Report for Continued Surveys for Bats on Boulder County Open Space

Submitted to Boulder County Parks and Open Space Department
Final

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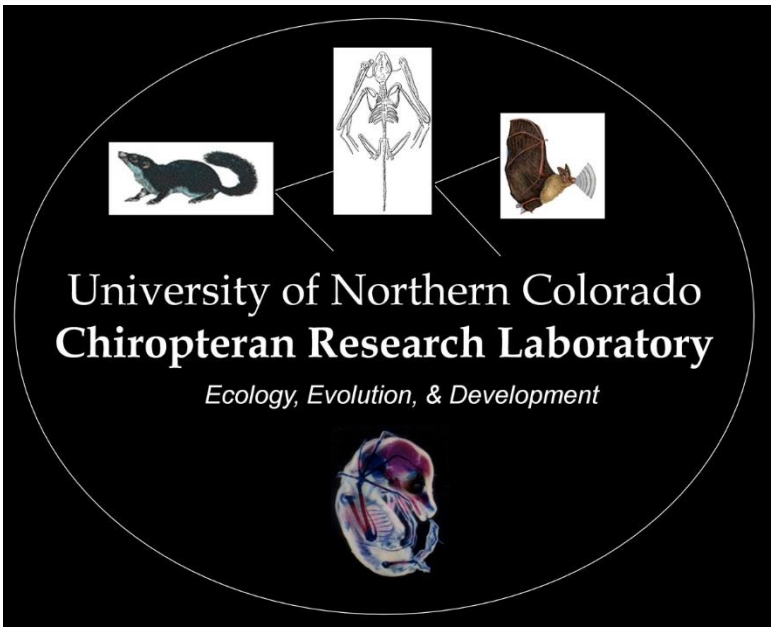

(27 pages, 21 Figures, 15 Tables)

Abstract

We surveyed areas of Heil Valley Ranch's lower Geer Canyon using SM2BAT sonar devices to map out high activity areas. We also netted at Ingersol Quarry and in lower Geer Canyon. We began first surveys of eastern property holdings (Walden Ponds, Twin Lakes, and Lagerman Reservoir) for eastern red and tricolored bats. We monitored upper Geer and Plumely canyons as well as Cardinal Mill above Nederland. In addition, we monitored bat activity around two fracking well pads on BCPOS property.

Introduction

Long-term monitoring of bats on Boulder County has led to an understanding of ecological patterns associated with changes in forest structure, climate change, water availability, roost site fecundity, altitudinal migration, flood-induced changes to stream structure, sex-ratio shifts, and tracking for possibilities of white-nose syndrome in Colorado. In 2018 we continued long-term monitoring of bat populations as well as surveyed new areas for bats activity and species richness. Although much has been achieved with understanding lower elevation foothills summer populations, little is known about eastern protected properties that, unlike foothills open space, lack interconnectedness. In addition, there is deficient data on high-elevation bat populations occupying protected lands.

Methods

General Survey Methods: We used SM2s and mist nets to survey for bats at various Boulder County Properties. Sonar surveys were conducted over four consecutive nights at each deployment locality at all sampled properties. SM2s were moved across the landscape every 5th day to new locations based upon randomized grid designations in a stratified habitat method. Mist netting was conducted at water sources or in flyways. Bats were removed immediately from nets and processed for species identification, sex,

reproductive condition, and mass (g) and released. We also surveyed Cardinal Mill above Nederland using SM2s and emergence counts and began a preliminary assessment of bat activity at fracking well sites.

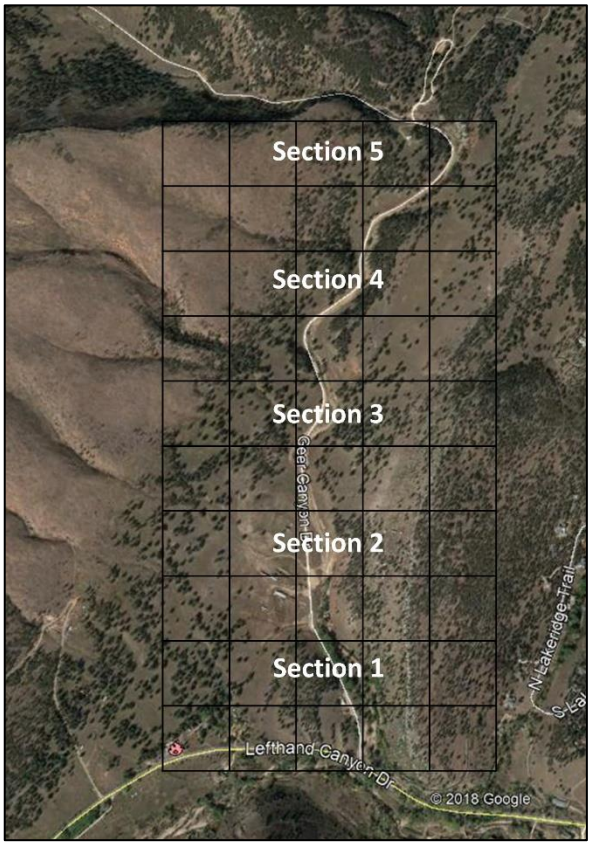

Figure 1. Section of Heil Valley Ranch surveyed using SM2 bat detectors and mist netting. Fifty grid squares 150x150m split into five sections containing 10 squares. We randomly determine placement within each section.

Results

Capture Data: A total of 39 bats were captured across sites. Of these, 33 were captured at Ingersol Quarry for which the large majority were little brown myotis (*Myotis lucifugus*). Other species captured at Ingersol Quarry were small footed myotis (*M. ciliolabrum*), long-eared myotis (*M. evotis*), and big brown bats (*Eptesicus fuscus*). At Walden Ponds, netting at Site 1, we captured a male *E. fuscus* and a male silver-haired bat (*Lasionycteris noctivagans*). At Twin Lakes we captured a male small-footed myotis (*M. ciliolabrum*) and a male *E. fuscus*. Data on all captures are presented in Table 1.

Table 1. Capture data for 2018. MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, EPFU = *Eptesicus fuscus*. A = Adult, M = Male, F = Female, NS = Nonscrotal, P = Pregnant, NR = Nonreproductive. Mass is in grams.

DATE	SITE	LOCAL	SPP	AGE	SEX	REPRO	MASS
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYEV	A	M	NS	5.3
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	6.6
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	6.6
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	7.6
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	6.9
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	7.1
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	6.4
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	8.3
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	7
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYTH	A	F	NR	8.6
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYCI	A	F	NR	4.5
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	7.6
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	6.7
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	6.3
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	6.8
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	7.2
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	7.1
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	7.7
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	7.6
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	NW

DATE	SITE	LOCAL	SPP	AGE	SEX	REPRO	MASS
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	6.7
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	7
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	6.7
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	7.6
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	8.1
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	6.6
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYLU	A	M	NS	6.6
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYTH	A	M	NS	7.9
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYTH	A	F	NR	8.9
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYEV	A	F	P	7.6
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYEV	A	M	NS	6.7
9-Jul	Heil Valley Ranch	Ingersol Quarry	EPFU	A	M	NS	17.1
9-Jul	Heil Valley Ranch	Ingersol Quarry	MYCI	A	M	NS	4.6
18-Jul	Walden Ponds	Site 1	no	cap			
19 July	Lower Geer Canyon	Stream site	MYTH	A	F	P	7.3
21-Jul	Twin Lakes	Site 4	MYCI	A	M	NS	5.1
7/21	Twin Lakes	Site 3	EPFU	A	M	NS	12.1
24-Jul	Walden Ponds	Site 1	EPFU	A	M	NS	19
24-Jul	Walden Ponds	Site 1	LANO	A	M	NS	10.3
3-Aug	Walden Ponds	Site 1	no	cap			

Sonar Surveys: A total of 1,824 call sequences was identified to species across 18 sites sampled for four nights each (Fig. 1) from 21 June - 31 July 2018. Of the 18 locations, two had greater than 200 passes (red circles) and six had greater than 100 passes (yellow circles) over the four-night survey periods.

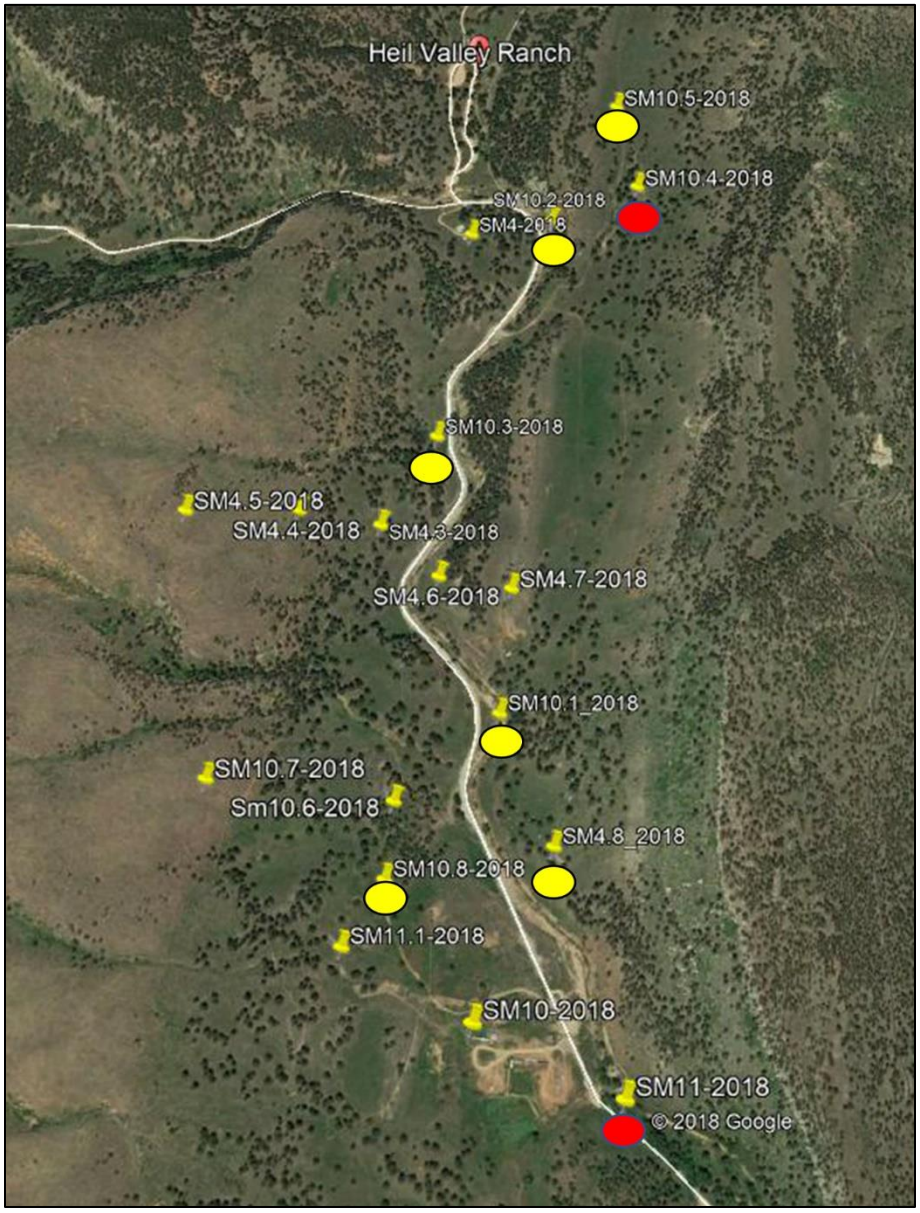

Figure 1. Location of sites for lower Geer Canyon survey in 2018. Red areas indicate greater than 200 passes over four nights. Yellow areas indicate greater than 100 passes over four nights.

Highest richness at any site was nine co-occurring species (SM10.7), whereas five sites had eight species (SM4.8, SM10.0, SM10.1, SM10.2, and SM11). Lowest richness was four species (SM4.4) (Figs. 2 and 3, Table 2). Species recorded in highest numbers was *Eptesicus fuscus* (EPFU, big brown bat, N = 663) and lowest number of calls was for tricolored bats (*Perimyotis subflavus,* PESU, N = 4) (Fig. 4).

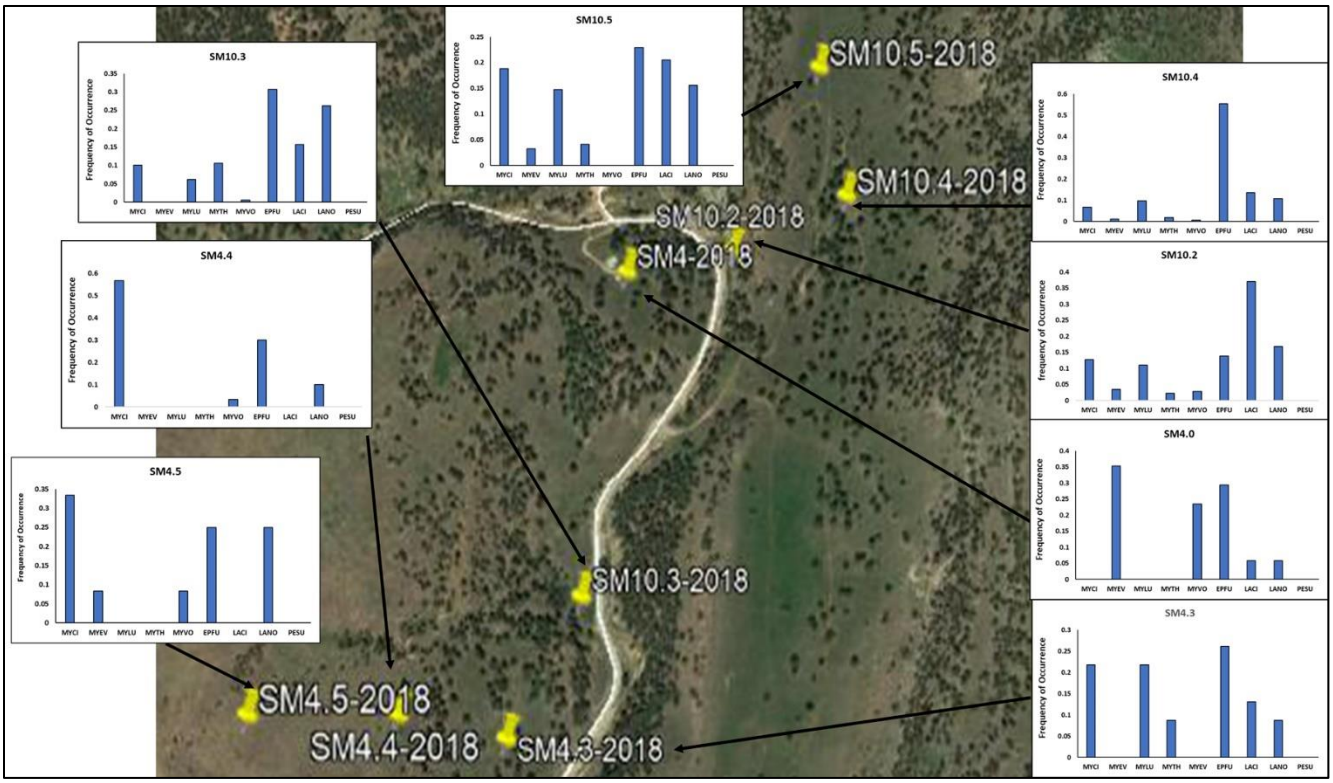

Figure 2. Frequency of species occurrence at each site in lower Geer Canyon.

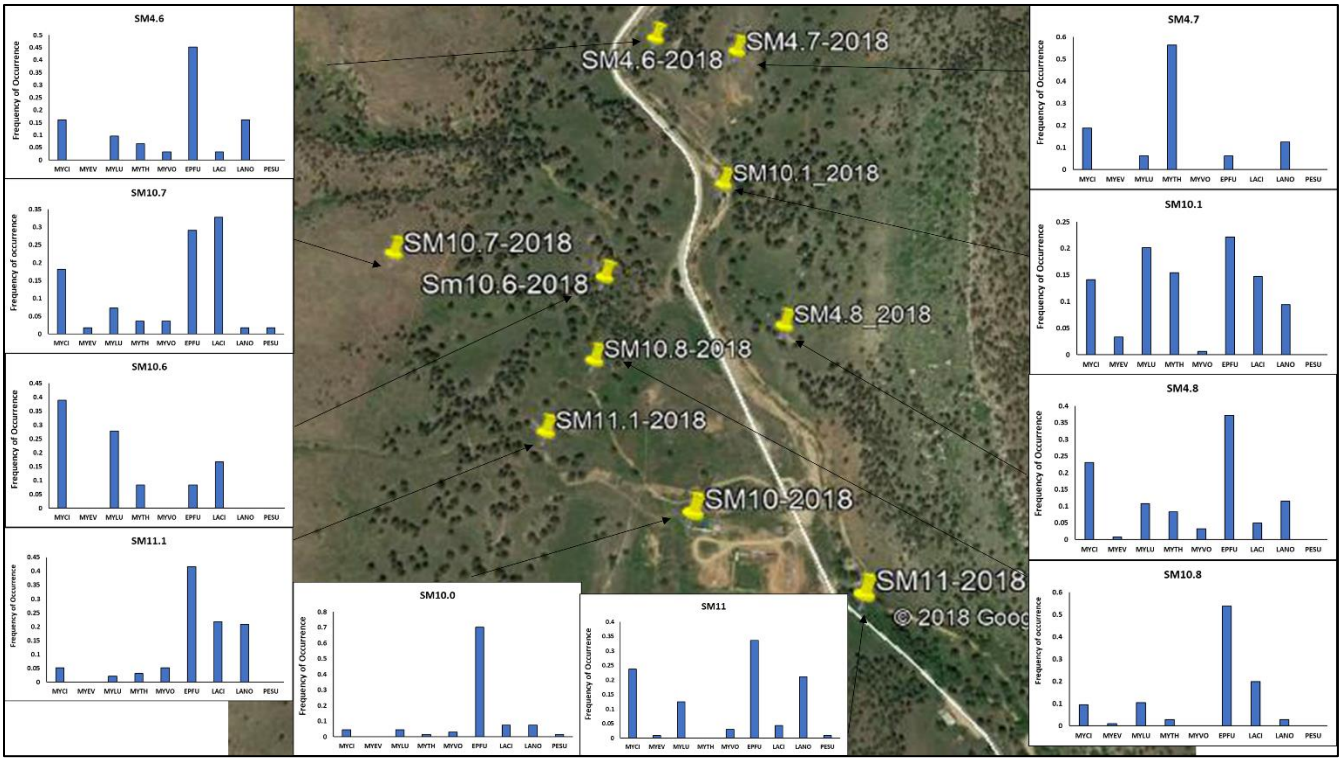

Figure 3. Frequency of species occurrence at each site in lower Geer Canyon.

Table 2. Raw numbers of passes per SM2BAT location in Geer Canyon.

	SM4.0	**SM10.3**	**SM4.5**	**SM4.4**	**SM4.7**	**SM4.6**	**SM10.7**	**SM10.6**	**SM4.8**
MYCI		18	4	17	3	5	10	14	28
MYEV	6		1				1		1
MYLU		11			1	3	4	10	13
MYTH		19			9	2	2	3	10
MYVO	4	1	1	1		1	2		4
EPFU	5	55	3	9	1	14	16	3	45
LACI	1	28				1	18	6	6
LANO	1	47	3	3	2	5	1		14
PESU							1		
SUM	**17**	**179**	**12**	**30**	**16**	**31**	**55**	**36**	**121**

	SM10.2	SM10.4	SM10.5	SM10.8	SM10.1	SM11.1	SM10.0	SM11	SM4.3
MYCI	22	24	23	10	21	5	3	55	5
MYEV	6	4	4	1	5			2	
MYLU	19	35	18	11	30	2	3	29	5
MYTH	4	7	5	3	23	3	1		2
MYVO	5	2			1	5	2	7	
EPFU	24	199	28	57	33	40	47	78	6
LACI	64	49	25	21	22	21	5	10	3
LANO	29	39	19	3	14	20	5	49	2
PESU							1	2	
SUM	**173**	**359**	**122**	**106**	**149**	**96**	**67**	**232**	**23**

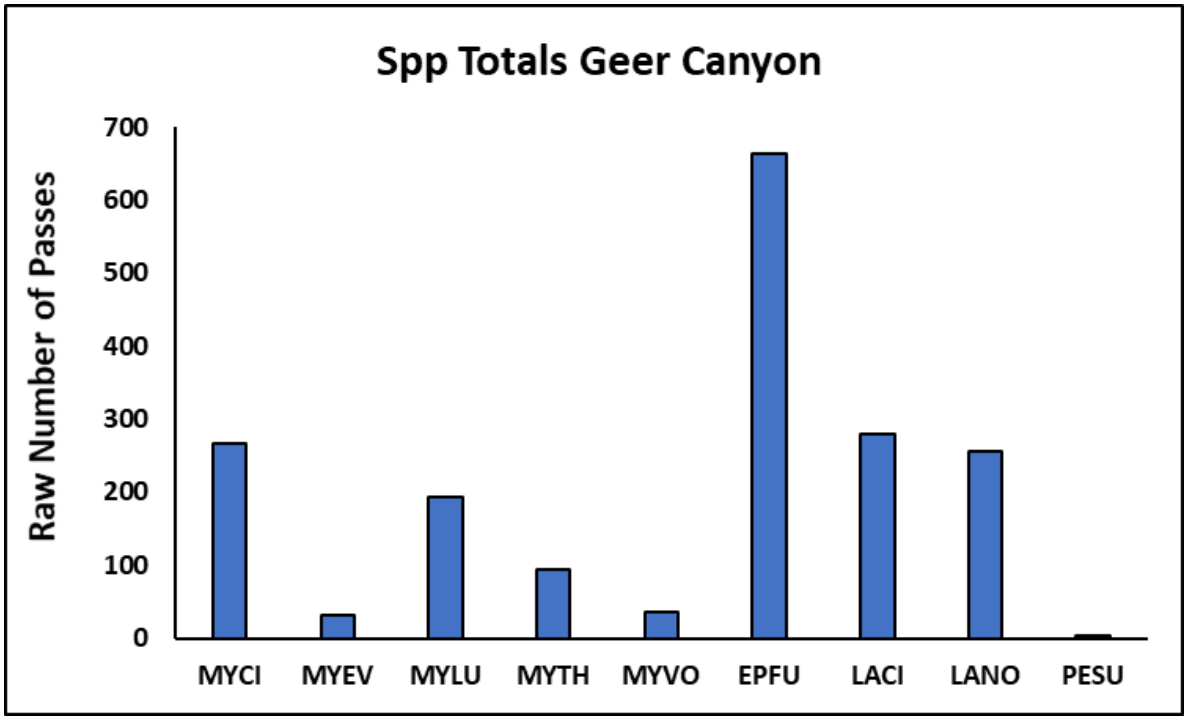

Figure 4. Raw numbers of passes by species recorded throughout survey period in lower Geer Canyon.

Eastern Property Sonar Surveys

Walden Ponds: A total of 11,282 call sequences was recorded at Walden Ponds between 7 July-30 August 2018. Of these 2,160 were identified to species. Site 1 had the highest number of recordings and Site 4 the lowest (Fig. 5). All in all, 10 species were recorded (Table 3), but species richness and

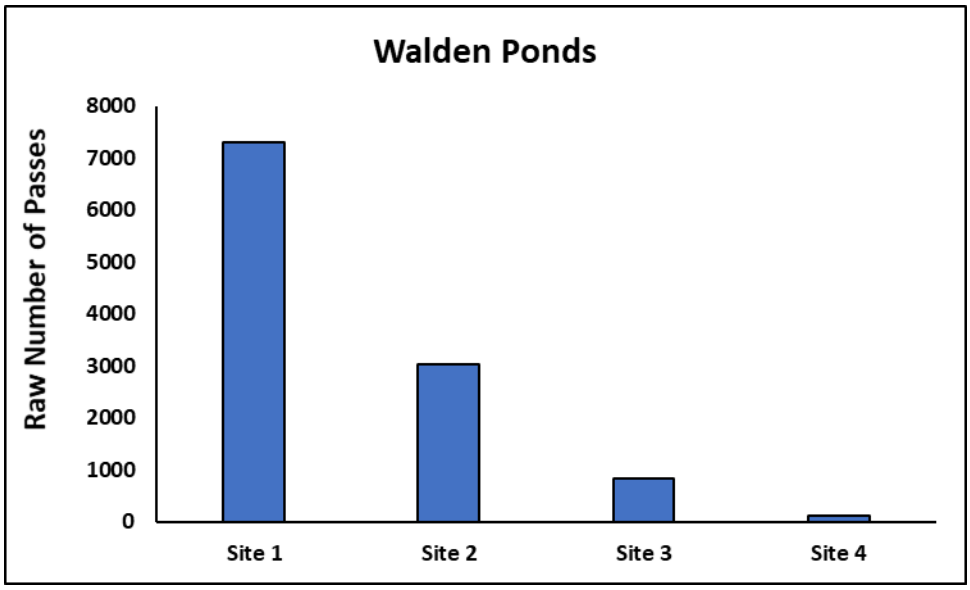

Figure 5. Total numbers of passes recorded at four sites on Walden Ponds property.

frequency of occurrence varied by site (Table 3, Fig. 6, Fig. 7). Site 1 (7.9-7.15.2018) was dominated by *E. fuscus* (N = 999) and had a richness of six species including the highest numbers of calls from eastern red bats (*Lasiurus borealis*, N = 33) and tricolored bats (*Perimyotis subflavus*, N = 66). Site 3 had the highest species richness (N = 10) and had the second highest numbers of *P. subflavus* recordings, whereas Site 2 (7.12-7.16.2018) had the second highest numbers of *L. borealis* recordings (N = 7) and a very large number of passes by small-footed myotis (*M. ciliolabrum*). Site 3 (8.14-8.18.2018) also had high numbers of *M. ciliolabrum*. Site 4 (8.26-8.30.2018) was the lowest in species richness (N = 5) and total calls (N = 115). Over the four sites sampled, a total of 41 *L. borealis* and 107 *P. subflavus* call sequences were recorded.

Table 3. Raw number of passes by species across sites at Walden Ponds. Dates of surveys at each site provided.

	Site 1 7.9-7.15	Site 2 7.12-7.16	Site 3 8.14-8.18	Site 4 8.26-8.30	SUM
MYCI		437	181	3	621
MYEV		2	1		3
MYLU	12	17	118	5	152
MYTH		1	1		2
MYVO		2	1		3
EPFU	999	19	23	3	1044
LABO	33	7	1		41
LACI	35		22	3	60
LANO	91	20	11	5	127
PESU	66	5	36		107
SUM	1236	510	395	19	2160

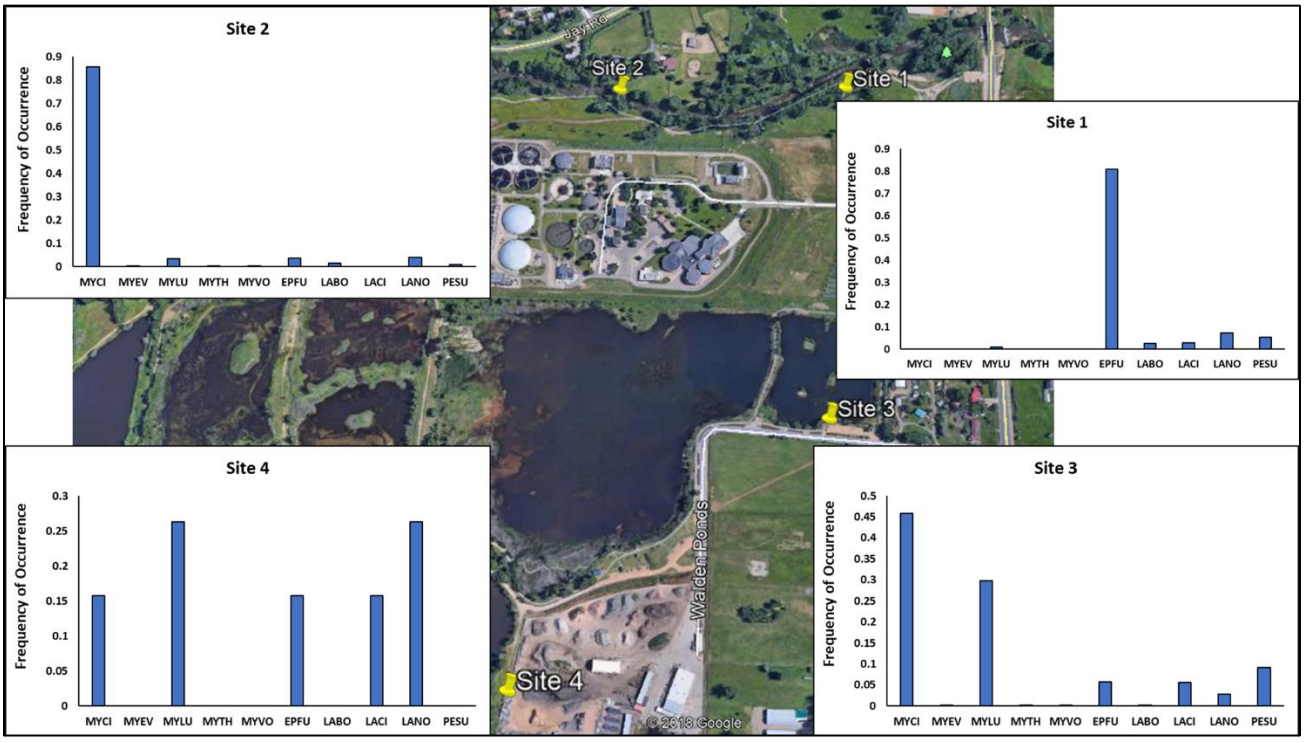

Figure 6. Distribution of species by survey sites at Walden Ponds.

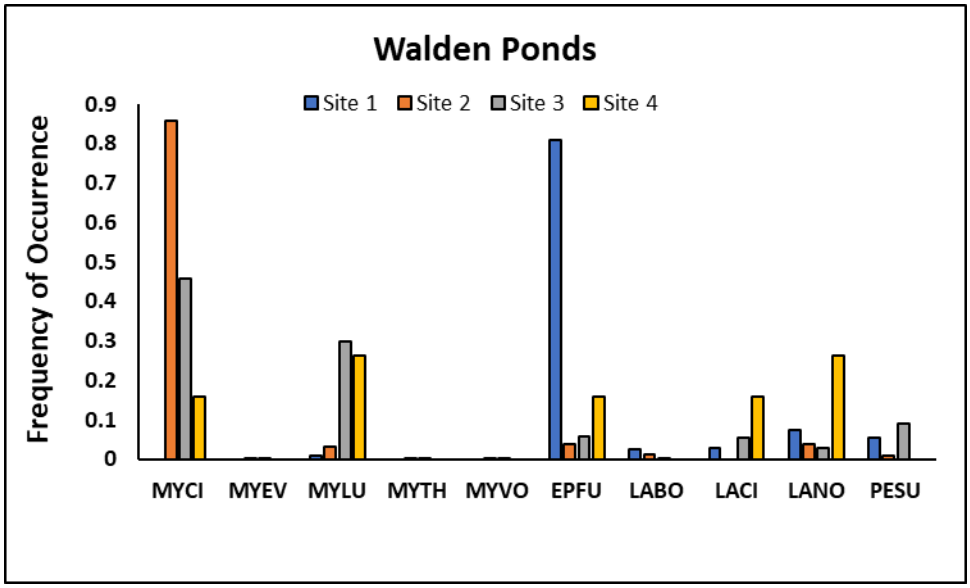

Figure 7. Relative frequency of occurrence of species by site at Walden Ponds.

Lagerman Reservoir: Due to a lack of trees and a secure site for SM2 placement, the detector was placed west of Lagerman Reservoir on a fencepost from that marked the edge of POS 3-7 August 2018

Figure 8. Placement of SM2 near Lagerman Reservoir in 2018.

A total of 372 sonar passes was recorded. Of these, 245 were identified to species. Highest number of passes was from Mexican free-tailed bats (N = 176), second highest was from little brown bats (N = 44). A single pass was identified to an eastern red bat (*Lasiurus borealis*). Species richness was six (Table 4).

Table 4. Total number of identified passes at Lagerman Reservoir in 2018.

Species	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	LABO	LACI	LANO	PESU	TABR	TOTAL
Passes	2		44			19	1		3		176	245

Twin Lakes: Four sites were surveyed at Twin Lakes between 7 June - 21 July 2018. Two sites were along the wetlands at the east side of the East Lake and two were along the riparian corridor south of the East Lake (Fig. 9). Both tricolored (*P. subflavus*) and eastern red bats (*L. borealis*) were recorded at

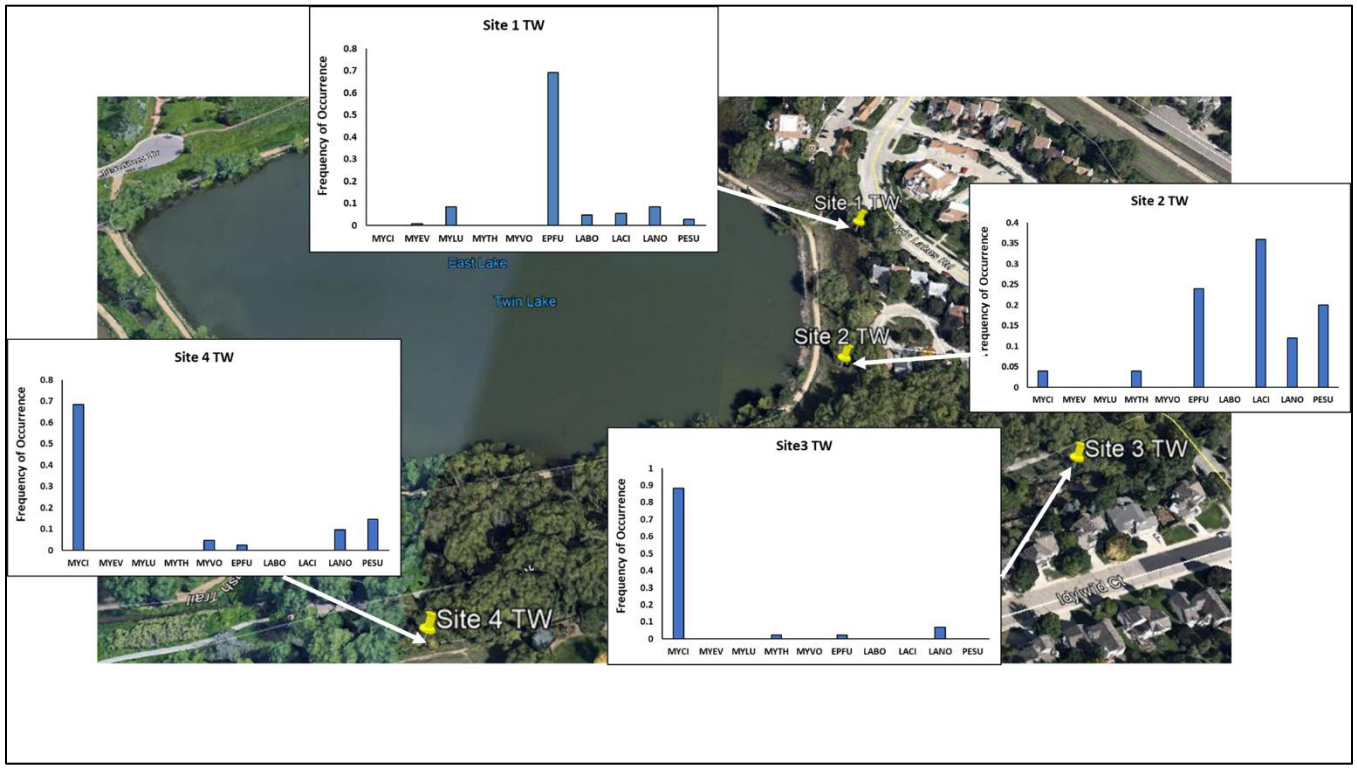

Figure 9. SM2 survey sites at Twin Lakes with figures showing frequency of occurrence of each species.

Twin Lakes. The highest number of passes was at Site 1 over the eastern wetlands with the second highest being at the farthest west site along Left Hand Ditch (Fig. 10, Table 5). The most common species recorded at Twin Lakes was *E. fuscus* (N = 82) with the least common being the long-eared myotis (*M. evotis*). There were 14 passes by tricolored bats (*P. subflavus*) and five passes by eastern red bats (*L. borealis*). Big brown bats (*E. fuscus*) dominated the wetlands, whereas small-footed myotis (*M. ciliolabrum*) dominated the riparian area along Left Hand Ditch (Table 6).

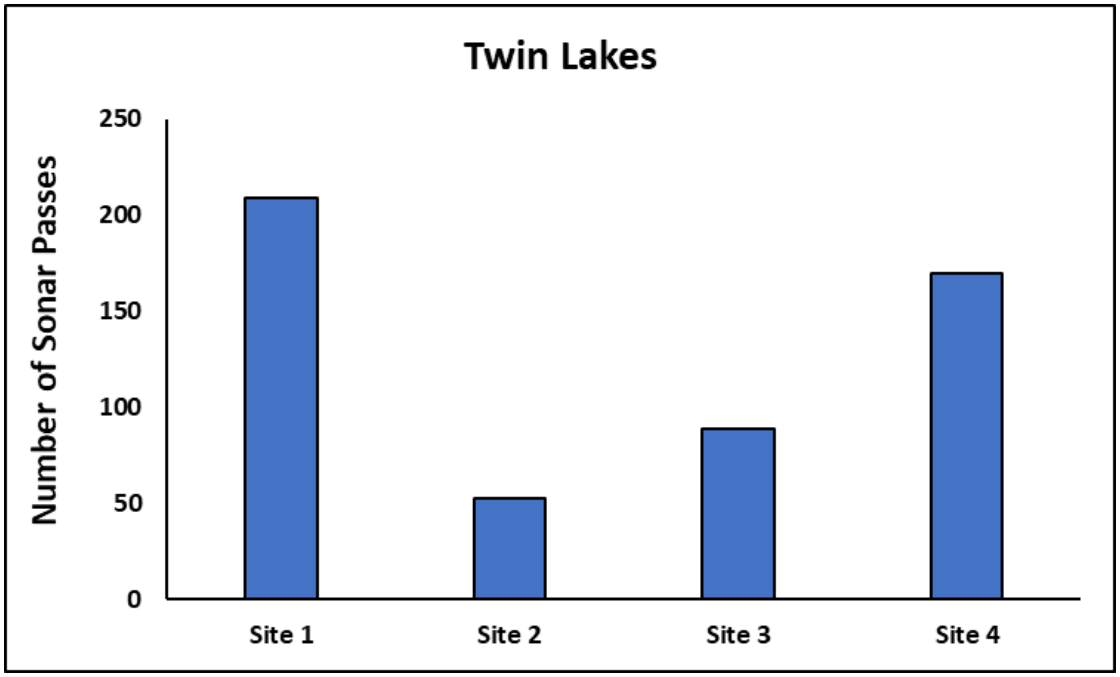

Figure 10. Relative number of sonar passes (activity) at each of the four survey sites at Twin Lakes.

Table 5. Raw number of passes (activity) recorded at each survey site at Twin Lakes.

	Site 1	**Site 2**	**Site 3**	**Site 4**
Passes	209	53	89	170

Table 6. Number of sonar sequences recorded for each species at each of the four survey sites at Twin Lakes.

	Site 1	**Site 2**	**Site 3**	**Site 4**	**SUM**
MYCI		1	38	28	67
MYEV	1				1
MYLU	9				9
MYTH		1	1		2
MYVO				2	2
EPFU	74	6	1	1	82
LABO	5				5
LACI	6	9			15
LANO	9	3	3	4	19
PESU	3	5		6	14
SUM	107	25	43	41	**216**

Cardinal Mill: An SM2 was placed just outside of Cardinal Mill on the south side on 12 August and let run till 19 August. During this survey period 8,673 sonar sequences were recorded. Of these, 1,908 were identified to species. Highest number of sonar passes was from little brown bats (*M. lucifugus*, N = 804), seconds highest was from small-footed myotis (*M. ciliolabrum*, N = 519), and third highest was from long-legged myotis (*M. volans*, N = 406) (Table 7). Cardinal Mill is likely a maternity roost for these species.

Table 7. Raw pass data (activity) of bat species recorded at Cardinal Mill 12-19 August.

Species	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	COTO	LABO	LACI	LANO	PESU	SUM
Passes	519	105	804	12	406	9	1	16	1	14	21	1908

three species. Other species that were in relatively high frequency of occurrence were eastern red bats (*L. borealis*) and tricolored bats (*P. subflavus*). Eleven species were recorded at the site during this survey period (Fig. 11).

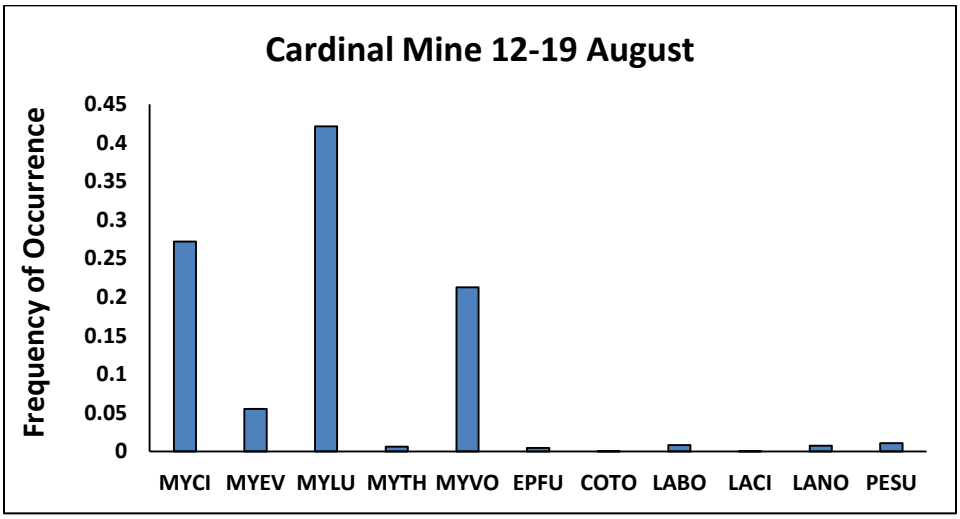

Figure 11. Frequency of occurrence of bats species at Cardinal Mill from 8-19 August 2018.

We moved the SM2 that was located outside Cardinal Mill to an offsite location (at 39.968949 and 105.549791) in the direction of where most of the bats flew after leaving the mill. This detector ran from 24 August – 19 September. A total of 149 passes was recorded of which 58 were analyzed to species. Six species were recorded at the site during this survey period. Most prominent species were *E. fuscus* (N = 22), *Lasiurus cinereus* (N = 15), and *Lasionycteris noctivagans* (N = 11) (Table 8, Fig. 12).

Table 8. Numbers of passes per species at Cardinal Mill 24 August – 19 September.

Species	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	COTO	LABO	LACI	LANO	PESU	SUM
Passes		1	8			22		1	15	11		58

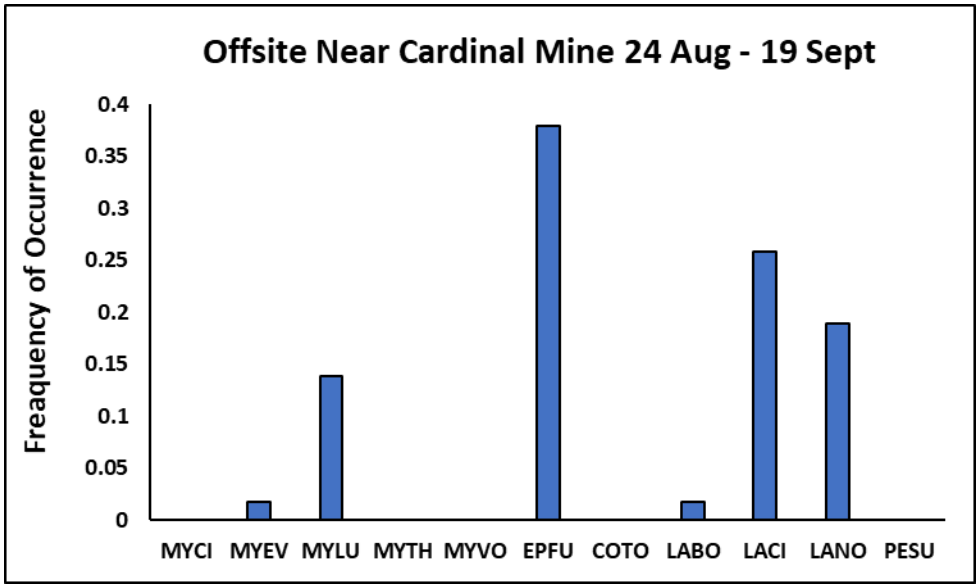

Figure 12. Frequency of occurrence of species recorded at Cardinal Mill 24 August – 19 September.

Further sonar surveys at Cardinal Mill from 10 Sept – 15 October yielded 76 sonar passes of which 46 were identified to species. Most prominent calls were from *M. lucifugus* (Fig. 13). Notably no *M. volans* were at the site at this time (Table 9).

Table 9. Number of sonar passes recorded by species at Cardinal Mill 10 Sept – 15 October.

Species	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	COTO	LABO	LACI	LANO	PESU	SUM
Passes	1		17			10			9	9		46

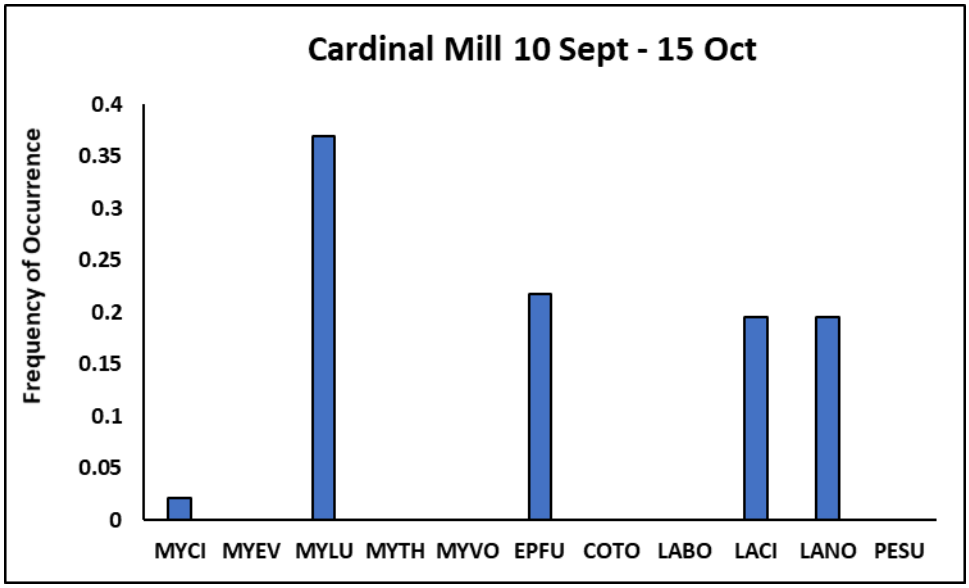

Figure 13. Frequency of occurrence of species recorded at Cardinal Mill 10 Sept – 15 October.

Emergence Counts at Cardinal Mill: Four emergence counts were conducted at Cardinal Mill from 3-25 September. We arrived at the mill 30 minutes before sunset. The general area that each bat exited the mill was recorded, as well as the direction the bat was traveling. The surveys were concluded after 15 minutes passed without a bat emerging from the mill.

On 3 September, 91 bats were recorded emerging from roosts within Cardinal Mill with 53 emergences on 10 September, 0 on 24 September two on 25 September (Table 10). On 24 and 25 September a great horned owl (*Bubo virginianus*) was observed perched approximately 8 meters from one of the emergence sites. Table 11 gives data on timing of emergences. We located three emergence holes at Cardinal Mill (Fig. 14).

Table 10. Emergence count data from Cardinal Mill.

Date	S &W Facing	E Facing	Total
3-Sep	69	22	91
10-Sep	25	28	53
24-Sep*	0	0	0
25-Sep**	2	0	2

Table 11. Emergence times of bats at Cardinal Mill.

Date	Time of Sunset	Time of 1st emergence	Temp start/end (F)	Weather Condition
3-Sep	7:30	7:32	56.6/55	Mostly cloudy
10-Sep	7:19	7:29	58/52.8	Clear
24-Sep	6:56	N/a	42/41.5	Rain/thunderstorms strong wind gusts
25-Sep	6:54	6:40	36.9/35.5	Clear

Fig. 14. Emergence sites on Cardinal Mill. Most bats exited from sites A, B, and C respectively on September 3rd.

Upper Geer Canyon: A total 7,213 sonar call sequences were recorded in upper Geer Canyon between 15 June and 1 August. Of these, 4,260 calls were identified to species showing 11 species using the canyon. Highest number of calls were recorded for fringed myotis (*Myotis thysanodes*, N = 1389) and lowest number of calls was for tricolored bats (*Perimyotis subflavus*, N = 3) (Table 12). Fringed

Table 12. Total number of passes by species recorded in upper Geer Canyon from 15 June – 1 August 2018.

Species	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	COTO	LABO	LACI	LANO	PESU	SUM
Passes	526	32	214	1389	73	1063	18	16	363	563	3	4260

myotis composed 32.6% of all calls and big brown bats (*Eptesicus fuscus*) composed 24.9% of all calls. It should be noted that Townsend's big-eared bat (*Corynorhinus townsendii*) composed 0.4% of calls (N = 18) which is a high relative frequency especially because the soft calls of this species are not readily captured (Fig. 15).

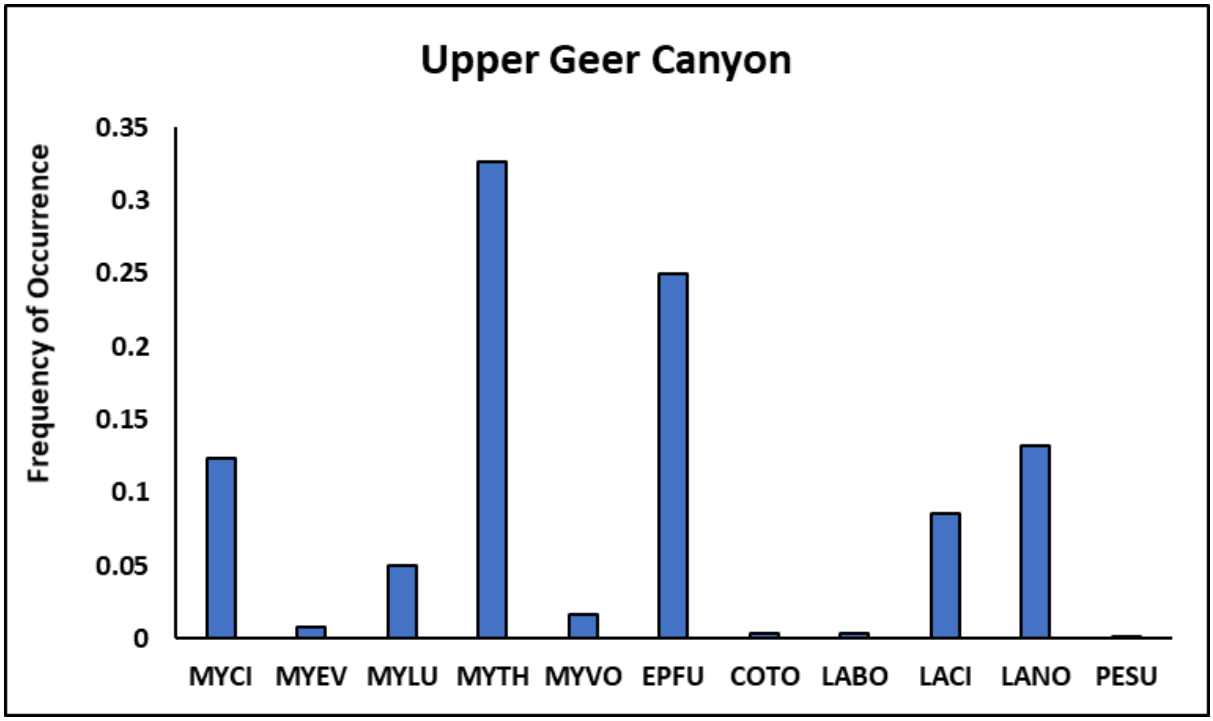

Figure 15. Frequency of occurrence of the 11 species of bats revealed by sonar capture in upper Geer Canyon in 2018.

Plumely Canyon: A total of 2,803 calls was recorded in Plumely Canyon between 15-27 June. Unfortunately, the detector failed from recording later in the summer. Of these 1,555 calls were identified to species. Eight species were recorded during the survey period. Highest number of passes was from small-footed myotis (*M. ciliolabrum*, N = 490), with second highest from *E. fuscus* (N = 421). Lowest number of passes was from long-eared myotis (*M. evotis*, N = 53) (Table 13). Frequency of occurrence shows that *M. ciliolabrum*

Table 13. Number of passes by species in Plumely Canyon 2018.

Species	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	COTO	LABO	LACI	LANO	PESU	SUM
Passes	490	53	217	172	17	421			60	125		1555

composed 31,5% of all passes with *E. fuscus* contributing 27.1%. Little brown myotis (*M. lucifugus*) composed 13.9% and fringed myotis contributed 11.1% (Fig. 16).

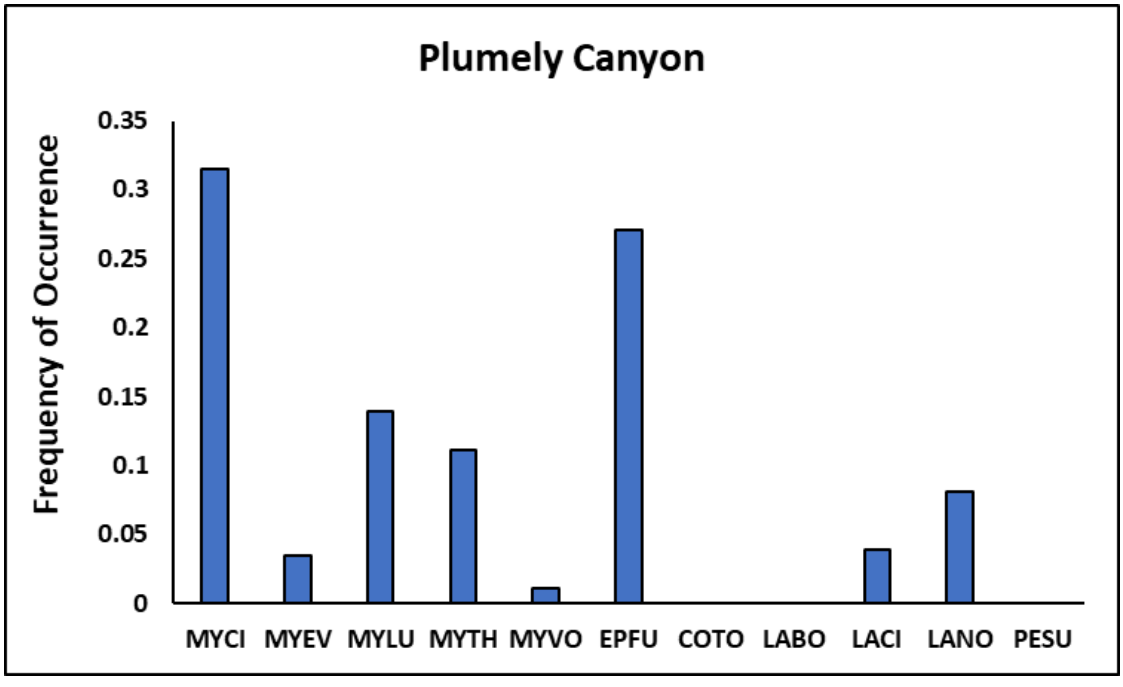

Figure 16. Frequency of occurrence of the eight species of bats using Plumely Canyon in June 2018.

Fracking and Bats: We tested the hypothesis that there would be no significant differences between bat activity patterns over fracking well sites in relation to areas 100m away. We used SM2 detectors, one placed at the well site for 9 nights, and the other moved through three positions 100m away recording three nights at each position. The well sites (N = 2) were positioned 255m apart and were located off Kenosha Road in Weld County on property owned by Boulder County Parks and Open Space (Fig. 17). Well Pad 1 was the larger of the two pads (Fig. 18).

Figure 17. Map location of Kenosha Road fracking well sites where we tested for bat activity patterns.

Figure 18. Position of fracking pads and offsite reference points 100m from pads.

Well Pad 1 (Fig. 19): Surveyed from 9 – 19 Aug. A total of 510 sonar passes was recorded making 56.7 the average number of passes per night. Of total passes, 349 were identified across five species. At Offsites, six species were recorded with a total of 1,722 passes making 191.3 mean passes per night. Average number of passes per night were more than three times at Offsites than recorded at Well Pad 1. Most numerous passes at Well Pad 1 and Offsites were from big brown bats (*E. fuscus*, N = 1,231) (Table 14).

Figure 19. Larger fracking well pad (Well Pad 1) located off Kenosha Road in Weld County.

Table 14. Number of passes by species recorded at Well Pad 1 and Offsites.

Species	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	LACI	LANO	SUM
Passes Pad 1	1		15			256	14	63	349

Passes Offsites	9		45		9	975	56	179	1273

Well Pad 2: Surveyed from 9 – 19 Aug. A total of 1,058 sonar passes was recorded at Well Pad 2 making 117.6 passes per night on average across five species. Offsite passes totaled 1,395 making the average number of passes per night 155 across six species. Highest number of calls by species show *E. fuscus* to be the most active with 1,411 calls and silver-haired bats (*Lasionycteris noctivagans*) being the seconds most recorded species (N = 104) (Table 15).

Table 15. Number of passes by species recorded at Well Pad 2 and Offsites.

Species	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	LACI	LANO	SUM
Passes Pad 2	2		17			523	38	19	599
Passes Offsites	9		59		2	888	37	85	1080

All in all, higher numbers of sonar call passes (activity) of bats were recorded at Offsites areas around both Pad 1 and 2. However, Pad 1 had the most dramatic effect, most likely because it was the much larger of the well pads.

Conclusions

Lower Geer Canyon: Surveys of lower Geer Canyon showed hot and warm spots of bat activity mostly in the lower elevations along the creek corridor. Although not as active as upper Geer Canyon, this area provides foraging habitat and drinking opportunities that are likely important for maintain species richness and abundance at Heil Valley Ranch.

Eastern Properties Surveys: Eastern property holdings showed that Walden Ponds is a hot spot for bats with both high species richness (N = 11) and high activity, especially near Site

1. Tricolored (*Perimyotis subflavus*) and eastern red bats (*Lasiurus borealis*) are present in high relative abundance. These bats use tree branches for diurnal roosting and at Site 1, the many cottonwoods trees likely provide roosting and potentially breeding habitat for these two species. Twin Lakes also has these two species present but apparently in much lower numbers. However, cottonwoods and ash trees along Left Hand Ditch are likely diurnal roosting areas for these species and potentially a breeding area.

Cardinal Mill: This site above Nederland is highly diverse and likely provides roosting and maternity sites for several species including little brown myotis (*M. lucifugus*), long-legged myotis (*M. volans*), and big brown bats (*Eptesicus fuscus*). In addition, significant number of passes from both eastern red bats (*L. borealis*) and tricolored bats (*P. subflavus*) were recorded in midAugust. Little is known of eastern red bat winter ecology. Labelled a migratory species, it was originally thought that hibernation was a component of its natural history. However, eastern red bats have been found hibernating in tree hollows where they could not withstand prolonged temperatures below freezing and had to migrate (Fenton 1985). Furthermore, eastern red bats have been observed hibernating in conditions below freezing in Missouri by burrowing into leaf litter where they spent the winter months (Mormann et al. 2010). In addition, the finding that Ussurian tube-nosed bats (*Murina ussuriensis*) is the only other mammal besides bears to hibernate in self-built snow caves (Vignieri 2018) (Fig. 20) opens the possibility that other bat species may do this as well.

Fig. 20. An Ussurian tube-nosed bat (*Murina ussuriensis*) leaving its winter snow cave after hibernation (Vignieri 2018).

Both eastern red bats and tricolored bats use summer roosts located in deciduous trees along riparian corridors of slower moving streams where aquatic emergent insects breed. Therefore these species would not be expected to be active at higher elevations in pine forest habitat. If the sonar data are verified by capture data of high-elevation activity of these species in autumn, this would indicate that they are overwintering in the area. The many abandoned mines around Nederland may provide hibernacula for these species or, in the case of eastern red bats hibernacula may possibly be located under aspen tree leaf litter or possibly even in snow caves. The fact that these species were no longer in the area in September and October may indicate they had moved to local hibernation sites. For eastern red bats, it is possible they migrated south to more temperate climates, however, it is hard to conceive of an explanation for their presence at high-elevations in autumn where they would not commonly spend the summer, if they were not seeking hibernation opportunities. More research is needed in this area to determine its importance to foothills bats.

Cardinal Mill should be protected from excessive human disturbance as it appears to be a maternity colony for several species. Of these, Cardinal Mill is likely highly important to the long-legged myotis (*M. volans*) which resides and reproduces predominately at higher elevations presumably because it is intolerant of summer temperatures present in lower elevation foothills habitats in summer.

Upper Geer and Plumely Canyons: Both canyons are still supporting higher activity and species richness since the 2013 floods. Calls from 11 species in Geer Canyon and eight species in Plumely Canyon were recorded. For myotis species, Geer Canyon supports highest

number of fringed myotis (*Myotis thysanodes*) as predicted by the location of a maternity colony for this species. Plumely supports high number of small-footed myotis (*M. ciliolabrum*) and relatively high number of little brown myotis (*M. lucifugus*) as well as relatively high numbers of fringed myotis (*M. thysanodes*). Geer Canyon was visited by Townsend's big-eared bats (*Corynorhinus townsendii*), whereas this species was not recorded in Plumely Canyon. Big brown bats (*Eptesicus fuscus*) were relatively abundant in both canyons, whereas hoary bats (*Lasiurus cinereus*) and silver-haired bats (*Lasionycteris noctivagans*) were more relatively abundant in Geer Canyon. In addition, Geer Canyon was the only one to register calls from eastern red bats (*Lasiurus borealis*) and tricolored bats (*Perimyotis subflavus*).

Fracking and Bats: Surveys at two well pads in Weld County showed that bats appeared to avoid flying near the pads as opposed to offsites 100m away. Indeed, high activity and species richness occurred away from both well pads. The larger pad had the largest effect as would be predicted. This pattern is one that we have documented at three other well pads sites and this consistency certainly makes further study compelling (i.e. site near Greeley, Weld County: Offsites 48 passes, Well Pad 8 passes, Ft. Lupton, Aims College, Weld County: Offsite 224 passes, Well Pad 148 passes; Lookout Rd., Boulder County: Offsite 185 passes, Well Pad 112 passes).

Other Comments: Although we did not do much netting some disturbing patterns arose. Netting at Ingersol Quarry resulted in very few species captures with the exception of little brown myotis (*M. lucifugus*). In addition, only 12% of captures were females (N = 4) and only one of these was reproductive. Curiously, two little brown myotis captured had severe injuries to their uropatagia resulting ½ of the right-side membrane being missing (Fig. 21).

Figure 21. One of the two *M. lucifugus* captured with missing halves of their uropatagia. Both individuals had identical injuries to the right side. Bats had already been sacked so we are positive it was not the same individual.

Recent Literature for Boulder County Bats

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