Report on Census of Bats at Hall Ranch and Continued Research at Heil Valley Ranch and Hall II

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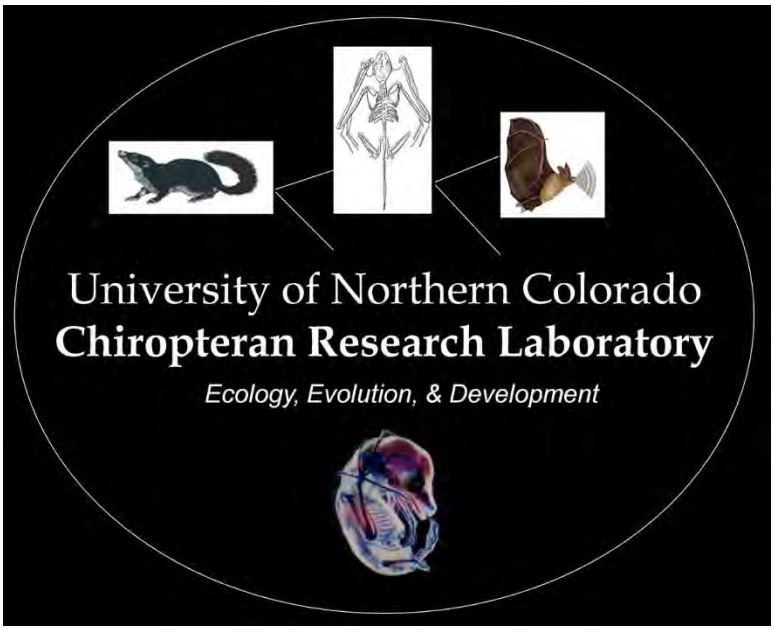

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Abstract. In 2015, we continued research at Heil Valley Ranch with mist netting and sonar detection at Ingersol Quarry, two ephemeral water sources located on the main service road, and in Plumely and Geer canyons. Plumely and Geer canyons continued to be higher in bat activity than before the 2013 floods. We also monitored along the St. Vrain River at Hall II property and found this area to be a migratory corridor for hoary and silver-haired bats. We conducted a sonar survey for bats at Hall Ranch as well as mist netted at water sources and found this property to be highly diverse in bat species and highly active in bat foraging, especially for little brown bats and small-footed myotis.

Introduction

Objectives: **A)** continue to gather data on the Overland Burn sites in terms of bat activity across the landscape, **B)** continue post-flood analysis of Geer and Plumely canyons hard hit by the September 2013 event, **C)** continue to collect data at Ingersol Quarry, **D)** sonar collection along St. Vrain River Hall II, **E)** conduct an intensive sonar survey and mist netting at Hall Ranch, E) begin a study of foraging patterns of bats at prairie dog colonies as compared to meadows lacking prairie dog colonies.

Methods and Materials

Census of Hall Ranch: We used a stratified random sampling technique within gridded areas encompassing Hall II property. We set four detectors (SM2BAT, Wildlife Acoustics) to run consecutively at paired sites (usually 2 forested and 2 meadow sites). Specific placement was judgmental to allow for unobstructed capture of sonar pulses from foraging bats. All SM2s were placed on trees using bungee

cords. We also netted at water sources and in a forest flyway using American-made mist nets (Avinet, Inc.). During netting we also deployed an EM3 sonar detector (Wildlife Acoustics) proximate to the netting site. Captured bats were identified to species and reproductive condition, weight, sex, and relative age were noted. We also checked each individual for any signs of overwinter damage to wings or rostral tissue by *Pseudogymnoascus destructans*, the fungus that causes White-nose Syndrome. We also set SM2s in the Hall Ranch black-tailed prairie dog (*Cynomys ludovicianus*) colony and control sites to test of bats foraged preferentially over the prairie dog colony.

Heil Valley Ranch: We will continue our research efforts at Heil Valley Ranch including sonar plots (SM2s) in the Overland Burn area, sonar detection in Geer and Plumely canyons as well as mist netting in Plumely Canyon as well as Ingersol Quarry. We also mist netted water sources that collected along the main dirt road NE of Ingersol Quarry in the spring.

Hall II: We set SM2s along the St. Vrain River in March, June and October to track presence/absence of bats foraging along the river with special attention to migratory species.

Results

Capture Data: A total of 35 bats were captured at Hall Ranch and Heil Valley Ranch (Table 1). Of the captures at Hall Ranch, two were big brown bats (*Eptesicus fuscus*), one was a hoary bat (*Lasiurus cinereus*), two were small-footed myotis (*Myotis ciliolabrum*), two were long-eared myotis (*M. evotis*), seven were little brown myotis (*M. lucifugus*), and four were fringed myotis (*M. thysanodes*). At Heil Valley Ranch, captures consisted of three big brown bats (*E. fuscus*), one silver-haired bat (*Lasionycteris*

noctivagans), four small-footed myotis (*M. ciliolabrum*), seven long-eared myotis (*M. evotis*), and two fringed myotis (*M. thysanodes*).

Table 1. Capture data from Hall Ranch and Heil Valley Ranch (HVR). MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, MYTH = *M. thysanodes*, EPFU = *Eptesicus fuscus*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, SPP = species, A = Adults, SA = Subadult, F = Female, M = Male, M = Male, NLNP = nonreproductive female, NS = nonscrotal male, L = lactating, S = scrotal, I = inguinal, Mass is in grams.

DATE	SITE	LOCAL	SPP	AGE	SEX	REPRO	MASS
22-Jun	Hall Ranch	Antelop Meadow	no	captures			
23-Jul	Hall Ranch	Forest Pool	MYCI	A	F	NLNP	4.7
23-Jul	Hall Ranch	Forest Pool	MYEV	A	F	NLNP	6.3
27-Jul	Hall Ranch	Pond	MYLU	A	M	NS	7.2
27-Jul	Hall Ranch	Pond	MYLU	SA	M	NS	6.9
27-Jul	Hall Ranch	Pond	MYLU	A	F	L	6.8
27-Jul	Hall Ranch	Pond	MYLU	A	M	NS	7.3
27-Jul	Hall Ranch	Pond	MYLU	A	M	NS	6.9
27-Jul	Hall Ranch	Pond	MYLU	A	M	NS	5.7
27-Jul	Hall Ranch	Pond	MYLU	SA	F	NLNP	5.6
27-Jul	Hall Ranch	Pond	MYCI	A	F	PL	5.4
27-Jul	Hall Ranch	Pond	LACI	A	M	NS	NW
27-Jul	Hall Ranch	Pond	EPFU	A	M	NS	NW
27-Jul	Hall Ranch	Pond	EPFU	A	M	NS	16.9
29-Jul	Hall Ranch	Forest Flyway 1	no	captures			
24-Aug	Hall Ranch	Forest Flyway 2	MYEV	escaped	net		
2-Sep	Hall Ranch	Pool 3	MYTH	A	M	NS	7.3
2-Sep	Hall Ranch	Pool 3	MYTH	A	M	NS	7.9
2-Jun	HVR	Road Hole	MYCI	A	M	NS	4.1
2-Jun	HVR	Road Hole	EPFU	A	M	NS	12.8
2-Jun	HVR	Road Hole	LANO	A	M	NS	9.5
8-Jun	HVR	Ingersol	MYCI	A	M	NS	4.2
8-Jun	HVR	Ingersol	EPFU	A	M	NS	11.8
8-Jun	HVR	Ingersol	MYCI	A	M		4.4
8-Jun	HVR	Ingersol					4
8-Jun	HVR	Ingersol	MYTH	A	F	P	6.5
8-Jun	HVR	Ingersol	MYEV	A	M	NS	5.6
8-Jun	HVR	Ingersol	MYTH	A	M	NS	6.7

DATE	SITE	LOCAL	SPP	AGE	SEX	REPRO	MASS
8-Jun	HVR	Ingersol	MYCI	A	F	P	4.5
8-Jun	HVR	Ingersol	EPFU	escaped	net		
9-June	HVR	Plumely Canyon	no	captures			
11-Jul	HVR	Plumely Canyon	no	captures			
2-Sept	Hall Ranch	Canyon Pool	MYTH	A	M	NS	7.3
2 Sept	Hall Ranch	Canyon Pool	MYTH	A	M	NS	7.9
8-Sep	HVR	Ingersol	MYEV	A	M	NS	6.7
8-Sep	HVR	Ingersol	MYEV	A	M	NS	5.8
8-Sep	HVR	Ingersol	MYEV	A	M	NS	6.1
8-Sep	HVR	Ingersol	MYEV	A	M	NS	5.5
8-Sep	HVR	Ingersol	MYEV	A	M	NS	6.6
8-Sep	HVR	Ingersol	MYEV	A	M	I	8.4
27-Sep	HVR	Ingersol	no	captures			

Captures and EM3 Sonar Recordings at Hall Ranch: We netted at six localities on Hall Ranch property (Fig. 1). The most successful sites were the pond where we captured seven *M. lucifugus* and two *M. thysanodes*, and the Canyon Pool (Table 1).

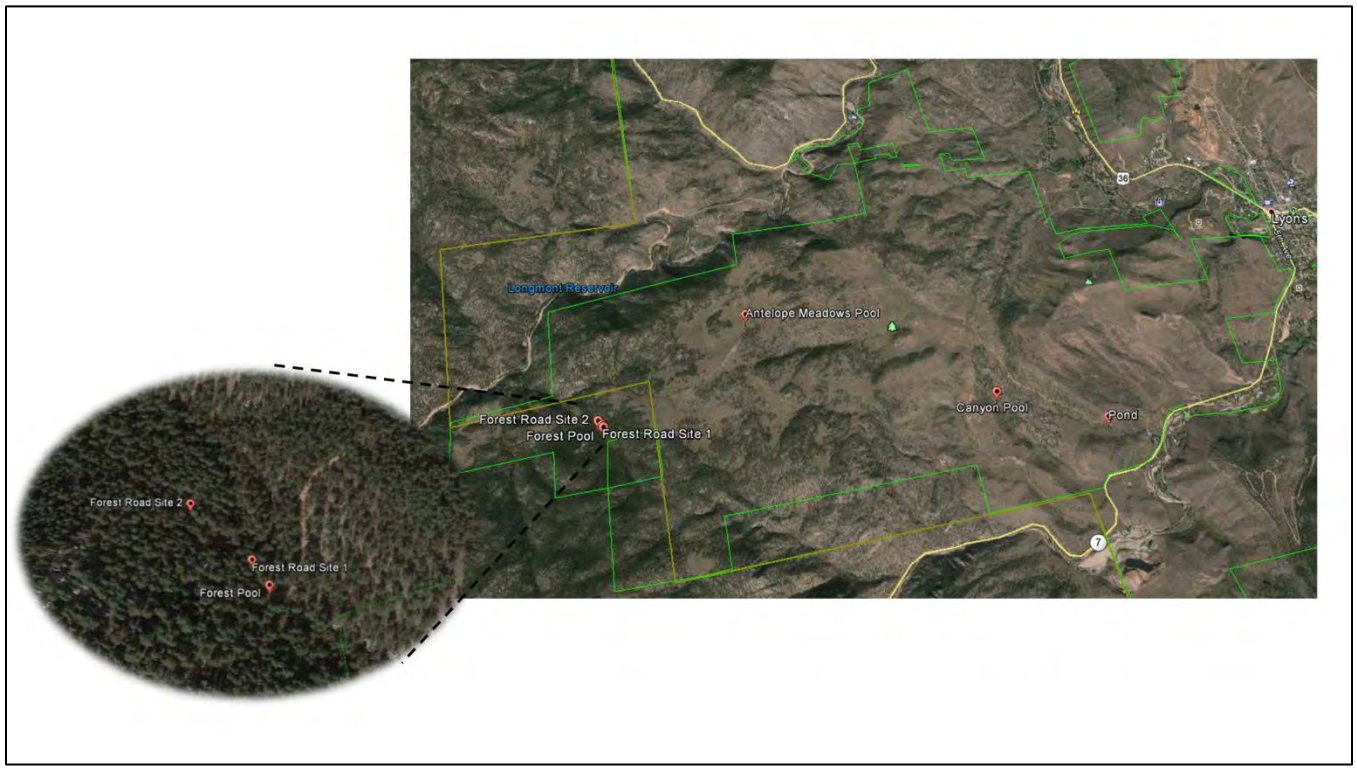

Figure 1. Map of netting areas at Hall Ranch in 2015. Inset shows forest sites in more detail.

Forest Water Pool Site: We netted twice at a forest water pool site near the flyway sites (Fig. 1). Netting on 23 July resulted in the capture of a female nonreproductive long-eared myotis (*M. evotis*) and a female nonreproductive fringed myotis (*M. thysanodes*). EM3 monitoring over the duration of netting (2.5 hours) captured 71 calls, 32 of which were identified to species: 30 were small-footed myotis calls (*M. ciliolabrum*), one was from a long-eared myotis (*M. evotis*), and 1 was from a little brown bats (*M. lucifugus*) (Fig. 2).

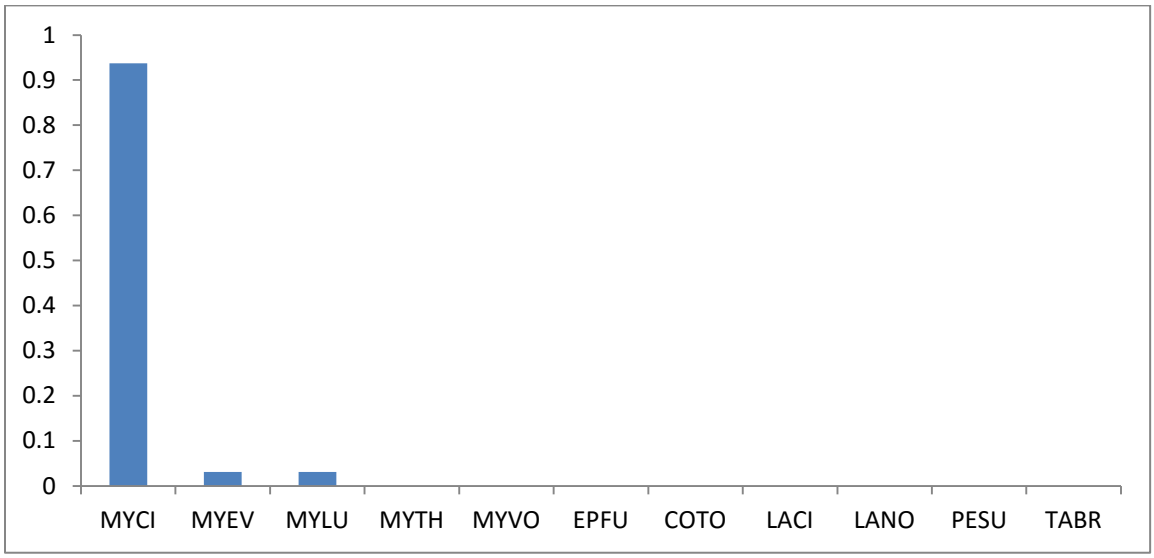

Figure 2. Frequency of presence of species at Forest Pool 1as recorded by an EM3 during netting. MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, MYTH = *M. thysanodes*, MYVO = *M. volans*, EPFU = *Eptesicus fuscus*, COTO = *Corynorhinus townsendii*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, PESU = *Perimyotis subflavus*, TABR = *Tadarida brasiliensis*.

Forest Road Site 1. On 29 July and 24 August there were no captures at this site. EM3 recoding during the duration of netting captured 30 sonar passes, 16 of which were analyzable to species. All recording identified to species (100%) were from small-footed myotis (*M. ciliolabrum*).

Forest Road Site 2. On 24 August we captured a single long-eared myotis (*M. evotis*) that escaped the net before we could remove the individual. EM3 survey during the netting session recorded only 6 sonar passes, two of which were from *M. ciliolabrum* and one of which was from a *M. evotis*.

Antelope Park: On 22 June, EM3 sampling from the small water hole in Antelope Park recorded three passes, one of which was identified as *M. ciliolabrum*. There were no mist net captures at this site.

Pool 3: On 2 September, EM3 sampling of a small pool in a canyon south-west of the prairie dog colony recorded a single call from a *M. thysanodes*. We captured two nonreproductive adult male *M. thysanodes*.

Hall Ranch Pond: EM3 sampling on 27 August at the Hall Ranch pond recorded 246 calls of which 92 were identified to one of six species. Highest number of identified calls were from *M. ciliolabrum* (N = 38), followed by *E. fuscus* (N = 31), *M. lucifugus* (N = 22), *T. brasiliensis* (N = 3), *L. cinereus* (N = 2), and *L. noctivagans* (N = 2) (Fig. 3). We captured seven *M. lucifugus*, 2 *E. fuscus*, 1 *L. cinereus*, and 1 *M. ciliolabrum* (see Table 1 for details).

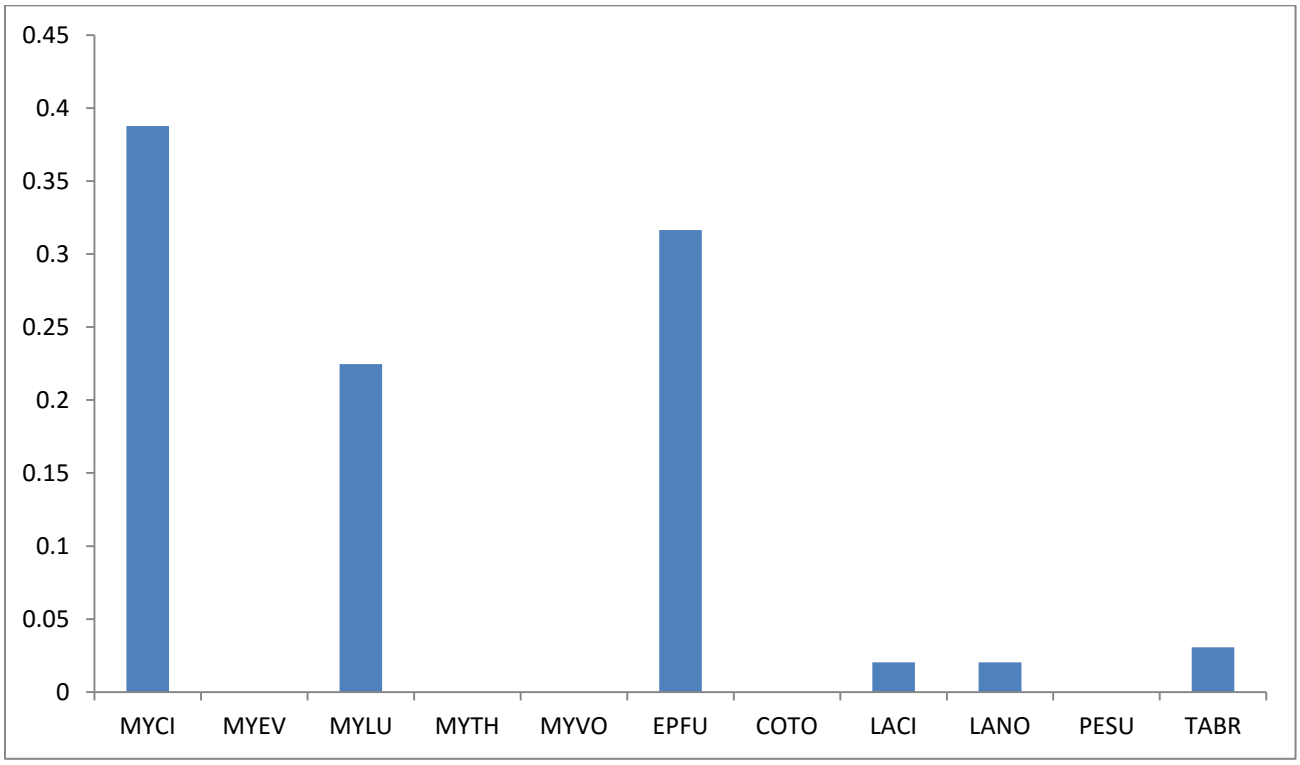

Figure 3. Frequencies of occurrence of bat species at Hall Ranch pond sampled by an EM3 recorded during netting on 27 August 2015 during mist netting. MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, MYTH = *M. thysanodes*, MYVO = *M. volans*, EPFU = *Eptesicus fuscus*, COTO = *Corynorhinus townsendii*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, PESU = *Perimyotis subflavus*, TABR = *Tadarida brasiliensis*.

Hall Ranch SM2 Sonar Survey. We censused 62 sites randomly selected within the park. Most deployments were paired with one detector placed in a forest area or edge and the other central in a

meadow (Fig. 4). Detector were moved every 5th day after four nights of recording regardless of weather. A total of 111,537 call sequences were determined by SonoBat 3.1 to be bat sonar calls.

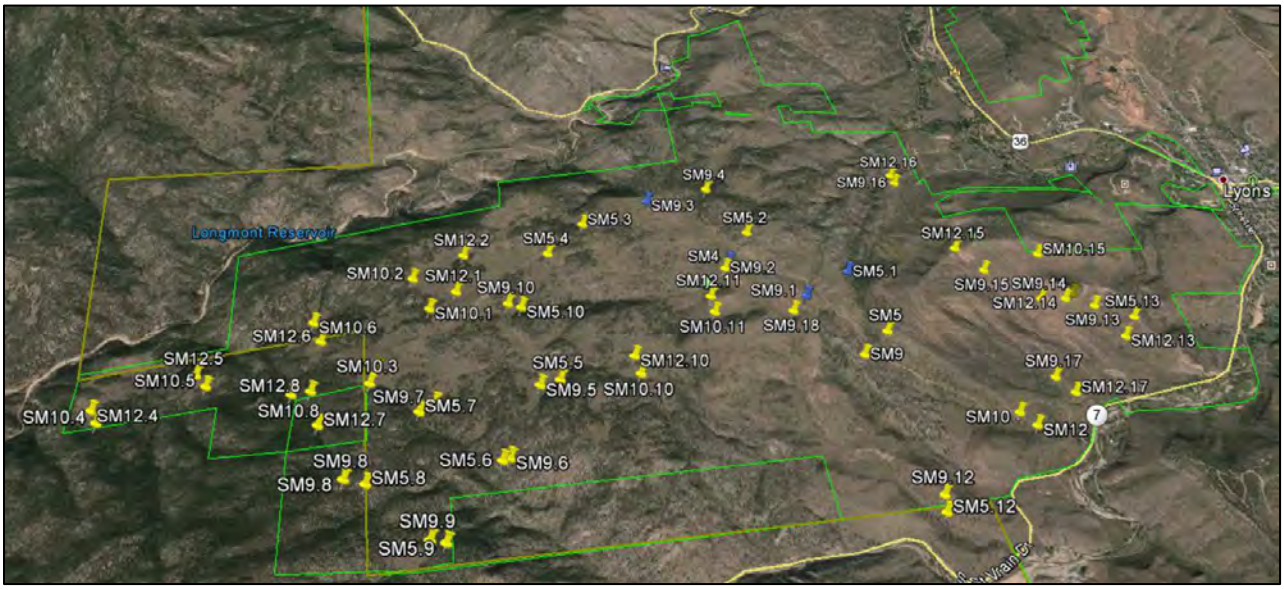

Figure 4. Hall Ranch property showing sampled sites for sonar census in 2015. Blue pins indicate sites associated with prairie dog study.

Assemblages. Species assemblages across the Hall Ranch landscape show a highly diverse and complex coexistence among bat species (Figs 5 through 10). Generally, forested areas were occupied by *Myotis* species, whereas more open habitats were used by *E. fuscus*, *L. cinereus*, and *L. noctivagans*. We also picked up many calls that were analyzed by Sonobat 3.1 to be high probability for Mexican free-tailed bats (*Tadarida brasiliensis*) and Eastern tri-colored bats (*Perimyotis subflavus*), however, neither of these species have been captured on site. In 2014, Adams recorded communication calls in Plumely Canyon and Hall II properties of *T. brasiliensis* indicating the presence of a local colony. In 2013, Adams found a dead male *P. subflavus* in the area of Twin Lakes (Boulder County Open Space)

approximately 20 kilometers south east of Hall II property and 15 kilometers southeast of Heil Valley Ranch representing the second record of this species in Boulder County (Armstrong et al. 2006).

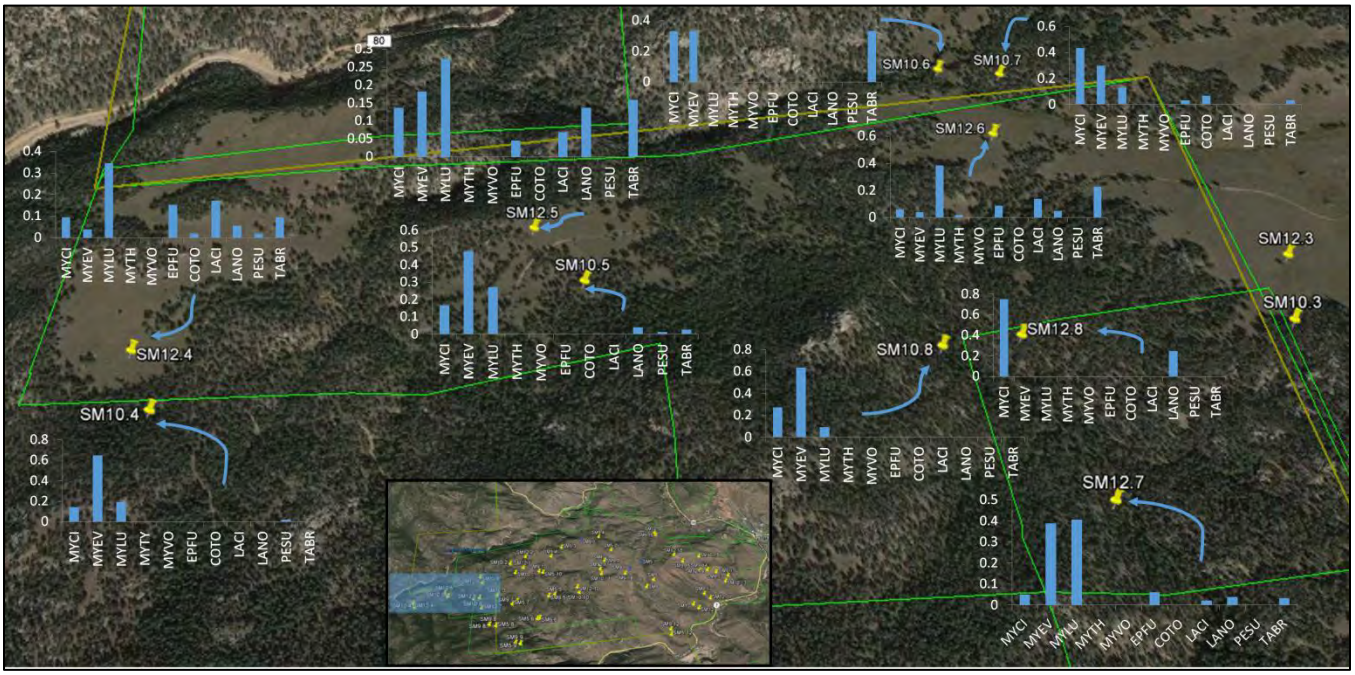

Figure 5. Species assemblages and frequencies of species occurrences at western edge of Hall Ranch. Inset shows area viewed to larger scale. MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, MYTH = *M. thysanodes*, MYVO = *M. volans*, EPFU = *Eptesicus fuscus*, COTO = *Corynorhinus townsendii*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, PESU* = *Perimyotis subflavus*, TABR* = *Tadarida brasiliensis*. * indicates species that have not been captured at Hall Ranch, but appear to exist based upon discrimination of sonar calls.

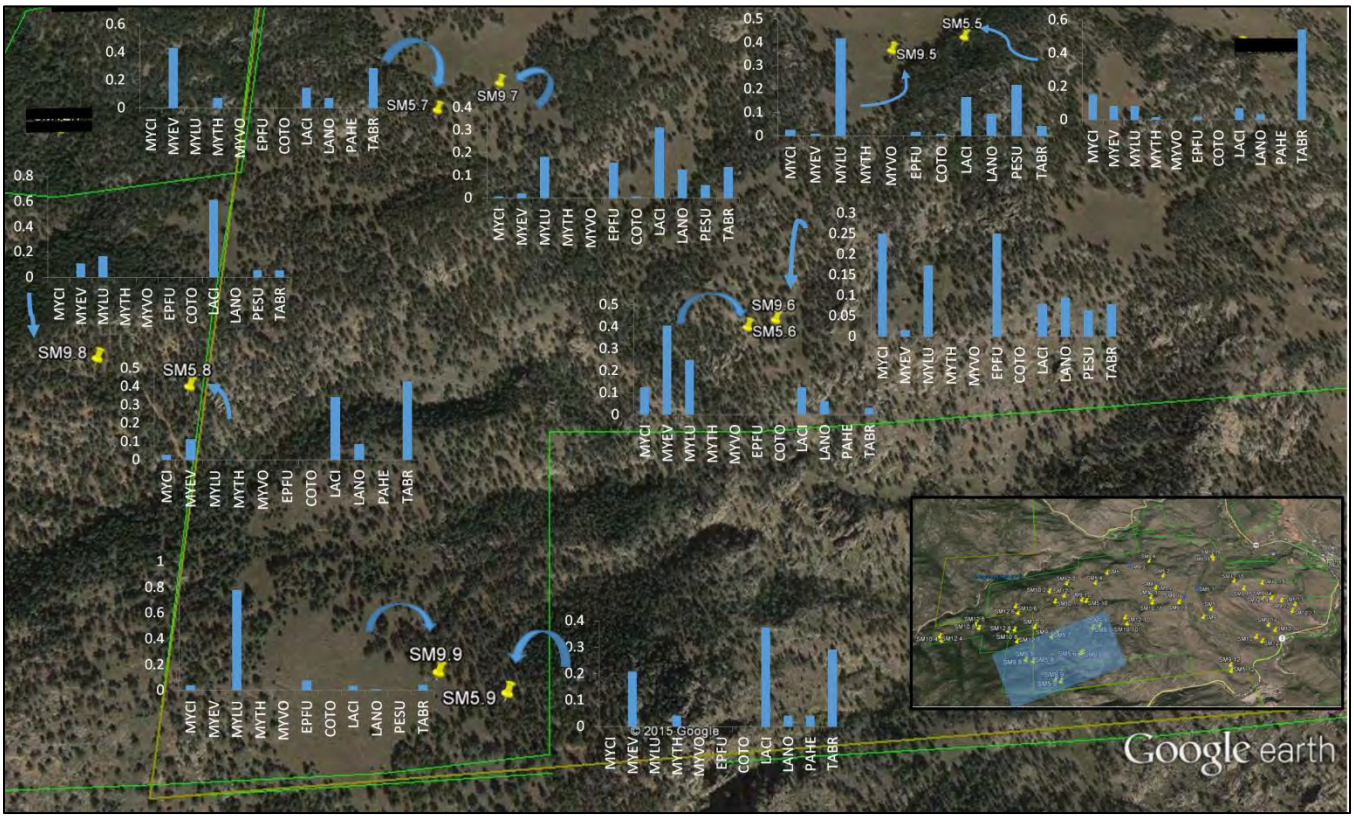

Figure 6. Species assemblages and frequencies of species occurrences at south-western edge of Hall Ranch. Inset shows area viewed to larger scale. MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, MYTH = *M. thysanodes*, MYVO = *M. volans*, EPFU = *Eptesicus fuscus*, COTO = *Corynorhinus townsendii*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, PESU* = *Perimyotis subflavus*, TABR* = *Tadarida brasiliensis*. * indicates species that have not been captured at Hall Ranch, but appear to exist based upon discrimination of sonar calls.

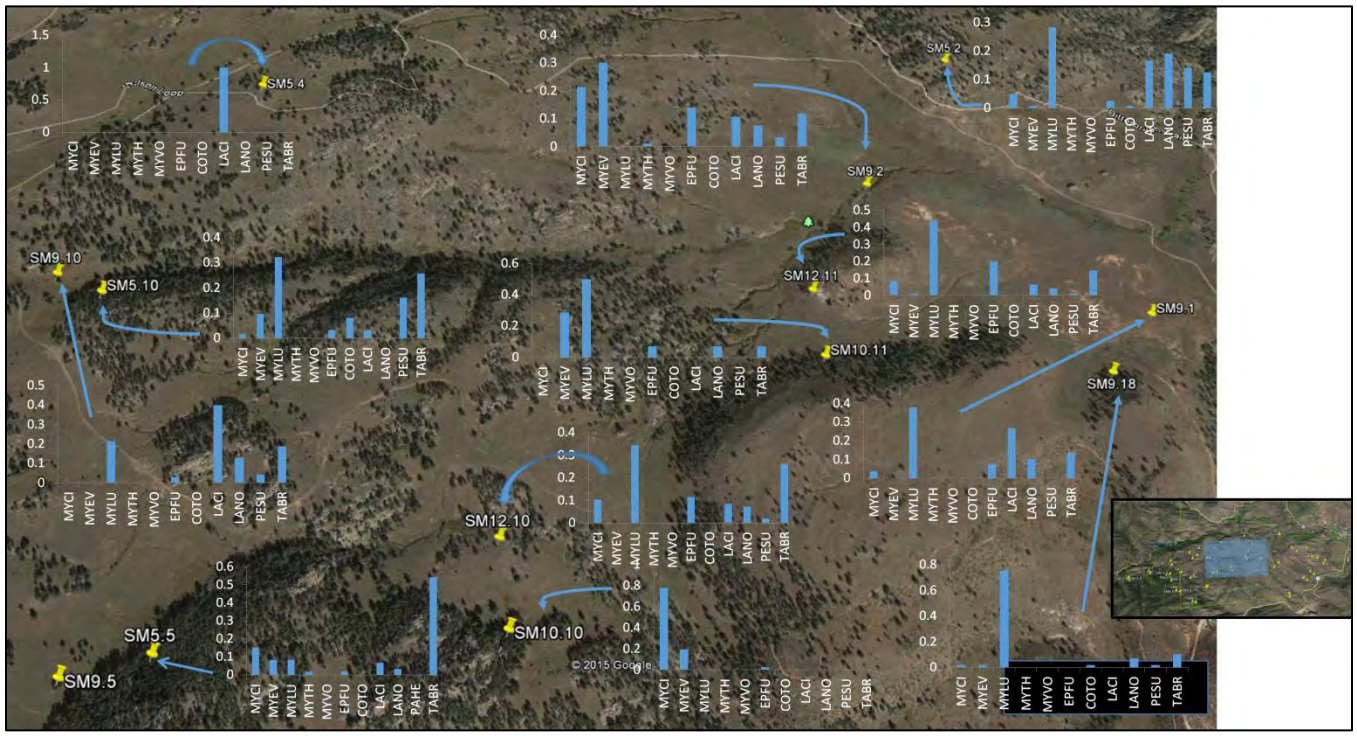

Figure 7. Species assemblages and frequencies of species occurrences at central locals of Hall Ranch. Inset shows area viewed to larger scale. MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, MYTH = *M. thysanodes*, MYVO = *M. volans*, EPFU = *Eptesicus fuscus*, COTO = *Corynorhinus townsendii*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, PESU* = *Perimyotis subflavus*, TABR* = *Tadarida brasiliensis*. * indicates species that have not been captured at Hall Ranch, but appear to exist based upon discrimination of sonar calls.

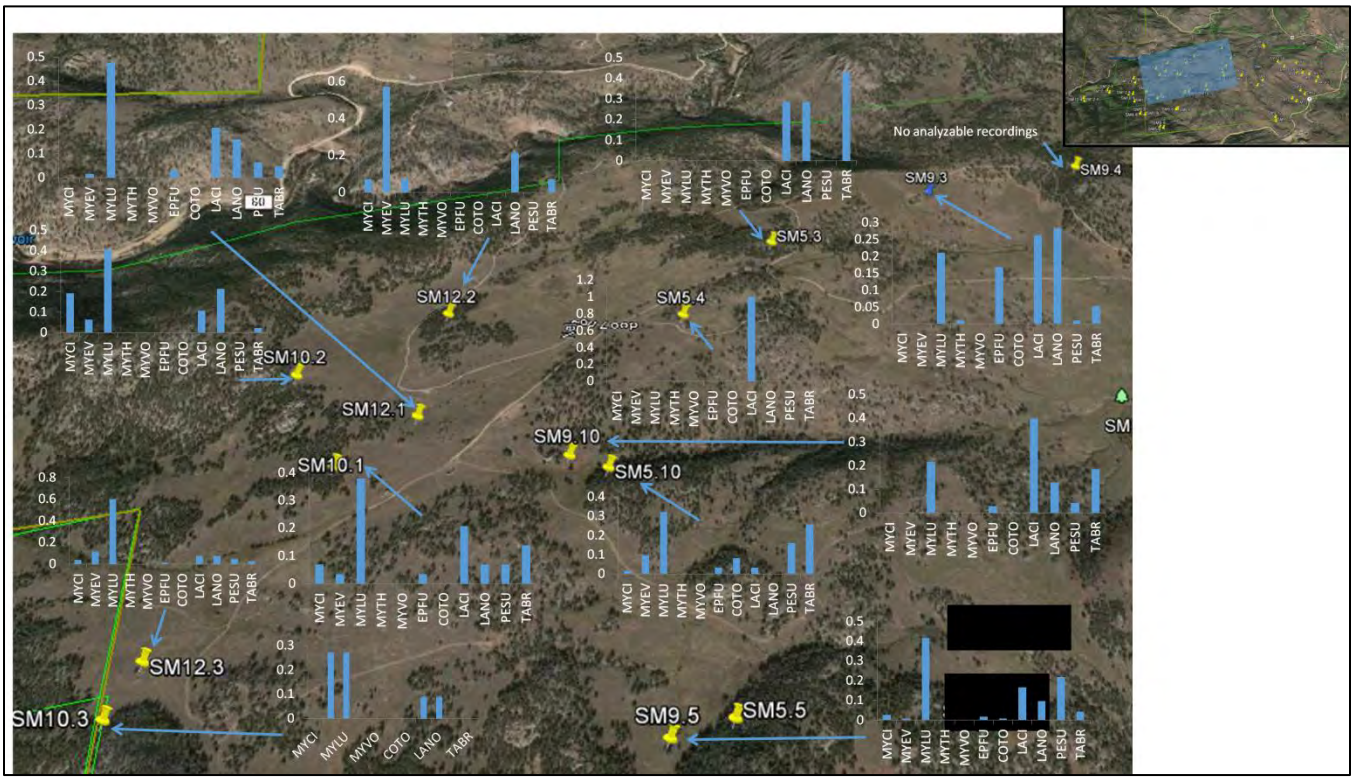

Figure 8. Species assemblages and frequencies of species occurrences at north-central locals of Hall Ranch. Inset shows area viewed to larger scale. MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, MYTH = *M. thysanodes*, MYVO = *M. volans*, EPFU = *Eptesicus fuscus*, COTO = *Corynorhinus townsendii*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, PESU* = *Perimyotis subflavus*, TABR* = *Tadarida brasiliensis*. * indicates species that have not been captured at Hall Ranch, but appear to exist based upon discrimination of sonar calls.

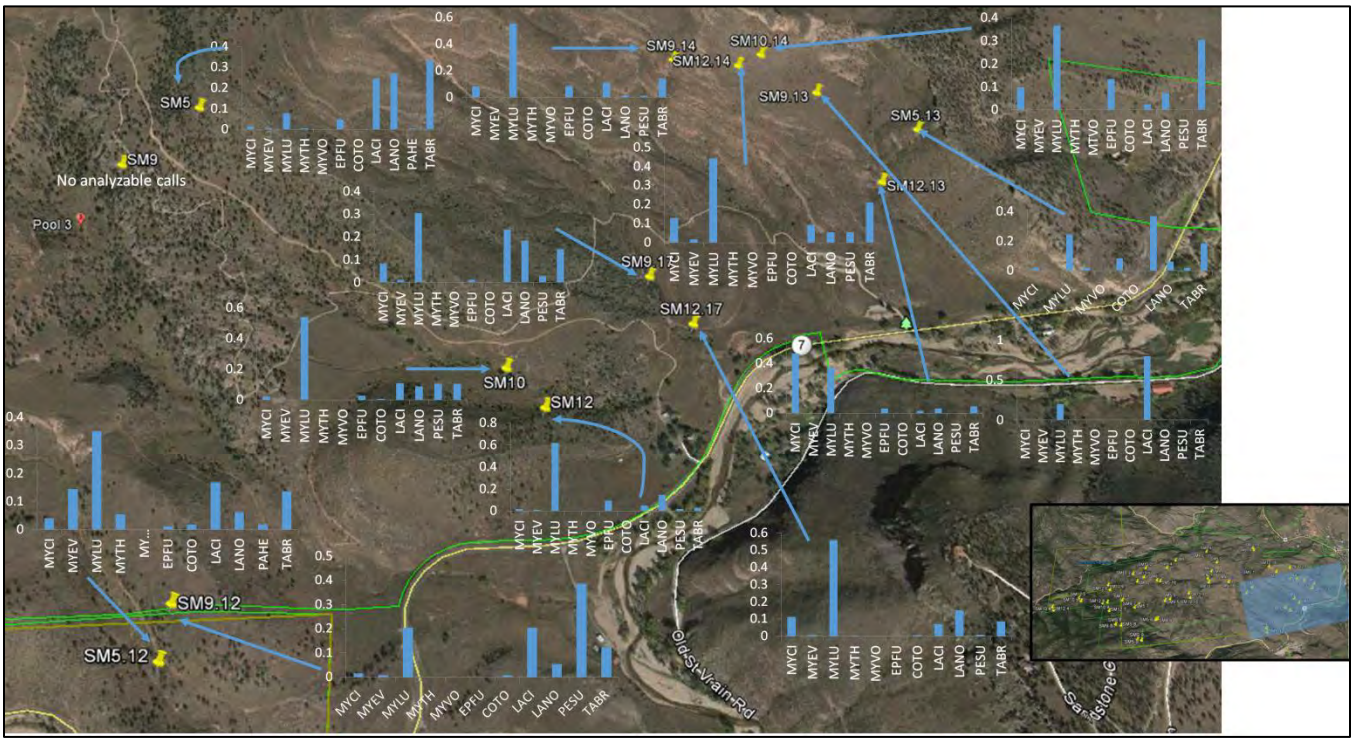

Figure 9. Species assemblages and frequencies of species occurrences at south-eastern locals of Hall Ranch. Inset shows area viewed to larger scale. MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, MYTH = *M. thysanodes*, MYVO = *M. volans*, EPFU = *Eptesicus fuscus*, COTO = *Corynorhinus townsendii*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, PESU* = *Perimyotis subflavus*, TABR* = *Tadarida brasiliensis*. * indicates species that have not been captured at Hall Ranch, but appear to exist based upon discrimination of sonar calls

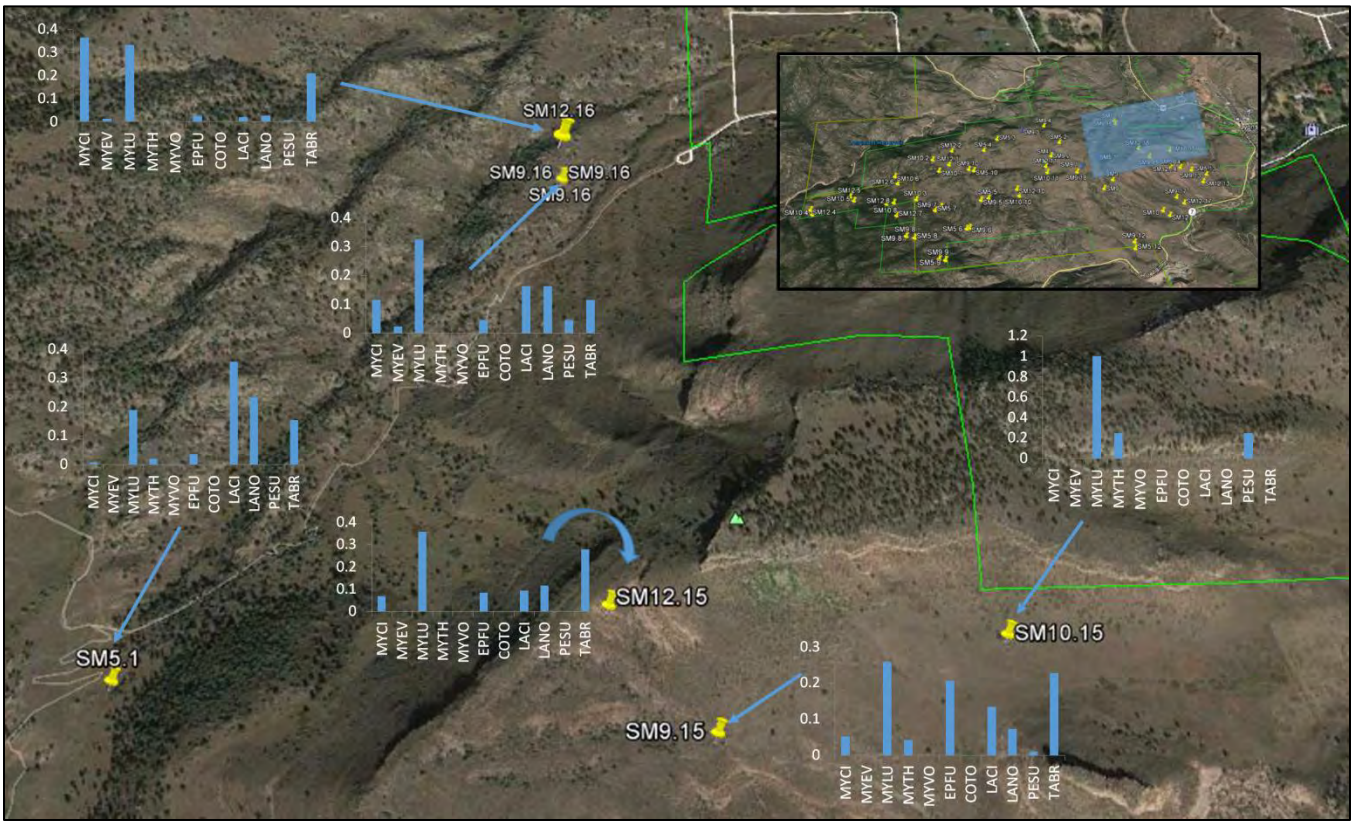

Figure 10. Species assemblages and frequencies of species occurrences at north-eastern locals of Hall Ranch. Inset shows area viewed to larger scale. MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, MYTH = *M. thysanodes*, MYVO = *M. volans*, EPFU = *Eptesicus fuscus*, COTO = *Corynorhinus townsendii*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, PESU* = *Perimyotis subflavus*, TABR* = *Tadarida brasiliensis*. * indicates species that have not been captured at Hall Ranch, but appear to exist based upon discrimination of sonar calls.

Table 2. Raw numbers of calls recorded per species at each SM2 position. MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, MYTH = *M. thysanodes*, MYVO = *M. volans*, EPFU = *Eptesicus fuscus*, COTO = *Corynorhinus townsendii*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, PESU* = *Perimyotis subflavus*, TABR* = *Tadarida brasiliensis*. * indicates species that have not been captured at Hall Ranch, but appear to exist based upon discrimination of sonar calls.

	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	COTO	LACI	LANO	PESU	TABR	Ided Calls	Total Calls
SM5	3	1	18	1		11		57	63	1	78	233	1700
SM5.1												0	1639
SM5.2	6	1	34			3	1	20	23	17	15	120	1941
SM5.3								2	2		3	7	103
SM5.4								2				2	205
SM5.5	9	5	5	1		1		4	2		32	59	1024

	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	COTO	LACI	LANO	PESU	TABR	Ided Calls	Total Calls
SM5.6	4	13	8					4	2		1	32	829
SM5.7		6		1				2	1		4	14	411
SM5.8	1	4						12	3		15	35	589
SM5.9		5		1				9	1	1	7	24	708
SM5.10	1	6	20			2	5	2		10	16	62	3237
SM5.12	23	83	201	31		6	10	96	35	10	78	573	4721
SM5.13	1		12	1		4		18	3	1	9	49	457
SM9.1												0	629
SM9.2	20	28		1		13		10	7	3	11	93	772
SM9.3			20	1		16		25	27	1	5	95	451
SM9.4												0	55
SM9.5	3	1	48			2	1	19	11	25	5	115	842
SM9.6	16	1	11			16		5	6	4	5	64	514
SM9.7	1	3	29			25	1	50	20	9	22	160	835
SM9.8		2	3					11		1	1	18	240
SM9.9	29	3	580	1		57		28	9	3		710	3328
SM9.10			15			2		28	9	3	13	70	1414
SM9.12	2	1	27				1	27	7	51	16	132	1335
SM9.13			4					16				20	82
SM9.14	15		103			16		21	3	2	26	186	1152
SM9.15	5		25	4		20		13	7	1	2	77	314
SM9.16	5	1	14			2		7	7	2	5	43	394
SM9.17	15	2	56			2		43	34	5	27	184	1315
SM9.18	1	1	43			1			4	1	6	57	1161
SM10	4		104			5	1	21	17	20	20	192	21182
SM10.1	2	1	11			1		6	2	2	4	29	217
SM10.2	9	3	19					5	10		1	47	790
SM10.3		3	3					3	3			12	318
SM10.4	8	37	11							1		57	512
SM10.5	13	37	21						3	1	2	77	567
SM10.6	1	1									1	3	131
SM10.7	13	9	4			1	2				1	30	353
SM10.8	3	7	1									11	412
SM10.10	32	8				1						41	393
SM10.11		4	7			1			1		1	14	117

	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	COTO	LACI	LANO	PESU	TABR	Ided Calls	Total Calls
SM10.14	8		30			11		2	6		25	82	1612
SM10.15			4	1						1		6	33
SM12	2	1	59			9		5	14	2	3	95	693
SM12.1		1	30			2		13	10	4	3	63	353
SM12.2	1	8	1						3		1	14	94
SM12.3	3	9	74			1		6	6	4	2	105	557
SM12.4	5	2	18			8	1	9	3	1	5	52	432
SM12.5	6	8	12			2		3	6		7	44	227
SM12.6	6	4	39	2		9		14	5		23	102	495
SM12.7	9	70	73			11		4	7		6	180	940
SM12.8	3								1			4	175
SM12.10	10		33			11		8	7	2	25	96	607
SM12.11	8	1	42			19		6	4	1	14	95	651
SM12.13	26		20			2		1	2		3	54	458
SM12.14	14	2	48					10	6	6	23	109	5569
SM12.15	9		46			11		12	15		36	129	374
SM12.16	109	4	100			8		6	8	2	63	300	2093
SM12.17	38	2	189	1			2	24	51	3	29	339	14444
SM4	482	13	189	15		237		42	243	5	22	1248	8329
SM13.1													10736

Activity Levels: Activity levels across Hall Ranch varied. However, some areas showed exceedingly high activity over the four night duration of sampling at each site. I organized activity into the following categories: super high activity hot spots = > 10K call sequences, high activity hotspots = > 5K call sequences, > 500 call sequences = activity warm spots (Fig. 11). Although sampling occurred over four

nights at each site, be considered that low activity levels at some sites may be due to weather conditions during sampling and not long-term use patterns by bats. In addition, there is also the consideration that capturing sonar calls of bats by detectors is easier in open areas where sound travels longer distances due to lack of obstructions. Thus, forested areas may appear to have less activity than open meadows, but this may be a bias of the recording devices rather than a true indicator of activity.

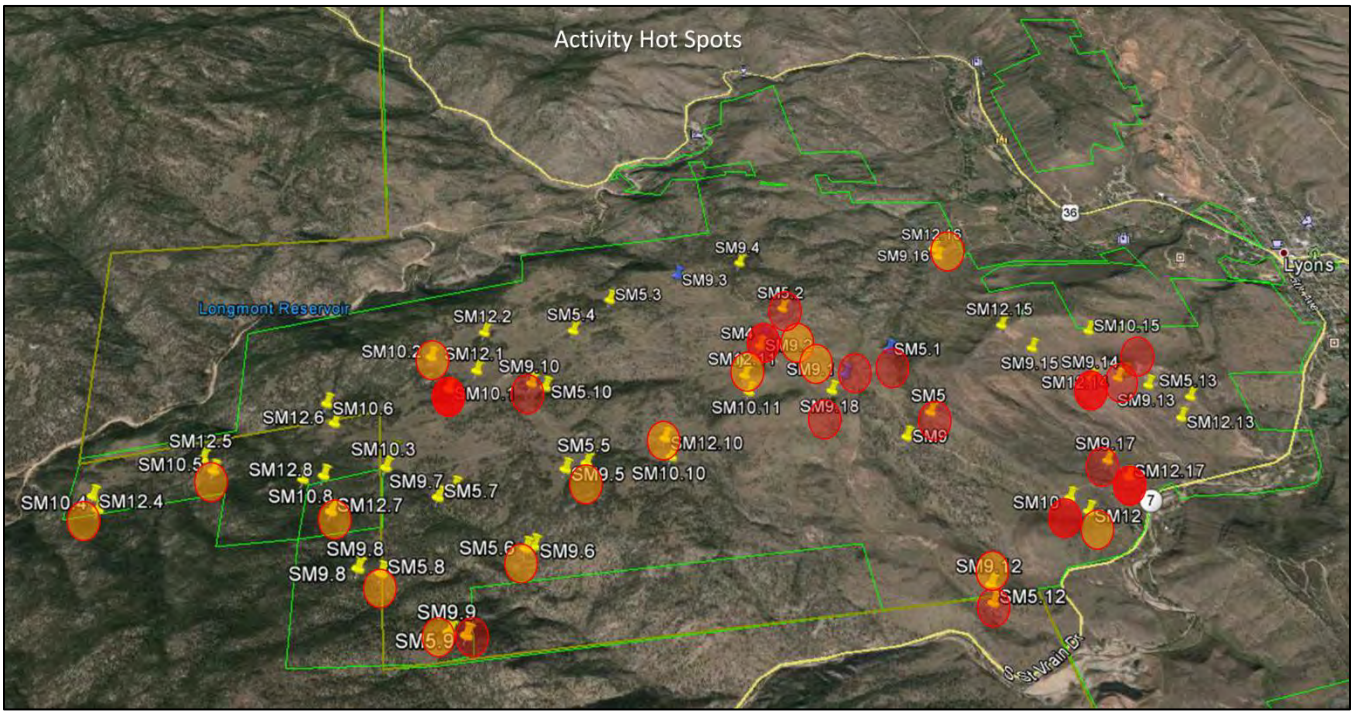

Figure 11. Levels of activity at sonar sites across the landscape. Deep red = > 10K sequences recorded, Light red = > 5K sequences recorded, Yellow = > 500 sequences recorded.

That being said, the largest number of calls were recorded for *M. lucifugus* (984) and the least number of calls recorded were for *Corynorhinus townsendii*, excluding the long-legged myotis (*M. volans*) which was not recorded at Hall Ranch. Use of the landscape was also very high for *M.*

ciliolabrum (984 calls), *L. cinereus* (731 calls), *L. noctivagans* (719 calls), and apparently *T. brasiliensis* (722 calls) (Table 3).

Table 3. Numbers of calls recorded by each speceis at each site with total number of calls per species tallied in the last row. MYCI = *Myotis ciliolabrum*, MYEV = *M. evotis*, MYLU = *M. lucifugus*, MYTH = *M. thysanodes*, MYVO = *M. volans*, EPFU = *Eptesicus fuscus*, COTO = *Corynorhinus townsendii*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, PESU* = *Perimyotis subflavus*, TABR* = *Tadarida brasiliensis*.

	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	COTO	LACI	LANO	PESU	TABR
SM5	3	1	18	1		11		57	63	1	78
SM5.1											
SM5.2	6	1	34			3	1	20	23	17	15
SM5.3								2	2		3
SM5.4								2			
SM5.5	9	5	5	1		1		4	2		32
SM5.6	4	13	8					4	2		1
SM5.7		6		1				2	1		4
SM5.8	1	4						12	3		15
SM5.9		5		1				9	1	1	7
SM5.10	1	6	20			2	5	2		10	16
SM5.12	23	83	201	31		6	10	96	35	10	78
SM5.13	1		12	1		4		18	3	1	9
SM9.1											
SM9.2	20	28		1		13		10	7	3	11
SM9.3			20	1		16		25	27	1	5
SM9.4											
SM9.5	3	1	48			2	1	19	11	25	5
SM9.6	16	1	11			16		5	6	4	5
SM9.7	1	3	29			25	1	50	20	9	22
SM9.8		2	3					11		1	1
SM9.9	29	3	580	1		57		28	9	3	
SM9.10			15			2		28	9	3	13
SM9.12	2	1	27				1	27	7	51	16
SM9.13			4					16			
SM9.14	15		103			16		21	3	2	26
SM9.15	5		25	4		20		13	7	1	2
SM9.16	5	1	14			2		7	7	2	5

	MYCI	MYEV	MYLU	MYTH	MYVO	EPFU	COTO	LACI	LANO	PESU	TABR
SM9.17	15	2	56			2		43	34	5	27
SM9.18	1	1	43			1			4	1	6
SM10	4		104			5	1	21	17	20	20
SM10.1	2	1	11			1		6	2	2	4
SM10.2	9	3	19					5	10		1
SM10.3		3	3					3	3		
SM10.4	8	37	11							1	
SM10.5	13	37	21						3	1	2
SM10.6	1	1									1
SM10.7	13	9	4			1	2				1
SM10.8	3	7	1								
SM10.10	32	8				1					
SM10.11		4	7			1			1		1
SM10.14	8		30			11		2	6		25
SM10.15			4	1						1	
SM12	2	1	59			9		5	14	2	3
SM12.1		1	30			2		13	10	4	3
SM12.2	1	8	1						3		1
SM12.3	3	9	74			1		6	6	4	2
SM12.4	5	2	18			8	1	9	3	1	5
SM12.5	6	8	12			2		3	6		7
SM12.6	6	4	39	2		9		14	5		23
SM12.7	9	70	73			11		4	7		6
SM12.8	3								1		
SM12.10	10		33			11		8	7	2	25
SM12.11	8	1	42			19		6	4	1	14
SM12.13	26		20			2		1	2		3
SM12.14	14	2	48					10	6	6	23
SM12.15	9		46			11		12	15		36
SM12.16	109	4	100			8		6	8	2	63
SM12.17	38	2	189	1			2	24	51	3	29
SM4	482	13	189	15		237		42	243	5	22
SM13.1											
TOTALS	984	402	2464	62	0	549	25	731	719	206	722

***Myotis* Activity**: In terms of the four *Myotis* species found to inhabit Hall Ranch, most calls were recorded of *M. lucifigus* (2,464 calls), followed by *M. ciliolabrum* (984 calls), *M. evotis* (402 calls), *M. thysanodes* (62 calls), and *M. volans* (0 calls) (Table 3).

There were several activity hotspots for *Myotis* species at Hall Ranch and several of these were in forested areas, including some parcels isolated from more contiguous forest stands (Fig. 12).

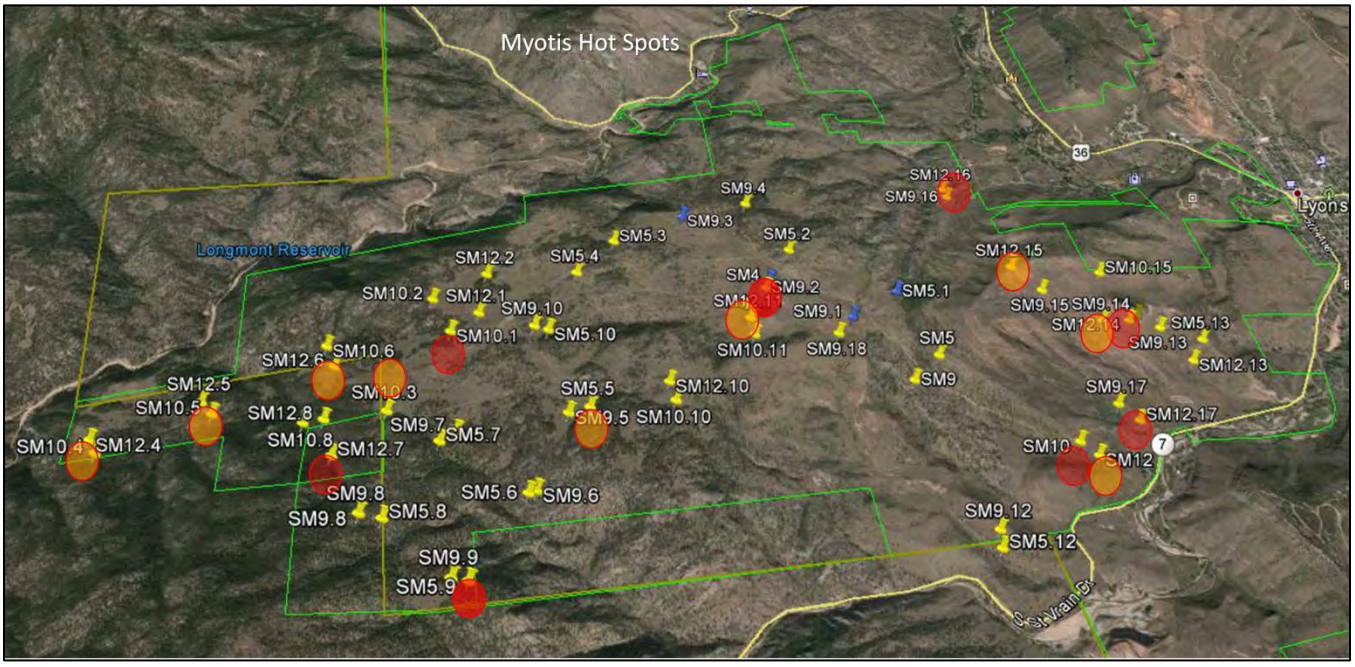

Figure 12. Hot spots of foraging activity for *Myotis* species based upon sonar calls. Hottest zones (marked in deep red) demarcate areas where > 500 *Myotis* calls were gathered over a four night period, whereas lighter red areas indicate > 100 *Myotis* calls recorded and yellow areas indicate where > 50 calls were recorded over a four night period.

Table 4. Number of *Myotis* calls detected at each sonar site over four nights.

Detector	Number of Calls	Category
SM5	23	
SM5.1	0	
SM5.2	41	
SM5.3	0	
SM5.4	0	
SM5.5	20	

Detector	Number of Calls	Category
SM5.6	25	
SM5.7	7	
SM5.8	5	
SM5.9	6	
SM5.10	27	
SM5.12	338	Hot Spot
SM5.13	14	
SM9.1	0	
SM9.2	49	
SM9.3	21	
SM9.4	0	
SM9.5	52	Warm Spot
SM9.6	28	
SM9.7	33	
SM9.8	5	
SM9.9	613	Super Hot Spot
SM9.10	15	
SM9.12	30	
SM9.13	4	
SM9.14	118	Hot Spot
SM9.15	34	
SM9.16	20	
SM9.17	73	Warm Spot
SM9.18	45	
SM10	108	Hot Spot
SM10.1	14	
SM10.2	31	
SM10.3	6	
SM10.4	56	Warm Spot
SM10.5	71	
SM10.6	2	
SM10.7	26	
SM10.8	11	
SM10.10	40	
SM10.11	11	
SM10.14	38	

Detector	Number of Calls	Category
SM10.15	5	
SM12	62	Warm Spot
SM12.1	31	
SM12.2	10	
SM12.3	86	Warm Spot
SM12.4	25	
SM12.5	26	
SM12.6	51	Warm Spot
SM12.7	152	Hot Spot
SM12.8	3	
SM12.10	43	
SM12.11	51	Warm Spot
SM12.13	46	
SM12.14	64	Warm Spot
SM12.15	55	Warm Spot
SM12.16	213	Hot Spot
SM12.17	230	Hot Spot
SM4	699	Super Hot Spot
SM13.1	0	
Total	3,912	

Forest Bats. **Townsend's Big-eared bat (*Corynorhinus townsendii*):** *C. townsendii* is a specialist species of highest conservation concern in Colorado. This species gleans and conducts aerial pursuit of insects in ponderosa pine woodlands and mixed coniferous forests of relatively high density. At Hall ranch, this species was found foraging in 10 locations across Hall Ranch, mostly within forested areas. In most cases only a single sonar sequence was recorded, however, at two sites between five and 10 call sequences were recorded (Fig. 13). In 2007 we tracked a lactating female *C. townsendii* from Ingersol Quarry at Heil Valley Ranch to a roost site off of Hwy 7 in St. Vrain Canyon (Fig. 14). Further checking of this site showed no bats present later in the season, but this site may be active during the reproductive time period. The site is located on private property.

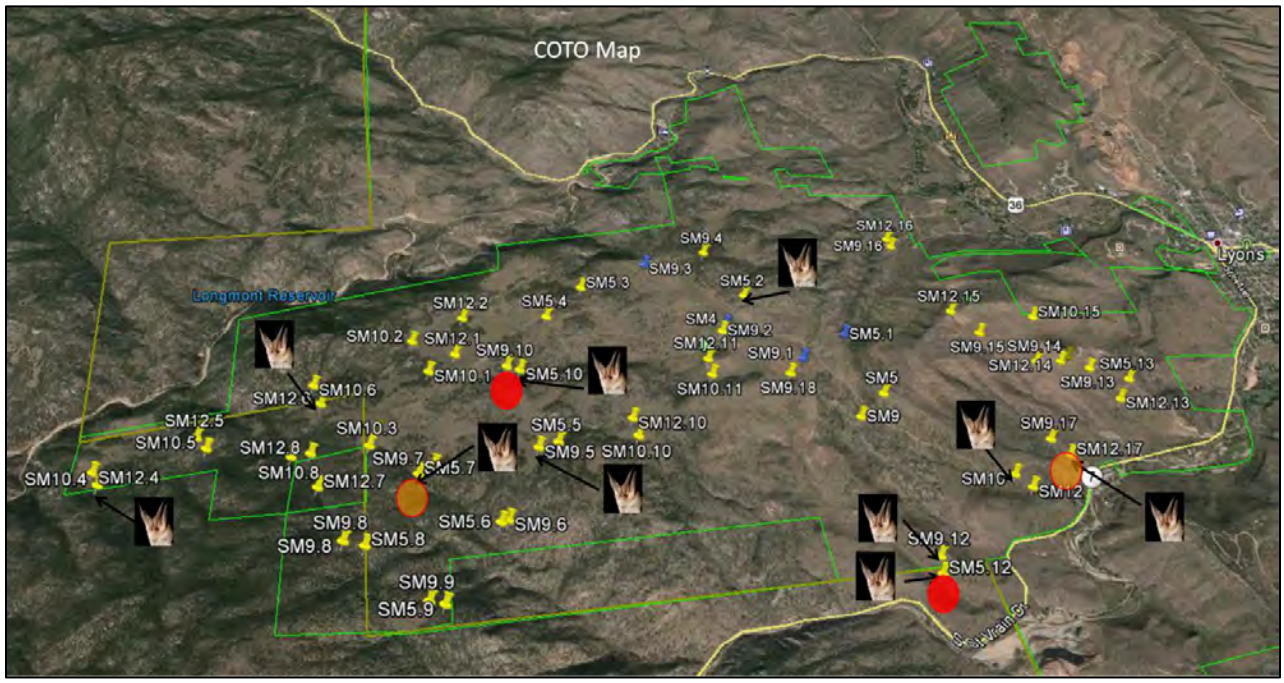

Figure 13. Distribution of foraging areas for *C. townsendii* based upon sonar calls. Ten sites were located, two of which were considered hotspots (5-10 sonar calls recorded, red areas) and two were warm spots (2 sonar calls recorded, yellow areas).

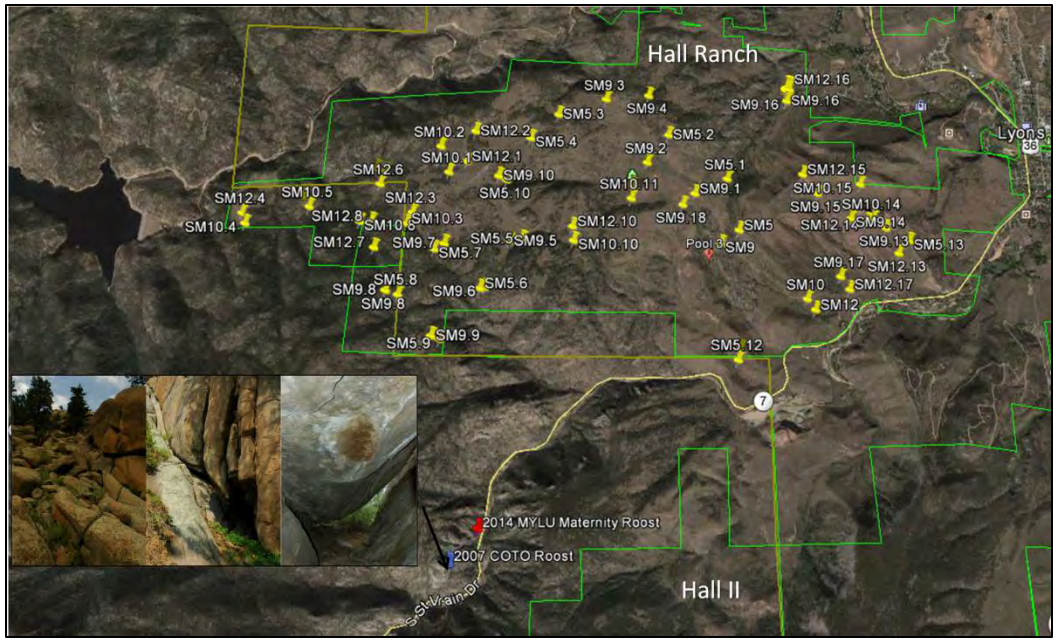

Figure 14. Location of 2007 *C. townsendii* roost and 2014 *M. lucifugus* maternity roost in relation to Hall ranch and Hall II. Insets are pictures of the COTO maternity roost taken in August 2007.

Fringed Myotis (*M. thysanodes*): *M. thysanodes* is also a species of highest conservation concern in Colorado. Individuals conduct aerial pursuit of insects in mixed coniferous forest of relatively high density. At Hall ranch this species was mostly of low occurrence with the exception of two areas, SM 5.12 near the St. Vrain road and river (31 call sequences recorded) and SM 4, one of the control sites for the prairie dog study (see below). A warm spot consisting of four sonar call sequences was found, whereas all other site recorded only a single call sequence over four nights (Fig. 15).

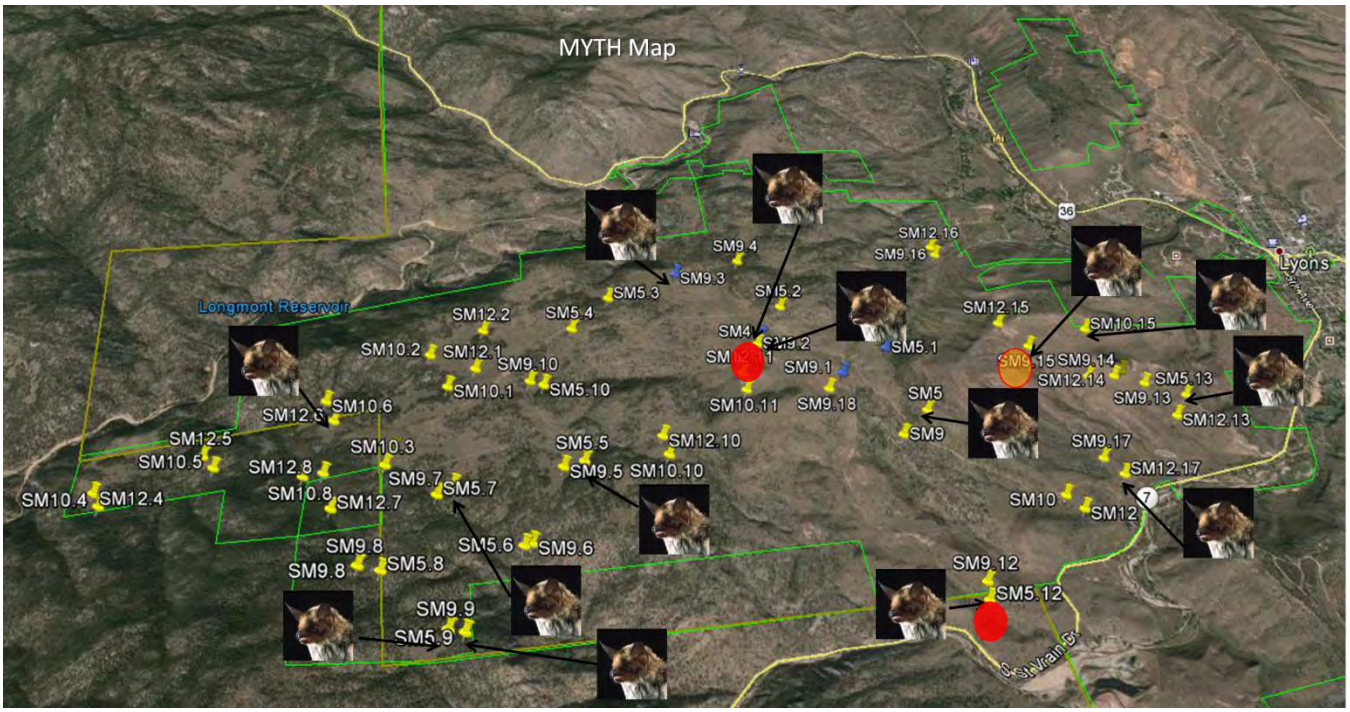

Figure 15. Distribution of fringed myotis (*Myotis thysanodes*) at Hall Ranch in 2015. Red circles indicate hot spots with between 15 and 30 call sequences recorded over four night and yellow area indicates warm spot where 4 sonar call sequences were recorded. All other sites had only a single call sequences with the exception of SM12.6 that recorded two cal sequences.

Long-eared Myotis (*M. evotis*). Although this is not currently a species of conservation concern in Colorado, its highly specialized foraging technique of hovering flight while gleaning insects requires relatively thick mixed coniferous forest stands that are becoming more rare due to excessive beetle kills,

forest thinning to reduce threats of catastrophic forest fires, and increases in forest fire threats due to climate change. Generally, *M. evotis* was found throughout the Hall Ranch, but mostly in low numbers. Exceptions wherein high abundances were noted were mostly in the western areas of Hall Ranch where elevations are higher and mixed coniferous forest occurs in relatively high densities (Fig. 16). Exceptions are in one of the control plots of the prairie dog study (SM4, see below) and near the St. Vrain road and river.

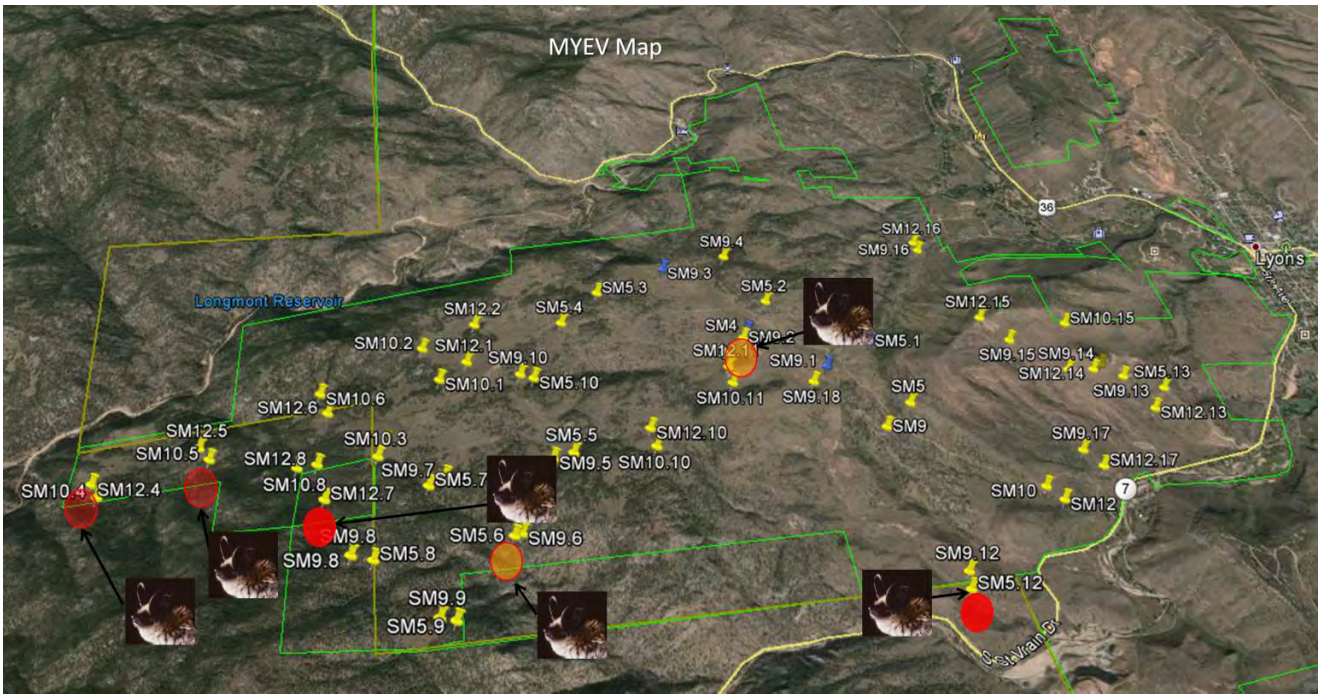

Figure 16. Map showing distribution of higher densities of *M. evotis* at Hall Ranch in 2015. Red circles indicate area where detectors recorded > 50 sequences over four survey nights, light red indicates areas where > 30 sequences were recorded and yellow area indicates where > 10 sequences were recorded.

Hall Ranch Prairie Dog Colony: The black-tailed prairie dog (*Cynomys ludovicianus*) colony at Hall Ranch is a hotbed of bat activity and many of the general foraging hotspots were in or near the colony. A comparison of activity at the prairie dog colony (SM 9.1) over four nights from 6/22-6/26/2015 and an

off-site control (Control Site 1, SM 5.1) showed greater activity at the control site (PD colony 628 passes, control 1,638 passes). In addition, the control site showed greater species richness based on identified calls. However, the prairie dog colony showed higher numbers of *M. ciliolabrum*, *M. lucifugus*, and *E. fuscus* compared to the control 1 site. In addition, this initial control site did have forest edge and also was later found to have some active prairie dog burrows (Fig. 17).

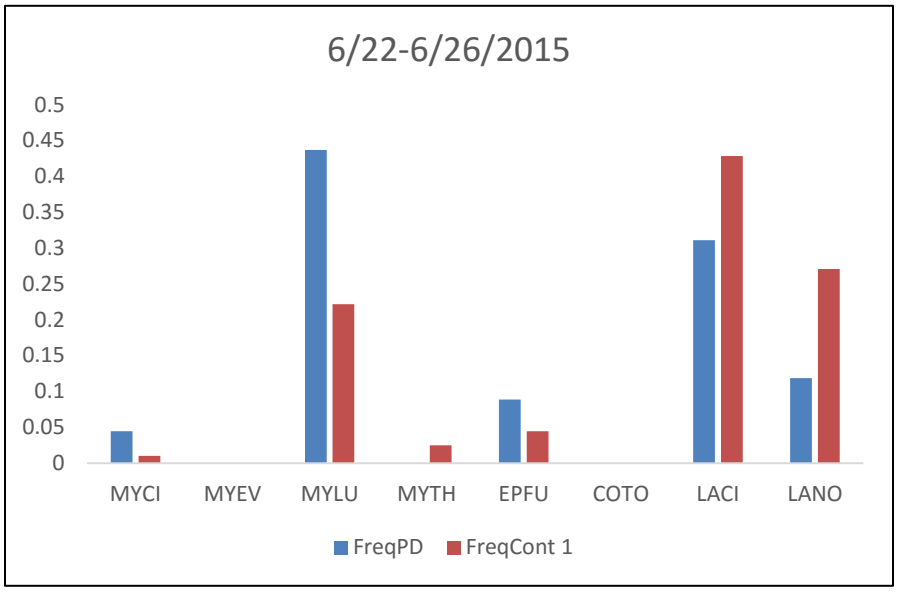

Figure 17. Frequency of occurrence of bats using the Hall Ranch prairie dog colony versus Control Site 1.

We ran tests on the prairie dog colony against two other control sites. For 14 nights we compared the same sampling locality in the prairie dog colony used in the June test (using SM4) with Control 2 located in the field (SM13) on the north side of a dry drainage that currently forms the northern edge to the prairie dog colony.

Within the active prairie dog colony 10,736 bat passes were recorded over a 14 night period in (7/18-7/31/15) (SM13). This averages to 767 passes per night and is surpasses only by the number of

calls recorded at the pond and near the road that parallels the St. Vrain River. Of the calls sequences recorded, 1,409 were identified to species. The largest number of calls recorded during this 14 day session was from *M. ciliolabrum* (N = 664) and the lowest number of calls from a species detected was for *M. evotis* (N = 1). No calls were detected from *M. volans* and *C. townsendii*. The relative frequency of species occurrence shows highest relative use by *M. ciliolabrum* (Table 5 and Fig. 18). Unfortunately, SM4 in the control plot malfunctioned and did not record any files during this test.

Table 5. Numbers of calls of species identified in the Hall Ranch prairie dog colony over a 14 night period.

SPP	No. Calls
MYCI	664
MYEV	1
MYLU	223
MYTH	4
MYVO	
EPFU	33
COTO	
LACI	70
LANO	30
PESU	8
TABR	376

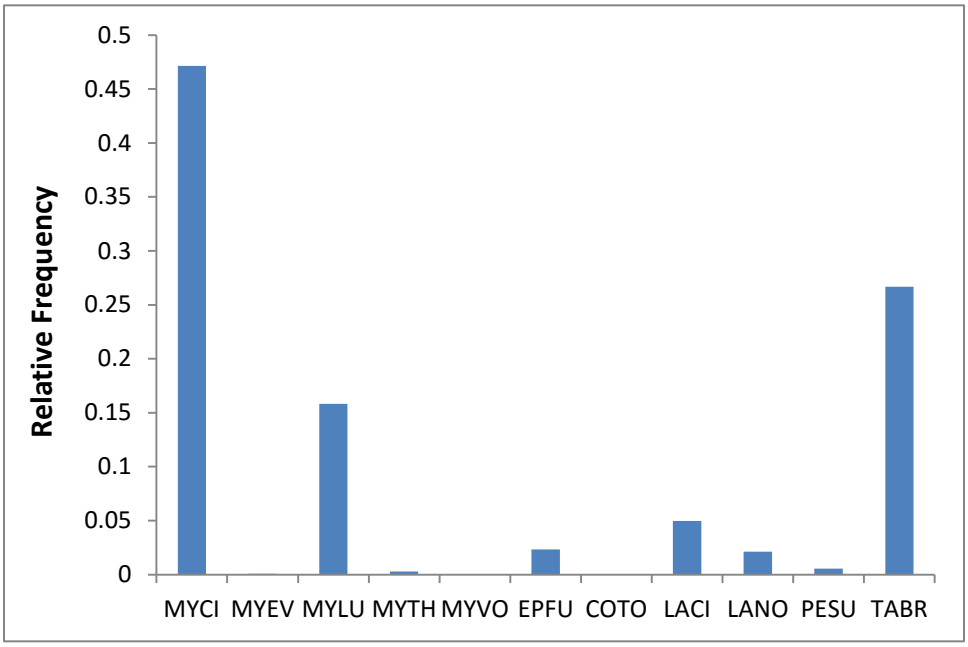

Figure 18. Relative frequency of calls sequences recorded per species over 14 night in the Hall Ranch prairie dog colony in July 2015.

In August, SM 9.1 was placed in the prairie dog colony at the same location as the two previous trails (SM13 and SM 13.1) and run against a Control Plot 2 (SM4) located across a drainage to the north

of the active colony from 8/4-8/16/2015. This field did not appear to have any active prairie dog burrows during summer 2015, but had abandoned burrows from the past. Raw pass numbers by species (based upon those calls that could be identified to species) show higher activity of *M. lucifugus*, *L. cinereus*, and potentially *T. brasiliensis* during this time period (Table 6 and Fig. 19). The relative frequency of species presence showed a similar pattern (Fig. 20).

Table 6. Raw pass data from the prairie dog colony and Control 2 plot (SM4) run at consecutive times over 14 nights.

Species	PDColony	Control 2
MYCI	327	182
MYEV	2	13
MYLU	359	185
MYTH	8	15
MYVO		
EPFU	185	238
COTO		
LACI	90	41
LANO	92	237
PAHE	7	5
TABR	428	275
Totals	1498	1191

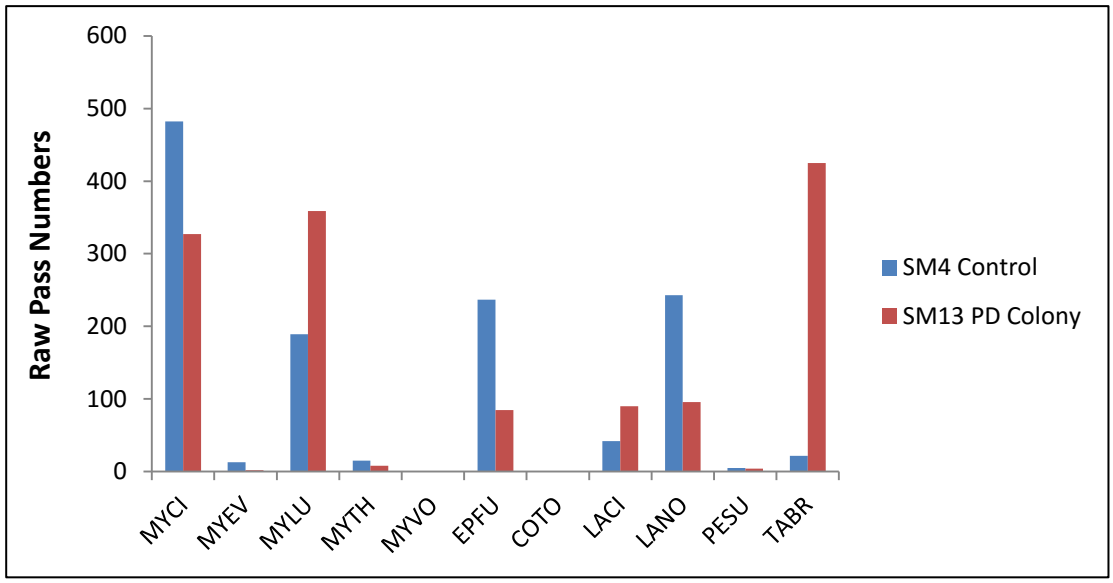

Figure 19. Raw pass numbers of bats calls that could be identified to species compared between the activity prairie dog colony and the abandoned prairie dog colony to the north.

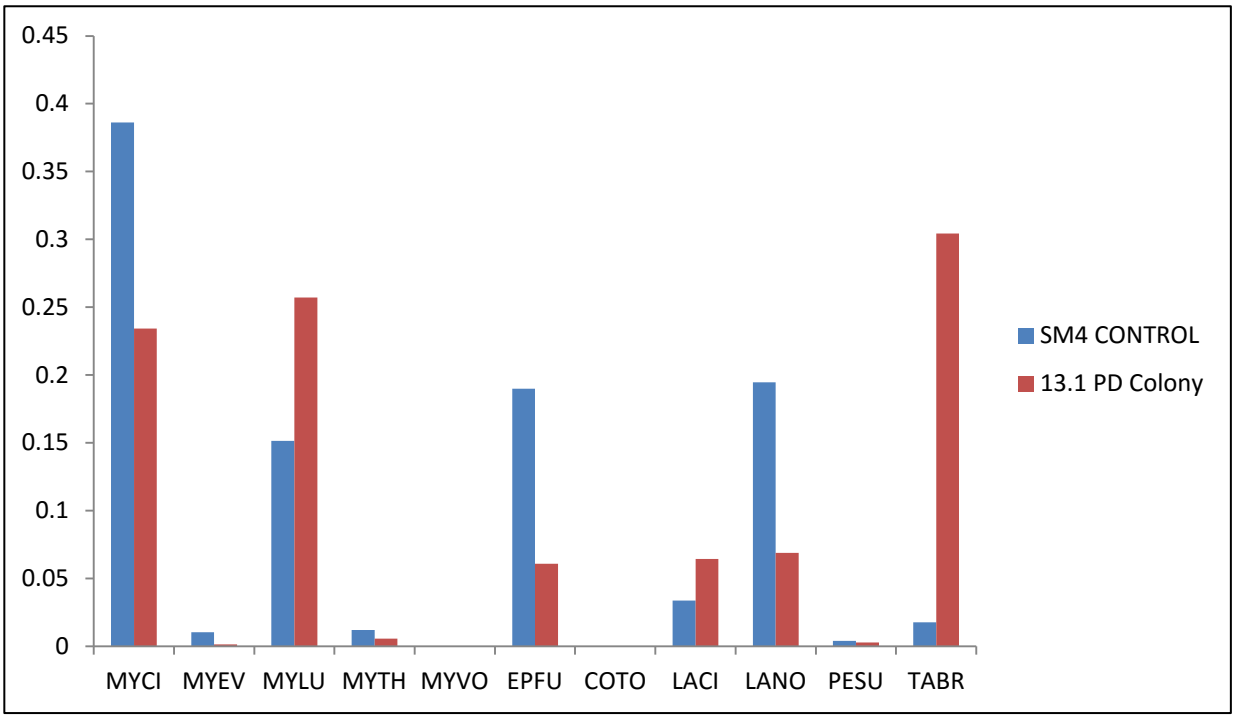

Figure 20. Species relative frequency distribution in of bats calls that could be identified to species compared between the activity prairie dog colony and the abandoned prairie dog colony to the north.

Overall bat foraging activity was highest in the active prairie dog colony, followed closely by the Control 2 site, Control 1 site, and Control 3 site. Species richness was highest in the prairie dog colony and Control 2 sites (9 species), whereas Control Sites 1 and 3 were used by 7 species (Fig. 21).

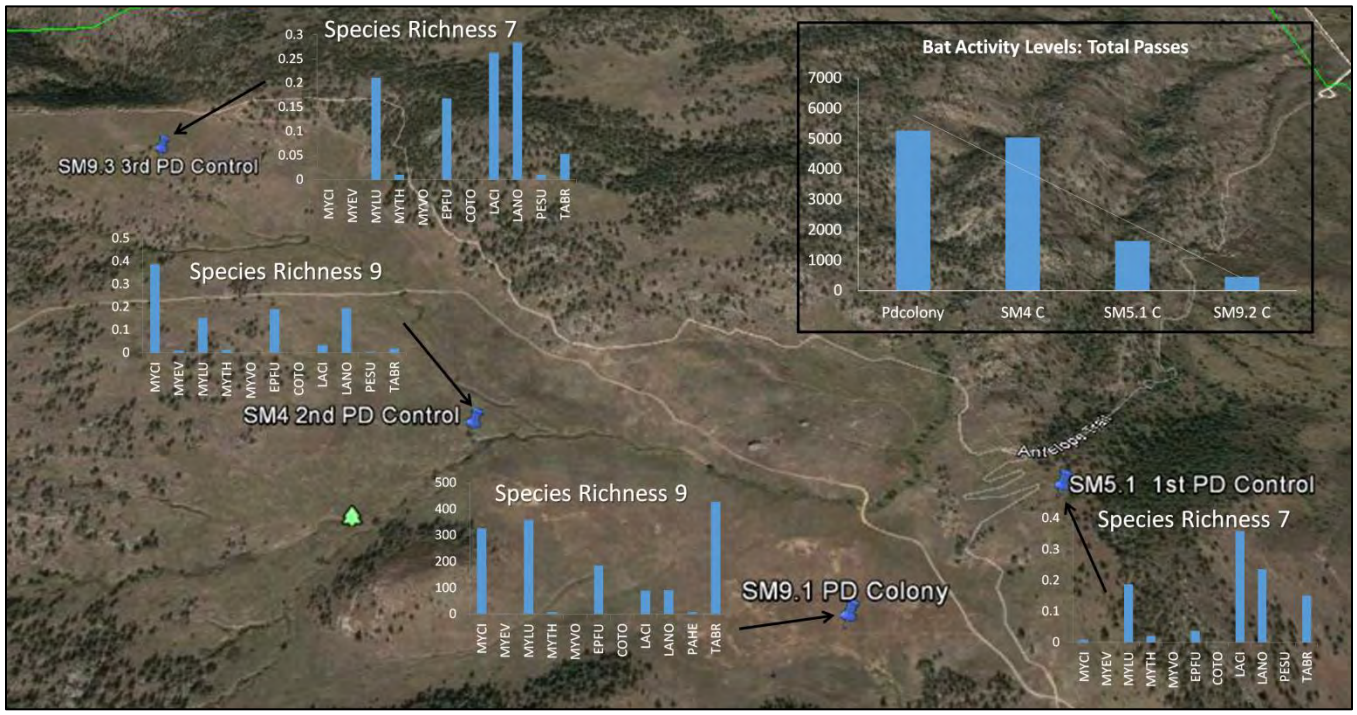

Figure 21. Relative activity levels by species and species richness in the Hall Ranch prairie dog colony as compared to three control sites in proximity to the colony. Inset shows overall activity calculated by the sum of all bat call sequences recorded, many of which could not be identified to species. Highest overall activity level was in the prairie dog colony, followed closely by Control Plot 2.

Heil Valley Ranch

Overland Burn Sites: We set detectors in the two Overland Burn sites that we have been monitoring since 2012.

Burn 1: From 8/14-8/26/15, 1,003 call sequences were recorded over 14 nights resulting in an average calls per night of 71.64. This was similar to activity levels in 2014, but lower than activity levels in 2013 and 2012 (Fig. 22).

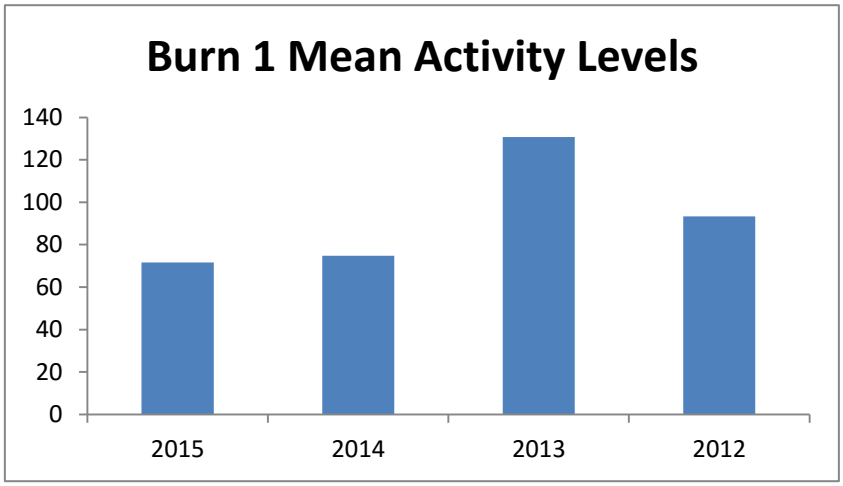

Figure 22. Mean activity levels of bats in the Overland Burn at site 1 from 2012-2015.

In terms of species-specific activity levels, 2015 represented the highest use of this area by *M. ciliolabrum, M. evotis, M. thysanodes, M. lucifugus, C. townsendii*, and *L. cinereus* (Fig. 23).

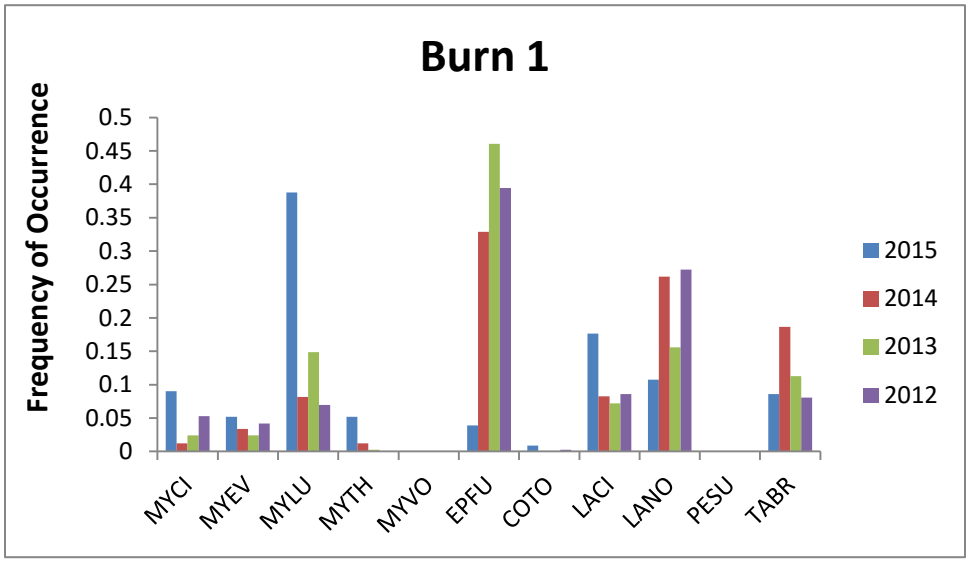

Figure 23. Relative frequency of occurrence by bat species using the Burn 1 site from 2012-2015.

Burn 2: From 8/14-8/26/15 (13 nights, average 29.1 passes per night), we surveys the Burn 2 site of the Overland Burn and recorded 379 sonar call sequences which was down slightly from 2014 activity, 588 call sequences between 8/8-8/21/2014 (14 nights, average 42 passes per night). Compared to the

previous three years, the mean number of passes per night was the lowest since 2012 (Fig. 24). Relative frequency distribution among bat species (Fig. 25), showed increased usage in 2015 by *M. ciliolabrum*, *M. thysanodes*, and *L. noctivagans*. All other species declined in usage.

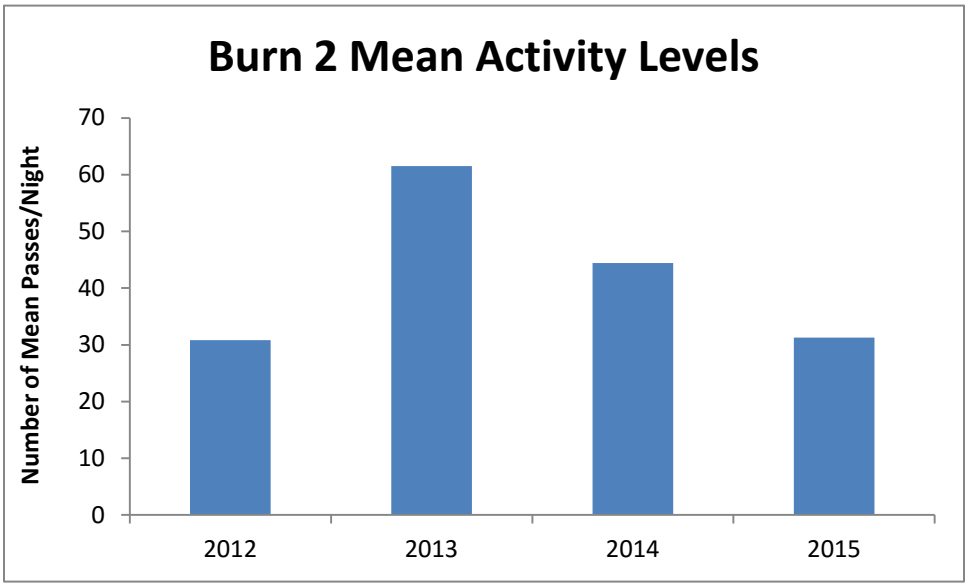

Figure 24. Mean number of passes per night in Burn 2 site in 2015 as compared to the previous three years.

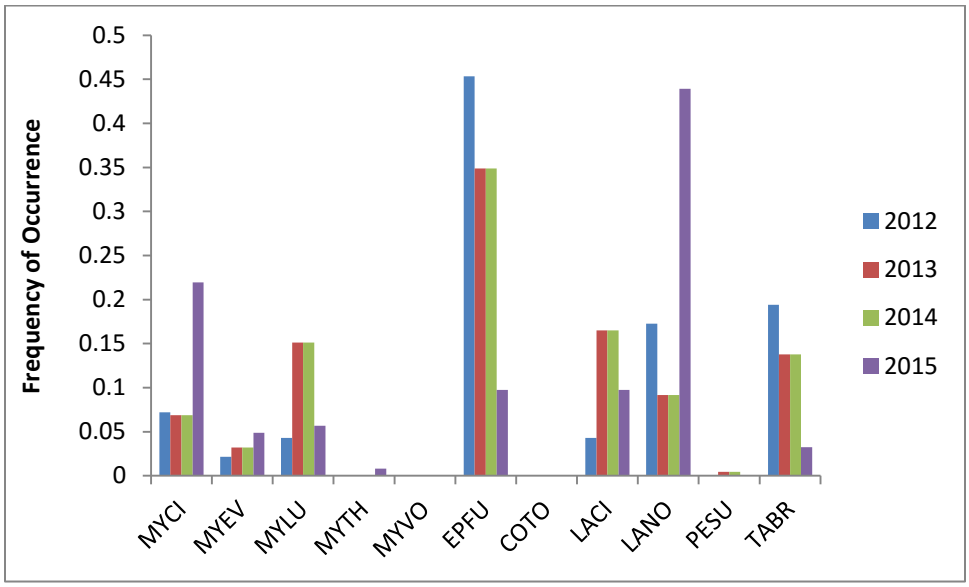

Figure 25. Frequency of occurrence of species using Burn 2 in 2015 compared to the previous three years.

Geer Canyon: SM2s placed in Geer Canyon showed highest activity in late August and early September (Fig. 26). Activity in the canyon did not reach 2014 levels (mean passes = 300.4) until late August (mean passes = 288.7).

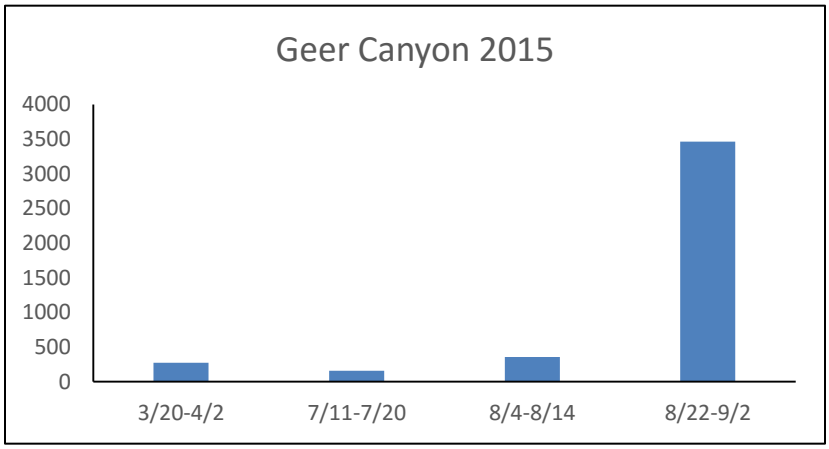

Figure 26. Number of sonar passes recorded from SM2 detectors in Geer Canyon by date.

Plumely Canyon: SM2s placed in Plumely Canyon showed high levels of bat activity (mean number of passes = 3,693.7). Activity levels were nearly the same during the 7/11-7/24 (N = 2,762 over 14 nights, 197.3 passes per night) and the 8/4-8/14 sampling (2,646 over 11 nights, 240.5 passes per night), but skyrocketed in the late August sampling, 8/22-9/2 (5,673 over 12 nights, 468.9 passes per night) (Fig. 27). In 2014, Plumely Canyon showed an average of 300.4 passes per night.

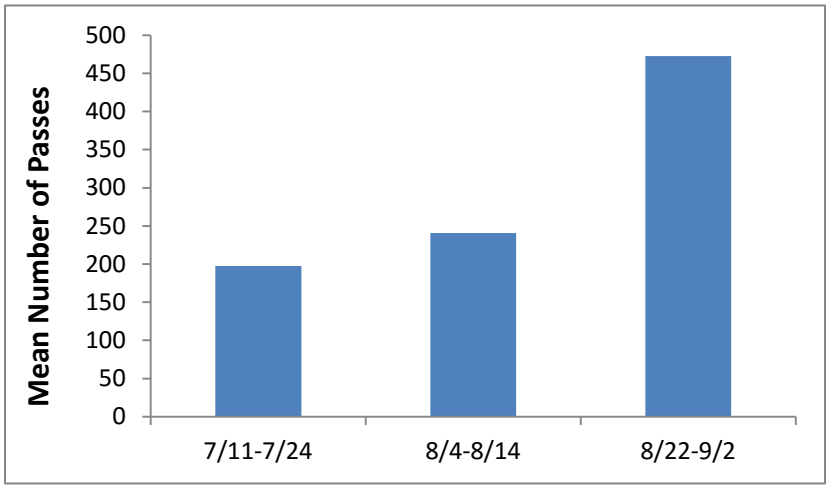

Figure 27. Mean number of passes (all species summed) per sampling period in Plumely Canyon in 2015.

Raw data on number of sonar passes increased dramatically in late August especially for *M. ciliolabrum, M. lucifugus, M. thysanodes, E. fuscus*, and *L. noctivagans* (Table. 7).

Table 7. Comparative raw data on number of passes per species during each survey period in Plumely Canyon.

	7/11-7/24	8/4-8/14	8/22-9/2
MYCI	7	15	99
MYEV	52	24	47
MYLU	71	72	192
MYTH	20	9	431
MYVO			
EPFU	23	5	227
COTO	3	3	9
LACI	32	99	126
LANO	47	25	203
PAHA	14	23	8
TABR	40	21	52
Totals	309	296	1,394

Frequency distribution showed large increases in relative species activity during late August for *M. thysanodes* and *E. fuscus*, whereas relative drops in numbers occurred for *M. evotis, M. lucifugus, L. cinereus*, and *P. subflavus* (Fig. 28). During 7/11-7/24 sampling, the assemblage was dominated by *M. evotis* and *M. lucifugus*, whereas for 8/4-8/14, the assemblage was dominated by *M. lucifugus* and *L. cinereus* and for 8/22-9/2, dominate species were *M. ciliolabrum, M. thysanodes*, and *E. fuscus*.

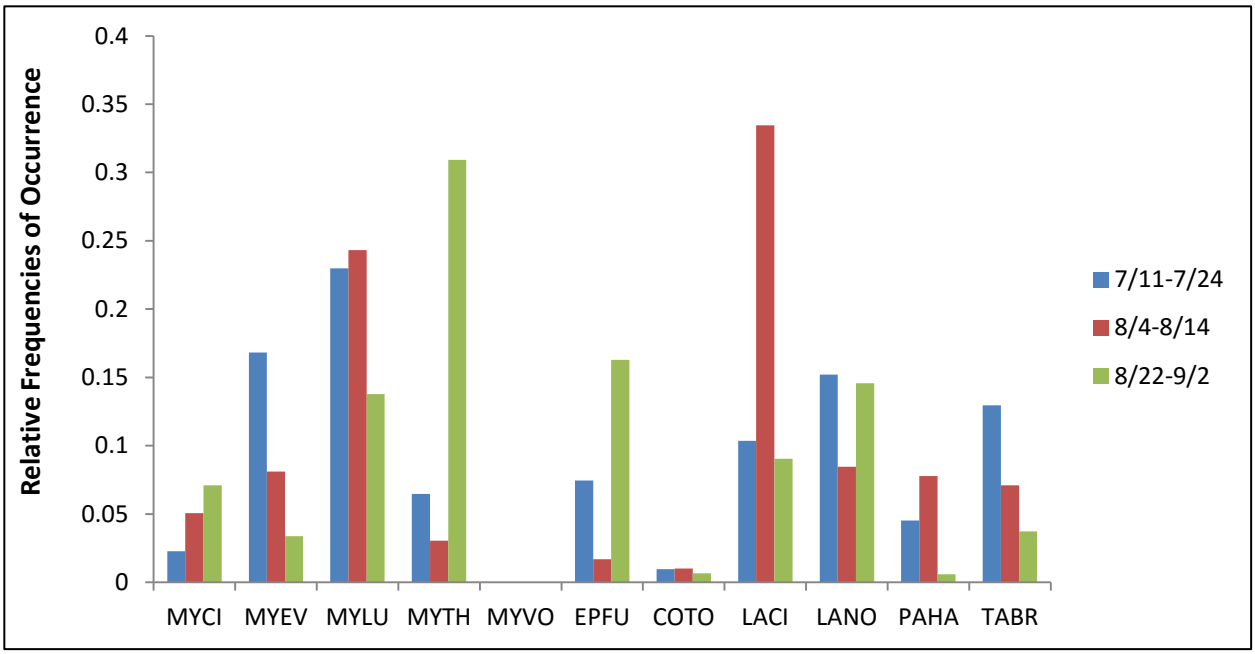

Figure 28. Relative frequencies of occurrence across species across time in Plumely Canyon.

EM3 Sonar Recordings During Netting at Heil Valley Ranch

Road Temporary Water Sources. The wet spring conditions generated pooled water along the main service road in Heil Valley Ranch (Fig. 29). We mist netted two of these pools on 2 June and captured three male bats, one each of *M. ciliolabrum, E. fuscus*, and *L. noctivagans* (see Table 1). We stationed an EM3 sonar detector on tripod off to the northwest (UTMs 40.10.757, 105.17.879) (Fig. 24). EM3 survey recorded 89 call sequences from which was identified activity from *M. ciliolabrum* (four call sequences), *L. noctivagans* (1 call sequence), and *T. brasiliensis* (seven call sequences).

Figure 29. Locations of ephemeral road water holes netted on 2 June 2015 during a an abnormally cool/wet spring. UTM Road Hole 1 = 40.10.738, 105.17.873, Road Hole 2 = 40.10.746, 105.17.873. Location of EM3 sonar detector (40.10.757, 105.17.879) is also shown.

Ingersol Quarry: During netting at Ingersol Quarry on 6/8 we set an EM3 detector near the quarry. A total of 247 call sequences were determined to be bat calls. Of these, 113 were identified to species (Table 8).

Table 8. Distribution of raw call sequences identified to species at Ingersol Quarry on 6/8.

SPP	Calls
MYCI	49
MYEV	3
MYLU	24

SPP	Calls
MYTH	1
MYVO	
EPFU	33
COTO	
LACI	
LANO	1
PESU	
TABR	2
Total	113

Relative frequencies of species-specific activity showed *M. ciliolabrum* to be the most active at Ingersol Quarry on this sampling night, followed by *M. lucifugus* and *E. fuscus* (Fig. 30)

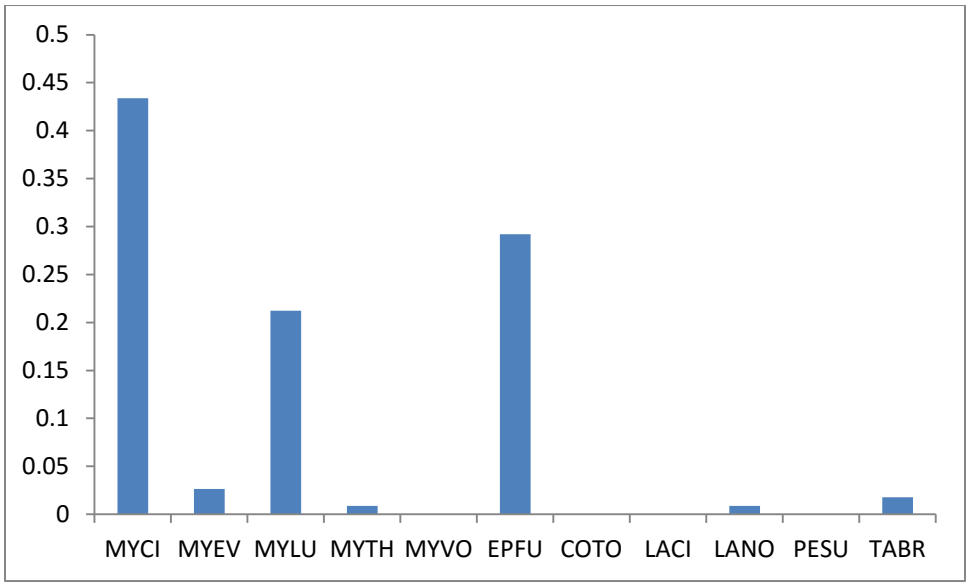

Figure 30. Relative frequency of each species based upon 113 call identifications at Ingersol Quarry.

Hall II

We set an SM2 detector along the St. Vrain River at Hall II property pointed out over the river from 20-30 March, 7-20 June, and 9-19 October. Activity (defined as total number

of bat sonar passes recorded) was highest in June, second highest in October, and lowest in March (Fig. 31).

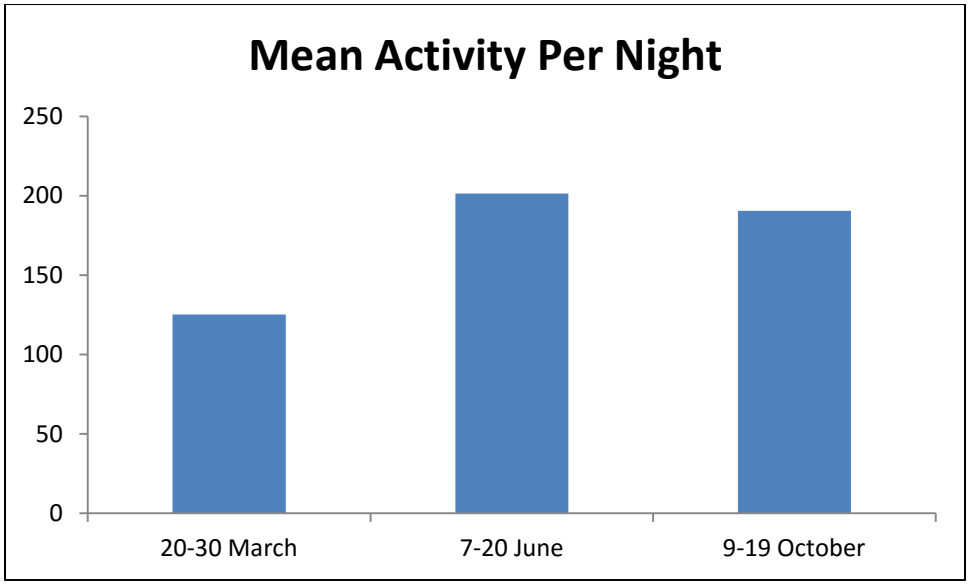

Figure 31. Number of passes divided by the number of survey nights per sampling period gives mean activity per night along the St.Vrain River at Hall II property.

Species composition along the St. Vrain differed markedly during different seasons (Fig. 32). Frequency of occurrence among species shows that in March a large number of migratory silver-haired bat (*Lasionycteris. noctivagans*) come through the site. In June, a large pulse of migratory hoary bats (*Lasiurus cinereus*) appears at the site. Curiously, *L. noctivagans*, in June the numbers at this location drop precipitously in June, but rise again markedly in October indicating a reverse migratory pulse. A slight pulse in *L. cinereus* occurs in October, but indications are that this migratory species does not come back through in a reverse migratory pattern as observed in March.

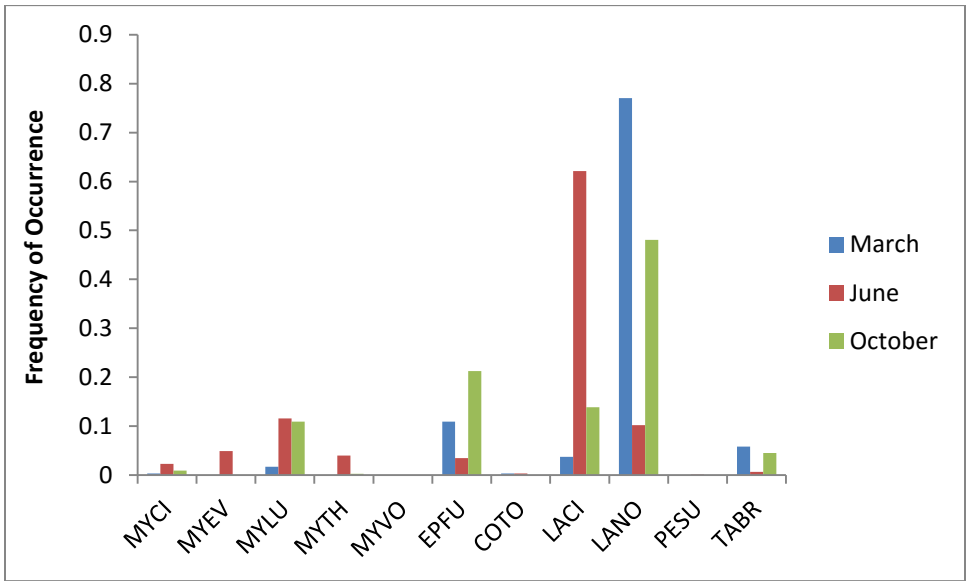

Figure 32. Species frequency distribution along the St. Vrain River in March, June, and October 2015. Patterns for migratory species, *L. cinereus* and *L. noctivagans*, indicates a spring migration pulse for the former and both a spring and fall migration pulses for the latter.

Summary of Most Interesting Data and Recommendations

Hall Ranch is a highly diverse and abundant park in terms of bat activity and species richness. This is likely due to the mosaic of habitats that the park offers allowing for species of various foraging strategies to be accommodated. By far the largest number of calls was from the generalist species, *Myotis lucifugus* (little brown myotis) with second most abundant being the small-footed myotis (*M. ciliolabrum*) that is known to be an edge-foraging species (Fig. 33). Because *M. lucifugus* is one of the species that is highly prone to White-nose Syndrome and has had populations decline by up to 95% in areas where this pathogen occurs, healthy populations of this species in the West is important. As for *M. ciliolabrum*, this is the smallest-bodied species in the eastern foothills and Hall Ranch

appears to house the highest number of this species so far discovered in Boulder County. Interestingly, the highest number of calls were recorded in the prairie dog colony at Hall Ranch (more on this below).

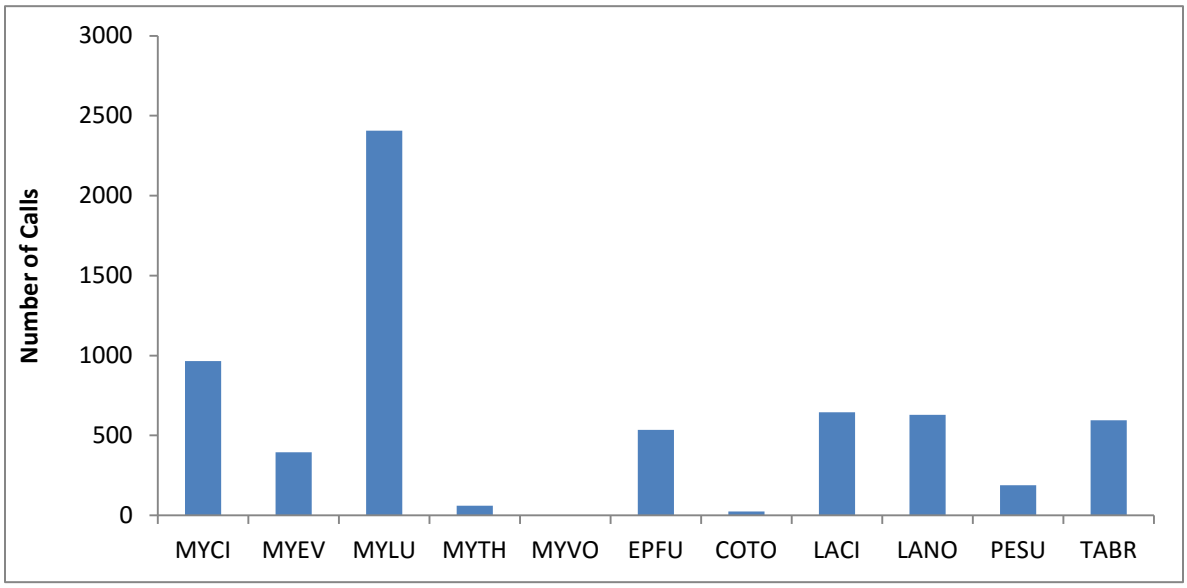

Figure 33. Overall number of calls of each species recorded at Hall ranch in 2015.

Much of the park is ponderosa pine woodlands and montane meadow habitats and therefore there is a tendency for the highest abundance of bat activity to be centered around open area bats. Forest specialist bats, which include *M. ciliolabrum*, the long-eared myotis (*M. evotis*), the fringed myotis (*M. thysanodes*), and Townsend's big-eared bat (*Corynorhinus townsendii*) were less abundant as a group that open aerial foragers (Fig. 34). **Because of this, forest thinning at Hall Ranch, especially in mixed coniferous forest, should be curtailed and possibly not undertaken, in areas where these species occurred**.

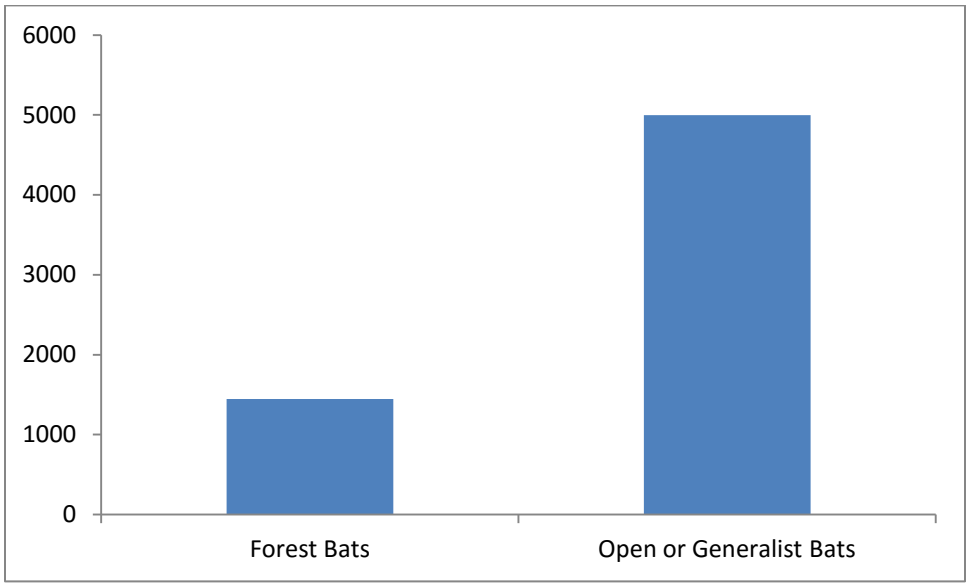

Figure 34. Comparison of number of calls recorded from forest bats versus open aerial and generalist bat species at Hall ranch.

Generally speaking, the meadow containing the prairie dog colony was a significant hotspot for bat activity, not only for open aerial foragers, but also species known to preferentially use forested areas. Therefore, more research is needed on the positive effects of prairie dog colonies on bat foraging patterns and species richness. **In addition, because such large numbers of calls were from small-footed myotis (*M. ciliolabrum*), it seems likely that this species may be using abandoned prairie dog burrows as diurnal roosting sites**. Small-footed myotis have been commonly found roosting on the ground under rocks and within talus slopes, thus the use of burrows would not be surprising. However, this has not been documented and this would be the first bat species known to use prairie dog burrows.

At **Heil Valley Ranch**, the two sites we have been monitoring in the Overland Burn area showed declines in usage by bats in 2015 compared to the three previous years. However, in Burn 1, there were marked increases in foraging by small-footed myotis (*M. ciliolabrum*), little brown bats (*M. lucifugus*), fringed myotis (*M. thysanodes*), and hoary bats (*L. cinereus*). In Burn 2, there were modest increases in activity by big brown bats (*E. fuscus*) and potentially Mexican free-tailed bats (*Tadarida brasiliensis*) with all other species showing declines in activity in 2015 (see Figs 22-25). Bat Activity in Geer and Plumely canyons showed marked increase in late August compared to other months in 2015. In Plumely Canyon, the largest increase in activity in late August was from small-footed myotis (*M. ciliolabrum*), fringed myotis (*M. thysanodes*) and big brown bats (*E. fuscus*) (see Fig. 28). **After three years of data collection, comparative analysis across years will be done.**

Hall II property along the St. Vrain River appears to provide an important migratory corridor for hoary bats (*Lasiurus cinereus*) and silver-haired bats (*Lasionycteris noctivagans*) (see Fig. 32). For silver-haired bats, it appears that large numbers of this species moves through in March presumably headed north to their breeding grounds. This species is in relatively low numbers during June, but increases markedly in October **suggesting a reverse migration from north to its southern over-wintering grounds most likely in Arizona**. Hoary bats appear to migrate through this site in June from their southern over-wintering grounds to northern breeding grounds, but do not appear to use this corridor for their southern migration back to their over-wintering grounds. However, because we did not have

a sonar detector in place in September, we have may misses this pulse. **More research is necessary to better understand these migratory patterns.**

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