

1997 SURVEY OF BOULDER COUNT
E5064 300000001174G



RICK A. ADAMS
LIB

Rick Adams

***1997 SURVEY OF BOULDER
COUNT BATS: A STUDY IN BIODIVERSITY
AND COMMUNITY ECOLOGY***

OVERSITE AGENCY: *City of Boulder Open Space*

**PRINCIPAL INVESTIGATOR: *Rick A. Adams, Department of Biological Sciences,
University of Wisconsin, Whitewater, WI 53190 and President, The Colorado
Bat Society, Boulder, CO 80302***

FIELD ASSISTANT: *Ms Katherine Thibault,*

REPORT AUTHOR: *Rick A. Adams, Ph.D.*

SUBMITTED: 29 SEPTEMBER 1997

STATEMENT OF OBJECTIVES AND GOALS: With the apparent loss of abundance and biodiversity of bat species in Colorado (Armstrong et al., 1994; Armstrong et al., 1995) there is a strong need for data in understanding patterns of resource use by Coloradan bats. Although some data have been gathered recently on Boulder County bats (Adams, 1995), we still have very little understanding the distribution and abundance of bat species as well as the location of summer and winter roost sites. For 1996, I concentrated on gathering further data on species abundance and distributions by continuing to net bats at various sites throughout Boulder County and I also undertook efforts to understand water use patterns. Four hypotheses were tested: Hypothesis 1: Bat species tend to visit watering sites predominately in species groups and not as lone individuals. Hypothesis 2: Most species tend to visit watering sites multiple times per night. Hypothesis 3: Order of species visitation will be similar at all watering sites. Hypothesis 4: There is seasonal variation in species diversity at watering sites. In 1997, we concentrated our efforts on gathering data from two of the sites with highest species diversity and evenness. The Shadow Canyon Site (i.e. Stockton Cabin, T1S R71W sec. 24) and the Bear Canyon Creek Site (T1S R71W sec. 12) were netted predominately, but Abbey Pond (T1S R70W sec. 18) and South Shanahan Pond (T1S R70W sec. 1) were periodically sampled. We also spent time locating and mapping potentially "new" sites for sampling next year. The hypotheses listed above remain the working questions for the study. In addition, we began a radio-tracking study in an attempt to locate and map the distribution of roost sites for each of the Front Range species. Unfortunately, the transmitters needed were three months backordered and, therefore, we only had time to tag a single individual.

METHODS: The study was conducted from 4 June to 24 August 1997 with the help of Kate Thibault, who acted as field assistant for the second consecutive year. The study concentrated predominately on two of the eleven documented (Adams, 1996) water sites used by bats in the area. All bats were captured using Japanese mist nets. If activity was low due to inclement weather the site was sampled again, sometimes on the following night. Data were recorded on species, sex, reproductive condition, relative age, and weight. Bats were tagged with numbered, plastic, split-ring, forearm bands. Bands also were marked with reflective tape, color-coded per species. Headlamps were used on consecutive nights to observe marked individuals returning to site. Timing of visitation by various species was recorded and this technique allowed observations without trapping individuals. A bat detector was used to measure activity patterns based upon the presence or absence of echolocatory calls.

One individual was fitted with a radio transmitter attached to its dorsal fur using superglue paste. Original plans included attachment of radio transmitters on six individuals. However, because the size transmitters required for small-sized bats were backordered for 3 months, we did not receive shipment until August and, therefore, only one transmitter was put into the field. The remainder were saved for the 1998 field season.

Statistics.—Histograms were plotted to show utilization curves based upon timing of visitation of each species to water holes. Species overlap indices based upon Chi Square Analysis (Ludwig and Reynolds, 1988) were calculated and compared time-based utilizations.

RESULTS: A total of 60 net nights at five sites (Table I & Table II) resulted in the capture of 348 individuals of nine species (Table I & III). In addition, 11 nights of observation of individuals marked with reflective tape and more than 30 hours over five days of tracking a

Table I. Capture data per species per site for 1997. (Total=348)

A. *Myotis lucifugus* at Stockton Cabin (n = 60)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|-------|--------|
| 2059 | 27 | 7.1 | NS | Male | Adult | Jun 19 |
| 2100 | 28 | 6.2 | NS | Male | Adult | Jun 19 |
| 2119 | 47 | 8.3 | NS | Male | Adult | Jun 19 |
| 2125 | 53 | 6.3 | NS | Male | Adult | Jun 19 |
| 2110-44 | 38-72 | 6.4 | NS | Male | Adult | Jun 19 |
| 2110-44 | 38-72 | 8.1 | NS | Male | Adult | Jun 19 |
| 2110-44 | 38-72 | 6.3 | NS | Male | Adult | Jun 19 |
| 2110-44 | 38-72 | 6.9 | NS | Male | Adult | Jun 19 |
| 2110-44 | 38-72 | 6.3 | NL P | Female | Adult | Jun 19 |
| 2110-44 | 38-72 | 7.3 | NL P | Female | Adult | Jun 19 |
| 2101-35 | 28-62 | 7.4 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.6 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.7 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 6.8 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.0 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.7 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.2 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.0 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.2 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.1 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.6 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 6.4 | NS | Male | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.1 | NS | Male | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.0 | NS | Male | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.5 | NS | Male | Adult | Jun 30 |

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|----------|---------|
| 2134 | 61 | 7.0 | NS | Male | Adult | Jun 30 |
| 2052 | 28 | ESCAPED | | | Adult | July 20 |
| 2037 | 23 | 6.3 | S | Male | Adult | Aug 1 |
| 2037 | 23 | 8.0 | S | Male | Adult | Aug 1 |
| 2037 | 23 | 7.2 | NL P | Female | Adult | Aug 1 |
| 2039 | 25 | 7.2 | L NP | Female | Adult | Aug 1 |
| 2039 | 25 | 6.9 | NL NP | Female | Juvenile | Aug 1 |
| 2040-50 | 26-36 | 7.8 | PostL | Female | Adult | Aug 1 |
| 2040-50 | 26-36 | 7.9 | L NP | Female | Adult | Aug 1 |
| 2040-50 | 26-36 | 6.9 | L NP | Female | Adult | Aug 1 |
| 2040-50 | 26-36 | 7.4 | L NP | Female | Adult | Aug 1 |
| 2040-50 | 26-36 | 7.8 | PostL | Female | Adult | Aug 1 |
| 2040-50 | 26-36 | 7.7 | PostL | Female | Adult | Aug 1 |
| 2040-50 | 26-36 | 7.9 | NL | Female | Adult | Aug 1 |
| 2040-50 | 26-36 | 7.8 | PostL | Female | Adult | Aug 1 |
| 2040-50 | 26-36 | 5.7 | Part. S | Male | Adult | Aug 1 |
| 2040-50 | 26-36 | 7.6 | S | Male | Adult | Aug 1 |
| 2040-50 | 26-36 | 8.3 | S | Male | Adult | Aug 1 |
| 2023 | 25 | 6.4 | NS | Male | Juvenile | Aug 14 |
| 2028 | 30 | 7.3 | S | Male | Adult | Aug 14 |
| 2005-17 | 16-28 | 7.6 | S | Male | Adult | Aug 22 |
| 2005-17 | 16-28 | 7.1 | NS | Male | Juvenile | Aug 22 |
| 2005-17 | 16-28 | 7.0 | NLNP | Female | Juvenile | Aug 22 |
| 2005-17 | 16-28 | 8.3 | PLNP | Female | Adult | Aug 22 |
| 2005-17 | 16-28 | 6.9 | NLNP | Female | Juvenile | Aug 22 |
| 2005-17 | 16-28 | 7.0 | NS | Male | Juvenile | Aug 22 |
| 2005-17 | 16-28 | 5.8 | NS | Male | Juvenile | Aug 22 |

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|----------|--------|
| 2005-17 | 16-28 | 7.0 | NS | Male | Juvenile | Aug 22 |
| 2005-17 | 16-28 | 7.9 | NLNP | Female | Juvenile | Aug 22 |
| 2005-17 | 16-28 | 7.5 | NLNP | Female | Juvenile | Aug 22 |
| 2005-17 | 16-28 | 6.5 | NS | Male | Juvenile | Aug 22 |
| 2017 | 28 | 6.3 | NLNP | Female | Juvenile | Aug 22 |
| 2019 | 30 | 6.5 | NLNP | Female | Juvenile | Aug 22 |
| 2021 | 32 | 6.1 | NS | Male | Juvenile | Aug 22 |
| 2030 | 41 | 6.8 | NS | Male | Juvenile | Aug 22 |

B. *Myotis thysanodes* at Stockton Cabin (n = 16)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|----------|--------|
| 2127 | 58 | 7.2 | NS | Male | Adult | Jun 11 |
| 2127 | 58 | 6.7 | NS | Male | Adult | Jun 11 |
| 2127 | 58 | 6.8 | NS | Male | Adult | Jun 11 |
| 2110-44 | 38-72 | 6.8 | NS | Male | Adult | Jun 19 |
| 2116 | 44 | 8.0 | NS | Male | Adult | Jun 19 |
| 2136-46 | 63-73 | 7.2 | NS | Male | Adult | Jun 30 |
| 2057 | 43 | 7.4 | NS | Male | Adult | Aug 1 |
| 2105 | 51 | 8.7 | S | Male | Adult | Aug 1 |
| 2115-25 | 61-71 | 9.5 | S | Male | Adult | Aug 1 |
| 2130-40 | 76-86 | 8.9 | S | Male | Adult | Aug 1 |
| 2130-40 | 76-86 | 7.9 | S | Male | Adult | Aug 1 |
| 2145-59 | 91-105 | 8.5 | S | Male | Adult | Aug 1 |
| 2201-09 | 107-115 | 8.0 | S | Male | Adult | Aug 1 |
| 2049 | 51 | --- | NS | Male | Adult | Aug 14 |
| 2141 | 111 | 7.9 | S | Male | Adult | Aug 22 |
| 2141 | 111 | 7.9 | NS | Male | Juvenile | Aug 22 |

C. Myotis volans at Stockton Cabin ($n = 32$)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|-------|--------|
| 2049 | 20 | 7.2 | NL P | Female | Adult | Jun 11 |
| 2110 | 41 | 8.2 | NL NP | Female | Adult | Jun 11 |
| 2111-19 | 42-50 | 7.7 | NL P | Female | Adult | Jun 11 |
| 2111-19 | 42-50 | 7.8 | NL P | Female | Adult | Jun 11 |
| 2111-19 | 42-50 | 8.1 | NL P | Female | Adult | Jun 11 |
| 2111-19 | 42-50 | 8.3 | NL P | Female | Adult | Jun 11 |
| 2236 | 127 | 8.0 | NL P | Female | Adult | Jun 11 |
| 2244 | 135 | 7.7 | NS | Male | Adult | Jun 11 |
| 2254 | 145 | ESCAPED | | | Adult | Jun 11 |
| 2301 | 152 | 8.1 | NL P | Female | Adult | Jun 11 |
| 2343 | 194 | ESCAPED | | | Adult | Jun 11 |
| 2051 | 19 | 6.3 | NS | Male | Adult | Jun 19 |
| 2110-44 | 38-72 | 8.7 | NL P | Female | Adult | Jun 19 |
| 2110-44 | 38-72 | 8.3 | NL P | Female | Adult | Jun 19 |
| 2110-44 | 38-72 | 7.7 | NL P | Female | Adult | Jun 19 |
| 2110-44 | 38-72 | 9.2 | NL P | Female | Adult | Jun 19 |
| 2110-44 | 38-72 | 8.7 | NL P | Female | Adult | Jun 19 |
| 2110-44 | 38-72 | 6.6 | NS | Male | Adult | Jun 19 |
| 2110-44 | 38-72 | 7.8 | NL P | Female | Adult | Jun 19 |
| 2110-44 | 38-72 | 8.8 | NL P | Female | Adult | Jun 19 |
| 2147 | 75 | 7.1 | NL P | Female | Adult | Jun 19 |
| 2147 | 75 | 7.5 | NS | Male | Adult | Jun 19 |
| 2101-35 | 28-62 | 7.2 | NS | Male | Adult | Jun 30 |
| 2101-35 | 28-62 | 7.6 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 6.7 | NL P | Female | Adult | Jun 30 |
| 2101-35 | 28-62 | 9.2 | NL P | Female | Adult | Jun 30 |

| 2130 | 57 | 9.0 | NL P | Female | Adult | Jun 30 |
|-------------|-------------------|------------|---------------|--------|-------|--------|
| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
| 2218-34 | 105-121 | 6.6 | NL P | Female | Adult | Jun 30 |
| 2238 | 125 | 9.2 | NL P | Female | Adult | Jun 30 |
| 2040-50 | 26-36 | 7.8 | NL NP | Female | Adult | Aug 1 |
| 2040-50 | 26-36 | 7.6 | L NP | Female | Adult | Aug 1 |
| 2032 | 34 | --- | S | Male | Adult | Aug 14 |

D. *Myotis evotis* at Stockton Cabin (n = 43) *indicates a recaptured individual

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|-------|--------|
| 2110 | 41 | 5.1 | NS | Male | Adult | Jun 11 |
| 2110 | 41 | 6.1 | NS | Male | Adult | Jun 11 |
| 2110 | 41 | 5.8 | NS | Male | Adult | Jun 11 |
| 2111-19 | 42-50 | 5.7 | NS | Male | Adult | Jun 11 |
| 2127 | 58 | 5.7 | NS | Male | Adult | Jun 11 |
| 2127 | 58 | 6.6 | NS | Male | Adult | Jun 11 |
| 2157 | 88 | 5.5 | NS | Male | Adult | Jun 11 |
| 2157 | 88 | 5.9 | NS | Male | Adult | Jun 11 |
| 2206 | 97 | 6.7 | NS | Male | Adult | Jun 11 |
| 2233 | 124 | 6.5 | NS | Male | Adult | Jun 11 |
| 2237 | 128 | 5.9 | NS | Male | Adult | Jun 11 |
| 2244 | 135 | 6.3 | NS | Male | Adult | Jun 11 |
| 2254 | 145 | 5.9 | NS | Male | Adult | Jun 11 |
| 2254 | 145 | 6.7 | NS | Male | Adult | Jun 11 |
| 2300 | 151 | 5.3 | NS | Male | Adult | Jun 11 |
| 2321 | 172 | 6.0 | NS | Male | Adult | Jun 11 |
| 2345 | 196 | 6.9 | NS | Male | Adult | Jun 11 |

| 2113 | 41 | 7.1 | NS | Male | Adult | Jun 19 |
|-----------------|-------------------|------------|---------------|-------------|--------------|---------------|
| 2114 | 42 | 5.3 | NS | Male | Adult | Jun 19 |
| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
| 2120 | 48 | 6.1 | NS | Male | Adult | Jun 19 |
| 2121 | 49 | ESCAPED | | | Adult | Jun 19 |
| 2138 | 66 | 5.9 | NS | Male | Adult | Jun 19 |
| 2217 | 105 | 7.8 | NL P | Female | Adult | Jun 19 |
| 2244 | 132 | ---- | NS | Male | Adult | Jun 19 |
| 2120 | 47 | 6.2 | NS | Male | Adult | Jun 30 |
| 2124 | 51 | 5.6 | NS | Male | Adult | Jun 30 |
| 2126 | 53 | 5.5 | NS | Male | Adult | Jun 30 |
| 2131 | 58 | 6.3 | NS | Male | Adult | Jun 30 |
| 2136-46 | 63-73 | 6.8 | NS | Male | Adult | Jun 30 |
| 2136-46 | 63-73 | 6.7 | NS | Male | Adult | Jun 30 |
| 2147-56 | 74-83 | 6.7 | NS | Male | Adult | Jun 30 |
| *2147-56 | 74-83 | 6.4 | NS | Male | Adult | Jun 30 |
| 2157-17 | 84-104 | 6.7 | NS | Male | Adult | Jun 30 |
| 2157-17 | 84-104 | 7.4 | NS | Male | Adult | Jun 30 |
| 2218-34 | 105-121 | 6.3 | NS | Male | Adult | Jun 30 |
| 2040-50 | 26-36 | 6.9 | S | Male | Adult | Aug 1 |
| 2045 | 31 | 6.5 | S | Male | Adult | Aug 1 |
| 2050 | 36 | 6.1 | S | Male | Adult | Aug 1 |
| 2050 | 36 | 5.7 | S | Male | Adult | Aug 1 |
| 2059 | 45 | 5.6 | NS | Male | Juvenile | Aug 1 |
| 2130-40 | 76-86 | 6.7 | S | Male | Adult | Aug 1 |
| 2145-59 | 91-105 | 6.5 | S | Male | Adult | Aug 1 |
| 2145-59 | 91-105 | 5.9 | S | Male | Adult | Aug 1 |
| *2107 | 69 | 6.1 | S | Male | Adult | Aug 14 |

E. *Eptesicus fuscus* at Stockton Cabin (n = 15)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|-------|--------|
| 2135 | 66 | ---- | NS | Male | Adult | Jun 11 |
| 2135 | 66 | 15.1 | NS | Male | Adult | Jun 11 |
| 2244 | 135 | 13.9 | NS | Male | Adult | Jun 11 |
| 2327 | 178 | ---- | NS | Male | Adult | Jun 11 |
| 2400 | 211 | 12.5 | NS | Male | Adult | Jun 11 |
| 2110 | 38 | 14.1 | NS | Male | Adult | Jun 19 |
| 2238 | 126 | 15.5 | NS | Male | Adult | Jun 19 |
| 2246 | 134 | 15.2 | NS | Male | Adult | Jun 19 |
| 2250 | 138 | 15.3 | NS | Male | Adult | Jun 19 |
| 2257 | 145 | 15.9 | NS | Male | Adult | Jun 19 |
| 2301 | 149 | 15.6 | NS | Male | Adult | Jun 19 |
| 2302 | 150 | 13.8 | NS | Male | Adult | Jun 19 |
| 2105 | 32 | 15.3 | NS | Male | Adult | Jun 30 |
| 2224 | 130 | 16.0 | S | Male | Adult | Aug 1 |
| 2048 | 50 | 16.0 | S | Male | Adult | Aug 14 |
| 2111 | 82 | 19.5 | S | Male | Adult | Aug 22 |
| 2146 | 118 | 23.2 | S | Male | Adult | Aug 22 |

F. *Myotis ciliolabrum* at Stockton Cabin (n = 6)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|-------|---------|
| 2102 | 29 | 5.8 | NS | Male | Adult | Jun 30 |
| 2058 | 34 | 5.1 | L NP | Female | Adult | July 20 |
| 2148 | 84 | 5.0 | NS | Male | Adult | July 20 |

| | | | | | | |
|---------|-------|-----|------|--------|-------|-------|
| 2036 | 22 | 5.7 | L NP | Female | Adult | Aug 1 |
| 2051 | 37 | 4.3 | NS | Male | Adult | Aug 1 |
| 2115-25 | 61-71 | 5.1 | L NP | Female | Adult | Aug 1 |

G. *Lasiurus cinereus* at Stockton Cabin (n=1)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|-------|--------|
| 2130 | 58 | 29.3 | NS | Male | Adult | Jun 19 |

H. *Lasionycteris noctivagans* at Stockton Cabin (n = 1)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|-------|--------|
| 2057 | 28 | 8.3 | S | Male | Adult | Jun 11 |

I. *Corynorhinus townsendii* at Stockton Cabin (n = 1)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|-------|---------|
| 2057 | 33 | 10.6 | L NP | Female | Adult | July 20 |

J. *Myotis lucifugus* at Bear Creek (n = 63) *indicates a recaptured individual

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|-------|-------|
| 2059 | 35 | 7.4 | NS | Male | Adult | Jun 4 |
| 2105 | 41 | 7.2 | NS | Male | Adult | Jun 4 |
| 2112-30 | 48-66 | 6.4 | NS | Male | Adult | Jun 4 |
| 2112-30 | 48-66 | 6.8 | NS | Male | Adult | Jun 4 |
| 2112-30 | 48-66 | 6.2 | NS | Male | Adult | Jun 4 |
| 2058-200 | 26-108 | 6.3 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.5 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.3 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.5 | NS | Male | Adult | Jun18 |

| 2058-200 | 26-108 | 6.8 | NS | Male | Adult | Jun18 |
|-------------|-------------------|------------|---------------|------|-------|-------|
| 2058-200 | 26-108 | 7.0 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.1 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.0 | NS | Male | Adult | Jun18 |
| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
| 2058-200 | 26-108 | 7.2 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 6.3 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.1 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 6.1 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.0 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 6.8 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.1 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 6.5 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 6.8 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.0 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 6.2 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 5.9 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.8 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 6.7 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | ---- | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 6.5 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.1 | NS | Male | Adult | Jun29 |
| 2058-200 | 26-108 | 7.2 | NS | Male | Adult | Jun29 |
| 2058-200 | 26-108 | ---- | NS | Male | Adult | Jun29 |
| 2058-200 | 26-108 | 6.5 | NS | Male | Adult | Jun29 |
| 2058-200 | 26-108 | 8.0 | NS | Male | Adult | Jun29 |
| 2058-200 | 26-108 | ---- | NS | Male | Adult | Jun29 |
| 2058-200 | 26-108 | 6.5 | NS | Male | Adult | Jun29 |

| | | | | | | |
|--------------------|--------------------------|-------------------|----------------------|-------------|--------------|--------------|
| 2108 | 35 | 6.0 | NS | Male | Adult | Jul 21 |
| 2112 | 39 | ---- | NS | Male | Adult | Jul 21 |
| 2112 | 39 | 7.1 | NS | Male | Adult | Jul 21 |
| 2114-19 | 41-46 | 7.9 | NS | Male | Adult | Jul 21 |
| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
| 2114-19 | 41-46 | 7.7 | NS | Male | Adult | Jul 21 |
| 2114-19 | 41-46 | 6.4 | NS | Male | Adult | Jul 21 |
| 2114-19 | 41-46 | 8.7 | NS | Male | Adult | Jul 21 |
| 2046 | 22 | ESCAPED | | | Adult | Jul 21 |
| 2046 | 22 | ESCAPED | | | Adult | Jul 21 |
| 2047-11 | 23-47 | 7.2 | NS | Male | Adult | Jul 21 |
| 2047-11 | 23-47 | 7.0 | NS | Male | Adult | Jul 21 |
| 2047-11 | 23-47 | 6.5 | NS | Male | Adult | Jul 21 |
| 2047-11 | 23-47 | 6.9 | NS | Male | Adult | Jul 21 |
| 2047-11 | 23-47 | 6.8 | S | Male | Adult | Jul 21 |
| 2047-11 | 23-47 | 7.0 | S | Male | Adult | Jul 21 |
| 2047-11 | 23-47 | 7.2 | S | Male | Adult | Jul 21 |
| 2047-11 | 23-47 | 8.4 | L NP | Female | Adult | Jul 21 |
| 2047-11 | 23-47 | 7.5 | S | Male | Adult | Jul 21 |
| 2054 | 30 | 7.7 | S | Male | Adult | Jul21 |
| 2100 | 36 | 7.7 | L NP | Female | Adult | Jul 21 |
| 2219 | 115 | 7.8 | NS | Male | Adult | Jul 21 |
| 2020 | 23 | 6.8 | NS | Male | Juvenile | Aug 15 |
| 2025 | 28 | 7.2 | S | Male | Adult | Aug 15 |
| 2030 | 33 | ---- | NS | Male | Juvenile | Aug 15 |
| 2030 | 33 | 6.4 | NLNP | Female | Juvenile | Aug 15 |
| 2014 | 28 | 6.4 | NS | Male | Juvenile | Aug 23 |
| 2015 | 29 | 7.9 | NLNP | Female | Juvenile | Aug 23 |

K. *Myotis thysanodes* at Bear Creek (n = 19)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|----------|---------|
| 2058 | 34 | 6.5 | | Female | Adult | Jun 4 |
| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
| 2112-30 | 48-66 | 6.2 | NS | Male | Adult | Jun 4 |
| 2112-30 | 48-66 | 9.0 | NL P | Female | Adult | Jun 4 |
| 2112-30 | 48-66 | 7.8 | NL P | Female | Adult | Jun 4 |
| 2112-30 | 48-66 | 9.6 | NL P | Female | Adult | Jun 4 |
| 2241 | 137 | 7.0 | NS | Male | Adult | Jun 4 |
| 2058-200 | 26-108 | 8.2 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 6.6 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.2 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 7.7 | NL P | Female | Adult | Jun18 |
| 2058-200 | 26-108 | 8.0 | ---- | ---- | Adult | Jun18 |
| 2101 | 37 | 8.0 | L NP | Female | Adult | July 21 |
| 2105 | 41 | 8.4 | L NP | Female | Adult | July 21 |
| 2105 | 41 | 9.0 | L NP | Female | Adult | July 21 |
| 2050 | 53 | 9.0 | L NP | Female | Adult | Aug 15 |
| 2110 | 73 | 7.0 | NS | Male | Juvenile | Aug 15 |
| 2137 | 100 | 8.2 | NS | Male | Adult | Aug 15 |
| 2018 | 32 | 7.8 | NLNP | Female | Juvenile | Aug 23 |
| 2025 | 39 | 8.7 | L NP | Female | Adult | Aug 23 |

L. *Myotis volans* at Bear Creek (n = 14)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|-------|-------|
| 2112-30 | 48-66 | 7.6 | NLNP? | Female | Adult | Jun 4 |

| 2112-30 | 48-66 | 7.8 | NL P | Female | Adult | Jun 4 |
|-------------|-------------------|------------|---------------|--------|-------|-------|
| 2112-30 | 48-66 | 7.2 | NS | Male | Adult | Jun 4 |
| 2218 | 114 | 7.8 | NL P | Female | Adult | Jun 4 |
| 2218 | 114 | 8.4 | NL P | Female | Adult | Jun 4 |
| 2259 | 155 | 8.0 | NL P | Female | Adult | Jun 4 |
| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
| 2308 | 164 | 9.1 | NL P | Female | Adult | Jun 4 |
| 2058-200 | 26-108 | 9.1 | NL P | Female | Adult | Jun18 |
| 2058-200 | 26-108 | 10.0 | NL P | Female | Adult | Jun18 |
| 2058-200 | 26-108 | 8.5 | NL P | Female | Adult | Jun18 |
| 2058-200 | 26-108 | 8.2 | NL P | Female | Adult | Jun18 |
| 2058-200 | 26-108 | 9.0 | NL P | Female | Adult | Jun18 |
| 2154 | 82 | 6.2 | NL P | Female | Adult | Jun18 |
| 2209 | 97 | --- | NL P | Female | Adult | Jun18 |

***M. Myotis evotis* at Bear Creek (n = 3)**

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|-------|---------|
| 2158 | 94 | 6.3 | NS | Male | Adult | Jun 4 |
| 2051 | 19 | 5.5 | NS | Male | Adult | Jun18 |
| 2127 | 63 | 6.8 | NS | Male | Adult | July 21 |

***N. Eptesicus fuscus* at Bear Creek (n = 12)**

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|-------|-------|
| 2241 | 137 | 13.6 | NS | Male | Adult | Jun 4 |
| 2259 | 155 | ----- | NS | Male | Adult | Jun 4 |
| 2308 | 164 | 16.6 | NS | Male | Adult | Jun 4 |
| 2202 | 90 | 13.2 | NS | Male | Adult | Jun11 |

| 2205 | 93 | 15.2 | NS | Male | Adult | Jun18 |
|-------------|-------------------|------------|---------------|--------|-------|--------|
| 2210 | 98 | 14.3 | NS | Male | Adult | Jun18 |
| 2210 | 98 | 16.0 | NS | Male | Adult | Jun18 |
| 2236 | 124 | 16.0 | NS | Male | Adult | Jun18 |
| 2236 | 124 | ---- | NS | Male | Adult | Jun18 |
| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
| 2244 | 132 | 16.4 | NL P | Female | Adult | Jun18 |
| 2155 | 22 | 16.3 | NS | Male | Adult | Jun 29 |
| 2158 | 25 | 15.5 | NS | Male | Adult | Jun 29 |

***O. Myotis ciliolabrum* at Bear Creek (n = 16)**

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|----------|--------|
| 2053 | 21 | 5.0 | NL P | Female | Adult | Jun18 |
| 2056 | 24 | 4.8 | NL P | Female | Adult | Jun18 |
| 2058-200 | 26-108 | 5.0 | NL P | Female | Adult | Jun18 |
| 2058-200 | 26-108 | 4.2 | NL P | Female | Adult | Jun18 |
| 2058-200 | 26-108 | 6.2 | NL P | Female | Adult | Jun18 |
| 2058-200 | 26-108 | 4.1 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 4.2 | NS | Male | Adult | Jun18 |
| 2058-200 | 26-108 | 5.6 | NS | Male | Adult | Jun18 |
| 2244 | 132 | 6.7 | NL P | Female | Adult | Jun18 |
| 2110 | 37 | 4.2 | NL P | Female | Adult | Jun 29 |
| 2151 | 78 | 3.7 | NS | Male | Adult | Jun 29 |
| 2020 | 23 | 4.0 | NLNP | Female | Juvenile | Aug 15 |
| 2025 | 28 | 3.7 | NLNP | Female | Juvenile | Aug 15 |
| 2025 | 28 | 4.0 | NLNP | Female | Juvenile | Aug 15 |
| 2025 | 28 | 4.1 | NS | Male | Juvenile | Aug 15 |

| | | | | | | |
|------|----|-----|----|------|----------|--------|
| 2035 | 38 | 4.6 | NS | Male | Juvenile | Aug 15 |
|------|----|-----|----|------|----------|--------|

P. *Corynorhinus townsendii* at Bear Creek (n = 2)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|-------|---------|
| 2106 | 42 | ---- | L NP | Female | Adult | July 21 |
| 2044 | 58 | 12.7 | PL NP | Female | Adult | Aug 23 |

Q. *Myotis lucifugus* at the North Shanahan Trail Pond (n = 20)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|----------|--------|
| 2106-12 | 33-39 | 7.3 | NS | Male | Adult | July 2 |
| 2106-12 | 33-39 | 7.0 | NS | Male | Adult | July 2 |
| 2106-12 | 33-39 | 7.1 | NS | Male | Adult | July 2 |
| 2106-12 | 33-39 | 7.0 | S | Male | Adult | July 2 |
| 2106-12 | 33-39 | 8.2 | NS | Male | Adult | July 2 |
| 2051-02 | 28-39 | 7.4 | S | Male | Adult | July24 |
| 2051-02 | 28-39 | 7.1 | NS | Male | Adult | July24 |
| 2051-02 | 28-39 | 8.9 | S | Male | Adult | July24 |
| 2051-02 | 28-39 | 8.9 | S | Male | Adult | July24 |
| 2051-02 | 28-39 | 7.3 | S | Male | Adult | July24 |
| 2051-02 | 28-39 | 8.0 | S | Male | Adult | July24 |
| 2051-02 | 28-39 | 7.8 | S | Male | Adult | July24 |
| 2051-02 | 28-39 | 7.7 | NS | Male | Adult | July24 |
| 2051-02 | 28-39 | 8.9 | S | Male | Adult | July24 |
| 2051-02 | 28-39 | 7.3 | NS | Male | Juvenile | July24 |
| 2051-02 | 28-39 | 7.9 | NS | Male | Adult | July24 |
| 2051-02 | 28-39 | 6.9 | NS | Male | Juvenile | July24 |
| 2051-02 | 28-39 | 7.7 | S | Male | Adult | July24 |
| 2110 | 47 | 7.1 | S | Male | Adult | July24 |
| 2111 | 48 | 6.9 | S | Male | Adult | July24 |

R. *Myotis ciliolabrum* at the North Shanahan Trail Pond (n = 1)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|-------|--------|
| 2115 | 42 | 6.0 | NS | Male | Adult | July 2 |

S. *Myotis thysanodes* at the North Shanahan Trail Pond (n = 1)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|-------|--------|
| 2131 | 58 | 7.2 | NS | Male | Adult | July 2 |

T. *Eptesicus fuscus* at the North Shanahan Trail Pond (n = 8)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|-------|--------|
| 2117 | 44 | 14.8 | S | Male | Adult | July 2 |
| 2137 | 64 | 15.8 | S | Male | Adult | July 2 |
| 2137 | 64 | 25.2 | NL P | Female | Adult | July 2 |
| 2145 | 72 | 17.0 | Partially S | Male | Adult | July 2 |
| 2157 | 84 | 17.0 | NL P | Female | Adult | July 2 |
| 2228 | 115 | 17.1 | NL P | Female | Adult | July 2 |
| 2233 | 120 | 15.2 | NS | Male | Adult | July 2 |
| 2241 | 128 | 17.2 | NS | Male | Adult | July 2 |

U. *Lasionycteris noctivagans* at the North Shanahan Trail Pond (n = 1)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|-------|--------|
| 2152 | 79 | 10.5 | NS | Male | Adult | July 2 |

V. *Myotis lucifugus* at the South Shanahan Trail Pond ($n = 7$)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | DATE |
|-------------|-------------------|------------|---------------|--------|--------|
| 2102-2116 | 30-44 | 7.3 | NL P | Female | July 6 |
| 2102-2116 | 30-44 | 8.0 | L NP | Female | July 6 |
| 2102-2116 | 30-44 | 7.5 | L NP | Female | July 6 |
| 2102-2116 | 30-44 | 7.2 | L NP | Female | July 6 |
| 2102-2116 | 30-44 | 7.0 | NL NP | Female | July 6 |
| 2102-2116 | 30-44 | 6.8 | L NP | Female | July 6 |
| 2102-2116 | 30-44 | 7.3 | L NP | Female | July 6 |

W. *Myotis ciliolabrum* at the South Shanahan Trail Pond ($n = 1$)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | DATE |
|-------------|-------------------|------------|---------------|------|--------|
| 2122 | 50 | 5.0 | NS | Male | July 6 |

X. *Eptesicus fuscus* at the South Shanahan Trail Pond ($n = 1$)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | DATE |
|-------------|-------------------|------------|---------------|------|--------|
| 2250 | 138 | 17.8 | S | Male | July 6 |

Y. *Myotis ciliolabrum* at Abbey Pond ($n=1$)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|-------|--------|
| 2111 | 38 | 5.15. | NL P | Female | Adult | Jun 27 |

Z. *Myotis thysanodes* at Abbey Pond ($n=1$)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|--------|-------|--------|
| 2118 | 77 | 10.0 | L NP | Female | Adult | Aug 12 |

AA. *Eptesicus fuscus* at Abbey Pond ($n = 2$)

| TIME CAPTRD | MINS AFTER SUNSET | WEIGHT (g) | REPROD. COND. | SEX | AGE | DATE |
|-------------|-------------------|------------|---------------|------|-------|--------|
| 2156 | 83 | 15.15 | Partially S | Male | Adult | Jun 27 |
| 2207 | 94 | 15.15 | Partially S | Male | Adult | Jun 27 |

Table II. Dates on which sites were sampled or observed in 1997.

| | Bear Creek T1S R71W Sec. 12 | Shadow Canyon T1S R71W Sec.24 | North Shanahan T1S R70W Sec.18 | South Shanahan T1S R70W Sec.18 | Abbey Pond T1S R70W Sec.18 |
|--|---|---|--|--|--|
| June | 4, 5, 18, 21, 22, 24, 29 | 11, 19, 26, 30 | ----- | ----- | 27 |
| July | 21, 25, 26 | 9, 20 | 2, 24 | 6 | ----- |
| August | 13(Upper pool), 15, 23 | 1, 6, 8, 14, 22, 24 | ----- | ----- | 12 |
| Total net nights | 26 | 24 | 4 | 2 | 4 |
| Total nights of observation | 6 | 5 | ----- | ----- | ----- |

Table III. Capture data for 1996 and 1997 of each species at the five sites sampled during the summer of 1997. *Ml* = *Myotis lucifugus*, *Mt* = *Myotis thysanodes*, *Mv* = *Myotis volans*, *Me* = *Myotis evotis*, *Ef* = *Eptesicus fuscus*, *Mc* = *Myotis ciliolabrum*, *Ln* = *Lasionycteris noctivagans*, *Lc* = *Lasiurus cinereus*, *Ct* = *Corynorhinus townsendii*

| Total | <i>Ml</i> | <i>Mt</i> | <i>Mv</i> | <i>Me</i> | <i>Ef</i> | <i>Mc</i> | <i>Ln</i> | <i>Lc</i> | <i>Ct</i> | ALL |
|--------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------|
| 1997 | 150 | 37 | 46 | 46 | 38 | 25 | 2 | 1 | 3 | 348 |
| 1996 | 70 | 22 | 21 | 18 | 67 | 9 | 2 | 4 | 2 | 215 |

radio-tagged individual occurred.

Capture Data.--Compared to 1996 data, numbers of individuals captured was almost 40% higher even though sites sampled was only 45% (five of 11) of 1996. Most captures occurred at the Bear Canyon Creek Site (T1S R71W sec. 12) and most numerous captures were of little brown bats (*Myotis lucifugus*). More than twice as many were captured in 1997 than was in 1996 (Table III). For *Myotis thysanodes*, *M. volans*, *M. evotis*, and *M. ciliolabrum* captures were up 41%, 55%, 60%, and 64% respectively. Down in number of captures were *Eptesicus fuscus* (down 56%) and *Lasiurus cinereus* (down 75%, however overall captures of this species are historically low), whereas *Lasionycteris noctivagans* and *Corynorhinus townsendii* were about the same, neither having particularly high number of captures over the past two years (Table III).

Biodiversity and Seasonality.--Relative biodiversity at Shadow Canyon and Bear Creek Canyon is illustrated in Figure 1. In 1997, nine species were captured at Shadow Canyon. Of these, six species were consistently present and in relatively high numbers. Greatest number of captures was *Myotis lucifugus* and lowest within this group of six species was *Myotis ciliolabrum*. *Myotis evotis* and *M. volans* had similar number of captures with *M. thysanodes* slightly less. At Bear Canyon Creek, *Lasiurus cinereus* and *Lasionycteris noctivagans* were not captured. Low number of *M. evotis* were captured at this site relative to Shadow Canyon, whereas other species showed similar relative numbers to Shadow Canyon.

Seasonality of captures occurred at both sites. More overall captures for all species, with the exception of *Myotis lucifugus*, occurred in June (Fig. 2a). Three of the nine species captured in June were not captured again. Significantly smaller number of *Myotis volans*, *M. evotis* and *Eptesicus fuscus* were captured in August as compared to June. For Bear Canyon Creek, a

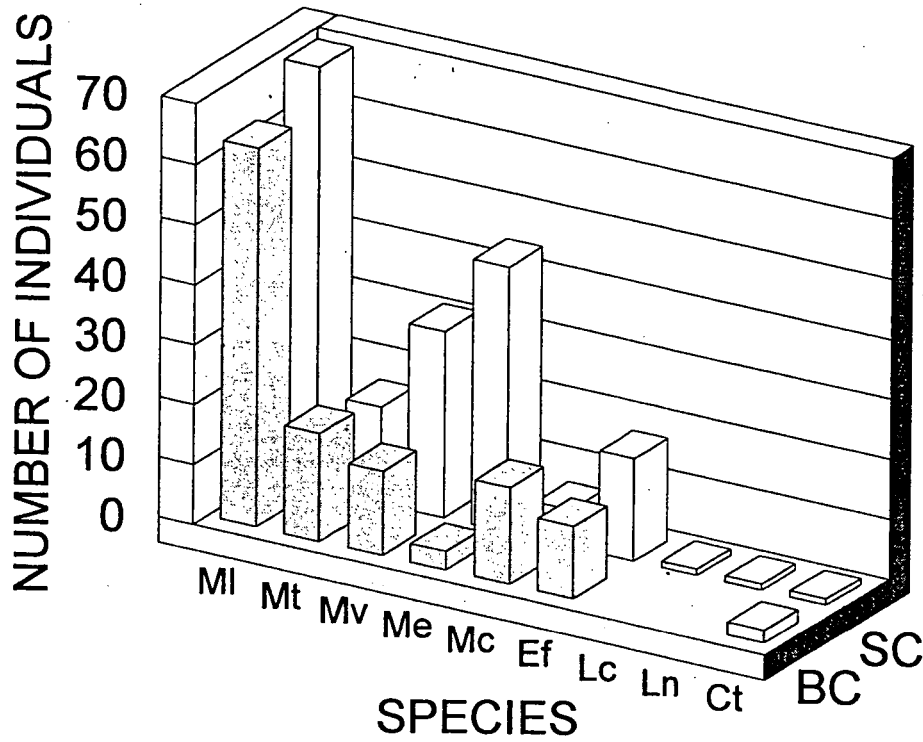
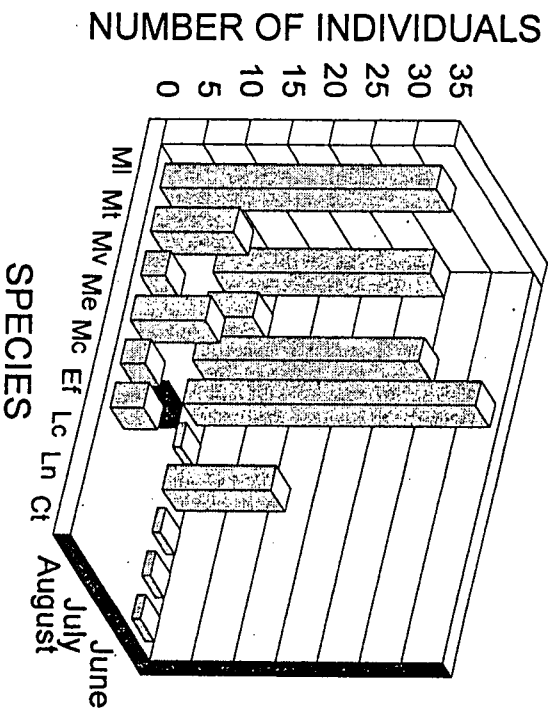


Figure 1. Plot of numbers of individuals captured per species for Shadow Canyon (SC) and Bear Canyon Creek (BC) sites. MI = *Myotis lucifugus*, Mt = *M. thysanodes*, Mv = *M. volans*, Me = *M. evotis*, Mc = *M. ciliolabrum*, Ef = *Eptesicus fuscus*, Lc = *Lasiurus cinereus*, Ln = *Lasionycteris noctivagans*, and Ct = *Corynorhinus townsendii*.

a) SHADOW CANYON

1997 DATA



b) BEAR CREEK CANYON

1997 DATA

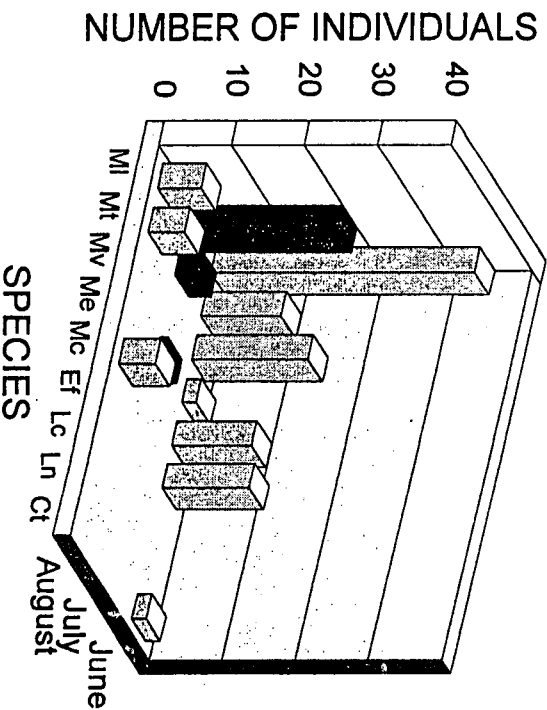


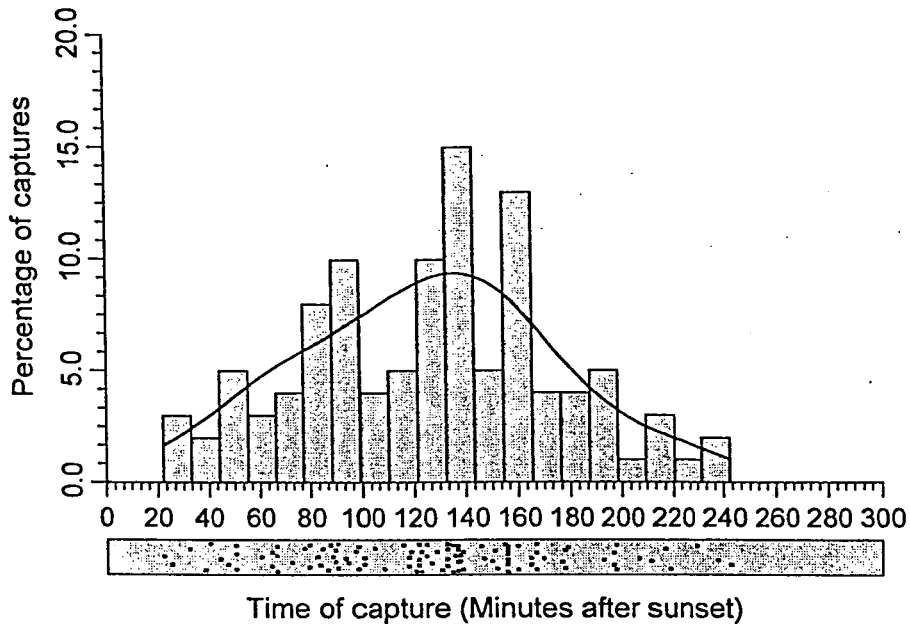
Figure 2. Plots of capture data for numbers of individuals per species per month for a) Shadow Canyon and b) Bear Canyon Creek. Species abbreviations as in Figure 1.

similar pattern was observed (Fig. 2b). Of the seven species captured in June, only three of these were captured, but in significantly less numbers, in July (*Myotis lucifugus*, *M. thysanodes*, and *M. evotis*). In August this trend continued with *M. evotis* not captured, whereas several *M. ciliolabrum* were. *Myotis volans* was not captured at the site after June.

Visitation Patterns.—Patterns in the timing of visitation to water holes (Table I) are illustrated in histograms (Fig. 1) based upon pooled data from 1996 and 1997 ($n = 480$). In general, of the nine species captured at Shadow Canyon and Bear Canyon Creek sites, pulses of activity although overlapping show maximum capture rates at different times of the night. For *M. ciliolabrum* (Fig. 3A), time of activity pulse (defined as time span over which most captures occurred) was from 36-45 minutes after sunset. Highest numbers of captures ($n = 35$) was at 40 minutes past sunset. For *M. evotis* (Fig. 3B), pulse spanned 36-75 minutes after sunset, with highest activity level at 60 minutes past sunset, but was highly variable in visitation, usually arriving as singles or in very small groups (3-5 individuals). *M. lucifugus* (Fig. 3C) was traditionally the first species to arrive at the sites and approached as a large group. Pulsing-span was 26-45 minutes after sunset with highest activity at 30 minutes post-sunset. *M. thysanodes* (Fig. 3D) arrived in highest numbers from 36-65 minutes past sunset with highest pulse at 53 minutes past. *M. volans* (Fig. 3E) lacked a strong pattern (although not as weak as *M. evotis*). Pulse-span ranged from 96-115 minutes past sunset with highest captures occurring at 100 minutes. *E. fuscus* (Fig. 3F) arrived late at sites and was quite predictable. Pulse range was from 116-155 minutes past sunset with most captures occurring at 150 minutes.

Within the stated pulse-times for each species, a large percentage of overall captures (Table IV) were recorded (range 23.8%-56.5%). Of the percentage of captures occurring during

Eptesicus fuscus



Myotis volans

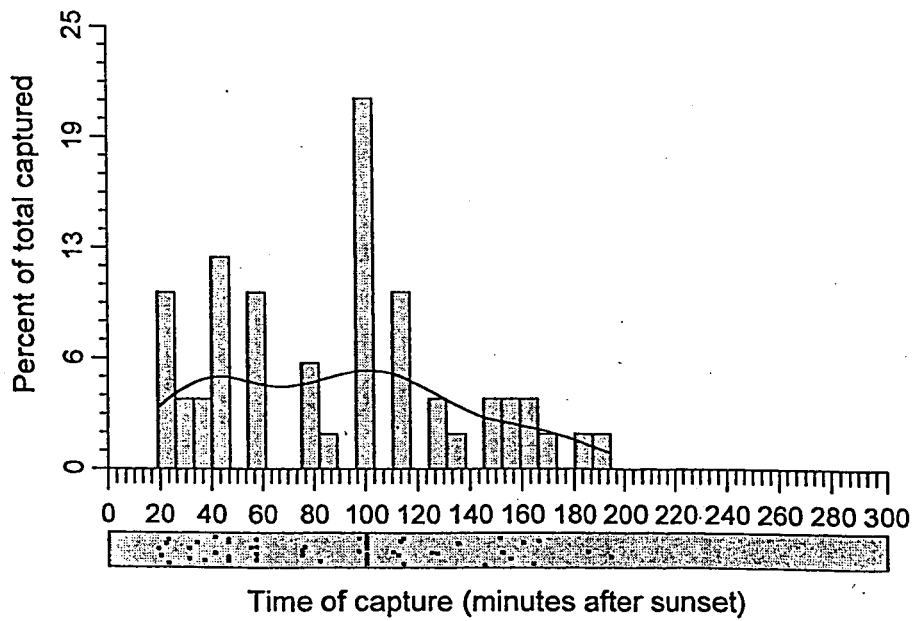
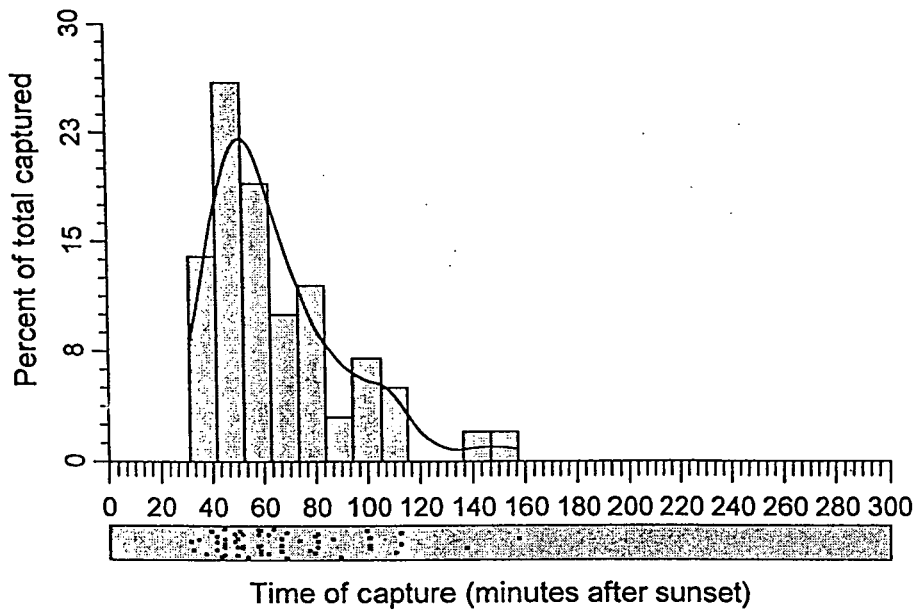


Figure 3. Histograms for six species of bats making up 98% of assemblage numbers based upon capture data for 1997.

Myotis thysanodes



Myotis evotis

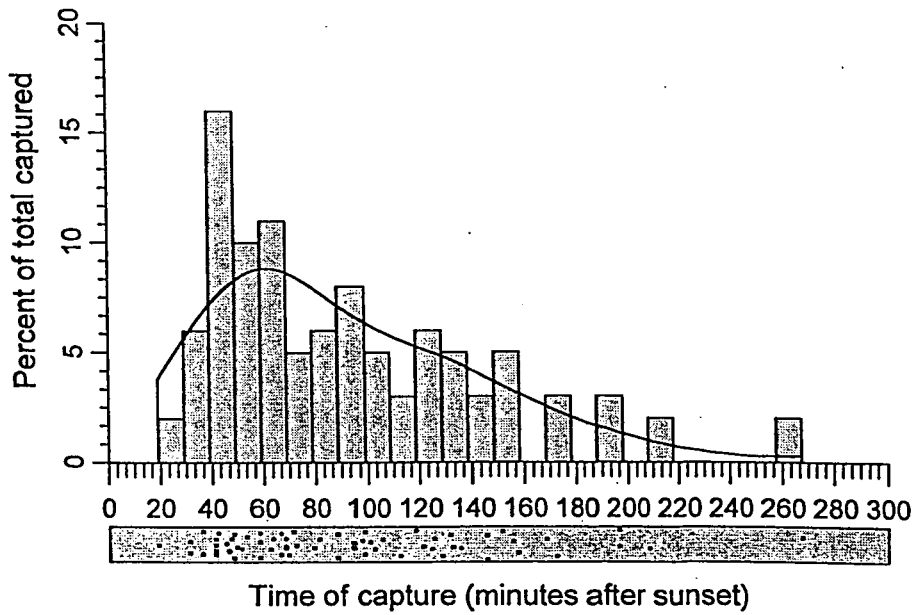
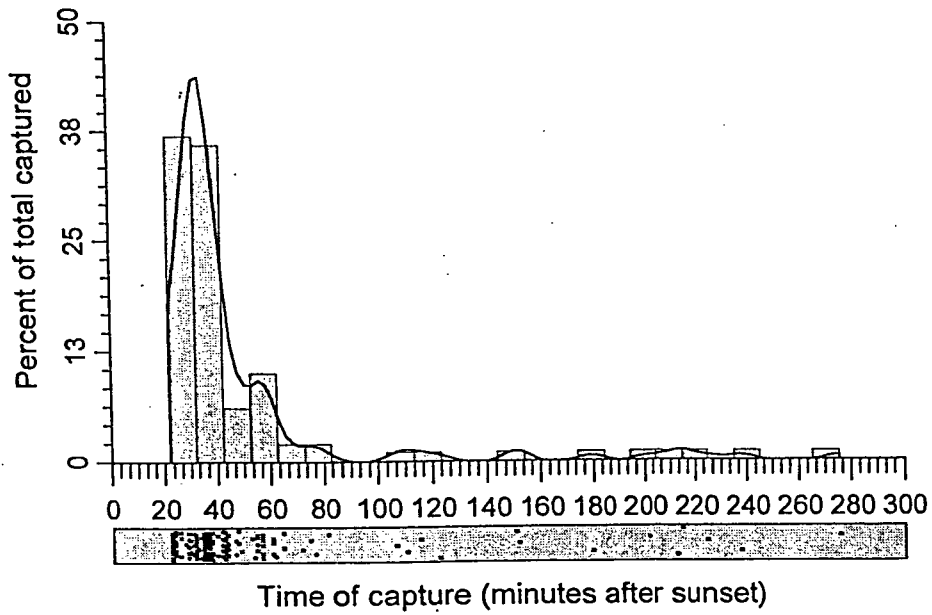


Figure 3. (Continued)

Myotis lucifugus



Myotis ciliolabrum

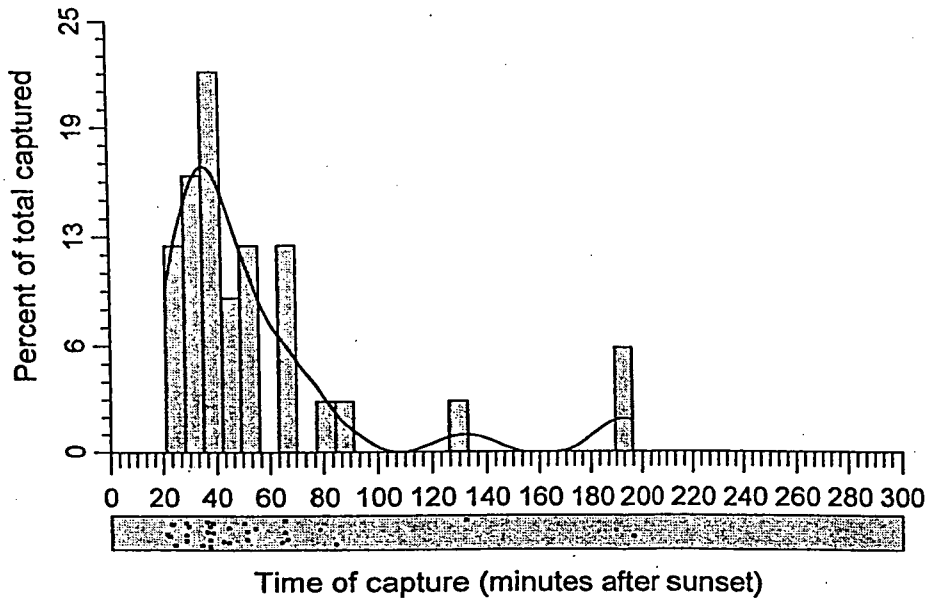


Figure 3. (Continued)

Table IV. Data expressed in percent of captures for each pulse time as well as for time of highest number of captures expressed as percentage of overall captures and percentage of pulse time span captures.

| Species | Pulse Time Span | % Captures Overall | Time of Highest Cap. | % Overall | % of Span |
|-----------------------|-----------------|--------------------|----------------------|-----------|-----------|
| <i>M. ciliolabrum</i> | 36-45 min. | 43.7% | 40 min. | 31.2 % | 66.6% |
| <i>M. evotis</i> | 36-75 | 23.8 | 60 | 7.9 | 28.6 |
| <i>M. lucifugus</i> | 26-45 | 56.5 | 30 | 36.7 | 64.2 |
| <i>M. thysanodes</i> | 36-65 | 53 | 53 | 17.2 | 32.0 |
| <i>M. volans</i> | 96-115 | 46.8 | 100 | 34.0 | 73.3 |
| <i>E. fuscus</i> | 116-155 | 40 | 150 | 12.1 | 35.5 |

B. *Myotis evotis* at Stockton Cabin (n = 9)

| TIME OBSERVED | MINS AFTER SUNSET | DATE |
|----------------------|--------------------------|-------------|
| 2117 | 44 | June 26 |
| 2145 | 72 | June 26 |
| 2251 | 138 | June 26 |
| 2053 | 23 | July 9 |
| 2100 | 30 | July 9 |
| 2112 | 42 | July 9 |
| 2112 | 42 | July 9 |
| 2111 | 65 | Aug 8 |

C. *Myotis thysanodes* at Stockton Cabin (n = 2)

| TIME OBSERVED | MINS AFTER SUNSET | DATE |
|----------------------|--------------------------|-------------|
| 2136 | 63 | June 26 |
| 2132 | 86 | Aug 8 |

D. *Myotis volans* at Stockton Cabin (n = 3) (Due to the lack of visibility of the blue bands, these data have been inferred from capture data)

| TIME OBSERVED | MINS AFTER SUNSET | DATE |
|----------------------|--------------------------|-------------|
| 2233 | 120 | June 26 |
| 2248 | 135 | June 26 |
| 2252 | 139 | June 26 |

E. *Myotis lucifugus* at Bear Creek (n = 7)

| TIME OBSERVED | MINS AFTER SUNSET | DATE |
|----------------------|--------------------------|-------------|
| 2115 | 51 | June 5 |
| 2105 | 32 | June 22 |
| 2125 | 52 | June 22 |
| 2128 | 55 | June 22 |
| 2136 | 63 | June 22 |
| 2136 | 63 | June 22 |
| 2101 | 39 | July 25 |

F. *Myotis evotis* at Bear Creek (n = 3)

| TIME OBSERVED | MINS AFTER SUNSET | DATE |
|----------------------|--------------------------|-------------|
| 2100 | 36 | June 5 |
| 2130 | 66 | June 5 |
| 2145 | 81 | June 5 |

G. *Myotis thysanodes* at Bear Creek (n = 1)

| TIME OBSERVED | MINS AFTER SUNSET | DATE |
|----------------------|--------------------------|-------------|
| 2130 | 66 | June 5 |

a time pulse, the time of highest capture (Table IV) accounted for a large percentage (range 28.6%-73.3%). *M. evotis* was anomalous with only 7.9% of the overall captures for this species occurring during its highest activity pulse and less than 30% of captures during the pulse-span occurred at the time of highest captures (Table IV). General Overlap Analysis determined significant differences in the utilization curves among species in the assemblage ($GO = 0.620$, $G_{adj.} = 0.584$, $V = 385$, $df = 115$, $p = 0.23$)

Observation Data.—Data based upon observation of tagged (reflective tape on forearm bands) supports mist net data. Since mist netting is highly intrusive since it requires handling the bats, patterns of visitation need be documented using a different technique that is less intrusive. By observing individuals marked with reflective tape when captured earlier in the season, patterns of visitation timing may be more accurate. Table V shows observation data for seven species marked with reflective tape during 1997. *M. lucifugus* was consistently observed to arrive first at watering holes. More than 40% of observations were between 23 and 35 minutes after sunset, whereas 40% of observations of *M. evotis* were between 42 and 44 minutes after sunset. *M. volans* ranged from 120-139 minutes after sunset and *M. thysanodes* ranged from 63-86 minutes after sunset. Although the times vary somewhat from capture data, the order of arrival at watering holes is consistent for both.

Radio Telemetry Data.—On 1 August a 0.47 gram Holohil, 10-day transmitter was placed on a scrotal male *Myotis evotis*. This individual was not banded due to fear by the investigators of overburdening this individuals with weight. We attempted to locate the roost site of this individual over the following 10 days. Inclimate weather precluded radio-tracking, but more than 25 hours were spent tracking. On 2 August, Kate Thibault located a signal from the top of

Table V. Observation data of marked individuals per species per site for 1997. (n = 48)

A. *Myotis lucifugus* at Stockton Cabin (n =23)

| TIME OBSERVED | MINS AFTER SUNSET | DATE |
|----------------------|--------------------------|-------------|
| 2108 | 35 | June 26 |
| 2108 | 35 | June 26 |
| 2129 | 56 | June 26 |
| 2151 | 78 | June 26 |
| 2101 | 31 | July 9 |
| 2103 | 33 | July 9 |
| 2104 | 34 | July 9 |
| 2105 | 35 | July 9 |
| 2105 | 35 | July 9 |
| 2106 | 36 | July 9 |
| 2107 | 37 | July 9 |
| 2108 | 38 | July 9 |
| 2108 | 38 | July 9 |
| 2108 | 38 | July 9 |
| 2108 | 38 | July 9 |
| 2119 | 49 | July 9 |
| 2119 | 49 | July 9 |
| 2119 | 49 | July 9 |
| 2120 | 50 | July 9 |
| 2137 | 67 | July 9 |
| 2029 | 23 | Aug 8 |
| 2031 | 25 | Aug 8 |
| 2025 | 41 | Aug 24 |

Shadow Canyon that directed us to the west site of Bear Mountain Peak. A late afternoon thunderstorm did not allow further tracking that day. On 3 August we climbed Bear Mountain Peak again locating the signal. Directionality of the signal was multiple, as was intensity. We began to question its validity, but continued to search. On 4 August, rain precluded once again our attempts to locate the roost site. On 5 August we resumed our search under extremely foggy conditions. We headed in from the Bear Canyon Creek side where we gained a signal coming from a ridge just south of NCAR. After following the signal for several hours we determined that this was a false signal, coming from somewhere in the city of Boulder. We drove up Flagstaff Mountain where we received the strongest signal of all coming directly from Boulder. This strong overlapping signal destroyed our attempts at locating the tagged *M. evotis*. We determined that the repetition rate of the false signal was slightly faster than our radio tag and we attempted to use this distinction to avoid being fooled. We returned on several consecutive nights to Shadow Canyon to observe tagged individuals and to see if the tagged individual would return. We never regained the proper signal and after 11 August the search was canceled.

CONCLUSIONS: Water sources provide two important ecological components for bats: 1) a source of drinking water and 2) water sources attract concentrations of insects used as food.

Because water holes tend to concentrate bat activity, it is at these times that interspecific interactions (i.e. direct competition) among the assemblage may be strongest. Due to this, interactions around water holes may act to organize assemblage structure and, if so, this structure should be quantifiable.

Generally, species diversity is highest in areas near the Flat Irons rock formations. This probably is due to the diversity of roost sites available to bats near the rocky and precipitous

outcroppings. The Flat Irons may be a crucial breeding area for the Front Range bat species. Therefore, we concentrated our efforts in 1997 at two sites, Shadow Canyon and Bear Canyon Creek.

In terms of species-specific patterns of water use, *as in 1996*, *Myotis lucifugus* is typically the first species to arrive at watering sites and usually does not make multiple or repeated visitations. In addition, *M. lucifugus* tends to arrive in gangs, independent of colony makeup (i.e. bachelor versus maternity). Captures of *M. lucifugus* increased more than 46% in 1997 compared with 1996 data. Time of visitation is usually at twilight and much of their water use and foraging at the sites occurs before dark and at a time when people still tend to be active in the Parks. Due to these two factors (i.e. single visitations and early arrivals) makes this species susceptible to disturbance at watering sites. For some reason, the Bear Canyon Creek population shows a steady decline in numbers from June to August, whereas numbers increase at Shadow Canyon. The Shadow Canyon pattern is the more expected one since population numbers of bats will increase throughout the summer as newborn young take to the wing. We had very few recaptures this year ($n = 2$), so it remains inconclusive whether the population using Bear Creek moves to another water site. The discovery this summer of multiple usable watering holes along the Bear Canyon drainage gives rise to the possibility that later in the year, as runoff decreases, more pools along the drainage become usable to bats, whereas earlier in the season faster running water makes these pools inaccessible to bats. Curiously, the Shadow Canyon drainage does not share this characteristic with Bear Canyon and, therefore, capture data from the former shows greater stability in diversity of species and population numbers throughout the season. This hypothesis will be tested next field season.

Interestingly, species richness and diversity remains highest at Stockton Cabin, which is one of the smallest diameter (< 7 m) and most shallow (< 20 cm in depth) watering holes used in the study. In addition, a hiking trail passes directly through the creek at exactly where the bats are active and therefore, the potential for human disturbance at this site is high. Interestingly, more female *M. lucifugus* were captured at the site in 1997 (females, $n = 31$; males, $n = 27$) than in 1996 (females, $n = 8$; males, $n = 33$), representing essentially a 50:50 sex ratio. At Bear Canyon Creek, males far outnumbered female *M. lucifugus* (females, $n = 4$; males, $n = 56$). All *M. thysanodes* captured at Shadow Canyon were males ($n = 16$), but females were captured in higher proportions than males at Bear Canyon Creek (females, $n = 10$; males, $n = 7$). Curiously, only a single female individual of *Myotis evotis* was captured in 1997 and this occurred at Shadow Canyon. Although *M. evotis* is known not to congregate in large colonies, females usually form maternity sites of around a dozen individuals. We are still in search of where this species is giving birth to their young.

For the second year, capture and observation data suggest temporal segregation among bat species representing the Boulder County assemblage. There are significant differences among species in timing of visitation to watering holes. Still uncertain are the movement dynamic among the watering holes available to bats. For the first year we have banded individuals which will allow us to follow them for many years to determine species-specific foraging patterns. Data on roost site selection and distribution are still pending further radio-telemetry trials.

FOR THE FUTURE:

The last two seasons have given compelling data on species diversity, species richness and water use patterns for the Front Range bat assemblage. It is anticipated that in 1998, further research will begin to unveil the processes behind the patterns so far documented. Description and quantification of ecological patterns is the first stage in analysis of community dynamics to be followed by investigations concerning causation. In order to address this level of diagnosis other aspects of assemblage dynamics must be analyzed. We need to gather data on foraging times, diet, and roost site locations for each species. Questions such as: Do species ingest different insect species and forage in different habitats, or at different levels above the ground in the same habitats must be addressed. Distance from roost sites to watering holes may be effecting of the water use patterns so far documented and must also be addressed. When roost sites are located, comparison of arousal times among species will be possible and, in combination with habitat use and diet, we can begin to understand the dynamics of the Boulder County bat community.

LITERATURE CITED:

- Adams, R.A. 1997. Resource partitioning between juvenile and adult little brown bats, *Myotis lucifugus* at a maternity site. *Journal of Mammalogy*, 78:425-431..
- Adams, R.A. 1996. Size-specific resource use in juvenile little brown bats, *Myotis lucifugus* (Chiroptera: Vespertilionidae): Is there an ontogenetic shift? *Canadian Journal of Zoology*, 74:1204-1210.
- Armstrong, D.M., R. A. Adams, K. Navo, J. Freeman, and S. Bissell. 1995. *Bats of Colorado*. Colorado Division of Wildlife publication. 30 pp.

Armstrong, D.M., R.A. Adams, and J. Freeman. 1994. Ecology and distribution of bats in Colorado. Natural History Inventory, No. 15, University of Colorado Museum, Boulder. 82 pp.

Ludwig, J.A., and J.F. Reynolds. 1988. Statistical ecology. John Wiley and Sons, New York. 337 pp.