

Develop a Bat Population and Disease Monitoring Program

Final Report

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Summary

Between 2022-2024, myself (Anna Doty) along with graduate and undergraduate students at California State University, Sacramento established a bat disease and population monitoring program within Sequoia National Park. The primary objectives of the study were to assess bats in Sequoia and Kings Canyon National Parks for evidence of White-nose syndrome, and to establish a population monitoring protocol in Sequoia National Park. At least 25 bats were sampled for evidence of disease within the park each year (2022-2024) primarily between April-September. Additionally, seven acoustic monitors were placed in the park over four elevational gradients to establish a baseline for future comparison should white-nose syndrome be detected within the park boundaries. The objectives of this study were successfully carried out. No sampled bats tested positive for evidence of white-nose syndrome or presence of the fungus that causes the disease, *Pseudogymnoascus destructans*.

Study 1: Assessing bats in Sequoia and Kings Canyon National Parks for evidence of White-nose syndrome.

The primary purpose of this study was to assess vulnerable bat species in the park for evidence of white-nose syndrome, a psychrophilic fungus affecting bats throughout most of the United States. The fungus causing the disease, *Pseudogymnoascus destructans*, establishes within the wing membranes, nose and ears of bats. The fungus causes a cascade of physiological effects, including irritation and frequent arousal from hibernation, which ultimately causes dehydration and depletes fat stores during winter months. The disease particularly affects small bats who have lower fat stores compared to larger bats.

During April – May of 2022-2024, at least 25 vulnerable bats per year were tested for evidence of *P. destructans*. Bats were caught using mist nets or harp traps, primarily within low elevation sites in the park, such as the Potwisha camp site. Prepared cotton swabs were gently rolled three times along the muzzle and wing of each sampled bat and placed into a container prepared with solution for testing. Data including age, sex, evidence of wing damage and parasites, presence of keel, species, ear and forearm length, and mass were also recorded (Table 1). Bats were released following sampling at the capture site. Containers were stored in a freezer until they were sent for testing.

None of the samples were reported to show evidence of the fungus *P. destructans*, indicating that at least those bats sampled were not at risk for white-nose syndrome at that time.

Study 2: Establishing a population monitoring protocol in Sequoia National Park.

In order to understand bat population dynamics within the park, we established a monitoring protocol using bat echolocation devices. Sequoia National Park is home to 17 bat species, and species may use elevation differently depending on the specific needs (e.g. diet and morphology). Until now, species composition and activity based on elevation within the park was unknown. We hope that a deeper understanding of bat populations can help to inform future conservation decisions and assist park managers in tracking population dynamics within the park, particularly with the rising threat of White-nose syndrome.

Devices (SM4Bat units fitted with ultrasonic microphones) were initially placed in the park in May 2023. Calls were recorded every three nights in seven different locations in the park: two at low elevation, two medium, two high, and one alpine (Figure 1). SonoBat 4.4.5 was used to determine the species attributed to each call. Data were then analyzed to assess the relationship between bat species activity and elevation.

Results from this study indicate that bats were more active in summer and spring compared to fall and winter (Figure 2). Notable differences in species composition based on elevation occurred with species such as *Parastrellus hesperus*, which was detected almost exclusively in low elevation portions of the park (Table 2). *Myotis californicus* and *Myotis yumanensis* were also detected more frequently at low elevations (Figure 3). *Tadarida brasiliensis* was detected most frequently in the alpine region, although nightly variability was extremely high. An analysis of variance also demonstrated a significant difference in the number of nightly bat calls based on elevation (Table 3).

We next plan to assess differences in population numbers between both season and year. Graduate student Jonathan Janes, along with myself, are currently assessing these differences. Results will be shared with SEKI biologists when available.

Products

- Public outreach presentation at Sequoia National Park, 2023.
- Two presentations at the 2025 Western Wildlife Society conference in Visalia, California, and one student-led research presentation at a CSU Sacramento student research conference.

- McNary, K. Bat community composition over an elevational gradient in Sequoia National Park. Presented at 2025 Student Research & Creative Activity Spring Symposium, CSU Sacramento, Sacramento, CA.
- *Janes, J., and Doty, A.C. Variation in acoustic activity of bats across multiple habitat types by season in Sequoia and Kings Canyon National Parks. Presented at 2025 Wildlife Society Conference, Visalia, CA.
- *Elston, J., *Weber, M., *McNary, K., *Compton, B., *Buencamino, G., and *Hanson, J. Bat community composition over an elevational gradient in Sequoia National Park. Presented at 2025 Wildlife Society Conference, Visalia, CA.
- One graduate student (Jonathan Janes) hopes to use data from the population assessment for his graduate thesis.
- Seven undergraduate students assisted with capture and identification of bats, and acoustic monitoring deployment, data collection, and analysis.
- A research publication is planned for submission in the next year focusing on population dynamics within the park.

Tables and Figures

Table 1. Collected data from all bats captured at Sequoia and Kings Canyon National Parks for the purpose of White-nose syndrome monitoring between 2022-2024.

Site	Date	Primary Observer	Spp Code	Genus	Species	Sex	Repro. Status	Age	FA	Ear	Keel	Weight	Sampled?
Giant Forest Air Quality Station	7/28/22	A. Doty	ANPA	Antrozous	pallidus	F	POST	A	56	26	Y	20.2	Y
South Fork Campground	7/30/22	A. Doty	ANPA	Antrozous	pallidus	M	DESC	A	52	26	N	17	
North Fork	7/25/22	A. Doty	MYCA	Myotis	californicus	F	NON	J	31	10	Y	4.4	Y
Potwisha	7/26/22	A. Doty	MYCA	Myotis	californicus	M	NON	A	30	8	Y	4.1	Y
Potwisha	7/26/22	A. Doty	MYCA	Myotis	californicus	F	NON	A	32	10	Y	4.3	Y
Potwisha	7/26/22	A. Doty	MYCA	Myotis	californicus	F	NON	J	29	11	Y	3.4	Y
Potwisha	7/26/22	A. Doty	MYCA	Myotis	californicus	F	NON	A	32	10	Y	4	Y
Potwisha	7/26/22	A. Doty	MYCA	Myotis	californicus	M	NON	J	30	9	Y	4.3	Y
Potwisha	7/26/22	A. Doty	MYCA	Myotis	californicus	M	NON	J	32	10	Y	3.8	Y
Potwisha	7/26/22	A. Doty	MYCA	Myotis	californicus	F	NON	J	33	10	Y	3.4	Y
Potwisha	7/26/22	A. Doty	MYCA	Myotis	californicus	F	NON	J	32	12	Y	3.5	
Potwisha	7/26/22	A. Doty	MYCA	Myotis	californicus	M	NON	J	31	10.5	Y	3.3	
Potwisha	7/29/22	A. Doty	MYCA	Myotis	californicus	M	NON	J	31	9	Y	4	Y
Potwisha	7/29/22	A. Doty	MYCA	Myotis	californicus	M	NON	J	33	11	Y	4.1	Y
South Fork Campground	7/30/22	A. Doty	MYCA	Myotis	californicus	F	NON	J	32	11	Y	3.4	Y
South Fork Campground	7/30/22	A. Doty	MYCA	Myotis	californicus	F	NON	A	31	11	Y	5.2	Y
South Fork Campground	7/30/22	A. Doty	MYCA	Myotis	californicus	M	NON	A	32	10.5	Y	4.6	Y
South Fork Campground	7/30/22	A. Doty	MYCA	Myotis	californicus	M	DESC	A	31	11	Y	4.4	Y
South Fork Campground	7/30/22	A. Doty	MYCA	Myotis	californicus	M	NON	A	31	11	Y	4.7	Y
South Fork Campground	7/30/22	A. Doty	MYCA	Myotis	californicus	F	POST	A	33	11	Y	4.6	Y
South Fork Campground	7/30/22	A. Doty	MYCA	Myotis	californicus	F	POST	A	32	12	Y	5.6	Y
South Fork Campground	7/30/22	A. Doty	MYCA	Myotis	californicus	M	NON	A	33	12	Y	4.8	
Potwisha	7/26/22	A. Doty	MYCI	Myotis	ciliolabrum	F	NON	J	33	12	Y	.	Y

Potwisha	7/26/22	A. Doty	MYCI	Myotis	ciliolabrum	M	NON	A	33	11	Y	4.7	Y
Potwisha	7/29/22	A. Doty	MYCI	Myotis	ciliolabrum	M	NON	A	31	11	Y	3.8	Y
South Fork Campground	7/30/22	A. Doty	MYTH	Myotis	thysanodes	M	NON	A	38	14	N	5.8	Y
Potwisha	7/26/22	A. Doty	MYYU	Myotis	yumanensis	F	NON	A	32	11	N	5.1	Y
Potwisha	7/26/22	A. Doty	MYYU	Myotis	yumanensis	M	NON	A	33	11	N	4.9	Y
Potwisha	7/26/22	A. Doty	MYYU	Myotis	yumanensis	F	NON	A	36	12.5	N	5.8	
Potwisha	7/26/22	A. Doty	MYYU	Myotis	yumanensis	F	NON	A	32.5	13	N	6	
Potwisha	7/26/22	A. Doty	MYYU	Myotis	yumanensis	F	NON	A	34	13	N	5.5	
South Fork Campground	7/30/22	A. Doty	MYYU	Myotis	yumanensis	M	NON	A	34	11	N	5.6	Y
Potwisha	6/12/23	A. Doty	MYCA	Myotis	californicus	F	NON	A	33.5	11	Y	5	Y
Potwisha	6/12/23	A. Doty	MYCA	Myotis	californicus	M	NON	A	31	11	Y	4	Y
Potwisha	6/12/23	A. Doty	MYCA	Myotis	californicus	F	NON	A	31	11	Y	3.5	Y
Potwisha	6/12/23	A. Doty	MYCI	Myotis	ciliolabrum	M	NON	A	33	14	Y	4	Y
Potwisha	6/12/23	A. Doty	MYCA	Myotis	californicus	F	PREG	A	31	12	Y	5.5	Y
Potwisha	6/12/23	A. Doty	MYCA	Myotis	californicus	F	PREG	A	34	11	Y	4.5	Y
Potwisha	6/12/23	A. Doty	MYCA	Myotis	californicus	F	LACT	A	32	11	Y	5	Y
Potwisha	6/12/23	A. Doty	MYCA	Myotis	californicus	M	NON	A	32	13	Y	4	Y
Potwisha	6/12/23	A. Doty	MYCA	Myotis	californicus	F	PREG	A	34	11	Y	5.5	Y
Potwisha	6/12/23	A. Doty	MYCA	Myotis	californicus	F	LACT	A	32	13	Y	5	Y
Potwisha	6/12/23	A. Doty	MYCA	Myotis	californicus	F	LACT	A	34	11	Y	5	Y
Potwisha	6/13/23	A. Doty	MYCA	Myotis	californicus	F	NON	A	32	12	Y	4	Y
Potwisha	6/13/23	A. Doty	MYCA	Myotis	californicus	F	REPRO	A	33	12	Y	5.5	Y
Potwisha	6/13/23	A. Doty	MYCA	Myotis	californicus	F	LACT	A	33	12	Y	5	Y
Potwisha	6/13/23	A. Doty	MYCA	Myotis	californicus	F	PREG	A	34	12	Y	5.5	Y
Potwisha	6/13/23	A. Doty	MYCA	Myotis	californicus	F	PREG	A	32	11	Y	5.5	Y
Potwisha	6/13/23	A. Doty	ANPA	Antrozous	pallidus	F	NON	A	55	24	Y	16.5	
Potwisha	6/13/23	A. Doty	MYCA	Myotis	californicus	F	LACT	A	33	12	Y	5.5	Y
Potwisha	6/13/23	A. Doty	ANPA	Antrozous	pallidus	F	NON	A	55	25	Y		Y
Potwisha	6/13/23	A. Doty	MYCA	Myotis	californicus	F	LACT	A	31	12	Y	4	Y

Potwisha	6/13/23	A. Doty	MYCA	Myotis	californicus	F	NON	A	33	13	Y	5.5	Y
Potwisha	6/14/23	A. Doty	MYCA	Myotis	californicus	F	NON	A	32	12	Y	4	Y
Potwisha	6/14/23	A. Doty	MYCA	Myotis	californicus	F	NON	A	31	10	Y	5	Y
Potwisha	5/21/23	A. Doty	ANPA	Antrozous	pallidus	M	NON	A	56	25	Y	17	
Potwisha	5/21/23	A. Doty	MYCA	Myotis	californicus	M	NON	A	31	10	Y	3.5	Y
Potwisha	5/21/23	A. Doty	MYCA	Myotis	californicus	F	NON	A	32	11	Y	4.5	Y
Potwisha	5/21/23	A. Doty	ANPA	Antrozous	pallidus	M	REPRO	A	57.5	27	Y	18.5	
Potwisha	5/21/23	A. Doty	MYCA MYU OR	Myotis	californicus lucifugus or	F	NON	A	33	12	Y	4.5	Y
Potwisha	5/21/23	A. Doty	MYLU	Myotis	yumanensis	M	NON	A	33	10	N	4.5	Y
Potwisha	5/21/23	A. Doty	MYCA	Myotis	californicus	M	NON	A	31	11	Y	3.5	Y
Potwisha	5/21/23	A. Doty	MYCA	Myotis	californicus	F	NON	A	33.5	12	Y	4.5	Y
Potwisha	5/21/23	A. Doty	MYCA	Myotis	californicus	F	NON	A	33.5	13	Y		Y
Potwisha	6/1/24	A. Doty	ANPA	Antrozous	pallidus	F	NR	A	56	23	Y	21	
Potwisha	6/1/24	A. Doty	ANPA	Antrozous	pallidus	F	NR	A	55	29	Y	17.5	
Potwisha	6/1/24	A. Doty	MYCI	Myotis	ciliolabrum	F	NR	A	32	12	Y	5	Y
Potwisha	6/1/24	A. Doty	ANPA	Antrozous	pallidus	F	NR	A	54	22	Y	17	
Potwisha	6/1/24	A. Doty	ANPA	Antrozous	pallidus	F	NR	A	55	23	Y	18	
Potwisha	6/1/24	A. Doty	ANPA	Antrozous	pallidus	F	NR	A	54	26	Y	17	
Potwisha	6/2/24	A. Doty	MYLU	Myotis	lucifugus	F	NR	A	33	10	N	5	Y
Potwisha	6/2/24	A. Doty	MYCA	Myotis	californicus	M	NR	A	31	10	Y	4.5	Y
Potwisha	6/2/24	A. Doty	MYCA	Myotis	californicus	M	NR	A	32	10	Y	4	Y
Potwisha	6/2/24	A. Doty	EPFU	Eptesicus	fuscus	M	NR	A	49	13	Y	14.5	Y
Potwisha	6/2/24	A. Doty	EPFU	Eptesicus	fuscus	M	NR	A	44	13	Y	14	Y
Potwisha	6/2/24	A. Doty	EPFU	Eptesicus	fuscus	M	NR	A	45	12	Y	14	Y
Potwisha	6/2/24	A. Doty	MYU	Myotis	yumanensis	M	NR	A	33	12	N	5.5	Y
Potwisha	6/3/24	A. Doty	MYCA	Myotis	californicus	F	NR	A	32	10	Y	5.5	Y
Potwisha	6/3/24	A. Doty	MYCA	Myotis	californicus	F	NR	A	33	10	Y	3.5	Y
Potwisha	6/3/24	A. Doty	MYCA	Myotis	californicus	F	NR	A	33	10	Y	5.5	Y
Potwisha	6/3/24	A. Doty	ANPA	Antrozous	pallidus	F	NR	A	52	26	Y	17	

Potwisha	6/3/24	A. Doty	EPFU	Eptesicus	fuscus	M	NR	A	44	11	Y	14	Y
Potwisha	7/12/24	A. Doty	PAHE	Parastrellus	hesperus	F	L	A	31	9	Y	4	Y
Potwisha	7/12/24	A. Doty	ANPA	Antrozous	pallidus	F	NR	A	52	29	Y	17	
Potwisha	7/12/24	A. Doty	MYCA	Myotis	californicus	M	NR	J	31	12	Y	3.5	Y
Potwisha	7/12/24	A. Doty	MYCA	Myotis	californicus	M	NR	A	32	11	Y	5	Y
Potwisha	7/12/24	A. Doty	MYCA	Myotis	californicus	F	L	A	32	7.5	Y	5	Y
Potwisha	7/12/24	A. Doty	MYCA	Myotis	californicus	F	NR	J	33	9.5	Y	4.5	Y
Potwisha	7/12/24	A. Doty	ANPA	Antrozous	pallidus	F	NR	A	59	24	Y	17.5	
Potwisha	7/13/24	A. Doty	MYCA	Myotis	californicus	F	L	A	31	9	Y	4	Y
Potwisha	7/13/24	A. Doty	MYCA	Myotis	californicus	M	N	J	32.5	11	Y	5.5	Y
Potwisha	7/13/24	A. Doty	MYCA	Myotis	californicus	M	N	A	32	11	Y	4	Y
Potwisha	7/13/24	A. Doty	MYCA	Myotis	californicus	M	N	A	30	12	Y	4	Y
Potwisha	7/13/24	A. Doty	MYCA	Myotis	californicus	M	N	J	31	11	Y	3.5	Y
Potwisha	7/13/24	A. Doty	MYCA	Myotis	californicus	F	NR	J	33	8.5	Y	4	Y
Potwisha	7/13/24	A. Doty	ANPA	Antrozous	pallidus	F	NR	A	55	28	Y	17.5	
Potwisha	7/13/24	A. Doty	MYCA	Myotis	californicus	F	NR	A	34	11	Y	4	Y

Table 2. Mean number of nightly calls (+ sd) per species based on elevation.

	Low	Medium	High	Alpine
<i>Eumops perotis</i>	1 ± 2	0 ± 0	0 ± 1	0 ± 0
<i>Euderma maculatum</i>	0 ± 0	0 ± 0	0 ± 1	0 ± 0
<i>Lasiurus cinereus</i>	0 ± 1	0 ± 1	0 ± 1	0 ± 1
<i>Tadarida brasiliensis</i>	12 ± 28	5 ± 11	30 ± 71	34 ± 114
<i>Myotis thysanodes</i>	0 ± 1	0 ± 2	1 ± 3	0 ± 0
<i>Corynorhinus townsendi</i>	0 ± 0	0 ± 1	1 ± 1	2 ± 1
<i>Lasiurus noctivagans</i>	3 ± 7	2 ± 3	8 ± 17	5 ± 14
<i>Eptesicus fuscus</i>	5 ± 14	1 ± 2	1 ± 3	1 ± 4
<i>Antrozous pallidus</i>	0 ± 1	0 ± 1	1 ± 2	1 ± 2
<i>Lasiurus blossevellii</i>	1 ± 3	1 ± 3	0 ± 1	0 ± 0
<i>Parastrellus hesperus</i>	32 ± 84	1 ± 2	0 ± 1	0 ± 0
<i>Myotis evotis</i>	0 ± 0	0 ± 1	3 ± 5	3 ± 6
<i>Myotis lucifugus</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0
<i>Myotis volans</i>	0 ± 1	0 ± 1	0 ± 1	0 ± 1
<i>Myotis ciliolabrum</i>	0 ± 1	0 ± 0	0 ± 0	0 ± 1
<i>Myotis californicus</i>	78 ± 146	31 ± 164	7 ± 36	12 ± 27
<i>Myotis yumanensis</i>	34 ± 88	1 ± 6	1 ± 12	1 ± 2

Table 3. Analysis of variance results for total number of bat calls per night, based on elevation in Sequoia National Park.

	Sum of Squares	df	Mean Square	F	P-value
Between Groups	1556106.0	3	518702.0	18.3	2.1E-11
Within Groups	18005083.1	636	28309.9		
Total	19561189.1	639			

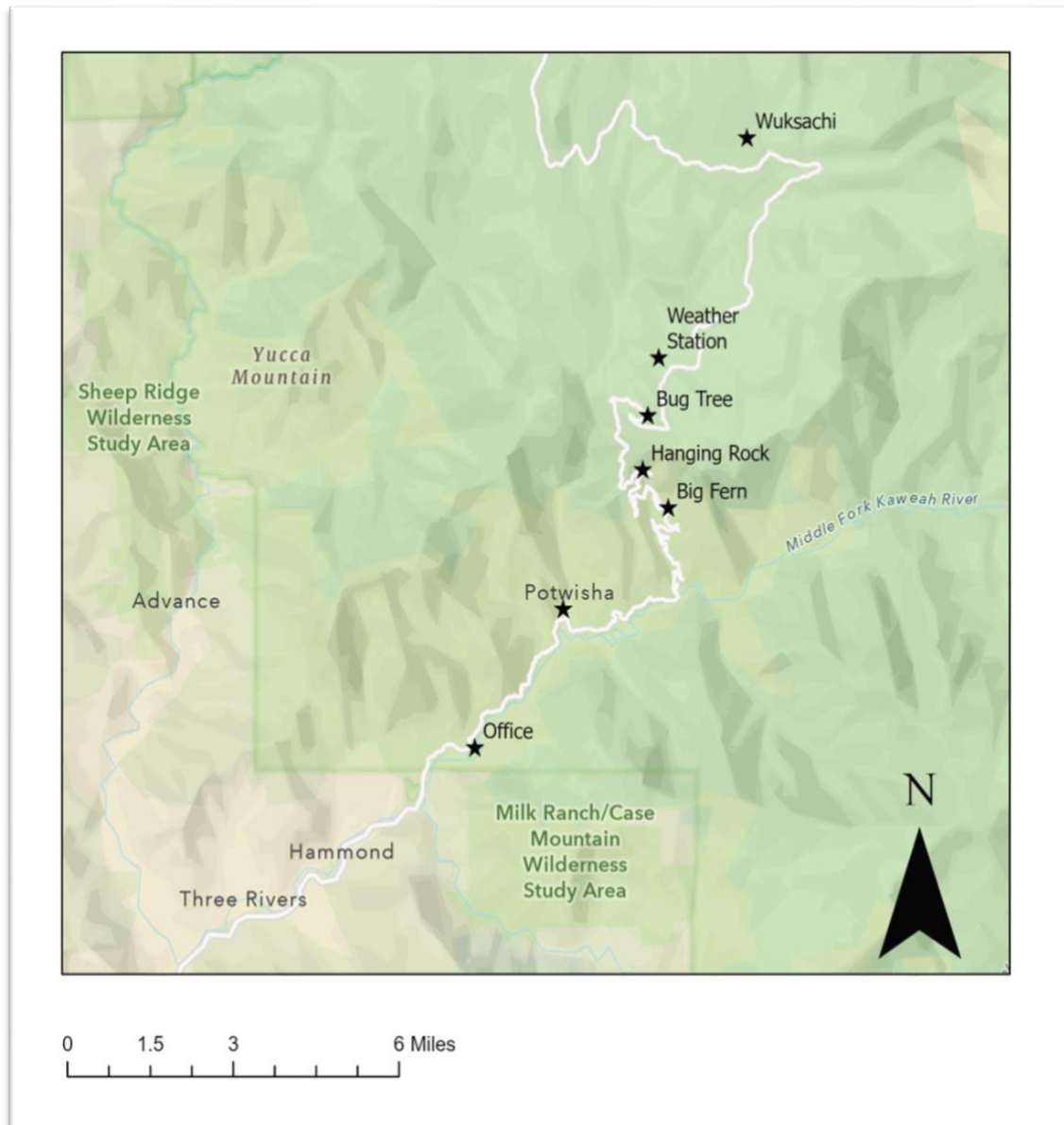


Figure 1. Location of all sites used to collect bat echolocation calls in Sequoia National Park. Low elevation = Office, Potwisha; Medium elevation = Hanging Rock, Big Fern; High elevation = Bug Tree, Weather Station; Alpine = Wuksachi.

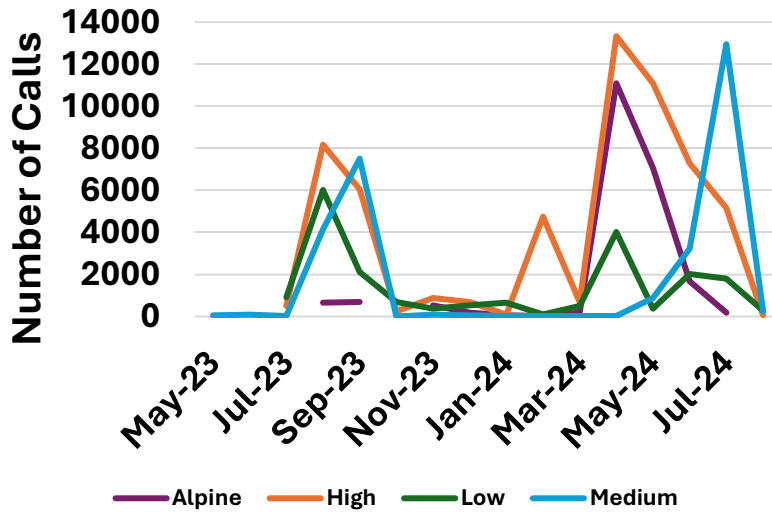


Figure 2. Number of bat echolocation calls collected per month at each elevation group (low, medium, high, and alpine). Calls were only collected at medium elevation sites in May and June 2023, hence the low number of calls reported.

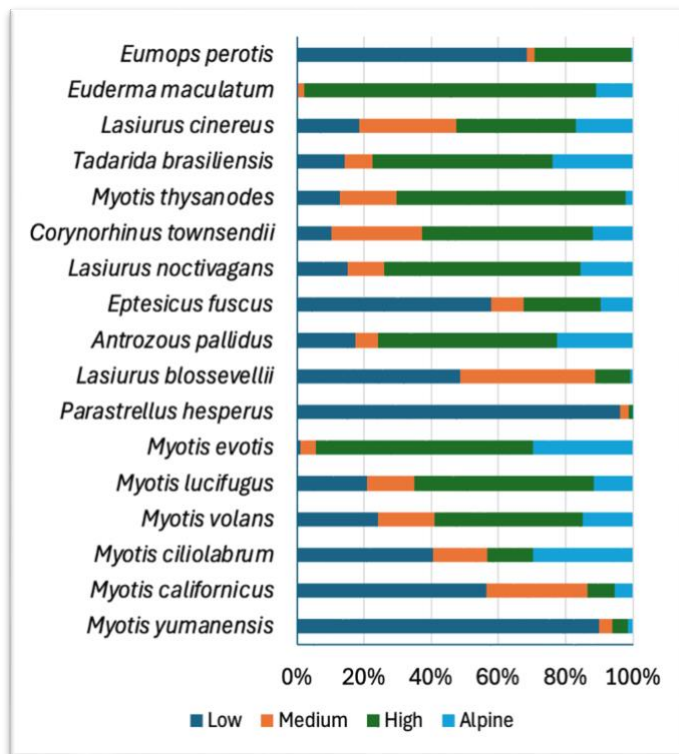


Figure 3. Proportion of the total number of calls for all detected bat species based on elevation in Sequoia National Park. Species are ordered from the lowest number of total calls collected to the highest.