularly in our case with species with zero detections in a given sampling period. As such, we approach

these rarer species descriptively rather than statistically. To identify species suitable for exploratory analysis (hereafter "rarer species"), we applied the following criteria: ≥10 detections in at least one period (pre- or post-fire), and ≥5 detections in each treatment type (burned or unburned). Acoustic detections were aggregated into fixed-duration time bins (60-minute intervals). For each species, a time bin was classified as either a detection or non-detection. A detection involved ≥1 file recorded during that time interval. This binning approach allowed us to increase the number of sampling units while facilitating comparison of detection despite low overall detections. For additional inference, we also calculated the proportion of nights detected for each species.

Sensitivity analysis

As an additional sensitivity analysis, we focused on data collected on the same three calendar nights (June 30 – July 2) in both the pre-fire (2018) and post-fire (2025) periods. We restricted this analysis to acoustic data of sufficient sample size. Specifically, we assessed overall bat activity, and species who fit into the "common species" criteria for the full dataset analysis. For overall bat activity and for each species, we modelled a negative binomial generalized linear model (GLM) parameterized with our BACI design. We did not include covariates or random effects due to the additional sample size limitation. We used the emmeans package (Lenth et al., 2024) to assess model-estimated means and changes in activity.

Results

Acoustic data collection

In 2018, 956 files were recorded, 259 of which were identified as bat calls. The mean (± SE) number of bat calls per site per night was 28.78 (± 11.39). In 2025, for the same nights surveyed as 2018 baseline data (June 30 – July 2), 1903 files were recorded, of which 1259 were identified as bat calls. For the extended post-fire monitoring period in 2025, 11,241 files were recorded over 16 nights, of which 6775 files were identified as bat calls. For breakdown of recorded acoustic files, including calls in burned versus unburned sites, refer to Table 2. For a breakdown of acoustic data by species category and date, refer to Supplementary Table S2.

Table 2. Acoustic categories and associated number of files in pre-fire (2018) and post-fire (2025) survey periods. Fire treatment (burned or unburned) refers to the state of the surveyed site(s) post-fire. As we had two unburned sites (S18 & S20), we present the number of files from each site ("S18 , S20"). Note that the number of nights surveyed (n) varied pre- and post-fire.

Code	**Description or scientific name(s)**	**# files pre-fire (n = 3)**		**# of files post-fire**			
				Same pre-fire survey nights[a] (n = 3)		**Full monitoring period (n = 16)**	
		Burned (S17)	**Unburned (S18 , S20)**	**Burned (S17)**	**Unburned (S18 , S20)**	**Burned (S17)**	**Unburned (S18 , S20)**
40kMyo	*Myotis* sp.with characteristic 40kHz call frequency[b]	18	2 , 13	283	3 , 116	1573	112 , 617
HighF	High frequency bats (Fc ≥35 kHz)	7	4 , 107	57	1 , 282	579	19 , 991
LowF	Low frequency bats (Fc 15-30 kHz)	0	0	0	0	2	0
MYLU	*Myotis lucifugus*	20	9 , 73	106	19 , 365	1048	0 , 1396
MYSE	*Myotis septentrionalis*	0	0	0	0	0	0
PESU	*Perimyotis subflavus*	0	0	1	1 , 5	22	4 , 21
EPFU/ LANO	*Eptesicus fuscus/ Lasionycteris noctivagans*	0	0	0	0	0	0
LABO	*Lasiurus borealis*	0	0	4	0 , 2	54	2 , 6
LABO/ PESU	*Lasiurus borealis/ Perimyotis subflavus*	0	0	10	2, 2	71	5 , 17
LACI	*Lasiurus cinereus*	0	6 , 0	0	0	0	0
LANO	*Lasionycteris noctivagans*	0	0	0	0	3	4 , 0
NoID	Unidentified bat call	0	0	0	0	22	0 , 1
NOISE	Noise	281	291 , 125	332	115 , 197	2728	703 , 1035
Total[c]		**326**	**630**	**793**	**1110**	**6102**	**5139**

a - For 2025 data collected on the same three calendar nights (June 30 – July 2) as 2018 baseline data

b – In our study area, *Myotis* species that fit into this category include the little brown bat (*Myotis lucifugus*) and the northern long-eared bat (*M. septentrionalis*).

c – The pooled totals for each category are shown, i.e., for unburned sites, files from both sites are added

Analyses

Overall bat activity

The most suitable model to assess impact of period and treatment on bat activity was that which included wind speed as a climatic covariate (Table 3). From this model, wind speed had a significant positive effect on bat activity ($p \approx 0$). Accounting for the impact of wind, the impact of treatment remained a primary driver of activity. Post-fire activity was significantly higher for the burned site ($z = 8.06$, $p<0.0001$) but not for unburned sites ($z = 1.76$, $p = 0.07$). The increase in activity was significantly higher for the burned site relative to the unburned sites ($z = 3.19$, $p = 0.001$; Figure 2, Figure 3).

Table 3. Candidate negative binomial generalized linear mixed models (GLMM) for assessing impact of wildfire period (pre- or post-fire) and treatment (burned or unburned) on overall bat activity (number of bat-generated acoustic files; N_files). Site ID was incorporated as a random effect in all models. Climatic covariables (temperature and wind speed) were scaled. Differences in AIC values are relative to the baseline model. Model selected for analysis is bolded.

Model & fixed effects	df	AIC	ΔAIC
Baseline: N_files ~ Period * Treatment	7	621.72	-
Temperature included: N_files ~ Period * Treatment + Temperature	8	623.71	+1.99
Wind included: **N_files ~ Period * Treatment + Wind**	**8**	**603.59**	**-18.13**
Temperature and wind included: N_files ~ Period * Treatment + Temperature + Wind	9	605.49	-16.23

Species-specific activity

Species categories that fit into our "common species" criteria included 40kMyo, MYLU and HighF. To increase the robustness of our modelling, we pooled 40kMyo and MYLU to simply have it be the 40kMyo species complex. We therefore created models for 40kMyo and HighF categories.

From suitable candidate models for 40kMyo, the most suitable model was that which included wind speed as a climatic covariate (Table 4). Wind speed had a highly significant positive effect on activity ($p \approx 0$). Post-fire activity for 40kMyo was significantly higher than pre-fire activity for

both the burn site ($z = 7.91$, $p<0.001$) and the unburned sites ($z = 2.94$, $p = 0.003$), but the increase in activity at the burn site was significantly greater than that of the unburned sites ($z = 2.17$, $p = 0.03$; Figure 2, Figure 3)

Table 4. Candidate negative binomial generalized linear models (GLM) for assessing impact of wildfire period (pre- vs post-fire) and treatment (burned or unburned) on 40kMyo (common) bat activity (number of acoustic files). Note that MYLU detections were pooled into 40kMyo category to increase statistical robustness. Site ID was incorporated as a random effect in all models. Climatic covariables (temperature and wind speed) were scaled. Differences in AIC values are relative to the first model listed. Model selected for analysis is bolded.

Model & fixed effects	df	AIC	ΔAIC
Temperature included: N_files ~ Period * Treatment + Temperature	8	579.88	-
Wind included: **N_files ~ Period * Treatment + Wind**	**8**	**554.31**	**-25.57**
Temperature and wind included: N_files ~ Period * Treatment + Temperature + Wind	9	556.18	-23.70

For our HighF category, the baseline model with the BACI as a fixed effect was the only model that met statistical assumptions. There was a significant increase in activity post-fire for both the burned ($z = 8.17$, $p<0.0001$) and unburned sites ($z = 2.20$, $p = 0.03$). While unburned sites generally had more activity, the increase in activity was significantly higher for the burned site post-fire ($z = 2.29$, $p = 0.02$; Figure 2, Figure 3).

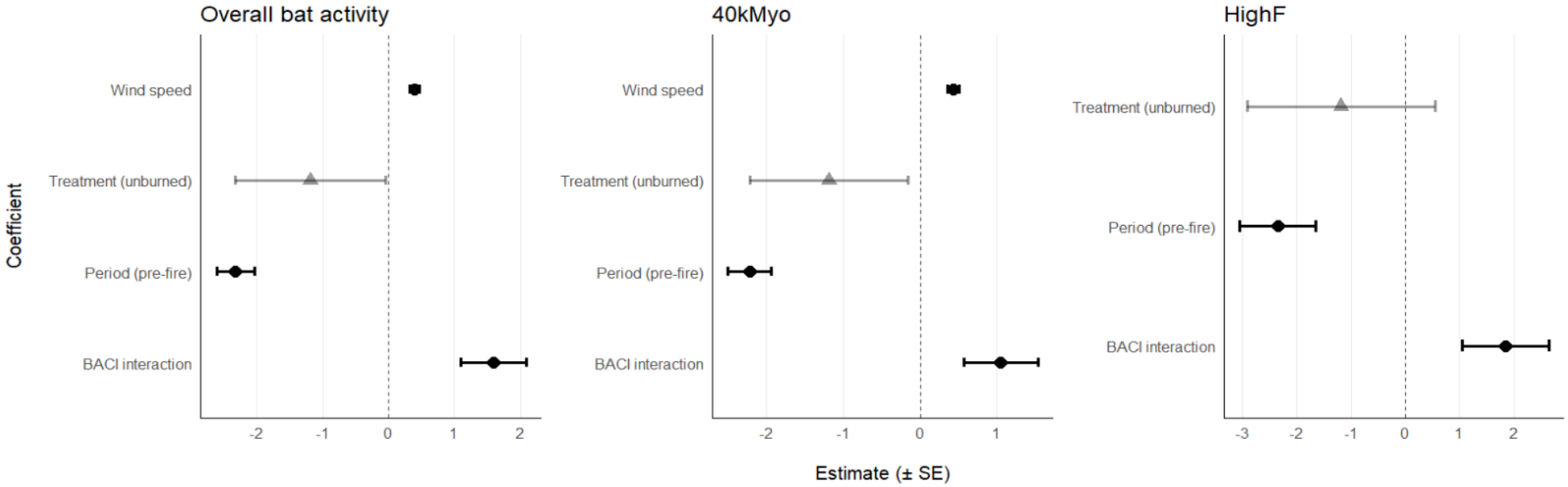

Figure 2. Effect of survey period, fire impact, before-after control-impact (BACI) interaction, and relevant climatic variables on nightly bat activity. Coefficient estimates (±SE) for the best-supported negative binomial generalized linear models for overall bat activity (left), 40kHz *Myotis* species (40kMyo & MYLU pooled; center), and high-frequency bats (right). Estimates that were insignificant ($p > 0.05$) are faded and denoted by a triangle.

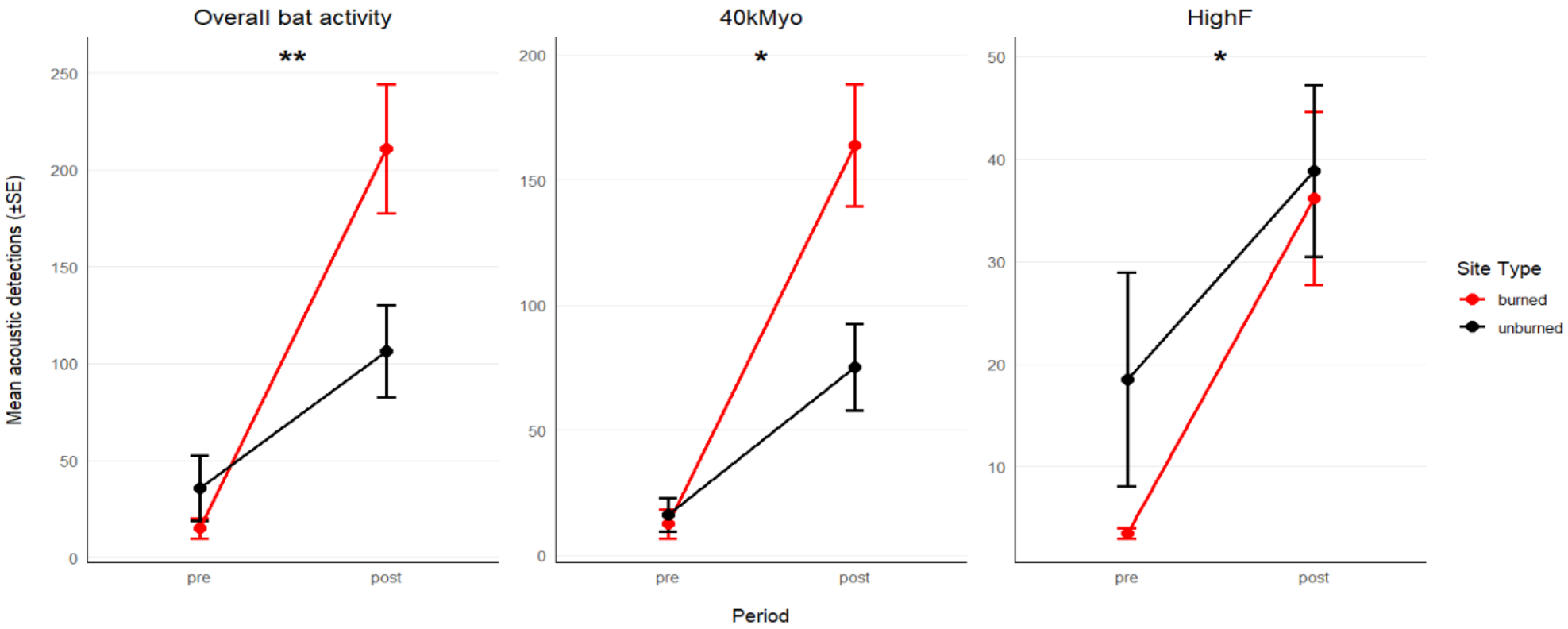

Figure 3. Changes in mean acoustic bat activity at a burned and at unburned sites in pre- and post-fire periods. Raw means (±SE) for the number of acoustic detections for overall bat activity (left), 40kHz *Myotis* species (40kMyo & MYLU pooled; center) and high frequency bats (right). The Barrington Lake wildfire occurred in the summer of 2023. Pre-fire data were collected in 2018, and post-fire data were collected in 2025. Significance is based on model-estimated means from respective negative binomial generalized linear models for each species. Significance is representative of the before-after control-impact (BACI) interaction term in the respective model. * $p<0.05$, ** $p < 0.01$

For our rarer species analysis, to increase our ability to make inferences, we pooled species detections together into their appropriate species complex, where applicable. Following this step, the LABOPESU species complex fit into our rare species category. From the time binning analysis, the probability of detection for LABOPESU in a given hour post-fire was 24.0% at the burned site, and 10.42% at unburned sites. Nightly occupancy also appeared to be higher at burned sites: there were detections of LABOPESU on 93.75% of survey nights at the burned site, and 59.38% of survey nights at unburned sites.

Sensitivity analysis

Despite the lower sample size and consequent statistical power, the increase in overall bat activity between pre-fire and post-fire periods remained consistent. Post-fire activity was significantly higher at both burned ($z = 2.78$, $p = 0.005$) and unburned sites ($z = 2.25$, $p = 0.02$). However, for the same calendar nights surveyed, there was no significant difference in activity post-fire between burned and unburned sites ($p = 0.32$). The same was observed for the 40kMyo species category. Post-fire activity of 40kMyo was significantly higher at both burned ($z = 2.88$, $p = 0.004$) and unburned sites ($z = 2.89$, $p = 0.004$), but activity between burned and unburned sites post-fire was comparable ($p = 0.49$). For HighF species, activity was significantly higher at the burned site ($z = 2.52$, $p = 0.01$) but not at unburned sites ($z = 1.62$, $p = 0.11$). Post-fire activity between burned and unburned sites remained comparable though ($p = 0.74$). While no significant BACI impacts were detected for either acoustic category (overall activity, 40kMyo, HighF), direction of effect remained consistent with our full models, suggesting underlying impacts even at a reduced level (Figure S1).

Discussion

As wildfire becomes more frequent and pervasive, understanding its impacts on wildlife, particularly given the ongoing biodiversity crisis, is of increasing importance. The Barrington Lake wildfire in Shelburne County, Nova Scotia, which burned >20000 ha of land in the summer of 2023, had dramatic impacts on the landscape. Bats (Chiroptera) generally responded positively to wildfire impact, with significantly greater increases in activity at a burned site post-fire. Common species groups reflected this increase in activity, and some rarer species in our study area also showed potential preference for burned landscapes relative to unburned ones.

Overall bat activity

Overall bat activity showed a marked increase at the burned site compared to the unburned control sites. This aligns with many previous studies, particularly studies involving prescribed fires, that have found that fire can be beneficial for some bats, at least in the shorter term. One of the main

drivers for this increase in activity is decreased vegetative clutter, promoting more open and edge habitats. These habitats are preferred by aerial hawkers and open foragers (Blakey et al., 2019). Fire can also lead to marked increases in insect abundance which can promote greater bat activity (Malison & Baxter, 2010b). The reduction of vegetative clutter post-fire facilitates and increases productivity of primary consumers and can lead to a subsequent rise in insect biomass (Malison & Baxter, 2010a). During early successional stages, this effect is often amplified by an influx of insects that exploit pioneer plant species as the landscape begins to recover (Malison & Baxter, 2010b; Swanson et al., 2011). Increases in aquatic biomass, including insects, can also be observed in riparian areas. The loss of riparian cover leads to increased nutrient loading from the surrounding burnt landscape which can fuel primary production within aquatic food webs and increase the emergence of aquatic insects (Malison & Baxter, 2010b). With suitable foraging habitat and greater abundance of prey, bats may also actively seek out roosts in or near burned areas (Doty et al., 2023; Lacki et al., 2009). Bats often roost in proximity, if not within, their foraging range (Balzer et al., 2023; Beilke et al., 2023) as this can increase foraging efficiency and consequently energetic benefits by reducing the distance to necessary food resources. We note that the overall bat activity is most reflective of more abundant species in our study system, particularly *Myotis lucifugus* as this species is the most common species in the study area and in Nova Scotia (Golestaneh et al., in prog; Balzer et al., 2021).

Common species

Common species in our analyses included *Myotis* sp. bats in the 40kHz range ("40kMyo", which included pooled MYLU detections), and high frequency ("HighF") bats. Detections for both of these acoustic categories were significantly higher post-fire, suggesting an overall increase in bat activity over the course of the study period. The increase in activity at the burned site was significantly higher than that of the unburned sites, aligning with and supporting what we found for the bat community overall.

For 40kMyo, our findings align with those of others that fire promoted activity (Buchalski et al., 2013; Low et al., 2024). In our study area, this category would encompass little brown bats (*M. lucifugus*) and northern long-eared bats (*M. septentrionalis*). While we pooled successful species-level detections of *M. lucifugus* into our 40kMyo category, we again acknowledge that the 40kMyo category is most likely representative of *M. lucifugus* activity. Northern long-eared bats (*M. septentrionalis*), while fitting into the 40kMyo category, are inherently more difficult to detect acoustically due to their shorter-range calls and ability to differentiate their acoustic signatures (McBurney & Segers, 2021). In addition to being more detectable by acoustic recorders, *M. lucifugus* are currently the most common and abundant bat in our study system (Golestaneh et al., in prog; Balzer et al., 2021). Generally, *M. lucifugus* can tolerate certain disturbances to a greater extent than many other sympatric bat species. For example, *M. lucifugus* frequently occupy

artificial structures in or near human-occupied areas (Brittingham & Williams, 2000; Rensel et al., 2023), and have a broad insect diet compared to our other resident bats (Thomas et al., 2012), thereby allowing them to exploit a greater diversity of habitat and resources. Our observed increased in wildfire-impacted habitat reflects the resilience of this species and may link to the creation of foraging and roosting habitat exploitable by these bats. Some studies have found that fire severity is an important factor of consideration, with activity decreasing following higher-severity fires (Burns et al., 2019; Jung, 2020). In their northern range limit especially, Jung (2020) observed a substantial decrease in activity following a major wildfire. Though, bats at higher latitudes experience greater environmental constraints (Lilley et al., 2026), and exhibit different adaptations and behaviours compared to conspecifics at lower latitudes (Boyles et al., 2016). Consequently, wildfire impacts may be exacerbated for *M. lucifugus* at higher latitudes, whereas in our study area, wildfire response may reflect positive benefits relating to foraging activity and, in turn, roosting activity should roosting habitat be available.

We must, however, exert caution when inferencing resilience for the northern long-eared bat (*M. septentrionalis*), the other 40 kHz *Myotis* species in our study area. *Myotis septentrionalis* has been observed to forage in edge habitat, but they are more of a clutter-tolerant species, often restricting their foraging behaviour to forest corridors (Broders et al., 2003; Henderson & Broders, 2008). We especially emphasize that *M. septentrionalis* are of the greatest conservation concern in Nova Scotia (Golestaneh et al., in prog; Balzer et al., 2021). As these species prefer more cluttered habitats and are much less abundant across the landscape, we must be cautious with inferences on extrapolating acoustic data suggesting resilience or positive response to wildfire disturbance, particularly as *M. lucifugus* activity may be masking *M. septentrionalis* declines. In the case of an actively-burning prescribed fire, a couple of *M. septentrionalis* were observed readily abandoning roosts (Dickinson et al., 2009). If suitable snags for roosting are created through fire, these bats may return when fire threat is no longer imminent. For example, a study in Eastern Kentucky demonstrated a positive response of *M. septentrionalis* to prescribed fire, with bats selecting more roosts in burned areas compared to unburned areas (Lacki et al., 2009). In Virginia in Central Appalachia, *M. septentrionalis* activity was marginally higher in edge habitats adjacent to prescribed fire treatments (Austin et al., 2018). Considering *M. septentrionalis* ecomorphology, response to wildfire may be negative: for a morphologically similar clutter-adapted species *M. evotis* (western long-eared myotis), activity declined following wildfire and bats actively selected roosts in unburned areas (Snider et al., 2013). Given several unknowns and the current conservation status, the impact of wildfire on *M. septentrionalis* in our study area should be speculated upon cautiously given this species critically low numbers in Nova Scotia (Golestaneh et al., in prog; Balzer et al., 2021).

For the HighF (high-frequency bat) category, species that would fit into our HighF category include the little brown bat (*M. lucifugus*), the northern long-eared bat (*M. septentrionalis*), the tri-colored bat (*Perimyotis subflavus*), and the eastern red bat (*Lasiurus borealis*). We reiterate that the HighF category represents a classification of high-frequency calls that could not confidently be assigned to a specific species. While high-frequency bats tend to be more clutter tolerant (Schnitzler & Kalko, 2001), specific habitat use can vary by species. As such, how fire influences certain landscape characteristics and features will dictate high-frequency bat response (Steel et al., 2019). From the likelihood of species detection, the increase in high-frequency bat response may be the artifact of increased 40kMyo activity. Alternatively, *P. subflavus* and *L. borealis* may be driving or contributing to the observed increase, as suggested by our exploratory analysis of these species.

Rare species

Perimyotis subflavus & Lasiurus borealis

For our rarer species, species that fit into our criteria for exploratory analysis included the tri-colored bat (*P. subflavus*) and the eastern red bat (*L. borealis*). With no detections of these species from baseline data, we cannot rule out absence in the pre-fire period as it is possible that these bats were simply not detected during the three baseline survey nights. Detections of these bats were seemingly more frequent and more likely to occur at the burned site relative to the unburned sites. Given no baseline comparison data and the low detection rates post-fire, we speak speculatively into potential wildfire impacts on these species.

Perimyotis subflavus are an interesting population in Nova Scotia: their rather restricted range in the southwest portion of the province and unique lichen-roosting behaviour among *Usnea* lichens suggest that the *P. subflavus* bats here represent a disjunct population (Broders et al., 2003; Poissant et al., 2010). There is limited research on the direct impacts of wildfire on *Usnea* lichens, but from research on declines of *U. longissima*, a lichen used by *P. subflavus* in Nova Scotia, we are confident in saying that roosting habitat for *P. subflavus* would be negatively impacted by wildfire. Declines of *U. longissima* elsewhere in its range are attributed to the lichen's susceptibility to climate change, air pollution, and tree-fall (Esseen et al., 2023). Additionally, many lichens are intolerant to fire disturbance, either experiencing direct mortality from fire and/or difficulty in regenerating in post-fire landscapes (Johansson & Reich, 2005; Miller et al., 2018). Direct mortality would certainly be the case in burned areas for *U. longissima* given its high flammability in dry conditions. These factors suggest to us that wildfire is more likely to negatively impact roosting habitat of *P. subflavus* in Nova Scotia, whether by direct mortality from burning or indirectly through air pollution in wildfire-adjacent areas. Given this, increased *P. subflavus* activity may more so relate to foraging activity. A study in the Cumberland Plateau area of the

Appalachian Mountains found that *P. subflavus* activity was higher in areas treated with prescribed burns, but that activity declined with burn severity, suggesting a threshold for fire tolerance (Burns et al., 2019). For these bats, response to wildfire depends heavily on vegetation characteristics (Taillie et al., 2021). Understanding how wildfire influenced vegetation structure and characteristics in our area could facilitate inference on habitat suitability and consequent *P. subflavus* activity post-fire.

For *Lasiurus borealis*, the impact of fire disturbance typically depends on temperature and time of year. There is concern about fire impact during colder periods when this species may be roosting in leaf litter and be more susceptible to mortality (Layne et al., 2021). However, *L. borealis* have shown neutral or positive response to fire frequency (Jorge et al., 2021; Taillie et al., 2021). We could anticipate that *L. borealis* response to wildfire aligns with that of other larger-bodied bats in that wildfire promotes suitable habitat (Blakey et al., 2019). *Lasiurus borealis* roost in foliage, and roosts are often selected in area with less ground-clutter (e.g., understory vegetation; Limpert et al., 2007). For foraging, *L. borealis* in natural landscapes forage near maintained forest openings (Beilke et al., 2023). Ultimately, how fire shaped surrounding vegetation characteristics will provide greater insight into prey population dynamics, habitat suitability and consequently likelihood of *L. borealis* occupancy post-fire (Steel et al., 2019; Taillie et al., 2021).

Lasiurus cinereus & Lasionycteris noctivagans

For some species in our study, detections were too sparse to pursue formal analysis. These species include the hoary bat (*Lasiurus cinereus*) and the silver-haired bat (*Lasionycteris noctivagans*). We approach these species' responses broadly and refer to documented responses elsewhere in these species' geographic range.

For *L. cinereus*, we had very few detections pre-fire and no detections post-fire. The nature of the pre-fire data could be representative of one or a couple individuals passing through the study area. This species has been observed to respond positively to fire, including severe fires (Starbuck et al., 2020; Steel et al., 2019). We can certainly anticipate a positive response of *L. cinereus* to fire given their large body and preference for open foraging habitat (Barclay, 1986; Blakey et al., 2019). However, a recent study by Low et al. (2024) did note declines of *L. cinereus* following a severe wildfire, which the authors speculate may be due to negative impacts of fire on preferred insect prey. Compared to the other species in our study, *L. cinereus* diet vastly consists of moths (Thomas et al., 2012; Whitaker, 1972). In the short-term period (1-4 years post-fire), wildfire negatively impacts moth populations, drastically reducing both diversity and abundance (Banza et al., 2019; Brantley et al., 2023). Consequently, exploitation of created roosting and foraging habitat by

L. cinereus will not occur if preferred prey is absent. Thus, more time may need to elapse to see increases in *L. cinereus* activity (Jorge et al., 2021).

For *Lasionycteris noctivagans*, we had very few detections both pre- and post-fire. In the extended post-fire monitoring period, we did detect some activity, but, similarly to pre-fire observations of *L. cinereus*, it was likely from one or very few individuals passing through. As this species was not detected prior to the fire in our study area, we cannot definitively say whether fire influenced *L. noctivagans* activity. First, it is often difficult to differentiate big brown bats (*Eptesicus fuscus*) and silver-haired bats (*L. noctivagans*). As such, many studies relying on acoustic data report on the impacts of fire on the EPFU/LANO species complex. The EPFU/LANO species complex has previously shown resilience, with either a neutral or positive response to fire (Austin et al., 2018; Cox et al., 2016; Steel et al., 2019). Like for *L. cinereus*, Low et al. (2024) report a negative response following severe wildfire: despite an initial positive response to fire (greater activity 1-year post fire), EPFU/LANO activity declined overall following wildfire disturbance.

An important note for our rarer species is that response to environmental events may not be evident given these animals' pre-existing abundance along the landscape. This is especially the case for the long-distance migratory species *L. cinereus*, *L. borealis*, and *Lasionycteris noctivagans* (Broders et al., 2003; Lucas & Hebda, 2011; Scott & Hebda, 2004). Anecdotal evidence suggests that migratory bat abundance is increasing (unpublished data), but abundance for these bats and for *P. subflavus* is still presumed to be low, especially in comparison to resident hibernating *Myotis* bats. As such, if these animals were not overly present to start with, it can be difficult to disentangle the impacts of an environmental event on species abundance, particularly for *L. cinereus* and *Lasionycteris noctivagans* who were too data deficient in our study for us to be able to make inferences. Considering species' life history, regional context, and response of these species to environmental events in other areas of their range can provide us with a greater understanding of what we can anticipate for these animals in our study area.

Additional considerations

Beyond species-specific considerations, there are several factors to consider that can influence our understanding of wildfire on resident bats. For bats, nightly activity is influenced by temperature, precipitation, moon phase, and many more abiotic factors (Gorman et al., 2021; Parsons et al., 2003; Perks & Goodenough, 2020). With our data structure, we were limited in how much natural variation we could encapsulate due to our limited sampling size. In some of our models for common species, we were able to account for the influence of wind. Bat activity is known to generally decrease with increasing wind speeds (Erickson & West, 2002; Squires et al., 2021), but our data interestingly suggested the opposite. We note though that that wind speed on our surveyed

nights ranged from 0 to 3.3 m/s, and decreases in bat activity are generally recorded for wind speeds higher than the range our survey nights experienced (Ellerbrok et al., 2024; Erickson & West, 2002). For other variables of interest, extended monitoring would allow for greater data resolution and facilitate disentangling the impacts of abiotic factors on bat activity versus the impacts of disturbance events like wildfire.

Spatiotemporal scales are also significant considerations, as the scale at which a study is conducted impacts the inferences that may be made. Our pre-fire surveys occurred five years prior to the Barrington Lake wildfire, and our post-fire monitoring surveys occurred two years after the wildfire. We do not know how much bat activity could have differed between our 2018 pre-fire surveys and the years immediately prior to the wildfire. If pre-fire activity was actually higher than what we captured in our 2018 surveys, our inferences on wildfire impact could be different. For the post-fire period, we conducted surveys at the two-year point post-fire. Studies with post-fire monitoring repeated over multiple years have shown varying bat response at different time points (e.g., Inman et al., 2026; Kay et al., 2023; Low et al., 2024). In the short-term, wildfire can trigger a pulse of increased ecosystem productivity, driven by vegetation succession, the colonisation of pioneer insect species, and the creation of suitable habitat (Malison & Baxter, 2010a; Steel et al., 2019; Swanson et al., 2011). However, these benefits may wane as the system matures; as vegetation structure stabilises, the high-nutrient flux that supports primary consumers and insect populations can decline. Additionally, trophic-specific responses to wildfire can emerge, where benefit for a lower trophic level does not translate to higher levels. For example, in a study by Banza et al. (2019), despite increases in floral plant abundance post-fire, moth abundance and diversity declined significantly. The intricacies of how fire influences ecosystem dynamics depends on the temporal scale of observation, with short-term gains potentially masking longer-term compromises in habitat quality (Blakey et al., 2019; Gajendiran et al., 2024). Additionally, since difference landscape characteristics influence bat activity at varying spatial scales, post-fire response depends on how fire modifies specific landscape features (Blakey et al., 2021; Blanco & Garrie, 2020; Starbuck et al., 2020). Factors such as the rate of ecological succession, prey response, and landscape structure are but some of the many factors that contribute to bat activity over time in a fire-impacted landscape (Loeb & Blakey, 2021; Steel et al., 2019).

Conclusion

Our study found that the Barrington Lake wildfire in Shelburne County, Nova Scotia generally promoted bat activity, with significantly more bat activity at a burned site relative to unburned areas. Increased activity at a wildfire-impacted site was observed for the 40kHz *Myotis* and high-frequency bat acoustic categories. We note, however, that we should exert caution when generalizing the findings of positive wildfire response. Our findings capture a snapshot of bat activity patterns from select nights surveyed pre- and post-fire. Additionally, our findings are most

likely reflective of the most abundant bat in the province, the little brown bat (*M. lucifugus*). Considering the current species status and the uncertainty in acoustic identification of the critically endangered northern long-eared bat (*M. septentrionalis*), we strongly suggest speculative inferences be made and that species-specific wildfire impact be further researched. For rarer species in Nova Scotia, including the hibernating tri-colored bat (*Perimyotis subflavus*) and long-distance migratory eastern red (*Lasiurus borealis*), hoary (*Lasiurus cinereus*) and silver-haired bats (*Lasionycteris noctivagans*), very few detections throughout our study limited our ability to make concrete inferences on these bats' response to fire. We suspect that, based on the literature, the long-distance migratory bats would respond more positively and show increased activity in burned areas. We also emphasize that fires, while able to provide important ecosystem services, are still a considerable disturbance that can negatively impact many taxa.

There are many factors that can influence our ability to capture animal activity, such as that in response to a natural disturbance, but we also highlight the importance of opportunistic work such as the work presented here. Natural disturbance events like wildfire can have substantial impacts on wildlife populations. While it can be difficult to perfectly encapsulate these impacts, being able to use the information we have available to us to make inferences still provides us with valuable knowledge, especially for cryptic animals like bats. Wildfire risk and severity is increasing (Flannigan et al., 2009), and this work represents a first step into understanding how bats in Nova Scotia may respond to future wildfire events.

Supplementary materials

Table S1. Acoustic deployment data for pre-fire (2018) and post-fire (2025) surveys.

Deployment data				
	Detector 1	**Detector 2**	**Detector 3***	**Detector 4**
Location name	S17	S18	S19*	S20
UTM Zone	20T	20T	20T	20T
Easting**	0299802	0310534	298617	0306227
Northing**	4837864	4854527	4863674	4868626
Survey start time	19:00			
Survey end time	7:00			
Pre-fire survey period	30-June to 3-July 2018			
Post-fire survey period	23-June to 9-July 2025			
Survey start date	23-June-2025			
Survey end date	9-July-2025			
Microphone orientation	N	SW	N	N
Microphone height	6 metres	6 metres	6 metres	6 metres
Habitat type	forested river	forested river	forested river	forested river
Distance to clutter	2 metres	6 metres	5 metres	0.2 metres
Type of clutter	tree branches	trees	trees	trees
Distance to water	2 metres	1 metre	1 metre	1 metre
Type of water	river	river	river	river
Detector settings				
Detector model	SM4 Bat-FS			
Microphone model	SMU2			
Trigger window length	2s			
Maximum file length	15s			
Gain	12 dB			
Frequency band filters	15 kHz to 120 kHz			

*Note Site 19 was not included in this study due to equipment failure and thus no data being collected. As such, only pre-fire (2018) baseline data from sites 17, 18, and 20 were made accessible for this study to have direct comparison of sites.

** Placement of ARUs in 2025 was within 3 meters of original recording locations in 2018

Table S2. Number of nightly acoustic detections for different species categories at three sites surveyed pre- and post-fire. Pre-fire surveys occurred in 2018, the Barrington Lake wildfire was active and burning the summer of 2023, and post-fire surveys were conducted in 2025 at the same sites surveyed pre-fire.

Pre-fire period (2018)											
	Number of detections										
	40kMyo	**HighF**	**LowF**	**MYLU**	**LABO**	**PESU**	**LABOPESU**	**LACI**	**LANO**	**NoID**	**NOISE**
S17											
2018-06-30	5	4		9							99
2018-07-01	13			9							120
2017-07-02		3		2							62
S18											
2018-06-30	1	1		2				5			154
2018-07-01	1	2		2				1			73
2017-07-02		1		5							64
S20											
2025-07-01	8	28		17							71
2025-07-02		13		17							20
2025-07-03	5	66		39							34
Post-fire period (2025)											
S17 (burned)											
2025-06-23	93	43		64	4	3	8			19	134
2025-06-24	116	64		73	2	1	1				133
2025-06-25	81	35		49					1		59
2025-06-26	28	16		33	6		4				21
2025-06-27	82	42		55	5		7				58
2025-06-28	230	36		84	13	7	15			1	1465
2025-06-29	35	26		37	2	1				1	53
2025-06-30	125	7		29			3				60
2025-07-01	103	40		56	3		6				202
2025-07-02	55	10		21	1	1	1				70
2025-07-03	66	15		44		2	7				36
2025-07-04	78	22		74	1	4	2				56
2025-07-05	69	6		36	1						44
2025-07-06	160	139	2	225		1	9		2		157
2025-07-07	190	71		142	13	2	8			1	137
2025-07-08	62	7		26	3						43

	40kMyo	HighF	LowF	MYLU	LABO	PESU	LABOPESU	LACI	LANO	NoID	NOISE
S18 (unburned)											
2025-06-23	1	1		3					1		37
2025-06-24	5	1		13					1		36
2025-06-25	3	1		13							43
2025-06-26		1		5							45
2025-06-27	5			8			1				54
2025-06-28	83	8		115							244
2025-06-29	2			2		1			2		8
2025-06-30	1	1		4							49
2025-07-01	2			9		1					60
2025-07-02				6			2				6
2025-07-03				2							43
2025-07-04	1	1		6	1	2					7
2025-07-05	4			3							29
2025-07-06	3	1		6	1		2				24
2025-07-07				4							10
2025-07-08	2			7							8
S20 (unburned)											
2025-06-23	36	54		62		1	1				36
2025-06-24	9	49		50		1	3				32
2025-06-25	17	27		44							42
2025-06-26	4	24		16							33
2025-06-27	33	103		112		1	1				74
2025-06-28		1									26
2025-06-29	6	26		21		1					38
2025-06-30	35	135		156		1	1				71
2025-07-01	31	82		75	2	2	1				75
2025-07-02	50	65		134		2					51
2025-07-03	57	91		146	1	2	2				50
2025-07-04	32	33		44	1						30
2025-07-05	19	27		49		2	2				21
2025-07-06	94	68		107	2	1	1		1		38
2025-07-07	150	133		269		4	2				124
2025-07-08	44	73		111		3	3				294

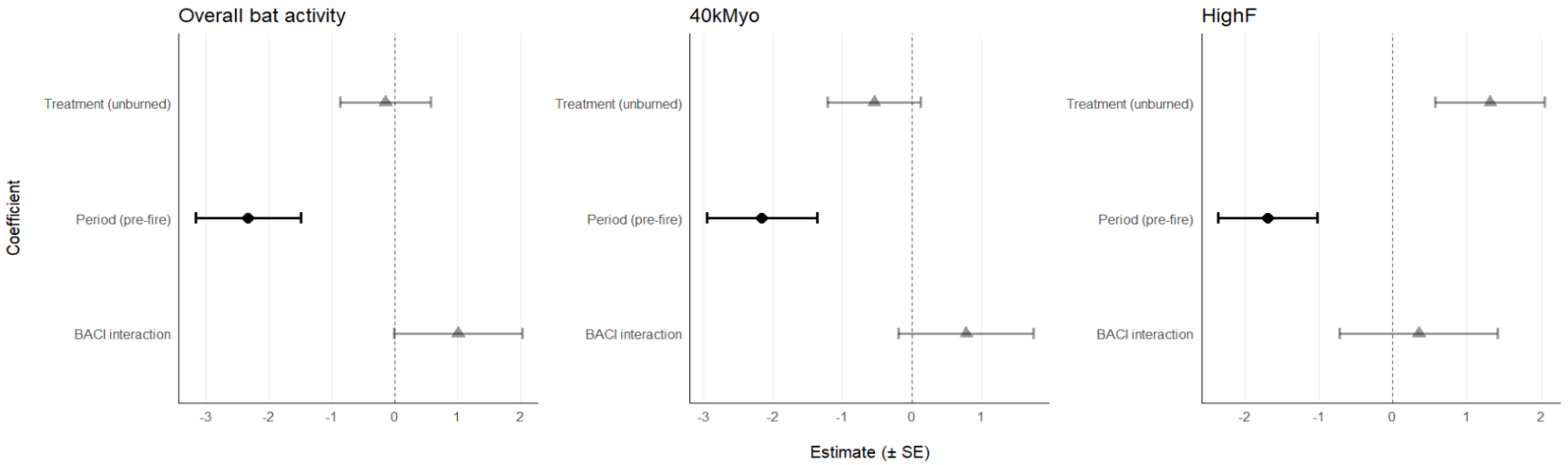

Figure S1. Effect of survey period, fire impact, before-after control-impact (BACI) interaction, on nightly bat activity. Coefficient estimates (± SE) for the best-supported negative binomial generalized linear models for overall bat activity (left), 40kHz *Myotis* species (center), and high-frequency bats (right). Pre-fire data were collected in 2018, and post-fire data were collected in 2025 on the same three calendar nights (June 30 – July 2) as pre-fire data. Estimates that were insignificant ($p > 0.05$) are faded and marked with a triangle.

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