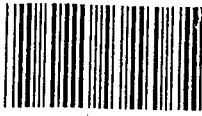


1999 Survey of Boulder County Bats: A St
OSMP Studies 4315

Study



Adams, Rick A.

1999 SURVEY OF BOULDER

COUNTY BATS: A STUDY IN ROOST SITE

DISTRIBUTION AND COMMUNITY ECOLOGY

(59 pages, 18 figures, 10 tables)

OVERSITE AGENCY: *City of Boulder Open Space &*

Boulder Mountain Parks

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ABSTRACT

In 1999, data were gathered on roost site locations, foraging patterns, home ranges, distances traveled and elevations profiles between roost sites and waterholes, temperature profiles of some roost sites, temperature profiles of waterholes and pH values of waterholes. Nine previously unknown roost sites were located for six species and outflight counts were conducted at seven of these colonies. As in 1998, all colonies documented were situated in rock crevices, except for a maternity colony of the long-eared myotis (*Myotis evotis*) that was located in an abandoned house on Flagstaff Mountain. This is the only known maternity site for *M. evotis* thus far located in the Boulder area. Four new roosting sites were located for two species listed by the Western Bat Working (Conservation) Group as being at highest risk, imperiled, and of the highest priority for protection and conservation efforts. Two sites for *Corynorhinus townsendii* were located as well as for *Myotis thysanodes*, in 1999. In this report we are requesting the enactment of protective measures for two of these four sites. Home range data and foraging patterns are documented for five species using triangulation telemetry. Temperature profiles are provided for four roost sites for four species. In addition, water temperature profiles are provided for eight sites, demonstrating that stream sites maintain lower temperatures throughout the summer than do pond sites. Furthermore, stream sites have a higher pH than do ponds, indicating more basic conditions of the water at these stream sites. We hypothesize that the lower pH readings at the stream sites may be a result of significantly higher mineral contents and correlating with high bat species diversity and evenness. This is a hypothesis we anticipate testing in the year 2000.

STATEMENT OF OBJECTIVES AND GOALS: The objective and goals of the 1999 bat project were to 1) add to the locality data base ($n = 7$) for maternity and bachelor diurnal roost sites of Boulder bats using radio telemetry, 2) document colony sizes by conducting visual counts during evening outflights, 3) document distance between water hole sites and diurnal roost sites, 4) document home range and preferred foraging habitats per species, and 5) continue to evaluate bat species richness, diversity, and evenness at waterholes. With the aid of a University of Wisconsin-Whitewater Faculty Development Grant, we were also able to purchase temperature-sensitive data loggers for placement into some roost sites to measure temperature profiles of these sites throughout the summer. With the expertise and gracious help of Ranger and Naturalist Burton Stoner, we were able to place data loggers into rock crevice roosts that required an experienced climber to access.

METHODS:

A. CAPTURE--The study was conducted from 14 May to 24 August 1999 with the help of Kate Thibault, who acted as field assistant for the fourth consecutive year. All bats were captured using American-made mist nets. Trapping was conducted over water and also at several sites in Ponderosa Pine Woodland (PP1, 2, 3) and Douglas Fir Forest (DF1, 2, 3). Captured bats were weighed, sexed, identified to species, and marked with color-coded, numbered, split-ring arm bands (*A.C. Hughes, London*).

B. RADIO TELEMETRY--Ten individuals of six species were tagged with 0.45 g radio transmitters (*Holohil Systems, Ltd., Canada*) and tracked with two 48 channel receivers (*Wildlife Materials, Inc., Ill.*). Individuals were tracked until either the transmitter stopped transmitting,

the transmitter fell from the animal, or the signal was not received over the 10 day life of the transmitter. General location of telemetry signals were first acquired by driving to high points, such as NCAR. After relative positions were documented, exact locations of roost sites were located by hiking and following transmitter signals from tagged individuals hanging in their day-roosts. On average, roost site locations required 21 hours of searching (Range: 5 to 35 hours), and, in most cases, the exact crevice that housed the colony was located. To determine coordinates of tagged bats while they foraged, we used triangulation techniques from two distant landmarks, coordinating the timing of compass readings by walkie-talkie communications. Time intervals between readings were either at 5 or 15 minutes depending on range of movement and flight patterns for that individual. Coordinates were mapped using TOPO Inc. (*San Francisco, CA*) computer software containing Front Range topographical maps. The point at which compass bearings intersect corresponds to the position of the foraging bat in space and time. Circumscribing of intersection points gives the approximate home range for that individual on that night. In order to gather roost site locality data, we used a Magellan 4000XL global positioning system to record coordinates at each roost site. We then used TOPO Inc, computer software to map the locations based upon our GPS readings. Once roosts were located, out-flight counts were made at dusk with unaided eyes until darkness, after which a MoonLight Night Vision scope (*Cabela's Inc., Ill*) was utilized.

C. ROOST TEMPERATURE RECORDINGS--Thanks to a Faculty Development Grant from the University of Wisconsin-Whitewater, I was able to purchase five Onset Computer Corporation 'Hobo' temperature-sensitive data-loggers equipped with six foot probes to measure temperature profiles of bat roost sites (*Forestry Supplies Inc., Ill.*). With the help of

Burton Stoner (Boulder Mountain Parks), one data-logger was placed in a *Myotis thysanodes* maternity roost discovered in 1998 on the climbing rock known as DerZerkle. Another data-logger was placed by K. Thibault and me in the maternity roost of *M. thysanodes* located in 1998 at Gregory Canyon. K. Thibault and I placed another data-logger in the roost of a lactating, female *M. ciliolabrum* located in 1999 in a talus slope near Stockton Cabin, and two data loggers were placed in Harmon Cave, one by Burton Stoner in an *Eptesicus fuscus* bachelor colony and the other by B. Stoner, K. Thibault and me in a *Corynorhinus townsendii* maternity colony (see Table V for placement dates). Data were downloaded from the data loggers after they were removed from the sites using BoxCar Pro version 3.5+ for Windows software, and graphical results from these sites are presented in the results section.

D. pH--We measured pH of water at our six main waterholes in August using an Okidata digital pH meter (*Forestry Supplies, Ill.*).

RESULTS

A. CAPTURE DATA

Waterhole Netting.--A total of 283 bats over 64 net nights was captured in 1999. Of these, 274 captures occurred at nine waterholes and 19 of 283 occurred at four forest-netting sites in 1999 (Table I, II, III & IV). Four individuals were recaptures of individuals banded in previous years. One recapture was a male *E. fuscus* at Stockton Cabin on 18 June (Table I, G), another was a male *M. lucifugus* recaptured at Bear Creek on 5 July (Table I, K), a male *M. thysanodes* was recaptured at Bear Creek on 15 August (Table I, L), and a male *E. fuscus* was recaptured at Bear Canyon on 4 June (Table I, Y).

Table I. Capture data per species per site for 1999.

A. *Myotis ciliolabrum* at Shadow Canyon.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2058	28	Male	NS	4.2	Adult	BK146	18 June
2105	35	Male	NS	4.3	Adult	BK145	18 June
2051	25	Male	NS	4.4	Adult	BK204	20 July
2051	25	Female	L	5.1	Adult	BK205- RTag#81	20 July
2054	28	Female	PL	5.1	Adult	BK206	20 July

B. *Myotis evotis* at Shadow Canyon.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2103	33	Male	NS	5.1	Adult	none	18 June
2117	47	Male	NS	7.1	Adult	BK131	18 June
2118	48	Male	NS	6.3	Adult	BK132	18 June
2120	50	Male	NS	5.2	Adult	none	18 June
2128	58	Male	NS	6.1	Adult	BK134	18 June
2130	60	Female	P NL	7.8	Adult	BK140	18 June
2131	61	Male	NS	5.7	Adult	BK135	18 June
2141	71	Male	NS	5.7	Adult	BK136	18 June
2144	74	Male	NS	6.7	Adult	BK137	18 June
2153	83	Male	NS	5.9	Adult	BK138	18 June
2155	85	Male	NS	5.5	Adult	BK139	18 June
2207	97	Female	L NP	8.0	Adult	BK143	18 June
2209	99	Male	NS	5.5	Adult	BK144	18 June
2247	137	Male	NS	6.2	Adult	BK155	18 June
2258	148	Male	NS	5.8	Adult	BK156	18 June
2103	37	Male	S	6.1	Adult	BK208	20 July
2127	61	Male	S	6.7	Adult	BK207	20 July

F. *Corynorhinus townsendii* at Shadow Canyon.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2210	104	Male	S	10.2	Adult	BK467	20 July

G. *Eptesicus fuscus* at Shadow Canyon. * denotes a recaptured individual. Individual a was initially captured at this site on 27 May 1998.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2200	90	Male	NS	15.9	Adult	BK447	18 June
2203	93	Male	NS	15.6	Adult	BK444	18 June
2213	103	Male	NS	16.2	Adult	BK448	18 June
2223	113	Male	NS	13.9	Adult	BK449	18 June
2229	119	Male	NS	12.9	Adult	BK446	18 June
2229	119	Male	NS	14.3	Adult	BK442	18 June
2229*	119	Male	NS	14.7	Adult	Old-745, 746 New- BK445	18 June
2235	125	Male	NS	19.5	Adult	BK443	18 June
2250	140	Male	S	13.0	Adult	BK450	18 June
2250	140	Male	NS	14.9	Adult	BK453	18 June
2254	144	Male	Partially S	15.1	Adult	BK454	18 June

H. *Lasiurus cinereus* at Shadow Canyon.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2210	104	ESCAP	ED				20 July

I. *Lasionycteris noctivagans* at Shadow Canyon.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2200	90	Male	NS	10.6	Adult	BK141	18 June

J. Myotis ciliolabrum at Bear Creek

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2122	64	Male	NS	---	Adult	BK101	26 May
2224	126	Male	NS	---	Adult	BK112	26 May
2033	30	Female	PostL	4.0	Adult	BK232	11 August
2153	110	Female	PostL	5.5	Adult	BK233	11 August

K. Myotis lucifugus at Bear Creek. * denotes a recaptured individual. Individual a was initially captured on 18 July 1998 at 2119h at NIST site.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2140	82	Male	NS	---	Adult	BK105	26 May
2140	82	Male	NS	---	Adult	BK113	26 May
2159	101	Male	NS	---	Adult	BK106	26 May
2235	137	Male	NS	---	Adult	BK110	26 May
2103	31	Male	NS	5.8	Adult	BK192	5 July
2104	32	Male	NS	6.2	Adult	BK193	5 July
2110	38	Male	NS	6.9	Adult	BK194	5 July
2117	45	Male	NS	7.0	Adult	BK195	5 July
2121	49	Male	NS	7.1	Adult	BK196	5 July
2122	50	Male	NS	6.8	Adult	BK197	5 July
2126-30*	54-58	Male	NS	7.2	Adult	GW140	5 July
2126-30	54-58	Male	NS	7.0	Adult	BK198	5 July
2126-30	54-58	Male	NS	6.7	Adult	BK199	5 July
2126-30	54-58	Male	NS	7.8	Adult	BK200	5 July
2126-30	54-58	Male	NS	8.8	Adult	BK201	5 July
2126-30	54-58	Male	NS	8.2	Adult	BK202	5 July
2126-30	54-58	Male	NS	6.0	Adult	BK203	5 July
2131	59	Male	NS	6.8	Adult	BK180	5 July
2131	59	Male	NS	7.2	Adult	BK183	5 July
2133	61	Male	NS	6.8	Adult	none	5 July
2134	62	Female	PostL	9.2	Adult	BK172	5 July
2135	63	Male	NS	7.4	Adult	BK185	5 July
2140	68	Male	NS	7.0	Adult	BK186	5 July

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2141	69	Male	NS	7.5	Adult	BK187	5 July
2142	70	Male	NS	7.0	Adult	BK188	5 July
2148	76	Male	NS	7.8	Adult	BK189	5 July
2200	88	Male	NS	6.8	Adult	BK190	5 July
2217	105	Female	ESCAP	ED			5 July
2210	98	Male	NS	6.8	Adult	BK191	5 July
---	---	Male	NS	7.0	Adult	BK184	5 July
2005	20	Male	NS	6.6	SubAdult	BK267	24 Aug

L. Myotis thysanodes at Bear Creek. * denotes a recaptured individual. Individual a was initially captured on 15 August 1997 as a juvenile at this site.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2056	38	Female	L NP	---	Adult	BK103	26 May
2102	44	Female	L NP	---	Adult	BK104	26 May
2117	59	Male	NS	---	Adult	BK102	26 May
2220**	122	Male	NS	---	Adult	Old-O621; New-BK111	26 May
2235	137	Female	P NL	---	Adult	BK108	26 May
2058	26	Female	P NL	9.3	Adult	BK176	5 July
2105	33	Female	L NP	8.4	Adult	BK179	5 July
2131	59	Female	L NP	8.4	Adult	BK178	5 July
2143	71	Male	NS	7.0	Adult	BK177	5 July
2019	34	Female	PostL	8.7	Adult	BK267	24 Aug
2026	41	Male	Scrotal	7.5	Adult	BK268	24 Aug
2033	48	Male	Scrotal	7.6	Juvenile	BK270	24 Aug
2040	55	Male	NonScr	6.5	SubAdult	BK271	24 Aug
2109	84	Male	Scrotal	8.1	Adult	BK272	24 Aug

M. Myotis volans at Bear Creek.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2156	98	Female	P NL	---	Adult	BK 107	26 May
2235	137	Female	L NP	---	Adult	BK 109	26 May
2103	31	Female	L NP	8.9	Adult	BK173	5 July
2210	98	Female	PostL	8.4	Adult	BK175	5 July
2209	126	Female	NLNP	7.3	Adult	BK234	11 August

N. Corynorhinus townsendii at Bear Creek.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2125	53	Male	NS	9.3	Adult	BK466- R-Tag	5 July
2115	72	Female	L NP	10.5	Adult	BK475	11 August

O. Eptesicus fuscus at Bear Creek.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2140	82	Male	NS	---	Adult	BK401- R- Tag	26 May
2213	115	Male	NS	---	Adult	BK403	26 May
2235	137	Male	NS	---	Adult	BK402	26 May
2136	64	ESCAP	ED				5 July
2148	76	Male	S	13.6	Adult	BK433	5 July
2149	77	Male	NS	15.4	Adult	BK436	5 July
2150	78	Female	L NP	16.6	Adult	BK434	5 July
2154	82	Female	L NP	17.6	Adult	BK463	5 July
2201	89	Male	NS	16.8	Adult	BK437	5 July
2201	89	Male	S	15.8	Adult	BK438	5 July
2205	93	Female	L NP	21.3	Adult	BK435	5 July
2205	93	Female	P NL	21.0	Adult	BK459	5 July
2209	97	Male	NS	16.0	Adult	BK439	5 July
2210	98	ESCAP	ED				5 July
2212	100	Male	S	17.2	Adult	BK440	5 July
2214	102	Male	S	15.1	Adult	BK455	5 July

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2220-32	108-120	Male	S	15.2	Adult	BK456	5 July
2220-32	108-120	Male	S	15.3	Adult	BK457	5 July
2220-32	108-120	Male	S	15.0	Adult	BK458	5 July
2220-32	108-120	Male	S	16.0	Adult	BK460	5 July
2220-32	108-120	Male	S	16.2	Adult	BK461	5 July
2220-32	108-120	Female	L NP	19.2	Adult	none	5 July
2220-32	108-120	Female	L NP	21.0	Adult	BK464	5 July
2237-2340	125-188	Female	P NL	18.0	Adult	BK462	5 July
2344	192	Male	NS	17.3	Adult	BK465	5 July
2127	84	Male	S	14.7	Adult	BK476	11 August

P. Lasionycteris noctivagans at Bear Creek.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2156	84	Male	NS	9.1	Adult	BK432	5 July

Q. Myotis evotis at Gregory Canyon.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2210	108	Female	P NL	7.7	Adult	BK 118 R-Tag	1 June

R. Myotis volans at Gregory Canyon.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2056	34	Female	L NP	7.5	Adult	BK115	1 June
2210	108	Female	L NP	7.4	Adult	BK116	1 June
2210	108	Female	L NP	9.1	Adult	BK117	1 June
2128	55	Male	NS	---	Adult	BK171	1 July

S. Eptesicus fuscus at Gregory Canyon

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2129	57	Male	NS	12.6	Adult	BK425	20 June
2139	67	Male	Partially S	13.4	Adult	BK426	20 June
2250	138	Male	NS	15.5	Adult	BK427	20 June

T. Lasionycteris noctivagans at Gregory Canyon.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2138	76	ESCAP	ED				1 June

U. Myotis ciliolabrum at NIST.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2102	38	Female	L NP	4.6	Adult	BK119	4 June

V. Myotis evotis at NIST

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2053	41	Male	NS	7.0	Adult	BK221	3 Aug

W. Myotis lucifugus at NIST

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2059	47	Male	Inguinal	7.5	Adult	BK222	3 Aug

X. Myotis volans at NIST.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2059	35	Male	NS	5.5	Adult	BK409	4 June
2125	61	Female	NL NP	7.3	Adult	BK120	4 June
2220	116	Female	L NP	9.1	Adult	BK121	4 June
2240	136	Female	L NP	9.4	Adult	BK122	4 June

Y. Eptesicus fuscus at NIST. * denotes a recaptured individual. Individual a was initially captured on 26 May 1999 at Bear Creek.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2104	40	Female	L NP	18.3	Adult	BK405	4 June
2120	56	Male	NS	12.1	Adult	BK406	4 June
2122	58	Male	NS	14.1	Adult	BK410	4 June
2129	65	Male	NS	14.9	Adult	BK412	4 June
2130	66	Male	NS	10.9	Adult	BK411	4 June
2130	66	Male	NS	13.1	Adult	BK413	4 June
2130**	66	Male	NS	13.7	Adult	BK402	4 June
2130	66	Male	NS	14.7	Adult	BK407	4 June
2135	71	Female	P NL	15.1	Adult	BK408	4 June
2140	76	ESCAP	ED				4 June
2144	80	ESCAP	ED				4 June
2151	87	Male	NS	14.4	Adult	BK404	4 June
2220	116	Male	NS	13.5	Adult	BK414	4 June
2245	141	Male	NS	14.0	Adult	BK415	4 June
2114	62	Male	S	17.5	Adult	BK473	3 Aug
2134	82	Male	NS	16.9	Adult	BK474	3 Aug

Z. Myotis ciliolabrum at Abbey Pond

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2133	61	Female	NLNP	5	Adult	BK161	21 June
2032	47	Male	NS	4.5	Adult	BK266	23 Aug

AA. *Myotis lucifugus* at Abbey Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2109	43	Male	NS	6.3	Adult	BK141	7 June

BB. *Eptesicus fuscus* at Abbey Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2210	104	Female	P NL	20.9	Adult	BK451	7 June
2218	112	Male	NS	13.5	Adult	BK452	7 June
2016		Female	PostL	no wgt	Adult	BK266	23 Aug

CC. *Myotis ciliolabrum* at South Shanahan Trail Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2106	40	Male	NS	1.7?	Adult	BK123	7 June
2126	54	Male	NS	4.1	Adult	BK160	21 June

DD. *Myotis lucifugus* at South Shanahan Trail Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2109	43	Female	P NL	3.5?	Adult	BK124	7 June
2226	120	Female	P NL	---	Adult	BK125	7 June
2112	40	Female	L NP	6.7	Adult	BK181 R-Tag	21 June
2112	40	Female	L NP	8.8	Adult	BK182	21 June

EE. *Eptesicus fuscus* at South Shanahan Trail Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2157	91	Female	P NL	18	Adult	BK416	7 June
2226	120	Female	P NL	21	Adult	BK417	7 June

FF. *Lasiurus cinereus* at South Shanahan Trail Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2157	91	Male	NS	28	Adult	none	7 June

GG. *Myotis ciliolabrum* at North Shanahan Trail Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2130	63	Male	NS	4.1	Adult	BK129	8 June

HH. *Myotis evotis* at North Shanahan Trail Pond

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2115	74	Male	NS	5.8	Adult	BK264	13 August

II. *Myotis lucifugus* at North Shanahan Trail Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2049	22	Male	NS	6.7	Adult	BK127	8 June
2133	66	Male	NS	7.3	Adult	BK128	8 June
2107	34	Male	NS	6.9	Adult	BK162	26 June
2111	38	Male	NS	8.0	Adult	BK165	26 June
2112	39	Male	NS	7.6	Adult	BK166	26 June
2113	40	Male	NS	7.1	Adult	BK167	26 June
2113	40	Male	NS	7.3	Adult	BK163	26 June
2114	41	Male	NS	6.5	Adult	BK168	26 June
2114	41	Male	NS	7.9	Adult	BK169	26 June
2119	46	Male	NS	6.6	Adult	BK164	26 June
2129	56	Male	NS	6.6	Adult	BK170	26 June
2023	22	Male	S	7.2	Adult	BK235	13 Aug
2023	22	Male	NS	6.8	Subadult	BK236	13 Aug
2024	23	Male	NS	8.2	Subadult	BK237	13 Aug
2025	24	Male	NS	6.9	Adult	BK238	13 Aug
2026	25	Male	S	8.0	Adult	BK239	13 Aug
2027	26	Male	NS	8.3	Adult	BK240	13 Aug
2028	27	Male	NS	7.0	Adult	BK241	13 Aug
2029	28	Male	NS	7.8	Adult	BK242	13 Aug
2030	29	Male	NS	7.5	Adult	BK244	13 Aug
2030	29	Female	NLNP	7.9	Adult	BK243	13 Aug
2031	30	Male	NS	7.0	Subadult	BK245	13 Aug

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2032	31	Female	NLNP	9.4	Subadult	BK246	13Aug
2033	32	Male	NS	7.9	Adult	BK247	13Aug
2034	33	Male	S	6.8	Adult	BK248	13Aug
2035	34	Male	NS	7.6	Adult	BK249	13Aug
2036	35	Male	NS	7.0	Subadult	BK250	13Aug
2037	36	Male	NS	7.5	Subadult	BK251	13Aug
2038	37	Female	PostL	9.1	Adult	BK252	13Aug
2039	38	Female	PostL	8.5	Adult	BK253	13Aug
2040	39	Male	NS	6.8	Subadult	BK254	13Aug
2040	39	Male	S	8.0	Adult	BK265	13Aug
2120	79	ESCAP	ED				13Aug
2320	199	ESCAP	ED				13Aug

JJ. *Myotis thysanodes* at North Shanahan Trail Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2124	57	Male	NS	6.8	Adult	BK126	8 June
2040	39	Female	L NP	8.0	Adult	BK255	13Aug
2046	45	Male	NS	7.8	Adult	BK256	13Aug
2052	51	Male	S	6.8	Adult	BK262	13Aug
2053	52	Female	PostL	8.0	Adult	BK259	13Aug
2053	52	Female	L NP	8.2	Adult	BK257	13Aug
2106	65	Female	L NP	8.8	Adult	BK260	13Aug
2114	73	Female	NLNP	7.1	Juvenile	BK261	13Aug
2154	113	Female	L NP	9.3	Adult	BK258	13Aug

KK. *Myotis volans* at North Shanahan Trail Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2209	102	Female	L NP	8.9	Adult	none	8 June
2104	63	Male	NS	8.1	Adult	BK263	13Aug

LL. *Eptesicus fuscus* at North Shanahan Trail Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2103	36	ESCAP	ED				8 June
2109	42	Male	NS	13.6	Adult	BK418	8 June
2119	52	Male	Partially S	16.7	Adult	BK422	8 June
2131	64	Male	NS	13.9	Adult	BK419	8 June
2136	69	Male	NS	14.0	Adult	BK420	8 June
2141	74	Male	NS	13.5	Adult	BK421	8 June
2144	77	Male	NS	14.1	Adult	none	8 June
2200	93	Female	P NL	21.1	Adult	BK423	8 June
2211	104	Male	NS	15.6	Adult	BK424	8 June
2224	117	Male	NS	---	Adult	none	8 June
2116	43	Male	Partially S	18	Adult	BK428	26 June
2130	57	Female	L NP	---	Adult	R-Tag	26 June
2201	88	Male	NS	17.0	Adult	BK429	26 June
2212	99	Male	NS	14.2	Adult	none	26 June
2222	109	Female	Very P	21.0	Adult	BK431	26 June
2106	65	Male	S	16.4	Adult	BK483	13Aug
2123	82	Female	NLNP	13.4	Juvenile	BK477	13Aug
2124	83	Male	S		Adult	BK478	13Aug
2216	135	Male	NS	18.4	Subadult	BK482	13Aug
2252	171	Male	NS	17.0	Adult	BK479	13Aug
2252	171	Male	S	26	Adult	BK480	13Aug
2252	171	Female	NLNP	16.8	Subadult	BK481	13Aug
2310	189	Male	NS	19.4	Adult	BK484	13Aug
2310	189	Female	L NP	21.0	Adult	BK485	13Aug
2320	199	Female	PostL	20.0	Adult	BK486	13Aug

MM. *Lasiurus cinereus* at North Shanahan Trail Pond.

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2121	54	Male	NS	27	Adult	none	8 June
2114	73	ESCAP	ED				
2154	113	Male	S	24	Adult	none	13Aug

NN. *Myotis thysanodes* at Lindsay Pond

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2059	37	Female	L	8.1	Adult	BK 214	25 July
2103	41	Female	L	8.8	Adult	BK 215	25 July
2108	46	Female	L	8.0	Adult	BK 216	25 July
2113	51	Female	L	8.4	Adult	BK 218	25 July
2128	66	Female	L	8.1	Adult	BK 217 RTag	25 July
2132	70	Female	L	9.4	Adult	BK 219	25 July

OO. *Myotis thysanodes* at Douglas Fir 1

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2114	44	Male	NS	6.6	Adult	none	17 June
2114	44	Female	P NL	9.4	Adult	none	17 June

PP. *Corynorhinus townsendii* at Douglas Fir 3

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2035	21	Female	PostL	10.3	Adult	BK468	2 Aug
2035	21	Female	L	10.1	Adult	BK469	2 Aug
2035	21	Female	L	9.0	Adult	BK470	2 Aug
2035	21	Female	L-PostL	8.9	Adult	BK471	2 Aug
2055	41	Female	PostL	10.2	Adult	BK472	2 Aug

QQ. *Myotis ciliolabrum* at Douglas Fir 3

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2033	25	Female	PostL	5.1	Adult	BK227	7 Aug

RR. *Myotis evotis* at Douglas Fir 3

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2124	70	Male	NS	5.9	Adult	BK220	2 Aug

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2049	41	Female	NLNP	6.0	Juvenile	BK229	7 Aug

SS. *Myotis lucifugus* at Douglas Fir 3

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2122	73	Female	NLNP	5.2	Juvenile	none	6 Aug

TT. *Myotis thysanodes* at Douglas Fir 3

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2114	65	Male	NS	7.5	Adult	BK223	6 Aug
2134	85	Female	NLNP	7.2	Juvenile	BK224	6 Aug
2209	120	Male	NS	5.8	Juvenile	BK225	6 Aug
2043	35	Female	PostL	8.0	Adult	BK226	7 Aug
2049	41	Female	NLNP	7.2	Juvenile	BK228	7 Aug
2052	44	Female	NLNP	---	Juvenile	none	7 Aug
2106	58	Male	NS	7.5	Adult	BK230	7 Aug
2133	85	Male	NS	7.8	Adult	BK231	7 Aug

Table II. Localities of net sites for 1999, all in Boulder County, Colorado

NAME OF SITE	LOCATION	TOPOGRAPHIC COORDINATES
Shadow Canyon/ Stockton Cabin Pool	Intersection of Mesa Trail and Shadow Canyon Trail	T1S R71W Sec. 24
Bear Creek Pool	Junction of Mesa Trail and Bear Creek, app. 1.2 miles from Wildwood Trailhead	T1S R71W Sec. 12
Gregory Canyon Pool	approximately 0.5 miles N from Saddle Rock Trailhead from base of Gregory Canyon	T1S R71W Sec. 1
Lindsay Pond	South end of Dowdy Draw Trail and just north of water diversion pipe	T1S R70W Sec. 31
North Shanahan Trail Pond	Intersection of the middle and north forks of Shanahan Ridge trail	T1S R70W Sec. 18
South Shanahan Trail Pond (a.k.a. Pollywog Pond)	Southwest of first right angle bend in south fork of Shanahan Ridge trail from Hardscrabble Drive access, approximately 0.5 mi.	T1S R70W Sec. 18
Abbey Pond	Casual path west from Hardscrabble Drive to Shanahan Ridge, app. 1/4 mi	T1S R70W Sec. 18
Schneider Pond	Northwest of intersection of US 36 and Longhorn Rd., app. 1.5 mi. up ravine leading to Old Stage Rd	T1N R71W Sec. 1
NIST Pond	National Bureau of Standards section of Skunk Canyon Creek, app. 50m from beginning of paved path, just north of Kohler Reservoir	T1S R71W Sec. 6

Table III. Dates on which waterhole sites were sampled in 1999.

	Bear Creek T1S R71W Sec. 12	Shad Cany T1S R71W Sec. 24	North Shan. T1S R70W Sec. 18	South Shan. T1S R70W Sec. 18	Abbey Pond T1S R70W Sec. 18	Greg Cany T1S R71W Sec. 1	Schnei Pond T1N R71W Sec. 12	NIST Site T1S R71W Sec. 6	Lind Pond T1S R70W Sec. 31
May	26	---	---	---	---	---	---	---	---
June	---	18	8, 26	7, 21	7, 21	1, 19, 20	---	4	--
July	5	20	---	---	---	1	---	---	25
August	11, 24	---	13	---	23	---	10	3	---
<i>Total net nights</i>	8	4	7	2	4	8	1	3	<u>2</u> T = 39

Table IV. Dates on which forest sites were sampled in 1998.

	Ponderosa Pine 1 T1S R70W Sec. 31	Douglas Fir 1 T1S R71W Sec. 12	Douglas Fir 2 T1S R71W Sec. 24	Douglas Fir 3 T1S R70W Sec. 6
June	14	17	18	---
July	---	---	---	---
August				2, 6, 7
<i>Total net nights</i>	8	4	2	11 Total = 25

Table V. Datalogger placement dates and locations.

Site	Start Date	End Date
<i>M. thysanodes</i> Der Zerkle roost	4 June	N/A—stolen
<i>E. fuscus</i> Harmon Cave	5 June	
<i>C. townsendii</i> Harmon Cave	5 June	
<i>M. thysanodes</i> Gregory Canyon	22 July	24 August
<i>M. ciliolabrum</i> Stockton Cabin	23 July	25 August

Forest Netting.--Of the 283 bats captured in 1999, 19 were captured in nets set in Douglas Fir habitat (Table I: OO, PP, QQ, RR, SS & TT; Table IV) and provided data on species-specific foraging patterns and habitat use. Species captured foraging in Douglas fir habitat included *M. ciliolabrum*, *M. evotis*, *M. lucifugus*, and *C. townsendii*. Of significance was the capture of five lactating, female *C. townsendii* at the Douglas Fir 3 site located SW of the diversion canal near Eldorado Mountain (Table IV and Figure 2). Attempts to recapture and radio-tag an individual of this species over the following three nights in order to locate the maternity roost were unsuccessful.

B. RADIO TELEMETRY

Most effort in 1999 was placed on radio-tracking to locate day-roost sites, as well as utilizing telemetry triangulation techniques to determine foraging patterns and home ranges of radio-tagged individuals. Of the 10 transmitters placed on bats, three signals were never reacquired (Table VI) despite rigorous searches on foot and with vehicles, covering at least a six-mile radius of the tagging site for up to 10 days. For seven individuals, telemetry signals were received usually within 2 days, and roost sites were found usually within a day of acquiring the signal. Five individuals had radio transmitters that remained attached long enough to provide foraging and home range data. In two instances, heavy over-night rains in the days following attachment of a transmitter precluded us from gathering activity data, and likely promoted premature loss of either the signal due to malfunction of the transmitter, or loss of the transmitter itself from the animal.

Roost Site Locations.--Roost sites were documented for seven of 10 radio-tagged individuals (Table VI & VII) in 1999. As in 1998, all roost sites were located only in rock crevices except

Table VI. 1999 Radio telemetry data.

Species	Sex	<u>Dates radio tracked</u>			# of days	<u>Number of roosts located</u>	
		Attached	Dis-appears	Drop		Communal	Solitary
<i>Eptesicus fuscus</i>	M	26 M	30 M	-----	4/6	0	1
<i>Myotis volans</i>	F	26 M	-----	-----	0/6	0	0
<i>Myotis evotis</i>	F	1 J	3 J	-----	1/5	0	0
<i>Myotis lucifugus</i>	F	21 J	-----	25 J	3/4	1	0
<i>Eptesicus fuscus</i>	F	26 J	28 J	-----	1/3	1	0
<i>C. townsendii</i>	M	5 JI	-----	10 JI	3/4	0	1
<i>Myotis ciliolabrum</i>	F	20 JI	23 JI	-----	1/3	1	0
<i>Myotis thysanodes</i>	M	20 JI	-----	-----	3/3	0	1
<i>Myotis evotis</i>	M	20 JI	-----	-----	0/3	0	0
<i>Myotis thysanodes</i>	F	25 JI	-----	29 JI	2/2	1	0

Table VII. Roost site location data (see Fig. 1).

Species	Roost Type	Colony Type	Colony Size			Location
			My	Jn	Au	
<i>Myotis thysanodes</i>	S facing rock crevice	Maternity	14 My 19	17 Jn 2	12 Au 0	NE of Mallory Cave T1S R71W Sec. 12
<i>Myotis thysanodes</i>	E facing rock crevice	Maternity	19 My 0	22 Jy 0	10 Au 0	Gregory Canyon T1S R71W Sec. 1
<i>Myotis lucifugus</i>	SE facing rock crevice	Maternity	15 My 17	18 Jun 58		The Matron T1S R71W Sec. 24
<i>Eptesicus fuscus</i>	S facing rock crevice	Solitary	28 May 1			Lower Bear Creek T1S R71W Sec. 12
<i>Myotis ciliolabrum</i>	rock crevice in E facing talus slope	Maternity	21 July ≥2			SW of Stockton Cabin T1S R71W Sec. 24
<i>Eptesicus fuscus</i>	cave	unknown	5 June 4-6			Harmon Cave T1S R71W Sec.13
<i>Eptesicus fuscus</i>	E facing rock crevice	Maternity	27 Jun e 80	29 June 4 6		Upper Bear Creek T1S R71W Sec.13
<i>Corynorhinus townsendii</i>	E facing dome rock crevice	Solitary	7 July 1			North Bear Canyon T1S R71W Sec.12
<i>Myotis thysanodes</i>	NE facing rock crevice	Solitary	23 July 1			SE of the Matron T1S R71W Sec. 24
<i>Eptesicus fuscus</i>	E facing rock crevice	Maternity	26 July 70			Gregory Canyon Amphitheater T1S R71W Sec. 1
<i>Myotis thysanodes</i>	SE facing rock crevice	Maternity	---			SE side of Eldorado Mountain T1S R71W
<i>Myotis evotis</i>	House	Maternity	---			Flagstaff Mountain, private residence across road (W) from Kossler Lake

for a maternity colony of *M. evotis* that was found resident in an abandoned house. Colony sizes varied from one to 80 individuals (Table VII). In addition to the roost sites found using radio telemetry, two sites were located by visual observations. After the discovery of a dead juvenile bat by a climber in the Amphitheater area near Gregory Canyon, Burton Stoner notified us, and we visually located a maternity colony of 80 *E. fuscus* IN the NW rock face of the Amphitheater. Also observed by Burton Stoner was a colony of *C. townsendii* using Mallory Cave as a day roost on 13 August. Thus, a total of nine roost sites were located in 1999. In addition, outflight counts were conducted in 1999 for several colonies that were documented in 1998 (Table VII). Outflight data at colonies located in 1998, were gathered starting on 24 May 1999. On this date maternity sites were, at least, partially inhabited by colony members (Table VII). Figure 1 & Figure 2 show the positions of roost sites so far established for Boulder County bats along the Front Range Corridor. All of these roost sites were in rock crevices; some were maternity colonies located within rocks used by recreational climbers and are at risk of human disturbance. So far, the positions of roosts show a clumped distribution in the vicinity of Mallory Cave, Harmon Cave, and Stockton Cabin. However, further data are required to determine if this pattern is due to sampling error. Thus far, the apparently abnormal pattern of bats using only rock crevice sites as diurnal roosts (see Barclay and Brigham, 1995), as opposed to also using tree-snags, was further supported by our 1999 data. Figure 3 shows the location of the only known maternity roost for *Myotis evotis* in the Front Range, and it was located in an abandoned house on Flagstaff Road. This is the only noncrevice roost site thus far found, and required 4 days of searching as this colony was located west of Green Mountain, 2.43 miles from site of capture of the tagged individual at Gregory Canyon (Figure 3).

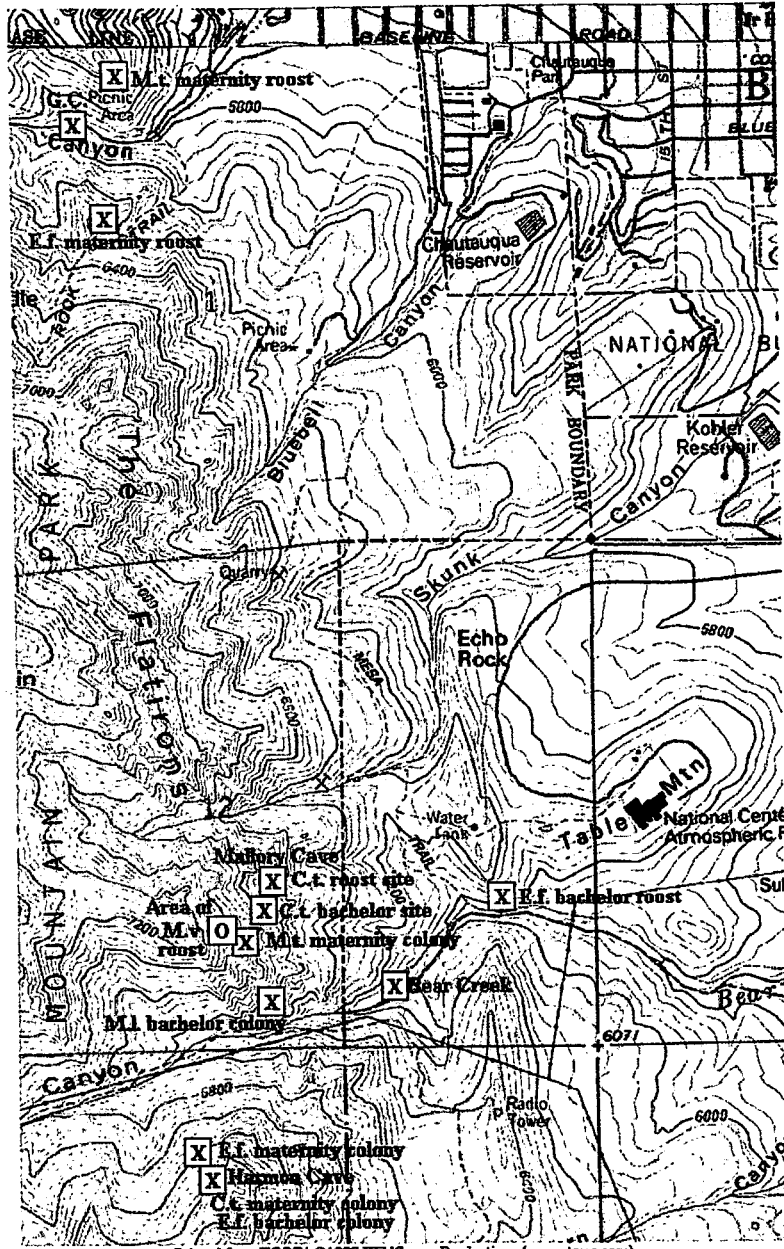


Figure 1. Map of roost sites found using radio-telemetry and located between Gregory Canyon and Harmon Cave along the Front Range Corridor. Mt = *Myotis thysanodes*, C.T. = *Corynorhinus townsendii*, M.V. = *Myotis volans*, and E.F. = *Eptesicus fuscus*.

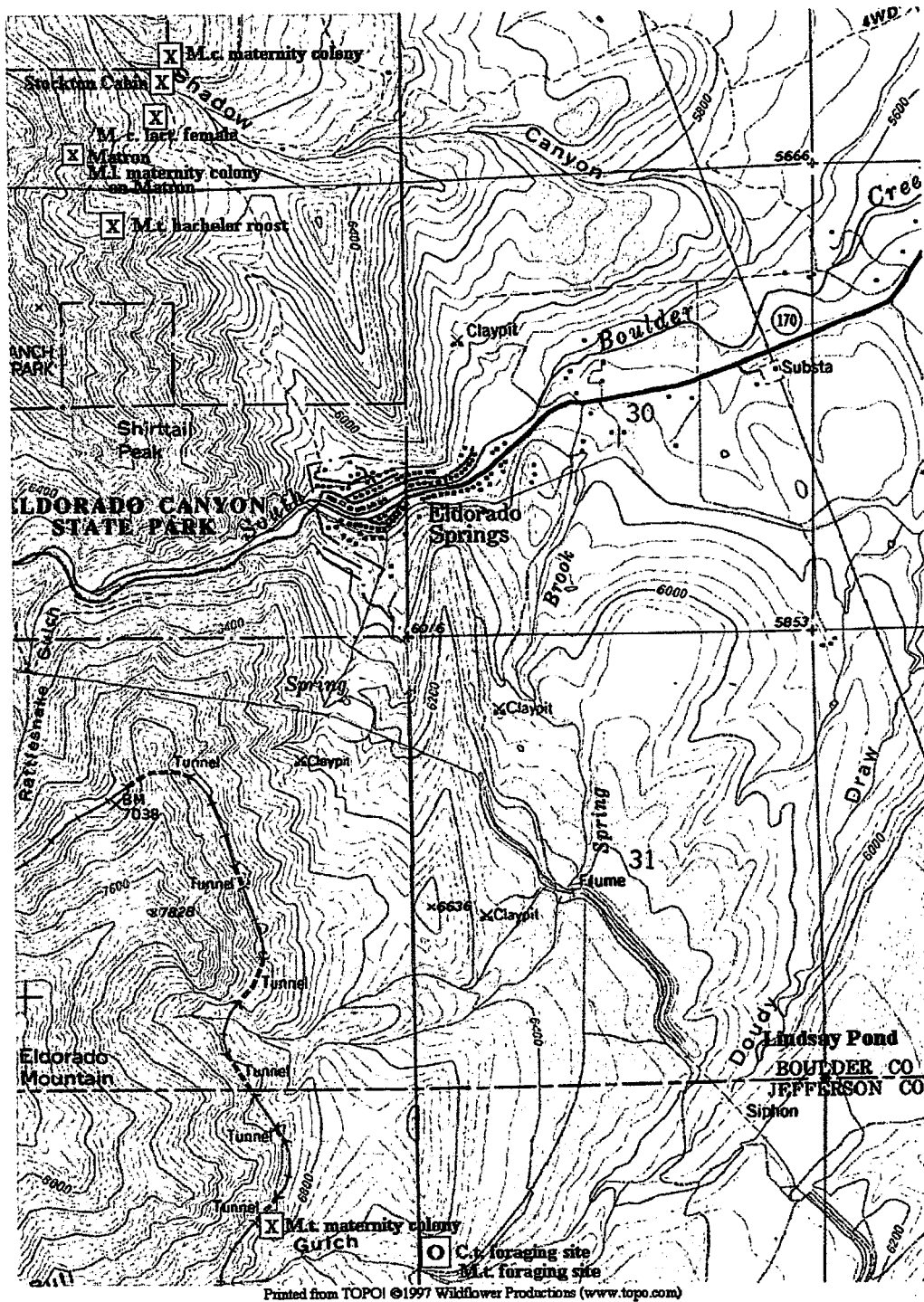
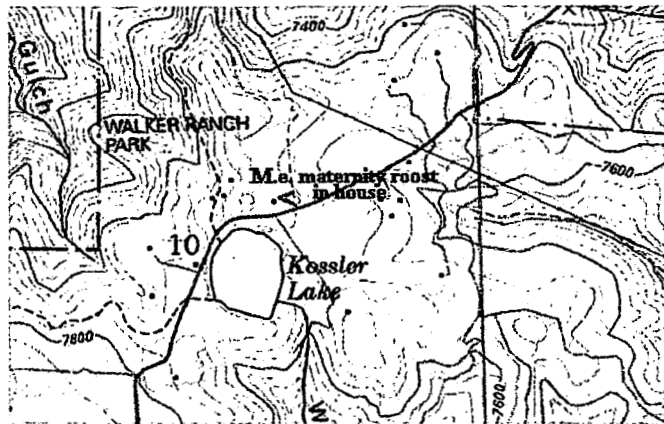


Figure 2. Map of roost sites found using radio-telemetry and located between Shadow Canyon and just south of Eldorado Mountain along the Front Range Corridor. M.l. = *Myotis lucifugus*, M.c. = *Myotis ciliolabrum*, Mt = *Myotis thysanodes*, and C.t. = *Corynorhinus townsendii*.



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Figure 3. Map of roost site found using radio-telemetry for *Myotis evotis* (M.e.) Located in a an abandoned house across from Kessler Lake near Walker Ranch.

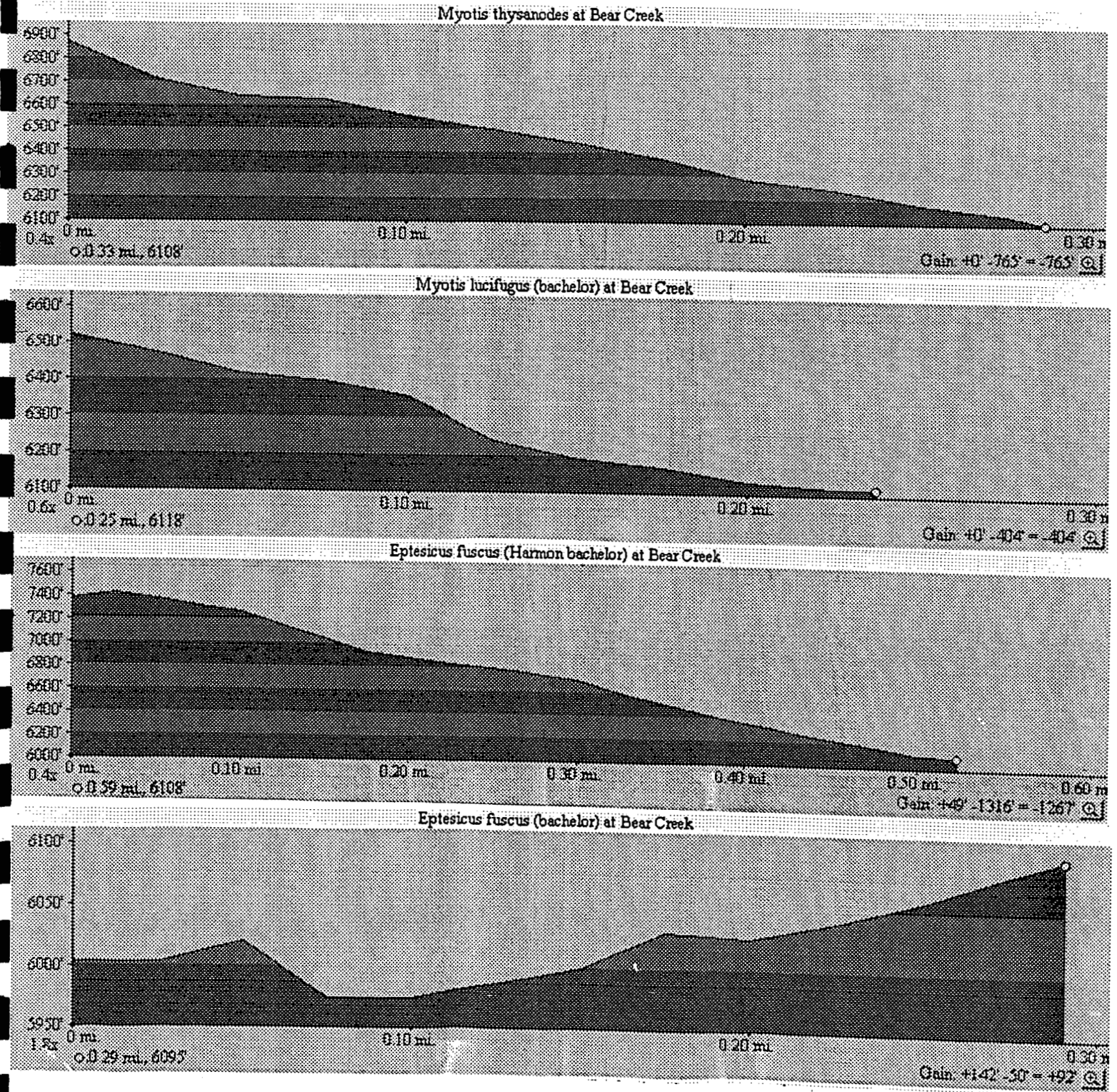
Relationship of Waterholes to Roost Sites.—Table VIII shows the minimum (linear) distances and elevational differences between roost site locations and capture waterhole sites. Generally speaking, individuals tended to use waterholes closest to their roost sites, and, in most cases, the travel distance was less than 0.5 linear miles. However, some individuals did travel to waterholes located greater than 1 mile (*E. fuscus*) away from their roost, and, in one case, greater than 2 miles away (*M. lucifugus*). In most cases, roost sites were located at higher elevations than were waterholes used by a tagged individual (Table VIII). Figures 4 through 9 give visual portrayals of elevational profiles and distances between waterholes and roost sites for each species. The largest elevational difference (approx. 850 ft. over 2.1 miles) between waterhole and roost site was for an *M. evotis* lactating female tagged in lower Gregory Canyon on 1 June 1999. Other species that traveled significant distances included a lactating female *M. lucifugus* that traveled from the Matron to South Shanahan pond (> 2 miles) and then moved even farther away heading northeastward out of range of our telemetry equipment. In addition, a lactating female *M. thysanodes* captured at Lindsay pond was tracked to a maternity site on Eldorado Mountain, moving a distance > 1 mile over an elevational change of approximately 850 ft. (Table VIII).

Telemetry of Foraging Patterns.—Foraging and home range estimates were gathered on four individuals of three species. Figure 10 shows the foraging pattern of a male *E. fuscus* on 28 May 1999. Although this individual appeared to be roosting singly, several other *E. fuscus* emerged from different crevices on the same rock face (Lat. 39° 58 52', Long. 105° 16 81', 5982 ft.) suggesting that this rock is a bachelor roosting site for this species. In addition, we have captured many male *E. fuscus* at our Bear Canyon Creek waterhole where this individual was caught and

Table VIII. Distances and elevational differences between waterholes of capture (*nearest waterhole) and roost site locations for 16 colonies representing six Boulder County bat species. - indicates colony at higher elevation than waterhole, + indicates vice versa.

Species	Roost Site Location	WaterHole Location	Distance Between	Elevational Difference
<i>M. thysanodes</i> maternity	DerZerkle	Bear Creek	0.33 mi.	-765 ft.
<i>M. lucifugus</i> bachelor	Spire	Bear Creek	0.25 mi.	-404 ft.
<i>E. fuscus</i> bachelor	Bear Creek	Bear Creek	0.29 mi.	+92 ft.
<i>M. ciliolabrum</i> maternity	Shadow Canyon	Stockton Cabin	0.13 mi.	+26 ft.
<i>M. lucifugus</i> maternity	Matron	Stockton Cabin	0.28 mi.	-508 ft.
<i>M. thysanodes</i> bachelor	S of Matron	Stockton Cabin	0.35 mi.	-465 ft.
<i>M. thysanodes</i> maternity	above Gregory Canyon	Gregory Canyon	0.14 mi.	-377 ft.
<i>M. evotis</i> maternity	house on Flagstaff Mtn.	Gregory Canyon	2.43 mi	-1820 ft.
<i>E. fuscus</i> * maternity	Amphitheater	Gregory Canyon	0.21 mi.	-449 ft.
<i>E. fuscus</i> maternity	Rock face N of Harmon Cave	North Shanahan Pond	1.12 mi.	-1256 ft.
<i>M. lucifugus</i> maternity	Matron	South Shanahan Pond	2.07 mi.	-1433 ft.
<i>C. townsendii</i> maternity	Harmon	Bear Creek	0.59 mi.	-500 ft.
<i>C. townsendii</i> maternity	Mallory	Bear Creek	0.36 mi.	-489 ft.
<i>C. townsendii</i> bachelor	bachelor NE of Mallory Cave	Bear Creek	0.29 mi.	-499
<i>E. fuscus</i> bachelor	Harmon Cave	Bear Creek	0.59 mi.	+500 ft.
<i>M. thysanodes</i> maternity	Eldorado Mtn.	Lindsay Pond	1.16 mi.	-857 ft.

Figure 4. Elevational and distance profiles between Bear Canyon Creek waterhole and roost sites for four individuals marked with radio tags (see Table VIII for tallied data).



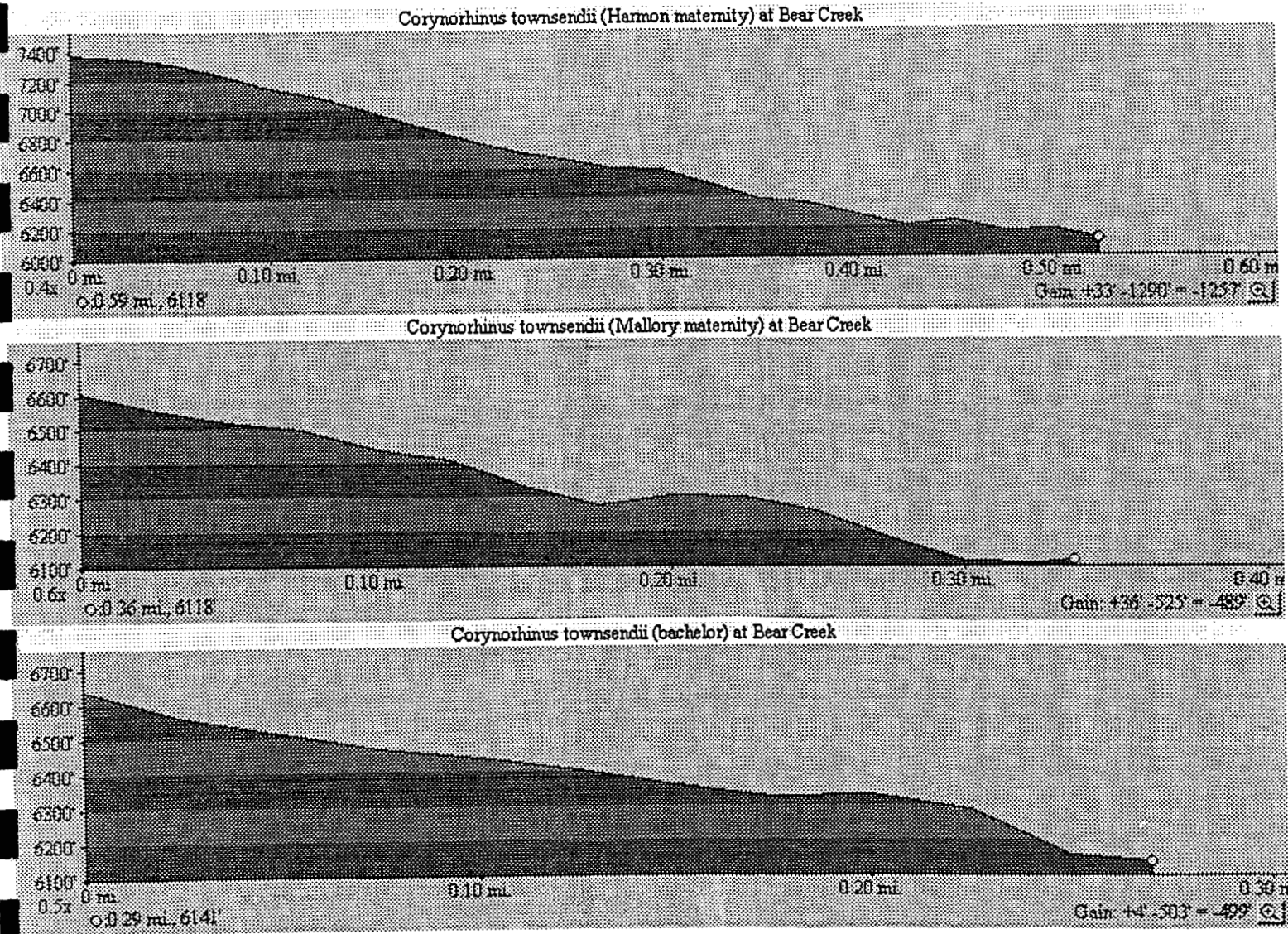
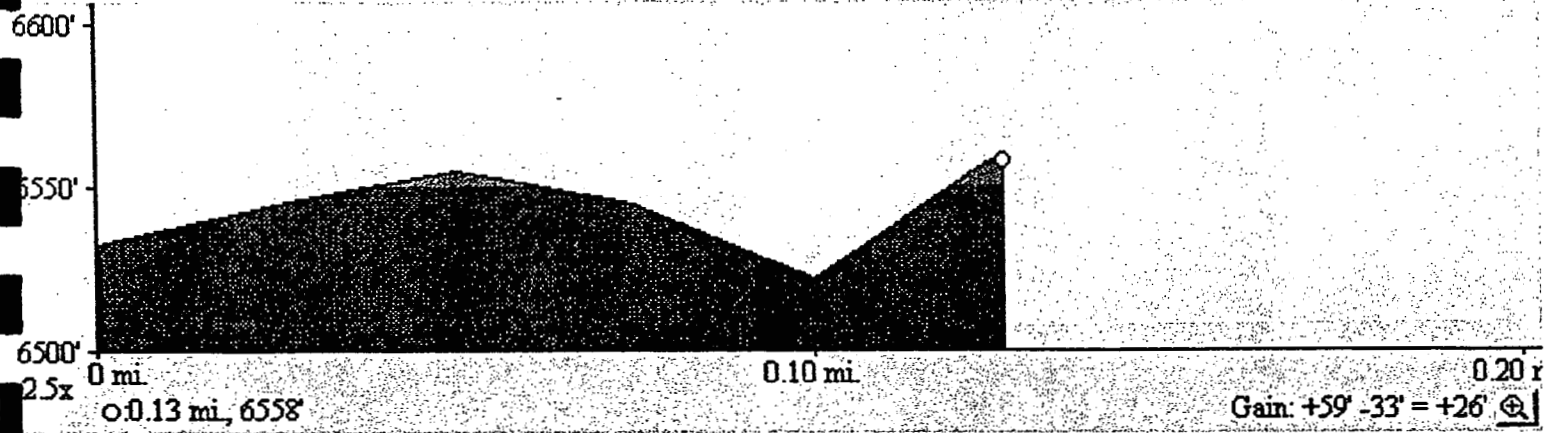
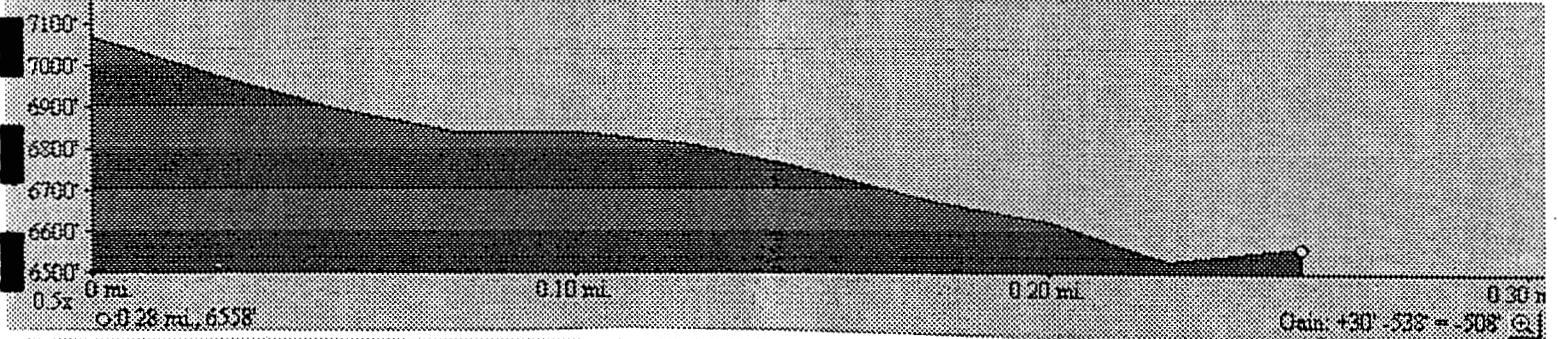


Figure 5. Elevational and distance profiles between Bear Creek waterhole and roost sites of three Townsend's big-eared bats. Top and middle are based upon captures of female individuals at Bear Creek. Bottom are data gathered from a radio-tagged male individual (See Table VIII).

Myotis ciliolabrum (lac. female) Shadow Canyon



Myotis lucifugus (Matron Maternity) at Shadow Canyon



Myotis thysanodes (Bachelor) at Shadow Canyon

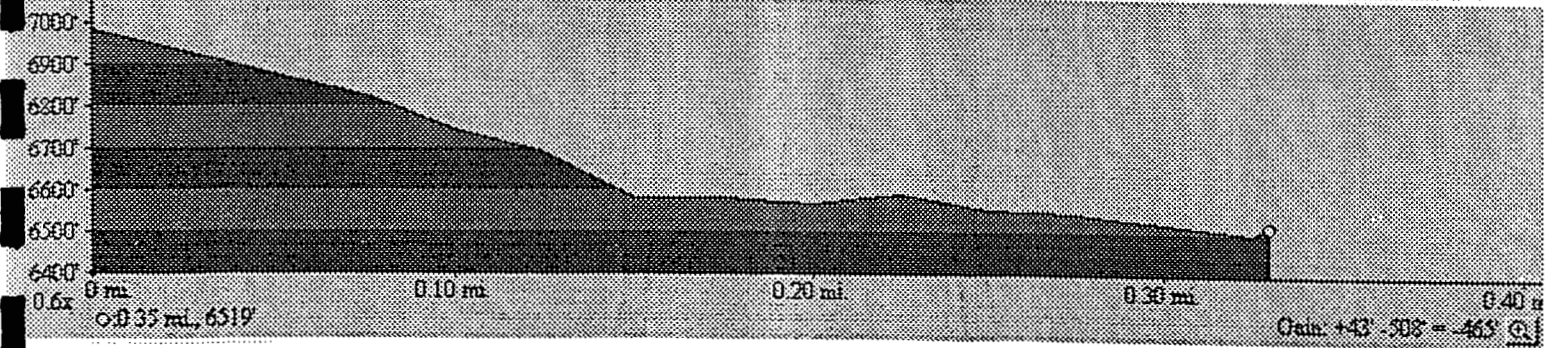
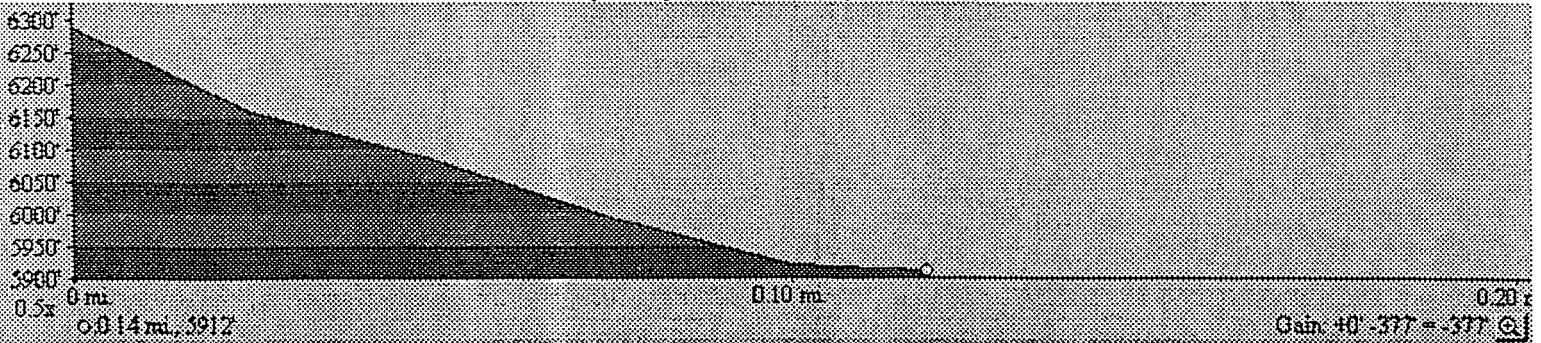
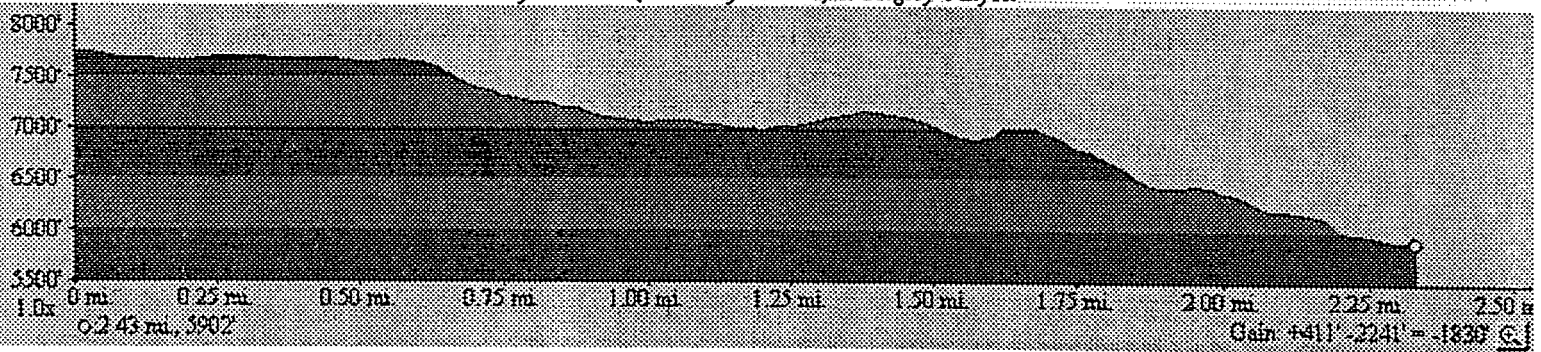


Figure 6. Elevational and distance profiles between Stockton Cabin waterhole at Shadow Canyon and roost sites for three individuals marked with radio tags (see Table VIII for tallied data).

Myotis thysanodes at Gregory Canyon



Myotis evotis (Maternity in house) at Gregory Canyon



Eptesicus fuscus at Gregory Canyon

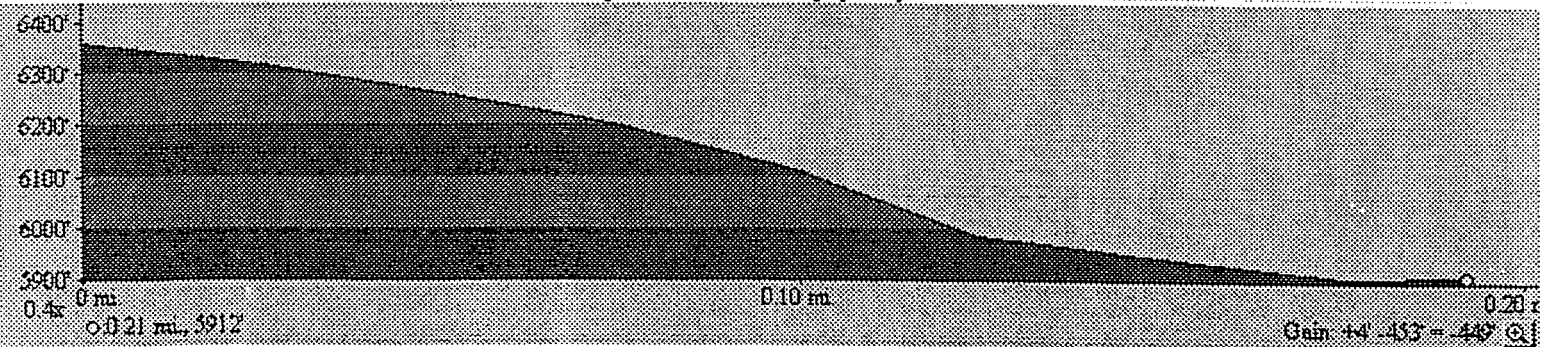
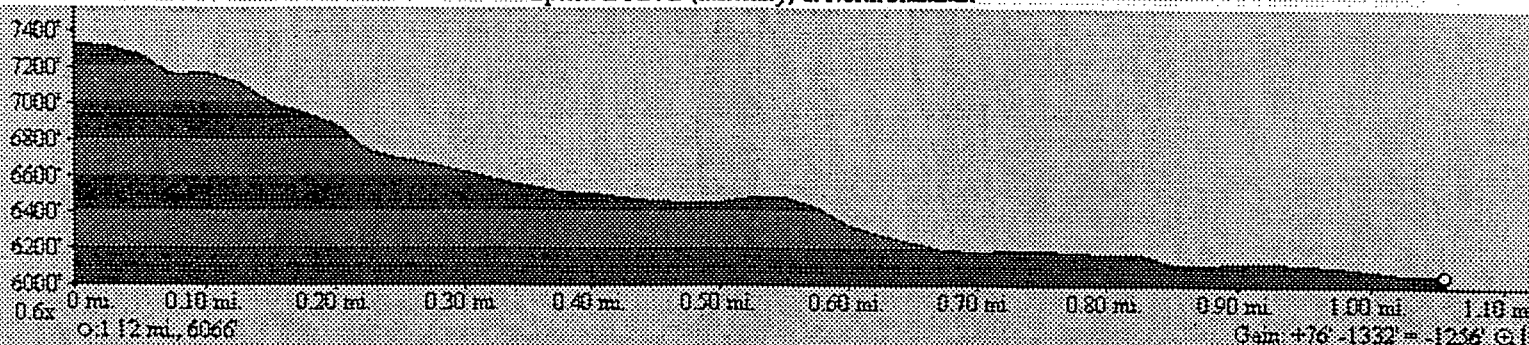


Figure 7. Elevational and distance profiles between Gregory Canyon waterhole and roost sites of three individuals of three species marked with radio-tags (See Table VIII).

Eptesicus fuscus (maternity) at North Shanahan



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Myotis lucifugus (Matron Maternity) at South Shanahan Pond

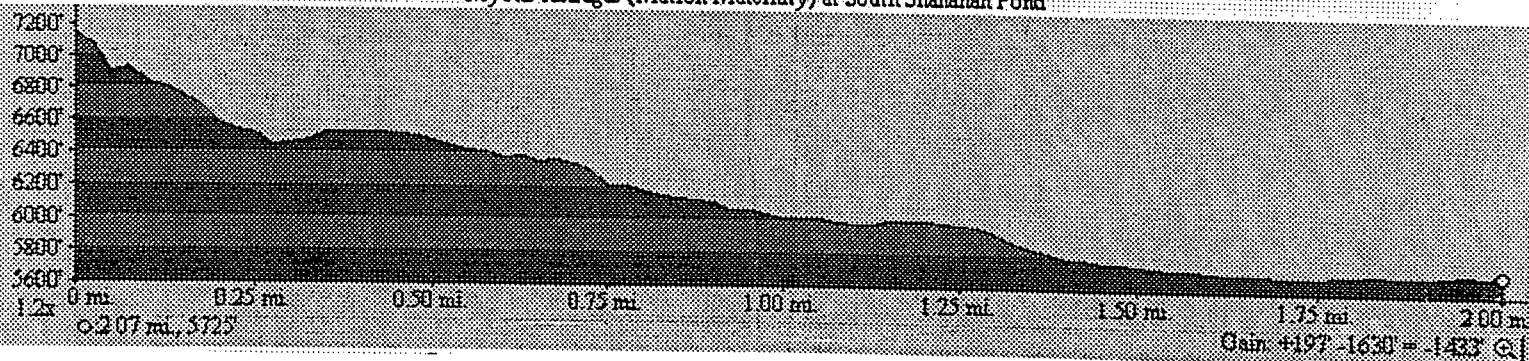
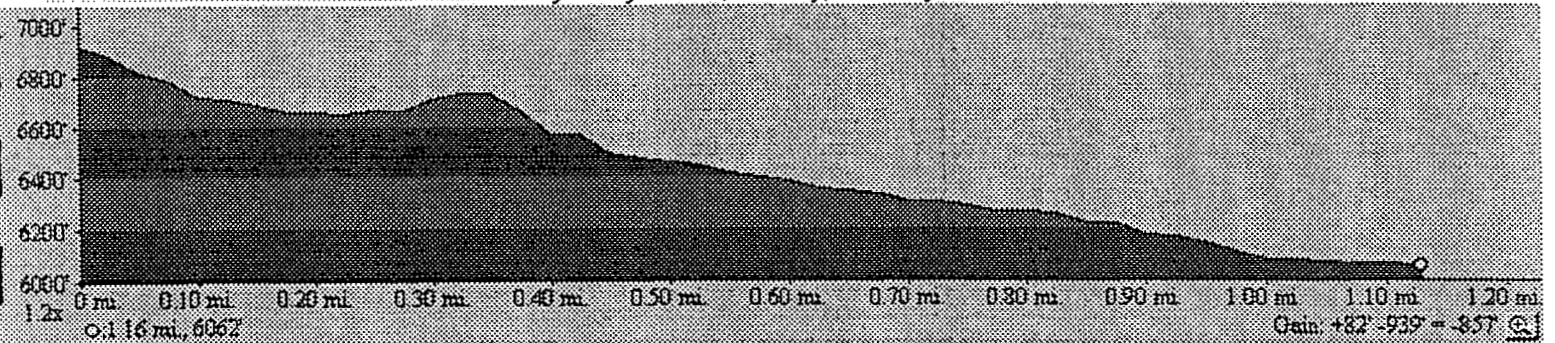


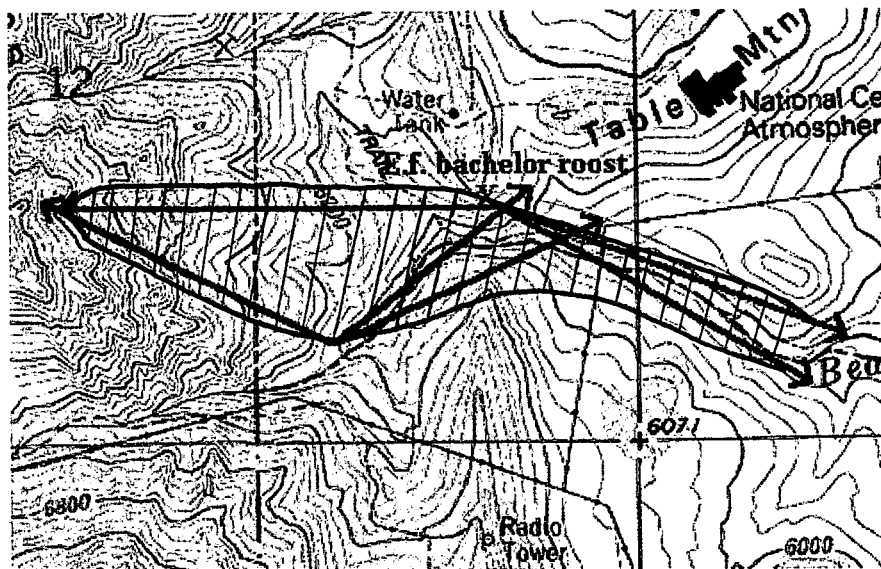
Figure 8. Elevational and distance profiles between two Shanahan Ridge pond sites and roost sites for two individuals marked with radio tags (see Table VIII for tallied data).

Myotis thysanodes (Maternity) at Lindsay Pond



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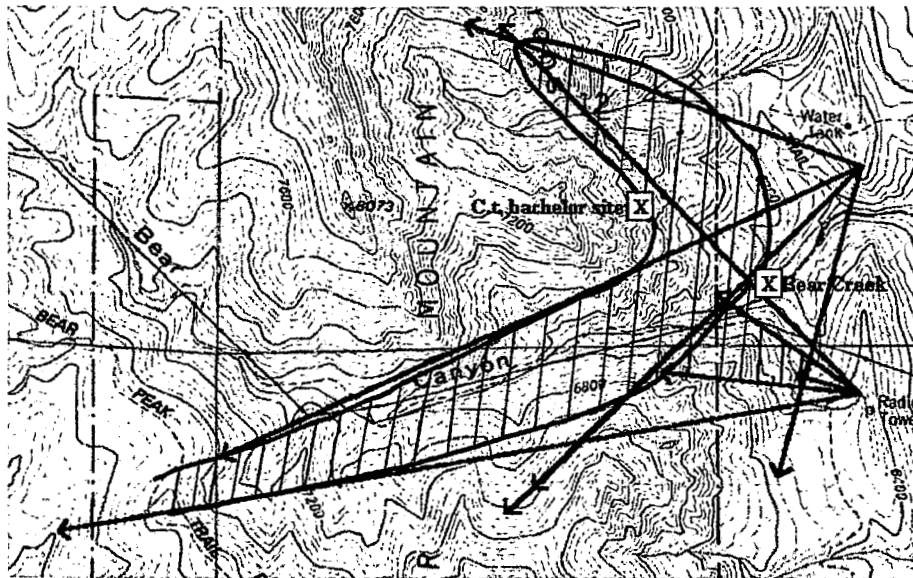
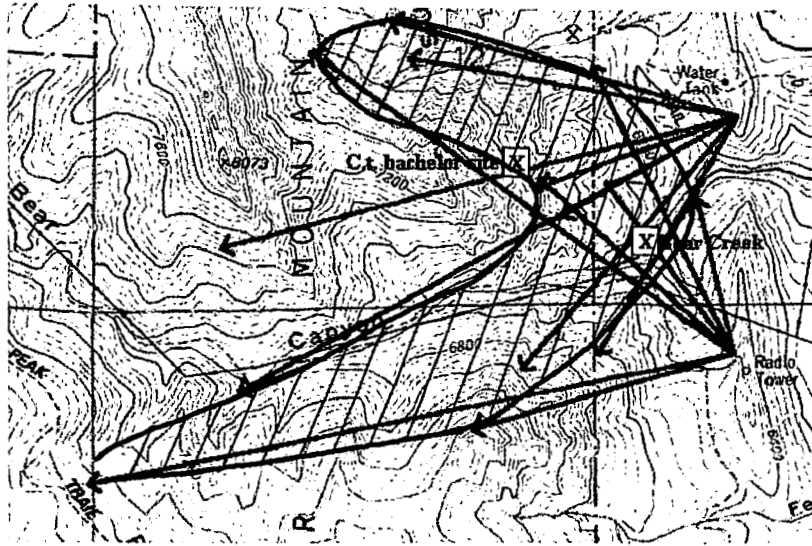
Figure 9. Elevational and distance profiles between Lindsay Pond and a maternity roost site for the fringed myotis, *Myotis thysanodes* based upon a radio tagged female (See Table VIII).



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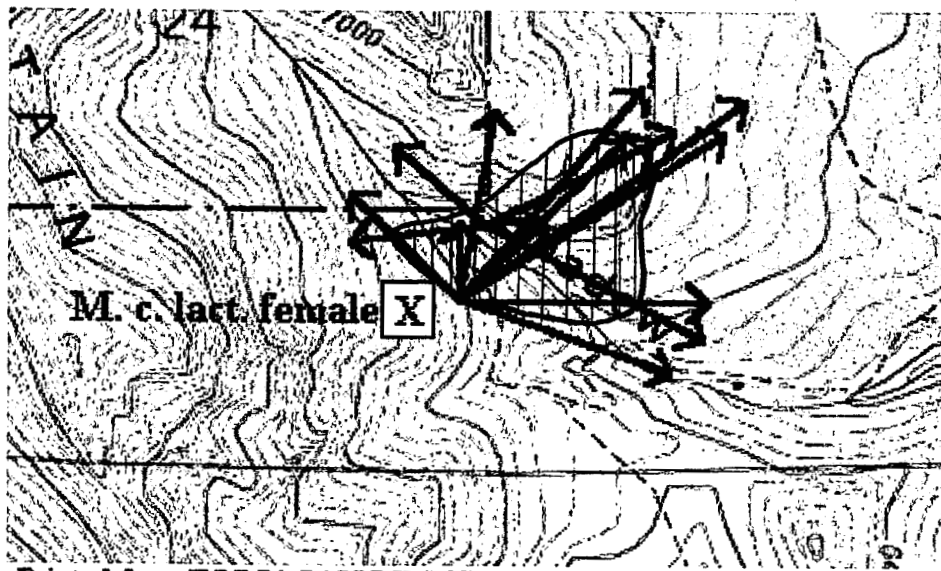
Figure 10. Telemetry data gathered on a foraging *Eptesicus fuscus* from two triangulation points. Point 1 just east of the bachelor roost and Point 2 from our Bear Canyon Creek waterhole site. Reading were gathered on 28 May 1999 at 15 minute intervals. Hatch-marks indicate estimated area of home range for this individual. Due to high winds after 2130, the individual hung up in an alternate roost site on the east side of rock outcropping at same site. Radio signal was lost the following day.

tagged. Unfortunately, due to a significant increase in wind as the night progressed, this individual flew for only about 45 minutes before hanging up in an alternative roost site on the leeward side of the same rock face, NNE of its original roosting site. After rain on 29 May, we checked the site the morning of 30 May and the individual was still in the alternate roost site. That night, after returning to the site to radio track, the signal was gone, perhaps due to battery failure. This is the first bachelor site of this species verified in the Front Range around Boulder, although we suspect that the Harmon Cave colony is also a bachelor roost. Figure 11 shows telemetry data gathered on 9 and 10 July for a male *Corynorhinus townsendii*. This roost site housed a single male *C. townsendii* that we had radio-tagged at the Bear Canyon Creek waterhole the previous night. On both nights, this individual foraged predominately along a corridor ranging north to south just east of its roost site. Using slow, maneuverable flight, it appeared to forage in dense vegetation, in close proximity to the ground among trees and shrubs. On both nights, this individual left the tracking area, moving out of range of our receivers as it flew westward up Bear Canyon Creek about 25 minutes, after which it returned within telemetry range to its initial foraging area. On 10 July, this individual returned to its roost site for about 10 minutes after returning from its canyon foraging bout, after which it resumed foraging just east of its roost site for the next hour. Figure 12 shows telemetry data for a lactating, female *Myotis ciliolabrum*, gathered using triangulation techniques on 21 July 1999. The roost site was located the morning of 21 July after the individual was tagged on the night of 20 July at Stockton Cabin. This individual was roosting in a crevice within a rock situated on the ground on talus slope just NE of the Matron and about 15 meters from the Mesa Trail on its west side. Visual observation of the individual in the roost site was verified by K. Thibault on 21 July. This individual foraged



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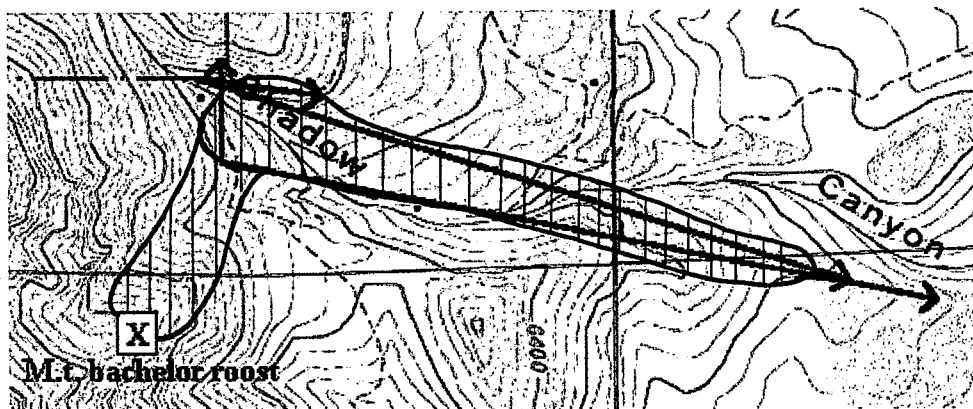
Figure 11. Telemetry data gathered on a foraging, male *Corynorhinus townsendii* from two triangulation points. Point 1 just south of the watertank west of NIST and Point 2 just NW of the Radio Tower near our Bear Canyon Creek waterhole site. Reading were gathered on 9 (top) & 10 (bottom) July 1999 at 5 minute intervals. Hatch-marks indicate estimated area of home range for this individual. On both nights contact was lost with this individual as if foraged west along Bear Canyon Creek. Telemetry was reestablished as it returned after approximately 25 minutes each time.



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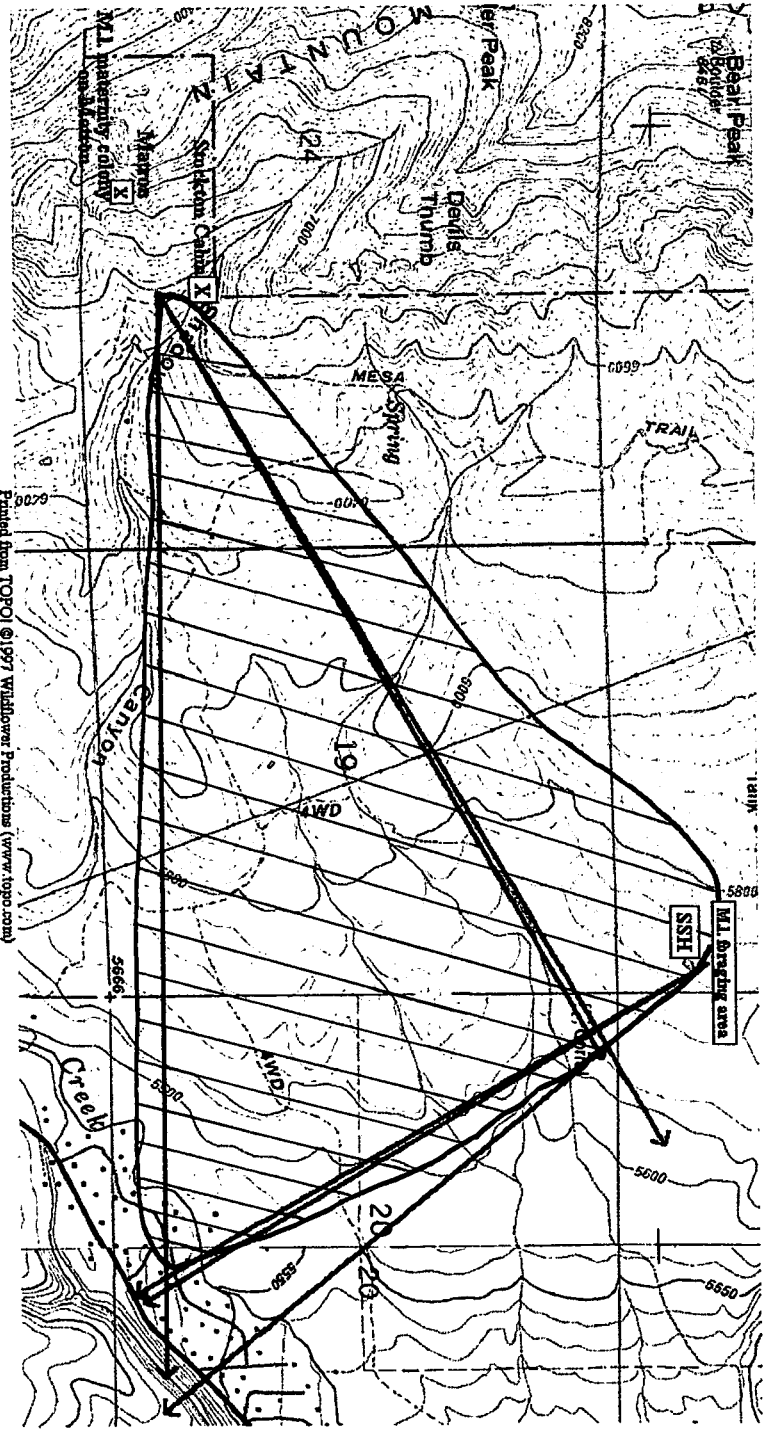
Figure 12. Telemetry data gathered on a foraging, lactating female *Myotis ciliolabrum* from two triangulation points. Point 1 just below roost site on talus slope (NE of Matron) and Point 2 from Stockton Cabin waterhole. Readings were gathered on 21 July 1999 at 5 minute intervals. Hatch-marks indicate estimated area of home range for this individual.

predominately in the vicinity of its roost site. Foraging was intermittent with roosting along the rock face just NE of the Stockton Cabin waterhole. At one point, she roosted for 30 minutes before resuming foraging. After two days of rain following this night, we lost the telemetry signal from this individual. Figure 13 shows the roost site and foraging pattern for a male *Myotis thysanodes* also radio tagged at Stockton Cabin on the night of 20 July. The roost site required seven hours to locate, and, after returning to watch the outflight that night, we determined that it contained between one and four individuals. Due to the angle of the opening of the roost site relative to our best position to watch the out-flight, it was difficult to tell if all four individuals emerged from the exact same crevice, or whether they were each in different crevices in proximity to one another. Using triangulation from the same two points as in Figure 12, we tracked this individual as it foraged in the vicinity of Stockton Cabin for about six minutes; this individual then moved out of telemetry range, heading SW along lower Shadow Canyon. After two days of rain that followed this night, the signal persisted from the roost site, indicating that the transmitter had fallen from the bat into the roost. Figure 14 shows telemetry data of a lactating, female *M. lucifugus* tagged at South Shanahan pond and tracked to the maternity colony located in the Matron. This is the same colony we found in 1998 by tagging an individual at Stockton Cabin. Triangulation points of movement were gathered on 22, 23, & 24 June 1999 from one position on the Mesa Trail just below the Matron and another position at South Shanahan pond. This individual had the largest home range of any bat so far tagged, and on all three nights flew out of range of our telemetry equipment heading 30° NNE from South Shanahan pond. On 25 June, we positioned one team with telemetry gear at South Shanahan pond and the other at the South Boulder Recreation Center to try and follow the individual after it left the



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Figure 13. Telemetry data gathered on a foraging, male *Myotis thysanodes* from two triangulation points. Point 1 just below roost site of *M. ciliolabrum* on talus slope (NE of Matron, as in Fig. 12) and Point 2 from Stockton Cabin waterhole. Readings were gathered on 21 July 1999 at 5 minute intervals. Hatch-marks indicate estimated area of home range for this individual.



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Shanahan Ridge area. Unfortunately, the transmitter had fallen from the individual, being dropped in the roost site. We determined that this individual was flying at least six linear miles from the roost site and covering at least 15 square miles in home range. Calculation of minimal home range is seen in Figure 14. In addition, I observed this individual foraging for about 10 minutes just off the north edge of South Shanahan pond on 24 June (Fig. 14) before heading out of range at 30° NNE.

C. ROOST SITE TEMPERATURE PROFILES

To date, virtually nothing is known concerning species-specific roost site temperature requirements for Coloradan bat species. Figure 15 shows temperature profiles gathered using data loggers positioned at two of the roost sites in 1999. The top graph is that of a *Myotis thysanodes* maternity site found in 1998 at Gregory Canyon, but apparently not used in 1999. The first day that the probe was inserted was 22 July, and it was removed on 24 August (Table V). Temperatures were recorded by the data logger every four hours and plots illustrate highs and lows for every 24 hour period. Ranges of temperatures experienced in this roost site were from 16° C to 31° C. The bottom graph of Figure 15 shows the temperature profile for a lactating, female *Myotis ciliolabrum* roost located in a rock talus slope near the Matron. Temperatures at this site were similar to the *M. thysanodes* site over the same period (22 July - 24 August). The range of temperatures was from 13° C to 31° C. Both graphs show an extensive drop in temperature the first 10 days of August corresponding with an extensively rainy period. One data logger placed in a maternity colony of 46 *M. thysanodes* located on DerZerkle was stolen from the site; therefore, we have lost these very important data. Figure 16 shows temperature profiles for the *C. townsendii* colony (top graph) and the *E. fuscus* colony (bottom

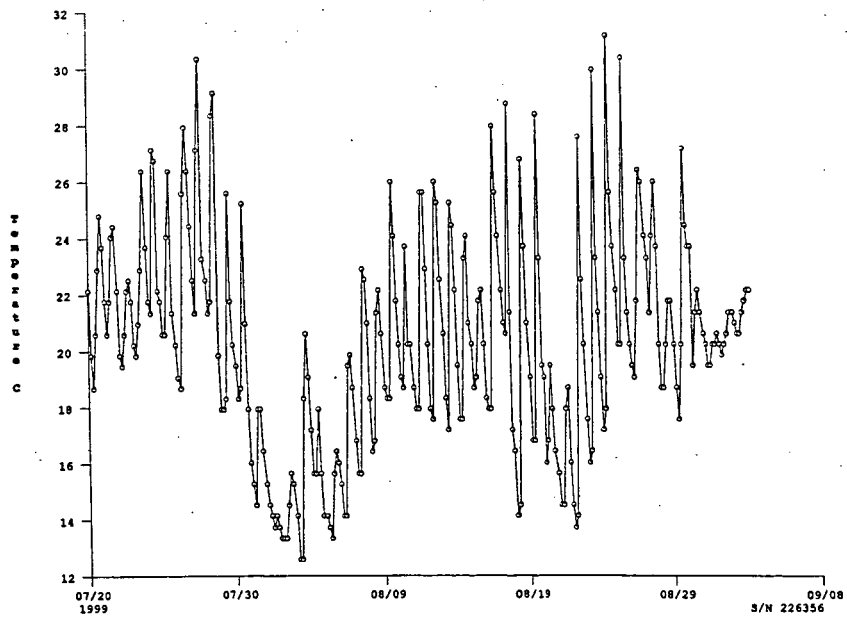
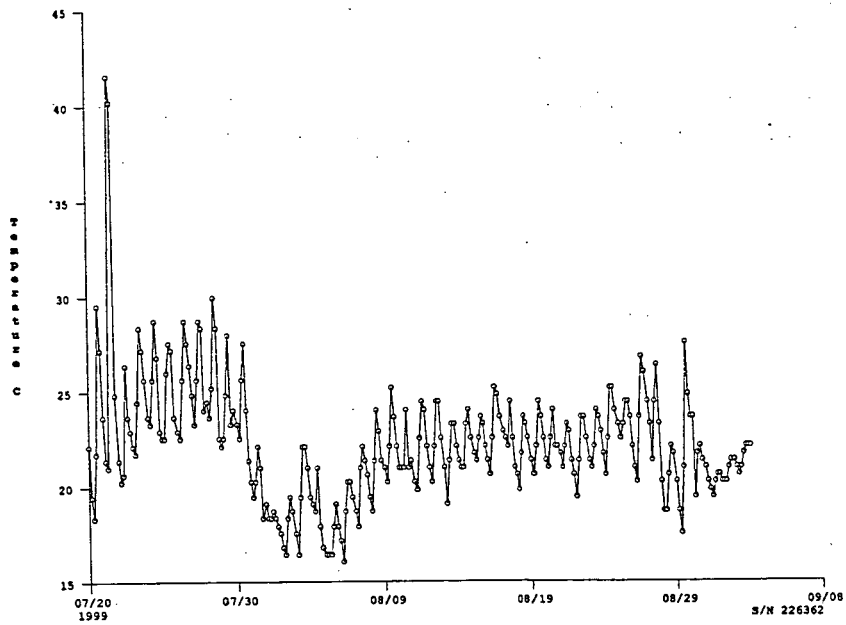


Figure 15. Plot of temperature profiles gathered with temperature-sensitive data loggers placed in two maternity sites, *Myotis ciliolabrum* near the Matron (top), and *Myotis thysanodes* at Gregory Canyon (bottom). See Table V

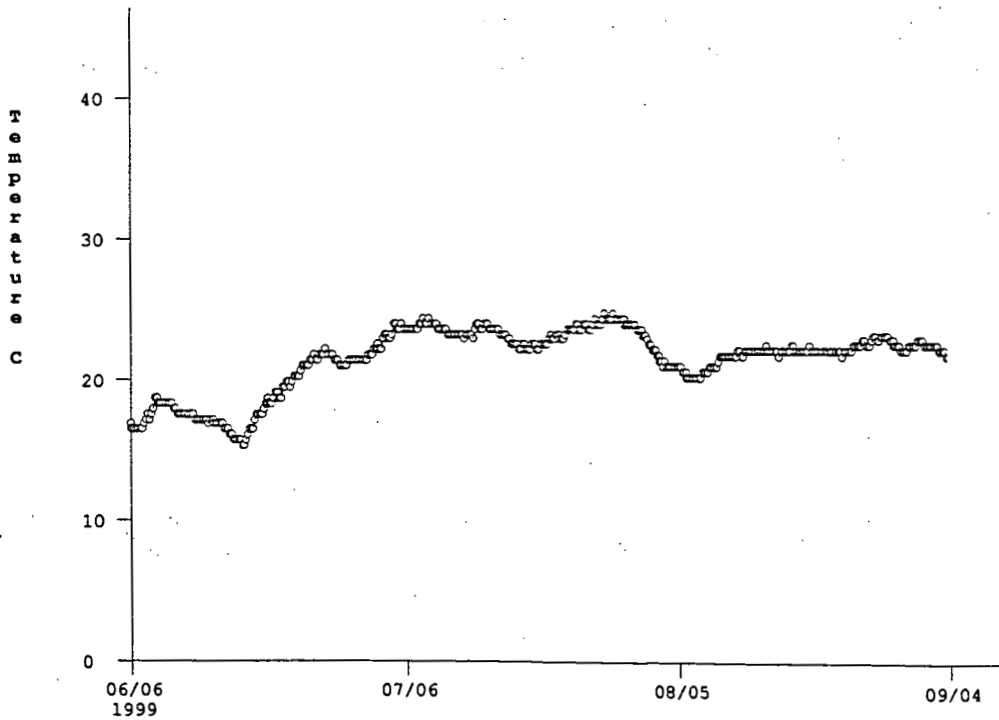
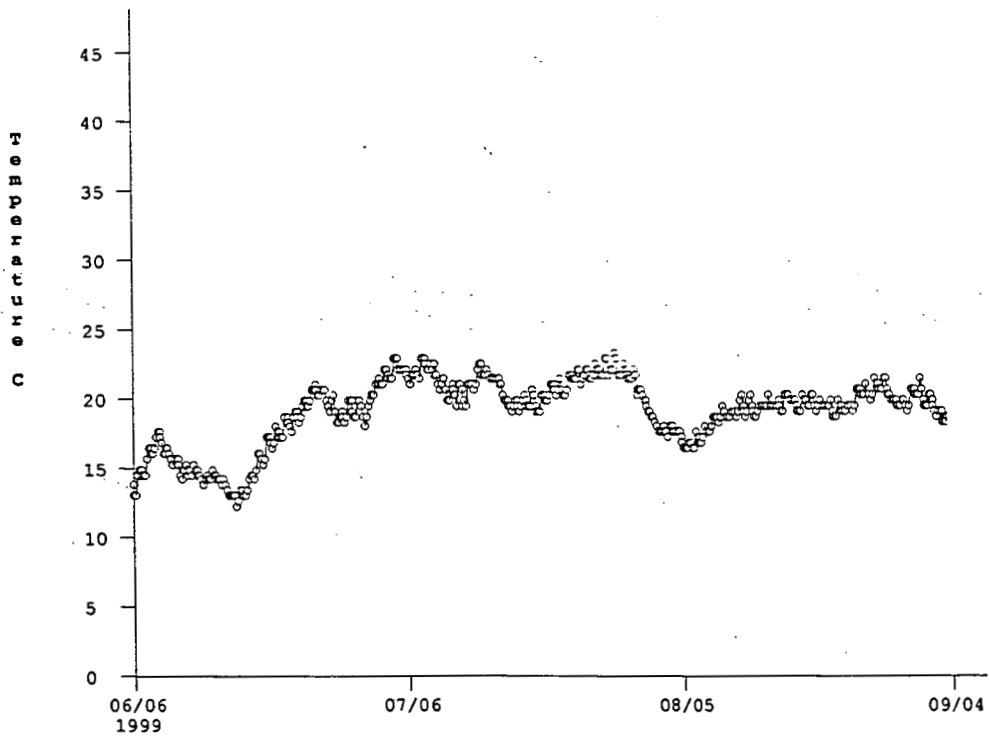


Figure 16. Plot of temperature profiles gathered with temperature-sensitive data loggers placed in two sites in Harmon Cave. (Top) *Eptesicus fuscus* bachelor roost, (bottom) *Corynorhinus townsendii* maternity roost. See Table V

graph) at Harmon Cave. For *C. townsendii*, temperatures ranged from about 12° C to 25° C and these cooler temperatures are in-line with other maternity roost sites used by this species (Armstrong et al., 1994). The temperature ranges gathered from the *E. fuscus* colony support the assertion that this is a bachelor roost since the temperatures are lower than would be typically expected for this species in a maternity site (Armstrong et al., 1994).

D. SPECIES DIVERSITY AND EVENNESS

As reported in our previous yearly reports, highest species diversity and evenness occurs at Bear Canyon Creek (BC) and Stockton Cabin (SC) at Shadow Canyon Creek. Table IX shows the breakdown of numbers of individuals per species captured at each of our waterhole sites, and Figure 17 shows pooled data gathered over the past four years from 10 waterholes in Boulder Open Space and Mountain Parks. The total number of individuals captured thus far is 1272. Interestingly, species that do not normally forage in the cluttered habitats surrounding BC and SC, such as *E. fuscus*, *L. cinereus*, and *L. noctivagans* continue to be captured at these sites. We measured pH values at each of these sites as well as water temperatures. Table X shows average waterhole temperatures (°F) sampled in 1998 and 1999. Stream waterholes maintain lower temperatures throughout the summer than do ponds, and the sites with lowest temperatures are also those with the highest number of bat species utilizing them. Figure 18 shows pH readings taken at six waterhole sites (3 creek and 3 pond sites). At the stream sites, pH averaged 8.2 (Range 8.8 - 7.7), whereas at ponds the pH averaged 6.9 (Range 6.4-7.4). For the two sites with highest bat usage (BC & SC), pH averaged 8.6, indicating basic conditions. What is causing more basic conditions at the most speciose stream sites is under investigation, but if it is due to mineral content, these sites may be critical watering holes for bats in the area..

Table IX. Total captures of bats at each waterhole in City of Boulder Open Space and Boulder Mountain Parks between 1996 and 1999. Total number of captures = 1272 individuals across 10 species. ABB = Abbey Pond, BC = Bear Creek, BP = Buckingham Park, GC = Gregory Canyon, LP = Lindsay Pond, NIST = National Institute of Standards, NSH = North Shanahan Pond, RR = Red Rock Park, SC = Stockton Cabin, SCH = Schneider Pond, and SSH = South Shanahan Pond.

SITE	<i>M. ciliolabrum</i>	<i>M. evotis</i>	<i>M. lucifugus</i>	<i>M. thysanodes</i>	<i>M. volans</i>	<i>L. cinereus</i>	<i>L. noctivagans</i>	<i>E. fuscus</i>	<i>C. townsendii</i>	<i>T. brasiliensis</i>
ABB	5	0	16	5	0	1	0	20	0	0
BC	31	7	146	56	51	0	2	81	4	0
BP	0	0	0	4	0	0	0	0	0	0
GC	6	5	3	8	7	1	1	4	1	0
LP	8	0	0	0	0	0	0	1	0	0
NIST	1	1	2	0	4	1	0	45	0	0
NSH	13	6	110	16	4	6	3	111	0	1
RR	0	0	0	0	0	0	0	4	0	0
SC	20	97	103	36	59	3	3	55	5	0
SCH	9	0	0	0	0	1	0	3	0	0
SSH	5	0	36	3	1	0	0	0	0	0

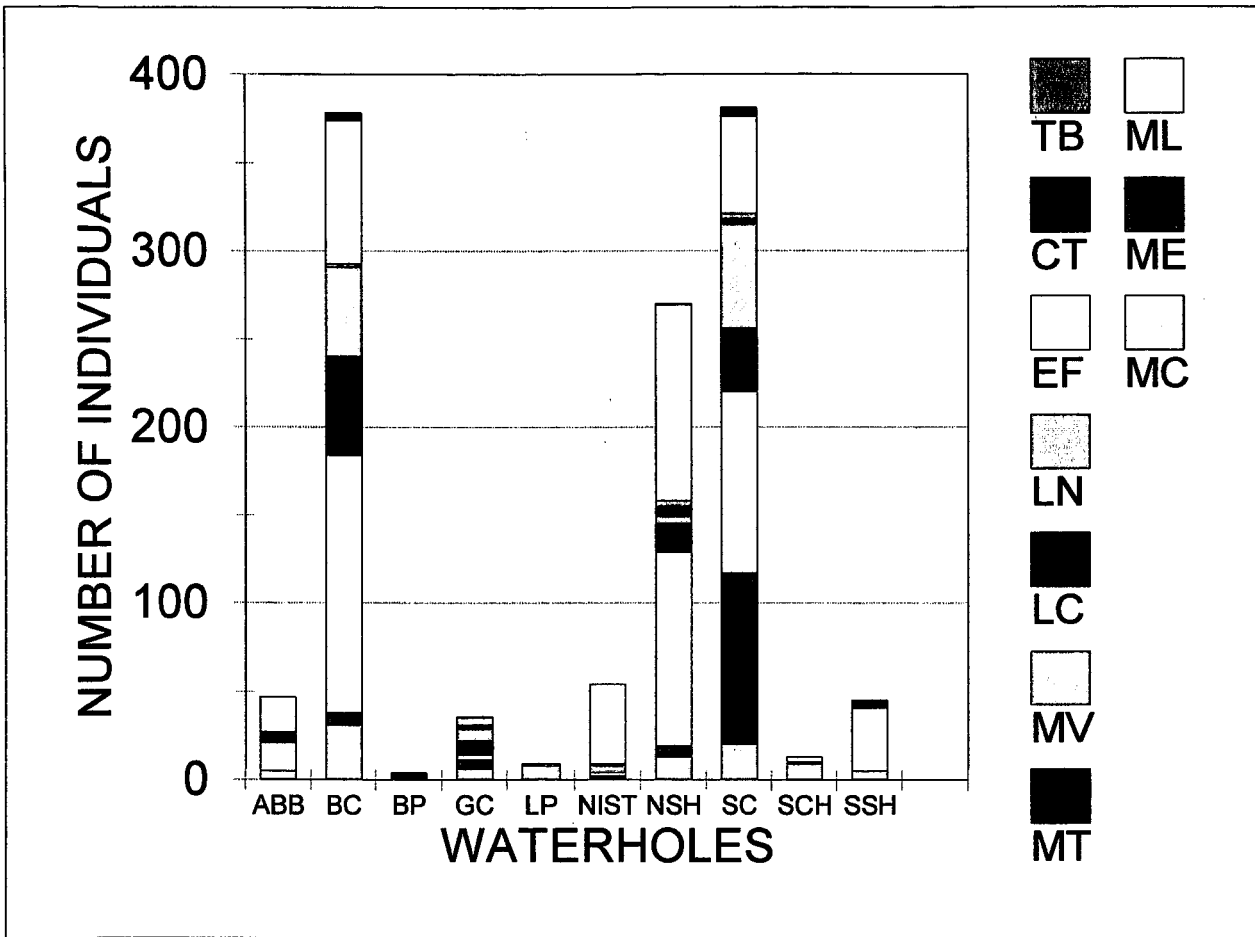


Figure 17. Histograms of total number captures of individuals at 10 waterholes between 1996 and 1999 ($n = 1272$). Highest number of captures as well as highest species diversity and evenness were present at Bear Creek (BC) and at Stockton Cabin (SC). See Table IX for breakdown and abbreviations.

Table X. Average water temperatures per month pooled from 1998 and 1999 data. Creek waterholes represented by BC, GC, & SC tend to maintain cooled water temperatures throughout the four month period than do ponds. Greatest species diversity is found at the cooler creek waterholes. BC = Bear Creek, GC = Gregory Canyon, SC = Stockton Cabin, NIST = National Institute of Standards, SSH = South Shanahan pond, NSH = North Shanahan pond, ABB = Abbey pond, and LD = Lindsay pond.

SITE	MAY	JUNE	JULY	AUGUST
BC	49.6	51	50	50
GC		57.3	57.7	58
SC	45.9	46	49.5	49.5
NIST		67.7	67	68.1
SSH		70	71.3	71.4
NSH	68	71	74	71
ABB	67.5	70.3		70.0
LD			78.5	76

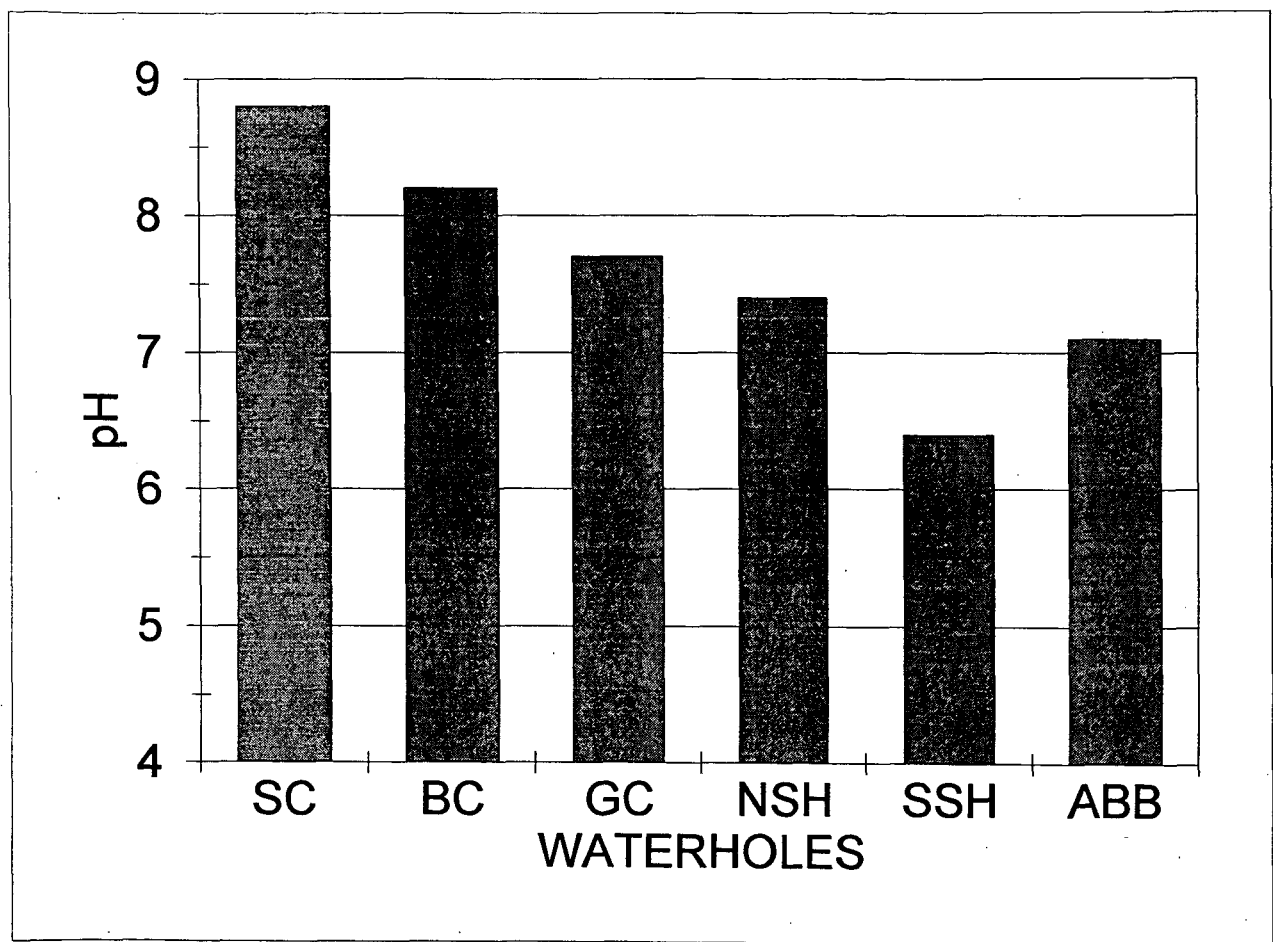


Figure 18. Bar graph of pH readings taken at six waterholes. Stream sites showed higher pH than did ponds which tended to be neutral or slightly acidic. SC = Stockton Cabin, BC = Bear Creek, GC = Gregory canyon, NSH = North Shanahan, SSH = South Shanahan and ABB = Abbey pond.

Miscellaneous.—A female *M. lucifugus* captured and banded at Bear Creek in 1998 was found roosting in a building under renovation at the junction of Pearl and 14th Streets. This is a linear movement of 3.23 miles from site of capture. This individual was seized by Ranger Stoner and was subsequently returned to Bear Canyon Creek by R. Adams and K. Thibault and released. A temperature sensitive data logger placed in the *M. thysanodes* maternity colony on DerZerkle in June was found to be missing when the site was revisited in August. In addition, no bats were present at the roost site. Because the data logger was securely fastened to the rock, it can only be assumed that a climber had removed the data logger (especially since some of Stoner's climbing gear was also missing). Because the bats were no longer in the site, it is likely that this deliberate human disturbance caused a premature breakup and evacuation of this nursery colony. The fringed myotis (*Myotis thysanodes*) is a species listed as imperilled and in need of immediate conservation efforts by the Western Bat Working (Conservation) Group (of which the Colorado Bat Society is a member); therefore, protection of this site must be considered critical (see below).

CONCLUSIONS

In 1999, priorities were to locate roost sites for bat species in our study areas, including City of Boulder Open Space and Boulder Mountain Parks, as well as to gain a better understanding of foraging patterns and roosting requirements for these species. To date, we have found 16 roost sites for six species (Table VIII). All roost sites thus far located occur in rock crevices, with the exception of a maternity roost of *Myotis evotis* found to inhabit an abandoned house on Flagstaff Mountain. The fact that bats are preferring rock crevices raises concerns as to the effect of rock climbing in the vicinity of such sites. Many of the Boulder bat species that

colony or perhaps a separate colony of this imperiled species. The open-cavern atmosphere of Mallory Cave provides perfect roost site physiography for this species. Because of the lack of 'true' caves in the area, Mallory Cave is one of the few sites that provides a large natural open, but protected, area for members of this species to establish a maternity colony. In fact, if not impacted by humans such as it is today, this site would perhaps house one of the largest colonies of this species in the area. It should be noted that we fully understand the popularity of this area, but feel that the majority of the public will support a closure to protect sensitive wildlife, as they have for the species of falcons in the area. At a minimum, a seasonal closure for this site is urgently necessary for the area in proximity to and within Mallory Cave. Eventually, the grating of this site should be seriously considered, particularly if the seasonal closure is not effective and/or leads to consistent usage of this cavern by *C. townsendii* and other bat species.

FUTURE RESEARCH: Several tasks await the 2000 season. 1) In 1999, we documented a foraging area for *C. townsendii* in Open Space near the Diversion Canal and east of Eldorado Mountain. This means that there is another colony of this imperiled species in the Boulder Open Space that remains undocumented. Despite several attempts to recapture and radio tag an individual to locate the colony in 1999, we were unsuccessful. Returning to this site in 2000 to tag an individual will enable us to locate this colonies roost site. For some of the Boulder species, we have yet to document maternity sites (*M. volans*) or bachelor sites (*M. evotis*, *M. ciliolabrum*, & *M. volans*), and for all species, only one to three sites have been found. Locating and mapping more roost sites per species will be necessary for management efforts. In addition, determining species preferences in terms of roost site temperatures, as begun in 1999 for crevice colonies of *M. thysanodes*, *M. ciliolabrum*, *E. fuscus* and *C. townsendii*) should be continued. In

2000, we would like to 1) compare temperature profiles of known crevice roost sites with nonroost site crevices, 2) measure temperature profiles inside tree snags that appear to be potential roost sites, and 3) compare them with the data from crevice roosts. Finally, we need also to determine if streams are providing certain minerals to bats that are not present at other waterholes such as the ponds. Bats are known to be calcium deficient throughout the reproductive period, and, if water flow over rocks liberates significant amounts of calcium (and/or other minerals) into stream water, this may be one of the reason that the stream sites are significantly higher in bat activity.

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