4

1998 Survey of Boulder County Bats: A Study in Roost Site Distribution and Community Ecology

OVERSITE AGENCY: *City of Boulder Open Space*

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ABSTRACT: In 1998, a total of 402 bats was captured over 54 net nights in mist nets set over waterholes. We concentrated on gathering information concerning roosting ecology and the physical parameters associated with water resource use. Four hypotheses were tested: We continued to test for temporal spacing at waterholes, predicting that there are species-specific differences in the timing of visitations and that highly discrete spacing would occur at waterholes where species diversity and evenness are high. We also predicted that certain parameters of waterholes (distance from roost site habitat, size of waterhole and water temperature) will correlate with high species diversity and evenness. We predicted that roost sites would be located predominately in rocky habitats (saxicoline brush) associated with the Flatiron formations. In addition, we predicted that community structure at waterholes would be dynamic throughout the summer months, with relative abundances of species captured at each site varying with the progression of the reproductive season. The preliminary data presented here indicate that south- or east-facing rock crevices, which allow for maximal sun exposure, provide the most desirable summer roost sites for the bats of Boulder, CO. Streamside waterholes, sites of high diversity and species evenness, show very different patterns of seasonal species sorting throughout the sampling periods than observed at the larger ponds on Shanahan Ridge, which are lower in species diversity and evenness. Temporal partitioning appears to be occurring among the species at the stream sites, with even spacing among the first species to visit the waterhole, suggesting that avoidance of interspecific competition is a significant structuring factor for this assemblage. At the Shanahan ponds, such discrete partitioning of use is not apparent, except between the two most common species at these sites, *M. lucifugus* and *E. fuscus*. The differences in use patterns between the stream and pond sites are most likely the driven by density-dependent effects. At

least, this is our working hypothesis that is supported by our data set so far. Further analysis of roosting and foraging ecology is necessary. The radio tracking of tagged individuals is paramount to success in locating, mapping, and analyzing roost site patterns and foraging areas, probably the most important information for management of bat populations in, and around, Boulder. In particular, the location of maternity colonies is highly important.

STATEMENT OF OBJECTIVES AND GOALS: With the apparent loss of abundance and biodiversity of bat species in Colorado (Armstrong et al., 1994, 1995), there is a strong need for data concerning patterns of resource use by Coloradan bats. Although some data have been gathered recently on Boulder County bats (Adams, 1996,1997), very little is known regarding the distribution and abundance of bat species or the location of summer and winter roost sites. During the summer of 1998, we concentrated on gathering information concerning roosting ecology and the physical parameters associated with water resource use. Four hypotheses were tested: We continued to test for temporal spacing at waterholes, predicting that there are species-specific differences in the timing of visitations and that highly discrete spacing would occur at waterholes where species diversity and evenness are high. We also predicted that certain parameters of waterholes (distance from roost site habitat, size and water temperature) will correlate with high species diversity and evenness. We predicted that roost sites would be located predominately in rocky habitats associated with the Flatiron formations. In addition, we predicted that community structure at waterholes would be dynamic throughout the summer months, with relative abundances of species captured at each site varying with the progression of the reproductive season.

METHODS: The study was conducted from 27 May to 28 August 1998 with the help of Kate

Thibault, who acted as field assistant for the third consecutive year. All bats were captured using Japanese mist nets. Trapping was conducted over water and also at several sites in Ponderosa Pine Woodland and Douglas Fir Forest. Captured bats were weighed, sexed, identified to species, and marked with color coded, numbered, split-ring arm bands. In addition, bats were monitored with an ANABAT II detector (Titley Electronics, Australia) interfaced with a Laptop computer at sites away from water to help in determining species-specific foraging times. Fecal samples were collected from individuals when available and stored for later evaluation. Observations were made at waterholes with a MoonLight night vision scope (Cabela's, Neb.) equipped with an infrared illuminator. In addition, eight bats were tagged with 0.45 g radio transmitters (Holohil Systems, Ltd., Canada) and tracked with a 16 channel radio with attenuator (Wildlife Materials, Ill.). Bats were tracked until either the transmitter stopped transmitting or the transmitter fell from the animal. Roost sites were documented and home range data gathered and mapped. A GPS Magellan 4000XL was used to determine roost site locations and out flight counts were made at located roost sites when possible.

Statistics.--Diversity (Shannon Index, H') and Evenness (E3) indices (Ludwig and Reynolds, 1988) were calculated per waterhole based upon pooled data gathered over the last three years. Pearson Correlation was used to determine the relationship between number of species and physical characteristics of waterholes.

RESULTS: ***Capture Data.***–In 1998, a total of 402 bats was captured (Table I) over 54 net nights in mist nets set over waterholes (Table II & III). Field sites are marked in Figure 1. No bats were captured over a total of 25 forest net nights (Table IV). A total of 892 bats has been captured over the last three years, with Shadow Canyon (Stockton Cabin) and Bear Creek having the highest numbers of individuals captured (Fig. 2) and the greatest species evenness (H' = 1.646 & 1.539; E3 = 0.8374 & 0.7325 respectively). Other sites may have similar numbers of species present, but evenness is much less (Fig. 2). Seasonal changes in species composition at Shadow Canyon and Bear Creek sites occur over three sampling periods of virtually equal net nights per site that roughly correspond to June (27 May - 25 June), July (27 June - 24 July) & August (31 July - 27 August) (Fig. 3). The general trend is that, while the numbers of captured individuals of *Myotis lucifugus, M. thysanodes* and *M. ciliolabrum* increase, the numbers of captured individuals of *M. volans, M. evotis* and *Eptesicus fuscus* decrease. *M. volans* was never captured during the third sampling period at either site. At Bear Creek (Fig. 3), there is an increase in *Myotis thysanodes* and *E. fuscus* from sampling period two to sampling period three, while *M. ciliolabrum* remains relatively constant and *M. lucifugus* declines. *Myotis volans* is only present in the first sampling period at this site.

At North Shanahan, the dominant species are *M. lucifugus* and *E. fuscus* (Fig. 4). Throughout the summer, the relative abundances of these species appear to be inversely proportional, such that when one is high the other is relatively low. *Myotis thysanodes* increases slightly throughout the summer, but the difference is not substantial, and *M. evotis* stays relatively constant at low numbers. South Shanahan (Fig. 4) is dominated by *M. lucifugus*, with, generally speaking, the second most dominant species being *E. fuscus*. Interestingly, the same pattern of negative correlation between the abundances of these species is observed at this site, as seen at North Shanahan. The remaining species visit both North and South Shanahan infrequently, with *M. ciliolabrum* and *M. volans* consistently absent during sampling period three and *M. evotis* absent during all periods at South Shanahan.

This summer, for the first time, we sampled a waterhole located at NIST (Table Igg-hh). This site is dominated by *E. fuscus* only and is, therefore, useful for comparison. Interestingly, the pattern of water use exhibited by *E. fuscus* at this site differs from that exhibited at all other sites. At NIST, *E. fuscus* comes in very early, just after sunset, whereas, at all other sites, the highest concentration of captures of this species usually occurs 120 to 150 minutes after sunset (Table I).

Abiotic Factors.–Effects of waterhole temperature, size, and distance from saxicoline brush habitat (Armstrong, 1972) on the number of species captured at a waterhole and on its indices of species diversity and evenness were examined. A dramatic difference in water temperatures exists between ponds and stream sites (Fig. 5). Ponds were much warmer than streams throughout the summer, but stream temperatures showed a greater change (increase) in temperature throughout the summer (Fig. 5). The number of species present correlates negatively ® = -0.721, $p < 0.01$) with water temperature across eight sites (Fig. 6). Species diversity and evenness also decrease with increasing mean water temperature, with the latter showing a stronger correlation (Fig. 7). Distance of waterholes from saxicoline brush habitats (Fig. 8, $r = -0.85$, $p < 0.01$) and waterhole size (Fig. 9, $r = -0.57$, $p < 0.05$) are also negatively correlated with the number of species present.

Radio-Tracking.–This summer, eight bats were equipped with radio transmitters. Radio-tracking of these bats resulted in the location of five roost sites, all in rock crevices. Relative positions of roost sites were located for two of the other three bats, but their transmitters died before exact locations could be determined. The male hoary bat (*Lasiurus cinereus*) that carried one of the eight transmitters apparently disappeared from the area the day following attachment, thereby prohibiting tracking to a roost site. The hoary bat's signal was never received after the night of attachment, despite numerous attempts made over the subsequent week. Table V consists of the localities of the five roost sites specifically located and the numbers of individuals counted emerging from the site in the evening. Of the five colonies counted, four were maternity roosts, the largest of which was a *M. lucifugus* colony of approximately 120 individuals. The colonies of *M. thysanodes* are of special concern, because this species is possibly endangered locally. A maternity colony of approximately 46 individuals was found near Mallory Cave, and another maternity site consisting of six individuals was located in Gregory Canyon. The Gregory Canyon colony was found in early August, late in the reproductive season, and abandoned the site two days after we located it. This suggests that its six inhabitants were members of a larger colony that was breaking up due to the weaning of the young.

Preliminary data on the movement and foraging patterns of tagged individuals were also collected via radio telemetry. Individuals foraged predominantly in Ponderosa Pine habitat, routinely traveling several kilometers from their roost to reach these areas. Individuals of different species that were tagged at the same waterhole tended to roost as well as forage in the same area. This result was unexpected, but may simply be due to small sample sizes.

Fecal Analysis.-Analysis of fecal materials was not a component of the current contract, but fecal samples were gathered from collection sacs after bats were released and will be analyzed at some later date.

DISCUSSION: After three years, we are beginning to accumulate enough data to begin understanding the ecology of Boulder bats. However, we have a long way to go, especially in understanding roost site preferences and availability, as well as activity patterns of foraging, dietary preferences and spatial segregation among species.

Roosting ecology.-The exclusive use of rock crevices by our study animals is unexpected, due to the seemingly high availability of potential roost trees in the study area, predominantly *Pinus ponderosa* and *Pseudotsuga menziesii,* tree species that are utilized by these same species in other parts of the Rocky Mountains (e.g. Brigham, 1991 & Vonhof & Barclay, 1996). Our data sample, however, is quite small and no reliable conclusions can be drawn at this point. If not sampling error, a factor that can only be alleviated with more research, it is possible that the availability of tree-snags for roost sites is limited and, therefore, limiting. Data collected in other studies on the natural roosts of *M. ciliolabrum* indicate that it is a crevice specialist (Tuttle and Heaney, 1974). Data collected on *M. lucifugus* and *M. thysanodes* support the prediction that maternity colonies of these species readily inhabit tree cavities (Kalcounis and Hecker, 1996; Rabe *et. al.*, 1998), and, therefore, we would expect this trend to be present in the foothills of Boulder. So far, this has not been the case, and, in fact, our study presents the first evidence, to our knowledge, of maternity roosts of *M. thysanodes* and *M. lucifugus* located in rock crevices, although males of the latter species have been reported roosting in such roosts (Krutzsch, 1961). The few studies conducted on *M. ciliolabrum* demonstrated that individuals of this species generally roost solitarily, and their favored roosting sites are located in rock crevices, as supported by our findings thus far (however, $n = 2$).

The ecology of crevice dwelling bats remains one of the most poorly understood areas of temperate bat biology (Kunz, 1982); therefore, the ecology of Boulder bats is somewhat enigmatic. Crevices are generally inferior to other roost types because thermal stability and protection, characteristics that enhance the growth of newborn young, are lacking; crevices are, however, typically much more numerous than are caves (Altringham, 1996). Although the availability of rock crevices suitable for maternity colonies of bats may appear high, the need for appropriate temperature regimes limits use of many, if not most, of them. The preliminary data presented here indicate that south- or east-facing rock crevices, which allow for maximal sun exposure, provide the most desirable summer roost sites for the bats of Boulder, CO. Although the three species studied appear to share a preference for the same roost type in our area, previous work has shown that different species minimize energy expenditure at different temperatures, and roost sites that provide these species-specific temperatures are selected (Studier and O'Farrell, 1976). Therefore, each crevice utilized by our study animals likely possesses a unique set of characteristics that is compatible with the needs of its occupant species. We have found no evidence so far that species cohabitate in rock crevices. If further study demonstrates that rock crevices are favored by most of the species in the area and strict species-specific temperature regimes are required, the implications for the biogeography and conservation of the bats of Boulder will be profound. Roost sites could prove to be limiting and would, therefore, affect population sizes, relative distributions, abundances, and assemblage diversity. In terms of conservation concerns within the study area, the natural constraining effects of limited roost availability could be potentially increased if there is disturbance at roost sites due to human recreational activities such as the increasingly popular sport of rock climbing. Further documenting and mapping of roost site locations, in particular maternity colony roosts, will give insight into the vulnerability of these sites to human disturbance.

Water use patterns.-Species-specific patterns of water use are beginning to be revealed, but are complex. With the addition of the NIST site this year, we hope to understand better the differences in water use patterns at low density versus high density waterholes over the next several years. Streamside waterholes, sites of high diversity and species evenness, show very different patterns of seasonal species sorting throughout the sampling periods than observed at the larger ponds on Shanahan Ridge, which are lower in species diversity and evenness. Temporal partitioning appears to be occurring among the species at the stream sites, with even spacing among the first species to visit the waterhole, suggesting that avoidance of interspecific competition is a significant structuring factor for this assemblage. At the Shanahan ponds, such discrete partitioning of use is not apparent, except between the two most common species at these sites, *M. lucifugus* and *E. fuscus*. The differences in use patterns between the stream and pond sites are most likely the driven by density-dependent effects. At least, this is our working hypothesis that is supported by our data set so far.

In a dry environment such as Boulder, a bat can lose up to 30% of its body weight in a day, as a result of evaporative water loss while roosting (Webb, 1995); therefore, a bat's need to drink water to replenish this loss soon after emergence is presumably intense. Predictively, waterholes closest to roost sites would be highly important and, therefore, high-use sites. This, in fact, is true at our small-stream waterholes that are close to roosting. From a bat's perspective, the disadvantage of visiting these sites, however, is the amount of 'air-traffic' encountered due to so many other bats trying to access the site. It is at these types of sites (SC and BC), that we see discrete temporal spacing at the species level. At our pond sites, that are located farther from roosting habitats in open Ponderosa Pine habitat, lower numbers of individuals and species of bats are captured and detected with bat detectors. These data suggests that these waterholes are marginal resources that are used primarily by colonies of (or individual) bats that are displaced by the high amounts of activity at the smaller waterholes located closer to the roosting sites. Although the ponds so far censused may appear to be unimportant to bats since they are not heavy-use areas, they may indeed be important in maintaining the carrying capacity of bat populations in the area since they allow for competitive release away from high density sites where access to water may be greatly limited for some groups.

The hypothesis that distance from roost sites determines the diversity of bats using a given waterhole does not, however, explain the fact that some of the species captured at these sites do not normally forage, and in some cases roost, in the immediately surrounding habitats. For example, *Eptesicus fuscus*, *Lasiurus cinereus*, and *Lasionycteris noctivagans* are known to have wings adapted for foraging in open areas where there is little clutter, and, therefore, it is more energetically expensive for them to fly through cluttered habitats (Norberg and Rayner, 1987). In the Front Range of Colorado, these species forage and roost predominately in Ponderosa Pine habitat, the habitat in which our larger pond sites are situated. The ponds on Shanahan Ridge would predictably be ideal for open area foragers to utilize, since these waterholes are likely close to their roost sites and, perhaps more importantly, these sites allow for clear and open approaches by these fast-flying, less maneuverable species. So why do we catch these species at waterholes in cluttered habitats along streams? What attracts them into areas to find water where they do not normally forage, when other, apparently more suitable sites in their foraging areas are available? Proximity of the stream sites to roost sites, therefore, does not fully explain why diversity is so high at the smaller, cluttered stream sites. An examination of the abiotic features of the pond and stream sites suggests that one of these features, water temperature, may help to explain the difference in diversity between these two waterhole types.

At ponds, bats come to forage on high density insect populations as well as to drink. At our stream sites, however, we do not record feeding buzzes, and, therefore, bats apparently come to these sites only to drink and not to feed. They are seeking out these sites apparently for some characteristic of the water that is directly attractive. Data so far collected suggest that water temperature may indeed be a determining factor in high species diversity at waterholes. Streamside waterholes are dramatically cooler throughout the year than are more stagnant ponds, and we find the highest species diversity and evenness at these cooler-water-temperature sites. The extremely high metabolic rate of a bat in flight results in the production of an excessive quantity of heat that must be dissipated efficiently (Altringham, 1996). Thus, on hot summer nights, cold water could help with in-flight thermoregulation. We are planning in-lab experiments in Wisconsin to test for water temperature preferences in active bats. There may be other factors that correlate with waterhole characteristics and visitation patterns of bats. For example, pH, turbidity of the water, or even mineral content could prove to be important in explaining these patterns of visitation observed in the Front Range. We would like to begin measuring some of these other parameters of waterholes next year. In addition, other aspects of the ecology of the Font Range assemblage would be instructive in understanding its dynamics. Next year we would like to begin studies of insect diversity and abundance at our study sites and further collection of fecal material in order to understand how another important resource, food, is utilized by the assemblage and to quantify differences in insect densities at each of the waterhole sites.

RECOMMENDATIONS: Further analysis of roosting and foraging ecology is necessary. The radio tracking of tagged individuals is paramount to success in locating, mapping, and analyzing roost site patterns and foraging areas, probably the most important information for management of bat populations in, and around, Boulder. In particular, the location of maternity colonies is highly important. If rock crevices are being used predominately, closures in areas used for rock climbing, similar to that already established for raptors, may be necessary.

Data collection on the physical aspects (pH, turbidity, water quality, mineral content) that may attract bats to waterholes is important in forest management of the area. In addition, understanding the dynamics of use between ponds and streams and teasing out the attractive characteristics of different types of water sources are very important to forest management decisions. Although ponds tend to attract fewer numbers and species of bats, they may be important 'overflow' resources for maintenance of carrying capacity of bats. Physical manipulations of waterhole size of the Shanahan Ponds would significantly facilitate the determination of waterholes size as an important variable affecting the Front Range bat assemblage, in particular, species-specific temporal spacing. This could be done in a manner that would not adversely affect animals and plants in the area. For example, covering parts of the ponds with tarps during the evening while staking up the edges to allow full assess by amphibians during the manipulation period, and removing the tarps immediately after each trapping session. Furthermore, analysis of fecal material will give insight in dietary overlap and preferences and utilizing the ANABAT II sonar detection and analysis system will allow for understanding species-specific foraging patterns.

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Table I. Capture data per species per site for 1998. P = pregnant, L = lactating, NL = nonlactating, S = scrotal, NS = nonscrotal

A. *Myotis ciliolabrum* at Shadow Canyon (*n*=8)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2102	43	Female	P NL	4.3	Adult	Y663	27 May
2129	60	Male	NS	5.2	Adult	Y863	11 June
2044	18	Female	ESCAP	ED			19 July
2049	23	Female	L	4.6	Adult	T43071	19 July
2057	31	Male	NS	4.2	Adult	none	19 July
2106	40	Female	ESCAP	ED			19 July
2107	41	Male	NS	4.6	Adult	none	19 July
2218	112	Male	NS	5.0	Adult	none	19 July

B. *Myotis evotis* at Shadow Canyon (*n*=22)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2058	39	Male	NS	5.5	Adult	R930, R931	27 May
2104	45	ESCAP	ED				27 May
2120	61	Male	NS	6.2	Adult	R686, R687	27 May
2148	89	Male	NS	7.9	Adult	R688, R689	27 May
2225	126	Male	NS	6.1	Adult	R932, R933	27 May
2258	159	Male	NS	7.7	Adult	R934, R935	27 May
2105	36	Male	NS	6.0	Adult	R951, R952	11 June
2113	44	Male	NS	6.0	Adult	R953, R954	11 June
2117	48	Male	NS	4.1	Adult	R955, R956	11 June
2120	51	Male	NS	5.4	Adult	R957, R958	11 June
2129	60	Male	NS	5.7	Adult	R959, R960	11 June

2132	63	Male	ESCAP	ED			11 June
2137	68	Male	NS	5.6	Adult	R961, R962	11 June
2138	69	Male	NS	5.5	Adult	R963, R964	11 June
2141	72	Male	NS	6.6	Adult	R965, R966	11 June
2149	80	Male	NS	6.1	Adult	R967, R968	11 June
2158	89	Male	NS	5.8	Adult	R972, R980	11 June
2200	91	Male	NS	5.7	Adult	R981, R982	11 June
2202	93	Male	NS	5.7	Adult	R983, R984	11 June
2210	101	Male	ESCAP	ED			11 June
2055	29	Male	NS	7.0	Adult	none	19 July
2117	51	Male	NS	6.0	Adult	none	19 July

C. *Myotis lucifugus* at Shadow Canyon (*n*=27)

Time of capture	**Mins after sunset**	**Sex**	**Repro. status**	**Weight (g)**	**Age**	**Bands**	**Date of capture**
2059	40	Female	L	9.0	Adult	W759	27 May
2108	49	Female	L	DIED	Adult		27 May
2119	60	Female	L	8.9	Adult	W760	27 May
2101	32	Female	P NL	8.1	Adult	W917	11 June
2104	35	Female	P NL	7.3	Adult	W912	11 June
2130	61	Male	NS	5.7	Adult	W918	11 June
2137	68	Male	NS	6.3	Adult	W919	11 June
2141	72	Male	ESCAP	ED			11 June
2144	75	Male	NS	6.9	Adult	W920	11 June
2152	83	Male	NS	7.0	Adult	W910	11 June
2152	83	Male	NS	7.1	Adult	W911	11 June
2211	102	Male	ESCAP	ED?			11 June
2219-2344	110-195	Male	NS	7.4	Adult	W925	11 June
2046	20	Female	L	----	Adult	T38363	19 July
2049	23	Female	PostL	8.4	Adult	none	19 July

2054	28	Female	PostL	6.3	Adult	none	19 July
2056	30	Male	NS	7.5	Adult	none	19 July
2102	36	Male	NS	7.0	Juvenile	none	19 July
2102	36	Male	NS	8.1	Adult	none	19 July
2103	37	Female	NL NP	6.2	Juvenile	none	19 July
2109	43	Male	NS	8.0	Adult	none	19 July
2110	44	Female	NlNP	5.2	Juvenile	none	19 July
2111	45	Male	NS	7.2	Adult	none	19 July
2112	46	Male	NS	7.1	Adult	none	19 July
2112	46	Female	NL NP	----	Juvenile	none	19 July
----	----	Male	NS	6.1	Adult	none	19 July
----	----	Female	PostL	7.5	Adult	none	19 July

D. ***Myotis thysanodes*** **at Shadow Canyon (*n*=7)**

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2110	51	Male	NS	6.5	Adult	O741, O742	27 May
2128	69	Male	NS	7.3	Adult	O743, O744	27 May
2225	126	Male	NS	7.0	Adult	O747, O748	27 May
2242	143	Male	NS	7.2	Adult	R690, O749	27 May
2114	45	Male	NS	7.6	Adult	O852, O853	11 June
2122-Recap	53	Male	NS	6.9	Adult	Old: O541 New: O854, O855	11 June
2116	50	Male	NS	7.3	Adult	none	19 July

E. *Myotis volans* at Shadow Canyon ($n=18$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2113	54	Female	P NL	8.6	Adult	Y664, Y665	27 May
2229	130	Male	NS	7.8	Adult	Y666, Y667	27 May
2246	146	Male	NS	7.8	Adult	Y668, Y669	27 May
2102	33	Female	P NL	7.5	Adult	Y864, Y865	11 June
2112	43	Male	NS	7.9	Adult	Y993, Y994	11 June
2118	49	Female	P NL	9.5	Adult	Y881, Y882	11 June
2130	61	Female	P NL	10.3	Adult	Y866, Y992	11 June
2143	74	Female	P NL	9.7	Adult	Y995, Y996	11 June
2147	78	Male	NS	7.1	Adult	Y877, Y878	11 June
2148	79	Female	P NL	9.7	Adult	Y997, Y998	11 June
2153	84	Female	P NL	6.4	Adult	Y999, Y1000	11 June
2156	87	Male	NS	7.4	Adult	Y879, Y880	11 June
2156	87	Female	P NL	----	Adult	Y901, Y902	11 June
2202	93	Female	P NL	9.5	Adult	Y903, Y904	11 June
2206	97	Female	P NL	8.1	Adult	Y905, Y906	11 June
2213	104	Female	P NL	9.5	Adult	Y876, Y907	11 June
----	----	Female	P NL	9.7	Adult	Y978, Y979	11 June
----	----	Male	NS	6.6	Adult	Y976, Y977	11 June

F. *Eptesicus fuscus* at Shadow Canyon ($n=21$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2123	64	Male	NS	15.3	Adult	R10,R 11, R12	27 May
2133	74	Male	NS	15.9	Adult	R13,W 54,W55	27 May
2138	79	Male	NS	16.1	Adult	R68, R 69,W56	27 May
2138	79	Male	NS	15.9	Adult	R70, R 71,W57	27 May
2138	79	Male	NS	14.4	Adult	R72, R 73,W58	27 May
2158	99	ESCAP	ED		Adult		27 May
2200	101	ESCAP	ED		Adult		27 May
2215	116	Male	NS	15.0	Adult	R74, R 75,W59	27 May
2219-Recap	120	Male	NS	16.4	Adult	Old:R?5 W25 New: none	27 May
2222	123	Male	NS	14.4	Adult	O745, O746, W14	27 May
2253	154	Male	NS	15.3	Adult	R393,W 15,W16	27 May
2307	168	Male	NS	14.4	Adult	R394, R395, W17	27 May
2321	182	Male	NS	15.0	Adult	R396, R3976, W18	27 May
2340	201	Male	NS	15.1	Adult	R7,W26, W27	27 May
2351	212	Male	NS	14.4	Adult	R937, R938, W19	27 May
0004	225	Male	S	17.8	Adult	R939, W20, W21	27 May

2115	56	Male	S	15.2	Adult	R969, W921, W922	11 June
2124	65	Male	NS	14.4	Adult	R970, W923, W924	11 June
2219-2344	110-195	Male	NS	15.2	Adult	R971, W908, W909	11 June
2056	30	Male	S	13.3	Adult	none	19 July
2058	32	Male	S	16.5	Adult	none	19 July

G. *Corynorhinus townsendii* at Shadow Canyon ($n=1$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2204	95	Male	NS	8.8	Adult	O856, O857, O892	11 June

H. *Lasionycteris noctivagans* at Shadow Canyon ($n=1$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2101	42	Male	NS	8.9	Adult	Y659, Y660, Y661, Y662	27 May

I. *Myotis ciliolabrum* at Bear Canyon Creek ($n=5$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2126	65	Male	NS	5.1	Adult	Y672	30 May
2206	93	Female	P NL	6.1	Adult	GY54	25 June
2225	112	Male	NS	4.6	Adult	GY57	25 June
2026	20	Female	L	4.3	Adult	none	8August
2039	33	Male	NS	4.0	Juvenile	none	8August

J. *Myotis evotis* at Bear Canyon Creek ($n=2$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2225	124	Male	NS	6.9	Adult	R399, R400	30 May
2046	40	Female	L	6.2	Adult	none	8August

K. *Myotis lucifugus* at Bear Canyon Creek ($n=37$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2052	31	Male	NS	7.3	Adult	W761	30 May
2301	160	Male	NS	8.4	Adult	W766	30 May
2310	169	Female	P NL	11.3	Adult	W767	30 May
2333	192	Female	P NL	11.1	Adult	W768	30 May
2342	201	Male	NS	7.9	Adult	W769	30 May
2354	213	Male	NS	7.8	Adult	W770	30 May
0001	219	Male	NS	8.1	Adult	W771	30 May
0044	262	Male	NS	8.9	Adult	W787	30 May
2107	34	Male	NS	8.0	Adult	GW162 T38366	25 June
2107	34	Male	NS	7.5	Adult	GW163	25 June
2108	35	Male	NS	7.4	Adult	GW11	25 June
2109	36	Male	NS	6.5	Adult	GW12	25 June
2109	36	Male	NS	6.7	Adult	GW158	25 June
2110	37	Male	NS	7.4	Adult	GW166	25 June
2110	37	Male	NS	7.5	Adult	GW17	25 June
2114	41	Male	NS	6.4	Adult	GW164	25 June
2127	54	Male	NS	6.8	Adult	GW165	25 June
2144	71	Male	NS	6.8	Adult	GW9	25 June
2153	80	Male	NS	7.9	Adult	GW10	25 June
----	----	Male	NS	5.6	Adult	GW18	25 June
2025	19	Female	NL NP	7.9	Adult	none	8August
2027	21	Male	S	8.2	Adult	none	8August
2028	22	Female	PostL	8.0	Adult	none	8August
2028	22	Male	NS	6.1	Adult	none	8August
2028	22	Female	NL NP	6.7	Juvenile	none	8August

2028	22	Female	NO	DATA		none	8August
2032	26	Male	NS	6.8	Adult	none	8August
2032	26	Male	NS	7.3	Adult	none	8August
2034	28	Male	NS	6.8	Juvenile	none	8August
2034	28	Male	NS	7.0	Adult	none	8August
2034	28	Male	NS	8.0	Adult	none	8August
2034	28	Male	Inguinal	6.8	Adult	none	8August
2034	28	Male	NO	DATA		none	8August
2035	29	Male	Inguinal	7.6	Adult	none	8August
2042	36	Male	S	7.7	Adult	none	8August
2055	49	Male	NS	6.8	Adult	none	8August
2122	76	Male	NS	7.6	Sub-adult	none	8August

L. *Myotis thysanodes* at Bear Canyon Creek (n=16)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2315	174	Male	NS	7.7	Adult	O783, O784	30 May
0044	273	Male	NS	----	Adult	O788, O789	30 May
2118	45	Female	NL NP	8.1	Adult	GO84, GO85	25 June
2125	52	Female	L	10.5	Adult	GO88, GO89	25 June
2130	57	Male	NS	7.2	Adult	GO86, GO87	25 June
2131	58	Male	NS	7.6	Adult	GO90, GO91	25 June
----	----	Male	NS	7.5	Adult	GO92, GO93	25 June
2035	29	Female	NL NP	6.2	Juvenile	none	8August
2038	32	Female	L	7.7	Adult	none	8August
2044	38	Female	L	7.6	Adult	none	8August
2044	38	Female	L	8.7	Adult	none	8August
2048	42	Female	L	8.6	Adult	none	8August
2118	72	Female	NL NP	8.2	Juvenile	none	8August
2118	72	Female	NL NP	7.1	Juvenile	none	8August

2118	72	Male	NS	7.1	Juvenile	none	8August
----	----	Male	S	9.1	Adult	none	8August

M. *Myotis volans* at Bear Canyon Creek (n=20)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2110	49	Female	P NL	9.4	Adult	Y670, Y671	30 May
2157	96	Female	P NL	7.5	Adult	Y673, Y674	30 May
2206	105	Female	P NL	9.4	Adult	Y675, Y726	30 May
2210	109	Female	P NL	8.3	Adult	Y727, Y728	30 May
2218	117	Female	P NL	10.7	Adult	Y777, Y778	30 May
2219	118	Female	P NL	8.6	Adult	Y729, Y776	30 May
2238	137	Female	P NL	9.6	Adult	Y779, Y780	30 May
2255	154	Female	P NL	9.1	Adult	Y781, Y782	30 May
2300	159	Female	P NL	9.3	Adult	Y801, Y802	30 May
2314	173	Female	P NL	9.6	Adult	Y803, Y804	30 May
2324	183	Female	P NL	9.3	Adult	Y807, Y808	30 May
2325	184	Female	P NL	10.6	Adult	Y805, Y806	30 May
2340	199	Female	P NL	12.8	Adult	Y809, Y810	30 May
2350	209	Female	P NL	8.8	Adult	Y811, Y812	30 May
0004	223	Female	P NL	9.2	Adult	Y813, Y814	30 May
2043	10	Male	NS	7.3	Adult	GY52, GY53	25 June
2125	52	Female	L	9.0	Adult	GY55,	25 June

						GY56	
2206	93	Female	NL NP?	----	Adult	GY68, GY69 T38365	25 June
2221	108	Female	P NL	10.6	Adult	GY58, GY67	25 June
2305	152	Female	NP	8.1	Adult	GY69, GY70	25 June

N. *Eptesicus fuscus* at Bear Canyon Creek (n=30)

Time of capture	**Mins after sunset**	**Sex**	**Repro. status**	**Weight (g)**	**Age**	**Bands**	**Date of capture**
2127-Recap	66	Male	NS	15.3	Adult	R?, W527, W30	30 May
2127	66	ESCAP	ED				30 May
2146	85	ESCAP	ED				30 May
2148	87	Male	NS	15.5	Adult	R397, W762, W763	30 May
2157	96	Male	NS	16.0	Adult	R398, W764, W765	30 May
0004	223	Male	NS	16.9	Adult	R607, R608, W772	30 May
0015	234	Male	NS	15.7	Adult	R611, R612, W774	30 May
0016	235	Male	NS	17.1	Adult	R613, R614, W775	30 May
0018	237	Male	NS	----	Adult	R609, R610, W773	30 May
0026	245	Male	NS	18.0	Adult	R615, R817, W815	30 May
0030	249	Male	NS	15.1	Adult	R818, R819,	30 May

						W816	
0030	249	Male	NS	17.0	Adult	R820, R821, W785	30 May
0039	258	Male	NS	17.0	Adult	R822, R823, W786	30 May
0049	268	Male	NS	16.1	Adult	R824, R825, W790	30 May
0056	275	Male	NS	17.9	Adult	R792, R793, W791	30 May
0103	282	Male	NS	16.0	Adult	R794, R796, W795	30 May
0114	293	Male	NS	17.5	Adult	R797, R799, W798	30 May
2207	94	Male	NS	17.7	Adult	GR34, GW13, GW14	25 June
2212	99	Male	NS	16.4	Adult	GR35, GW15, GW16	25 June
2221	108	Male	NS	15.8	Adult	GR39, GR40, GW19?	25 June
2221	108	Male	NS	15.2	Adult	GR41, GR167, GW8	25 June
2233	120	Male	NS	17.4	Adult	GR36, GW159 GW160	25 June
2237	124	Male	S	----	Adult	GR37, GR38, GW161	25 June
2241	128	ESCAP	ED				25 June
2325	172	ESCAP	ED				25 June
2325	172	Male	Partially S	----	Adult	GR29, GR30,	25 June

						GW?	
2338	185	Male	NS	----	Adult	GR31, GR32, GW?	25 June
2110-Recap	64	Male	S	16.9	Adult	R357, W?	8August
2142	96	Male	NS	18.0	Adult	none	8August
2143	97	Male	NS	17.0	Adult	none	8August

O. *Lasionycteris noctivagans* at Bear Canyon Creek (*n*=1)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2305	152	Male	NS	9.2	Adult	GO94, GO95, GY59, GY60	25 June

P. *Myotis ciliolabrum* at North Shanahan Pond (*n*=10)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2108	46	Male	NS	4.4	Adult	Y862	2 June
2216	114	Male	NS	7.0	Adult	Y861	2 June
2241	139	Male	NS	5.1	Adult	Y859	2 June
2248	146	Male	NS	5.0	Adult	Y860	2 June
2104	32	Female	P NL	6.0	Adult	GY62	5 July
2108	36	Male	NS	4.4	Adult	GY75	5 July
2114	42	Male	NS	----	Adult	GY63	5 July
2128	56	Female	L NP	5.4	Adult	GY61	5 July
2148	76	Female	L NP	6.5	Adult	GY74	5 July
2345	193	Female	L NP	5.0	Adult	GY64	5 July

Q. *Myotis evotis* at North Shanahan Pond (*n*=3)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2128	56	Male	NS	7.3	Adult	GR47, GR48	5 July
2046	58	Male	NS	6.2	Adult	none	22 Aug
2224	156	Male	NS	7.1	Adult	none	22 Aug

R. *Myotis lucifugus* at North Shanahan Pond (*n*=22)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2104	42	Male	NS	----	Adult	W848	2 June
2123	61	Male	NS	6.4	Adult	W849	2 June
2123	61	Male	NS	6.5	Adult	W850	2 June
2136	74	Female	P NL	9.4	Adult	W847	2 June
2200	98	Female	P NL	10.5	Adult	W846	2 June
2252	150	Female	P NL	10.0	Adult	W845	2 June
2103	31	Male	NS	7.4	Adult	GW109	5 July
2106	34	Male	NS	7.5	Adult	GW110	5 July
2106	34	Male	NS	7.2	Adult	GW111	5 July
2107	35	Male	NS	6.9	Adult	GW112	5 July
2108	36	Male	NS	7.2	Adult	GW113	5 July
2108	36	Male	NS	6.8	Adult	GW117	5 July
2110	38	Male	NS	7.3	Adult	GW118	5 July
2112	40	Male	ESCAP	ED			5 July
2115	43	Male	NS	8.2	Adult	GW119	5 July
2128	56	Male	NS	6.8	Adult	GW120	5 July
2128	56	Male	NS	7.4	Adult	GW121	5 July
2152	80	Male	NS	9.0	Sub-	GW108	5 July

					adult		
----	----	Male	NS	7.3	Adult	GW122	5 July
2016	28	Male	NS	6.8	Adult	none	22 Aug
2020-Recap	32	Male	S	6.6	Adult	old: B498	22 Aug
2030	42	Male	S	7.0	Adult	none	22 Aug

second "R"

R. *Myotis thysanodes* at North Shanahan Pond ($n=5$)

Time of capture	**Mins after sunset**	**Sex**	**Repro. status**	**Weight (g)**	**Age**	**Bands**	**Date of capture**
2120	58	Female	P NL	----	Adult	O851, O852, T	2 June
2122	50	Female	L NP	9.1	Adult	GO96, GO97	5 July
2139	67	Female	L NP	9.4	Adult	GO98, GO99	5 July
2030	42	Male	NS	8.7	Adult	none	22 Aug
2048	60	Female	NL NP	7.4	Juvenile	none	22 Aug

S. *Myotis volans* at North Shanahan Pond ($n=3$)

Time of capture	**Mins after sunset**	**Sex**	**Repro. status**	**Weight (g)**	**Age**	**Bands**	**Date of capture**
2123	61	Female	P NL	----	Adult	T	2 June
2213	111	Female	ESCAP	ED			2 June
2142	70	Male	NS	8.8	Adult	GY72, GY73	5 July

T. *Eptesicus fuscus* at North Shanahan Pond ($n = 36$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2103	41	Female	P NL	----	Adult	R826, R827, W837	2 June
2114	52	Male	NS	17.0	Adult	R949, R950, W939	2 June
2131	69	Female	L NP	17.0	Adult	R945, R946, W937	2 June
2131	69	Male	NS	14.0	Adult	R883, R884, W841	2 June
2135	73	Male	NS	14.9	Adult	R885, R886, W842	2 June
2139	77	Female	P NL	17.0	Adult	R830, R831, W839	2 June
2145	83	Female	P NL	16.0	Adult	R832, R833, W840	2 June
2145	83	Male	NS	15.0	Adult	R947, R948, W938	2 June
2146	84	Female	P NL	----	Adult	R889, R890, W844	2 June
2155	93	Male	NS	11.5	Adult	R887, R888, W843	2 June
2155	93	Male	NS	13.0	Adult	R891, R940, W934	2 June

2155	93	Male	NS	17.0	Adult	R941, R942, W935	2 June
2155	93	Female	P NL	19.0	Adult	932	2 June
2207	105	Female	P NL	21.0	Adult	929	2 June
2208	106	Female	P NL	21.0	Adult	974	2 June
2214	112	Male	NS	13.0	Adult	R943, R944, W936	2 June
2214	112	Male	NS	10.	Adult	930	2 June
2214	112	Male	NS	12.0	Adult	928	2 June
2214	112	Male	NS	14.0	Adult	933	2 June
2231	129	Female	P NL	23.0	Adult	R874, R875, W836	2 June
2239	137	Female	P NL	14.0	Adult	R828, R829, W837	2 June
2303	161	Male	NS	21.0	Adult	926	2 June
2314	172	Female	P NL	22.0	Adult	931	2 June
2314	172	Male	NS	15.0	Adult	927	2 June
2314	172	Male	NS	17.0	Adult	975	2 June
2330	188	Male	NS	----	Adult	973	2 June
2053	21	Female	L NP	19.5	Adult	GR33, GR42, GW114	5 July
2108	36	Female	L NP	18.1	Adult	GR43, GR44, GW115	5 July
2139	67	Male	S	----	Adult	GR45, GR46, GW116	5 July
2249	137	Male	NS	16.8	Adult	GR49, GR50,	5 July

						GW123	
2258	146	Male	NS	19.6	Adult	GR170, GR171, GW133	5 July
2304	152	Female	L NP	20.8	Adult	GR173, GR174, GW134	5 July
2317	165	Female	L NP	21.0	Adult	GR175, GR183, GW135	5 July
2343	191	Female	L NP	19.1	Adult	GR184, GR185, GW?	5 July
2129	101	Female	PostL	24.8	Adult	none	22 Aug
2224	156	Male	Inguinal	21.0	Adult	none	22 Aug

U. *Lasiurus cinereus* at North Shanahan Pond (*n*=1)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2200	88	Male	NS	----	Adult	GR167, GR168, GR169, T	5 July

V. *Tadarida brasiliensis* at North Shanahan Pond (*n*=1)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2322	170	Male	NS	Collect-ed	Adult	none	5 July

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

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2115	43	Female	P NL	5.8	Adult	Y988	19 June

X. *Myotis lucifugus* at South Shanahan Pond ($n=11$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2112	40	Female	P NL	9.2	Adult	W913	19 June
2112	40	Female	P NL	8.9	Adult	W914	19 June
2116	44	Female	P?	7.8	Adult	W915	19 June
2052	60	Male	NS	7.0	Juvenile	none	19 Aug
2155	123	Female	NL NP	8.0	Adult	none	19 Aug
2029	48	Male	S	8.0	Adult	none	27 Aug
2037	54	Male	S	7.6	Adult.	None	27 Aug
2039	56	Female	NL NP	8.1	Juvenile	none	27 Aug
2052	71	Male	S	6.8	Adult	none	27 Aug
2054	73	Female	----	9.5	Adult	none	27 Aug
2113	92	Female	PostL	10.4	Adult	none	27 Aug

Y. *Myotis thysanodes* at South Shanahan Pond ($n=2$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2307	195	Male	NS	8.0	Juvenile	none	19 Aug
2054	73	Male	NS	7.3	Juvenile	none	27 Aug

Z. *Eptesicus fuscus* at South Shanahan Pond ($n=4$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2225	113	Male	NS	15.0	Adult	R989, R990, W916	19 June
2051	59	Male	NS	18.0	Adult	none	19 Aug
2207	135	Female	NL NP	17.0	Adult	none	19 Aug

2231	159	Male	Inguinal	----	Adult	none	19 Aug

AA. *Lasiurus cinereus* at South Shanahan Pond ($n=1$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2116	44	Male	NS	----	Adult	R985, R986, R987	19 June

BB. *Myotis ciliolabrum* at Abbey Pond ($n=2$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2131	69	Male	NS	5.0	Adult	Y858	31 May
2116	43	Female	P NL	6.0	Adult	Y991	23 June

CC. *Myotis lucifugus* at Abbey Pond ($n=12$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2110	37	Male	NS	6.5	Adult	none	23 June
2110	37	Male	NS	6.7	Adult	W894	23 June
2111	38	Male	NS	6.7	Adult	W895	23 June
2112	39	Male	NS	7.1	Adult	W897	23 June
2116	43	Male	NS	6.1	Juvenile	W898	23 June
2116	43	Male	NS	7.9	Adult	W899	23 June
2116	43	Female	NP NL	6.2	Juvenile	W893	23 June
2118	45	Female	L NP	10.5	Adult	W896	23 June
2121	48	Male	NS	6.8	Adult	W900	23 June
2123	50	Male	NS	7.1	Adult	none	23 June
2123	50	Male	NS	7.2	Adult	none	23 June
2125	52	Male	NS	5.8	Juvenile	none	23 June

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

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2112	80	Female	NL NP	7.0	Juvenile	none	19 Aug

EE. *Eptesicus fuscus* at Abbey Pond ($n=11$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2134	72	Female	P NL	20.6	Adult	R867, R868, W834	31 May
2152	90	Female	P NL	22.1	Adult	R869, R870, W835	31 May
2115	83	Female	PostL	26.0	Adult	none	19 Aug
2139	107	Female	PostL	21.0	Adult	none	19 Aug
2158	126	Male	NS	----	Sub-adult	none	19 Aug
2225	153	Male	S	26.0	Adult	none	19 Aug
2229	157	Male	NS	26.0	Adult	none	19 Aug
2251	179	Male	S	23.6	Adult	none	19 Aug
2310	198	Male	NS	20.6	Adult	none	19 Aug
2318	206	Female	NL NP	22.0	Adult	none	19 Aug
2327	215	Female	NL NP	27.8	Adult	none	19 Aug

FF. *Lasiurus cinereus* at Abbey Pond ($n=1$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2156	94	Male	NS	28.0	Adult	R871, R872, R873	31 May

GG. *Myotis lucifugus* at NIST ($n=1$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2119	52	Male	NS	7.4	Adult	GW140	18 July

HH. *Eptesicus fuscus* at NIST (*n*=29)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2053	26	Female	L NP	16.6	Adult	none	18 July
2054	27	Female	L NP	17.6	Adult	none	18 July
2055	28	Female	NL NP	14.3	Adult	none	18 July
2055	28	Female	L NP	17.3	Adult	none	18 July
2056-Recap	29	Female	L NP	15.4	Adult	old: R826, R827, W837 new: none	18 July
2058	31	Male	NS	13.1	Juvenile	none	18 July
2058	31	Female	NL NP	17.0	Juvenile	GR182, GR151, GW143	18 July
2059	32	Female	PostL	16.8	Adult	none	18 July
2059	32	Male	S	14.9	Adult	GR178, GR179, GW141	18 July
2103	36	Female	L	16.0	Adult	none	18 July
2104	37	Male	Partially S	16.0	Adult	GR180, GR181, GW142	18 July
2104	37	Female	L	17.0	Adult	none	18 July
2105	38	Male	NS	13.4	Juvenile	none	18 July
2109	42	Male	NS	13.3	Juvenile	none	18 July
2110	43	Female	L	19.0	Adult	none	18 July
2112	45	Male	S	16.1	Adult	none	18 July
2114	47	Male	S	15.1	Adult	none	18 July
2115	48	Male	S	13.3	Adult	none	18 July
2115	48	Male	NS	16.5	Adult	none	18 July
2120	53	Female	L	19.0	Adult	none	18 July
2120	53	Male	S	17.1	Adult	none	18 July
2126	59	Female	P NL	17.5	Adult	none	18 July
2126	59	Male	S	15.6	Adult	none	18 July

2128	61	Male	Partially S	15.5	Adult	none	18 July
2155-2209	88-102	Male	NS	14.8	Sub-adult	none	18 July
2215-2238	108-131	Male	S	16.5	Adult	none	18 July
2114	20	Male	NS	20.4	Adult	none	18 Aug
2121	26	Male	Inguinal	19.9	Adult	none	18 Aug
2133	38	Male	NS	16.8	Adult	none	18 Aug

II. *Myotis ciliolabrum* at Schneider Pond (*n*=5)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2123	50	Male	NS	4.3	Adult	GY251	24 June
2101	32	Female	L NP	5.0	Adult	GY195	14 July
2103	34	Female	NL NP	4.2	Adult	GY197	14 July
2107	38	Female	NL NP	5.0	Adult	GY196	14 July
2143	113	Male	Inguinal	4.0	Adult	none	20 Aug

JJ. *Eptesicus fuscus* at Schneider Pond (*n*=3)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2130	57	Male	NS	14.9	Adult	GR26, GW1, GW2	24 June
2155	82	Male	S	15.3	Adult	GR27, GW4, GW5	24 June
2202	89	Male	NS	16.4	Adult	GR28, GW6, GW7	24 June

KK. *Lasiurus cinereus* at Schneider Pond (*n*=1)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2207	98	Male	NS	28.0	Adult	none	14 July

LL. *Myotis ciliolabrum* at Gregory Canyon ($n=3$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2056	27	Female	L NP	5.2	Adult	GY65	13 July
2107	38	Female	L NP	5.0	Adult	GY194	13 July
2112	43	Female	L NP	4.9	Adult	GY66	13 July

MM. *Myotis evotis* at Gregory Canyon ($n=4$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2109	40	Male	NS	6.8	Adult	GR188, GR189	13 July
2110	41	Female	L NP	7.2	Adult	GR190, GR191	13 July
2111	42	Male	NS	6.0	Adult	GR176, GR177	13 July
2128	59	Female	P NL	9.0	Adult	GR186, GR187	13 July

NN. *Myotis lucifugus* at Gregory Canyon ($n=3$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2107	38	Male	NS	7.6	Adult	GW139	13 July
2107	38	Male	NS	7.1	Adult	GW137	13 July
2109	40	Male	NS	7.6	Adult	GW138	13 July

OO. *Myotis thysanodes* at Gregory Canyon ($n=8$)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2103	34	Male	NS	7.6	Adult	GO100, GO101	13 July
2110	41	Female	L NP	7.7	Adult	GO106, GO107	13 July
2116	47	Male	NS	7.0	Adult	GO102, GO103	13 July
2118	49	Female	NL NP	8.0	Adult	GO104,	13 July

						GO105	
2101	50	Male	NS	6.8	Juvenile	none	5 Aug
2101	50	Female	L NP	10.5	Adult	T43072	5 Aug
2047	57	Female	PostL	8.1	Adult	none	20 Aug
2100	70	Male	NS	6.7	Juvenile	none	20 Aug

PP. ***Myotis volans*** **at Gregory Canyon (*n*=2)**

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2059	30	Male	NS	9.1	Adult	GY192, GY193	13 July
----	----	Female	PostL	9.3	Adult	none	20 Aug

QQ. *Corynorhinus townsendii* at Gregory Canyon (*n*=1)

Time of capture	Mins after sunset	Sex	Repro. status	Weight (g)	Age	Bands	Date of capture
2139	70	Male	NS	9.0	Adult	GO76, GO77, GO78	13 July

Table II. *Localities of net sites for 1998, 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
Skunk Creek Pool	National Bureau of Standards section of Skunk Canyon Creek, app. 100m from beginning of paved path	T1S R71W Sec. 6

Table III. *Dates on which waterhole sites were sampled in 1998.*

	Bear Creek T1S R71W Sec. 12	Shadow Canyon T1S R71W Sec. 24	North Shan. T1S R70W Sec. 18	South Shan. T1S R70W Sec. 18	Abbey Pond T1S R70W Sec. 18	Gregory Canyon T1S R71W Sec. 1	Schneid-er Pond T1N R71W Sec. 12	NIST Site T1S R71W Sec. 6	Skunk Creek T1S R71W Sec. 6	Lindsay Pond T1S R70W Sec. 31	Linden Pond T1N R71W Sec. 24
May	30	27	---	---	31	---	---	---	---	---	---
June	25	11	2	19	23	---	24	---	---	--	---
July	---	19	5	---	---	13	14	18	---	17	16
August	8	---	22	19, 27	19	5, 20	20	18	1, 2	---	---
Total net nights	6	6	6	6	6	6	6	4	4	2	2

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

	Ponderosa Pine 1 T1S R71W Sec. 24	Ponderosa Pine 2 T1S R70W Sec. 31	Douglas Fir 1 T1S R71W Sec. 24
May	19, 21	---	28
June	---	---	---
July	2, 4, 11	12	19
August	---	---	---
Total net nights	18	2	5

Table V. *Roost site location data.*

Species	Roost Type	Colony Type	Colony Size	Location
Myotis thysanodes	S facing rock crevice	Maternity	7 Jun: 43; 22 Jun: 46; 24 Au: 0	NE of Mallory Cave T1S R71W Sec. 12
Myotis thysanodes	E facing rock crevice	Maternity	6 Au: 6; 11 Au: 0	Gregory Canyon T1S R71W Sec. 1
Myotis lucifugus	SE facing rock crevice	Maternity	20 July >100	The Matron T1S R71W Sec. 24
Myotis lucifugus	rock crevice-aspect unknown	Bachelor	1 July ≥ 8	Bear Canyon Spire T1S R71W Sec. 12
Myotis ciliolabrum	SW facing rock crevice	Maternity	26 July ≥2	Base of Shadow Canyon T1S R71W Sec. 24

Table VI. *Radio telemetry data.*

Species	Sex	Dates radio tracked			# of days	Number of roosts located	
		Attached	Possible Drop	Confirm Drop		Communal	Solitary
Myotis thysanodes	F	2 Jn	9 Jn	13 Jn	7/13	1	1
Myotis volans	F	2 Jn	9 Jn	13 Jn	7/13	0	0
Myotis lucifugus	M	25 Jn	30 Jn	1 Jy	5/6	1	0
Myotis volans	F	25 Jn	27 Jn	-----	1/6	0	0
Lasiurus cinereus	M	5 Jy	-----	-----	0/7	0	0
Myotis lucifugus	F	19 Jy	26 Jy	29 Jy	7/10	1	0
Myotis ciliolabrum	F	19 Jy	27 Jy	29 Jy	7/10	1	0
Myotis thysanodes	F	5 Au	9 Au	11Au	3/5	1	0

Adams, R.A.

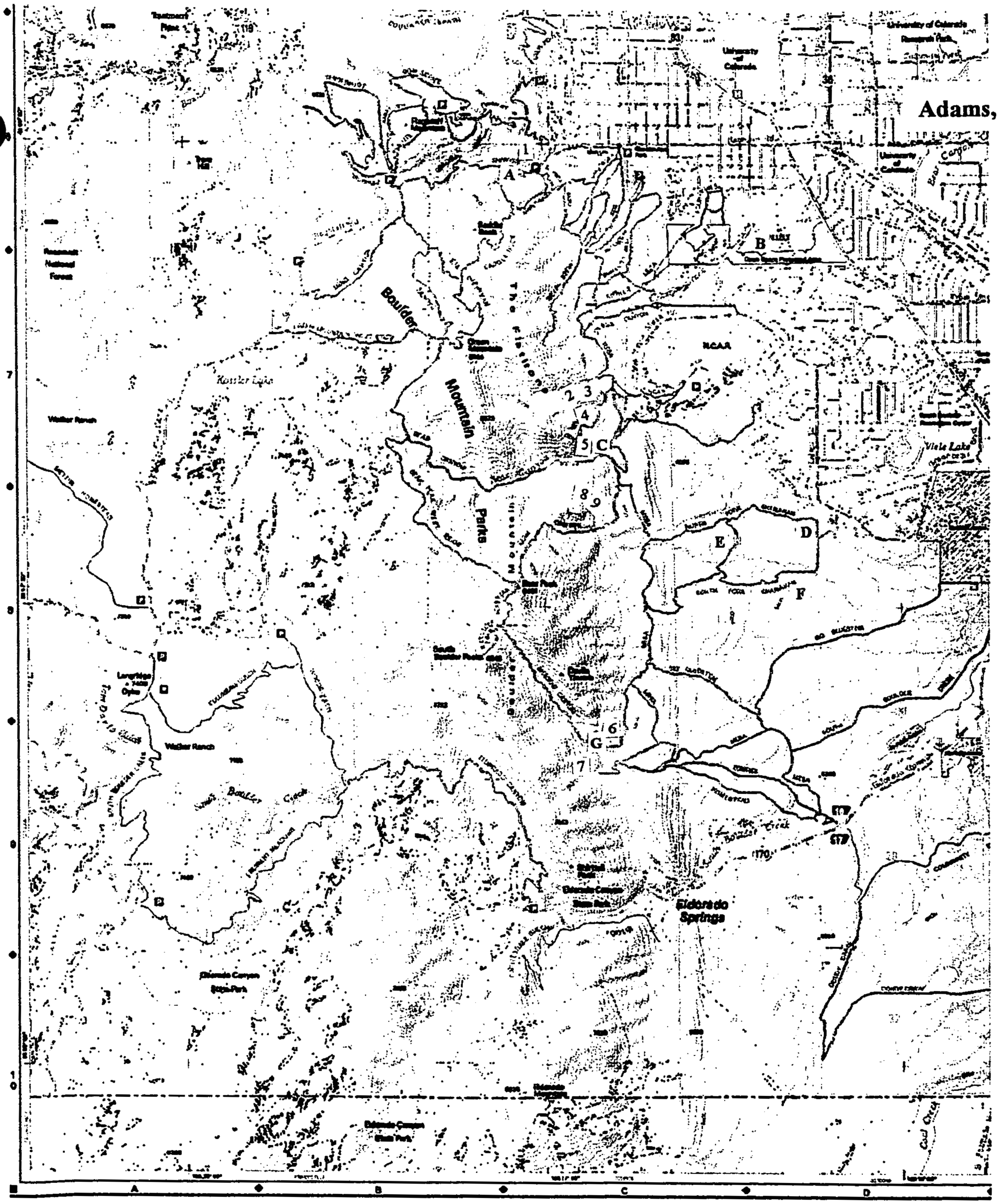

Figure 1. Map of our main field site locations outside of Boulder, Colorado. Letters refer to netting sites. A = Gregory Canyon (GC) stream site, B = NIST pond site, C = Bear Canyon (BC) stream site, D = Abbey Pond (ABB), E = North Shanahan Pond (NSH), F = South Shanahan Pond (SSH), G = Shadow Canyon (SC) stream site. Number refer to roost sites located with radio-telemetry. 1 = *Myotis thysanodes* (transmitter # 38366) maternity colony, *n* = 7; 2 & 3 = *M. volans* (#s 38362 & 38365) maternity colonies, *n* unknown; 4 = *M. thysanodes* (# 38364) maternity colony, *n* = 46; 5 = *M. lucifugus* (#38366) bachelor colony, *n* = 8; 6 = *M. ciliolabrum* (#43071) maternity colony, *n* = 2; 7 = *M. lucifugus* (#38363) maternity colony, *n* = 120; 8 = *Corynorhinus townsendii* maternity colony*, *n* = 28; *Eptesicus fuscus maternity colony**, *n* = 55. *Located by visual inspection.

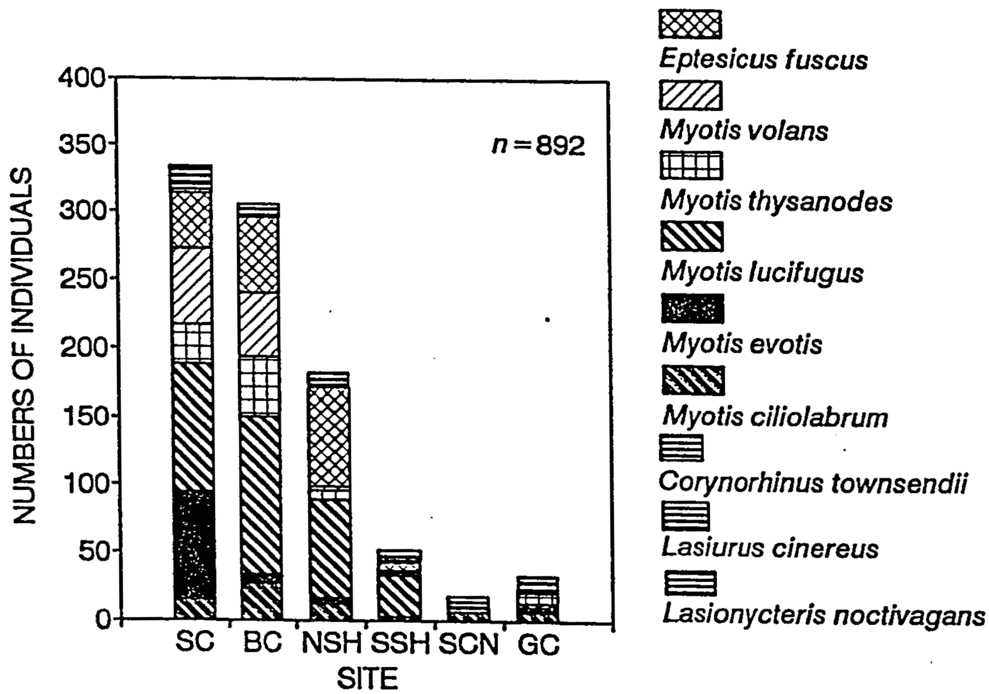

Figure 2. Stacked bar graph depicting species diversity and evenness per site compiled from three years of pooled data (1996-1998)

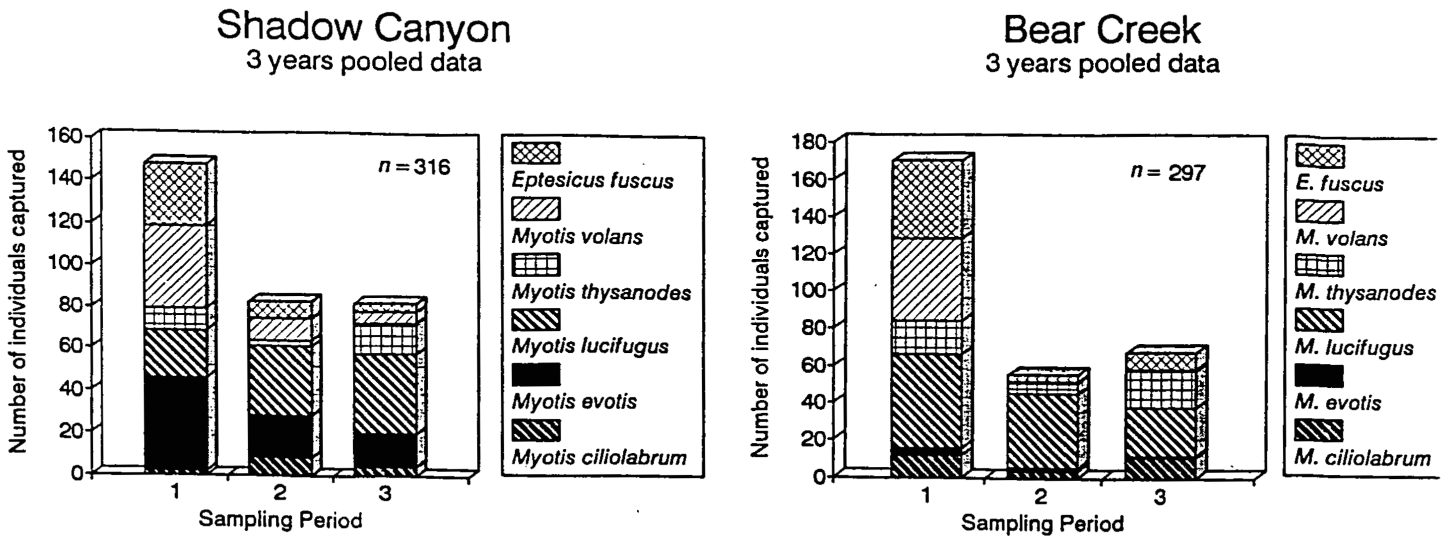

Figure 3. Changes in species diversity and evenness at Shadow Canyon and Bear Creek.

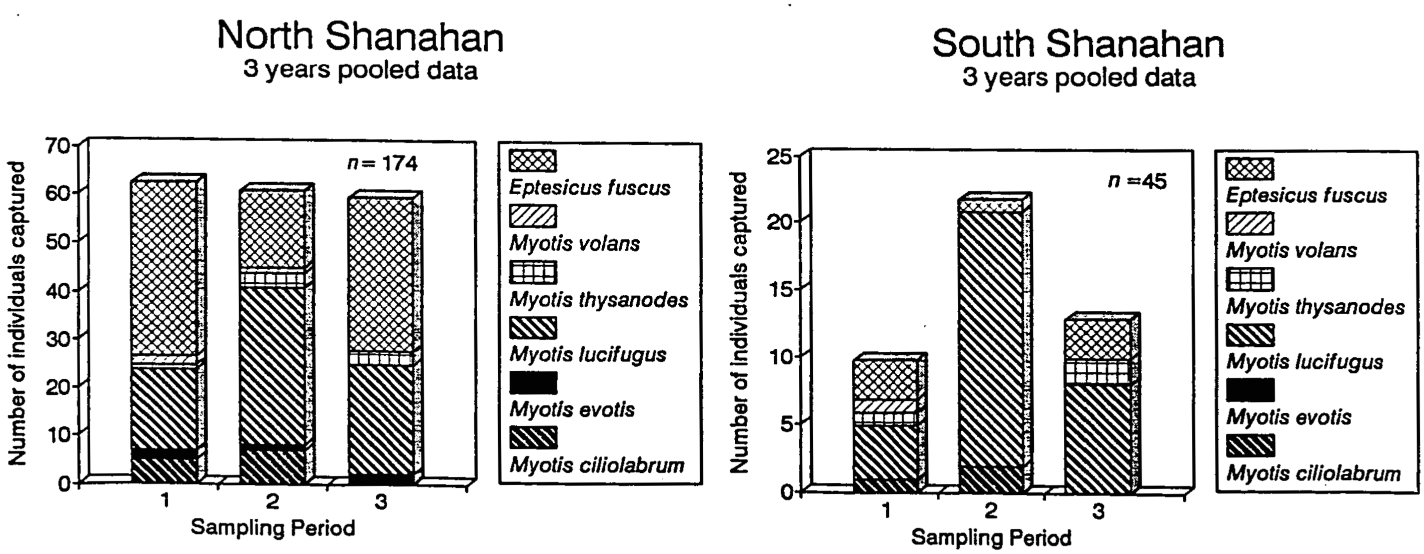

Figure 4. Changes in species diversity and evenness at North and South Shanahan ponds.

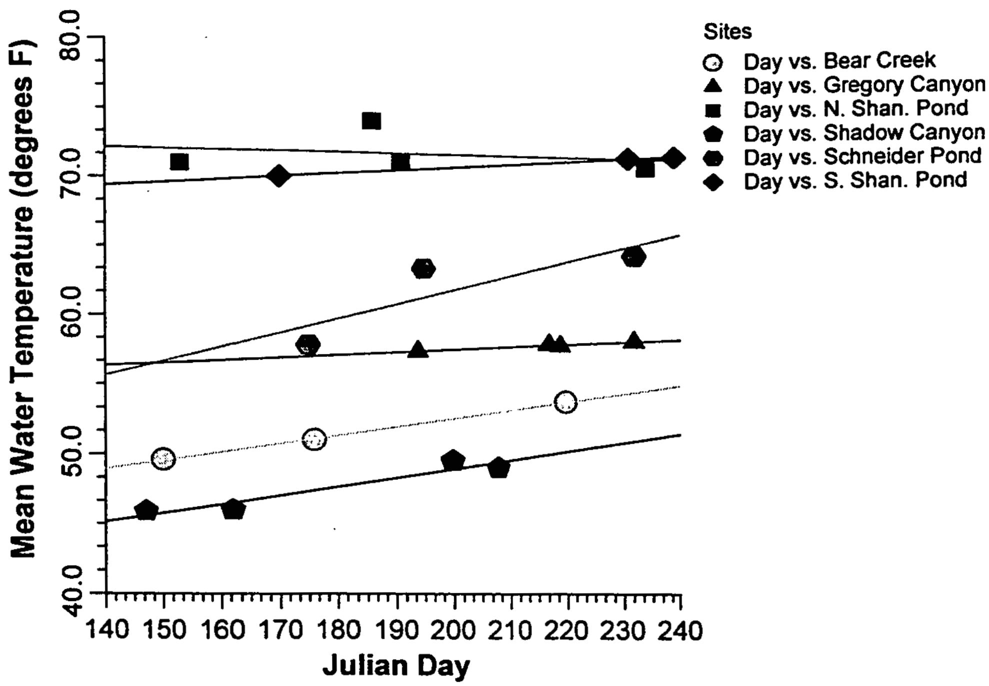

Figure 5. Changes in mean water temperature across sites throughout summer.

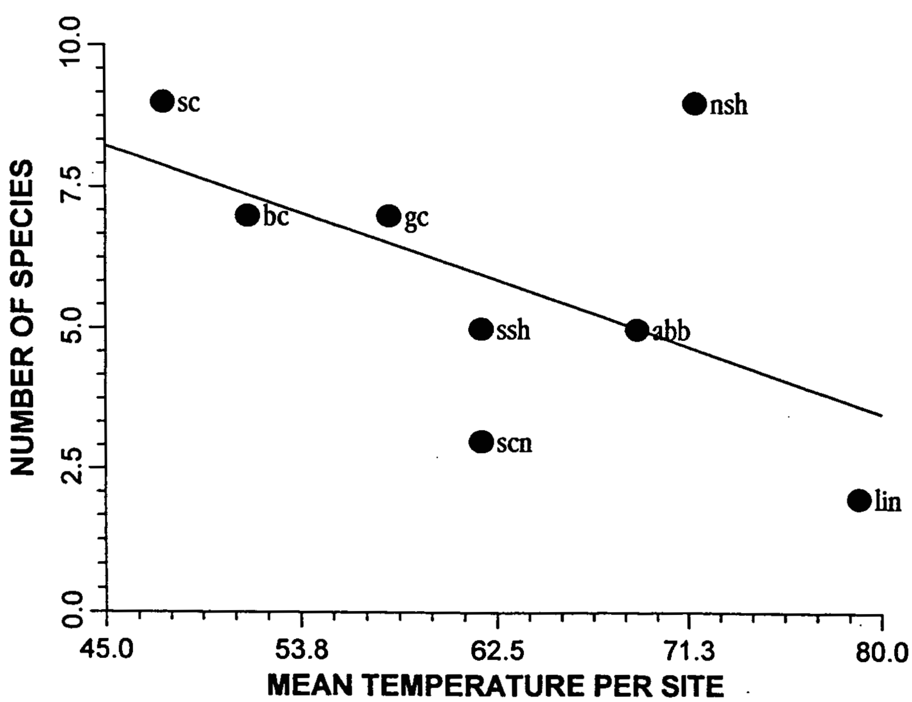

Figure 6. Relationship between water temperature and number of species present per site, $r = 0.721$, $p < 0.01$

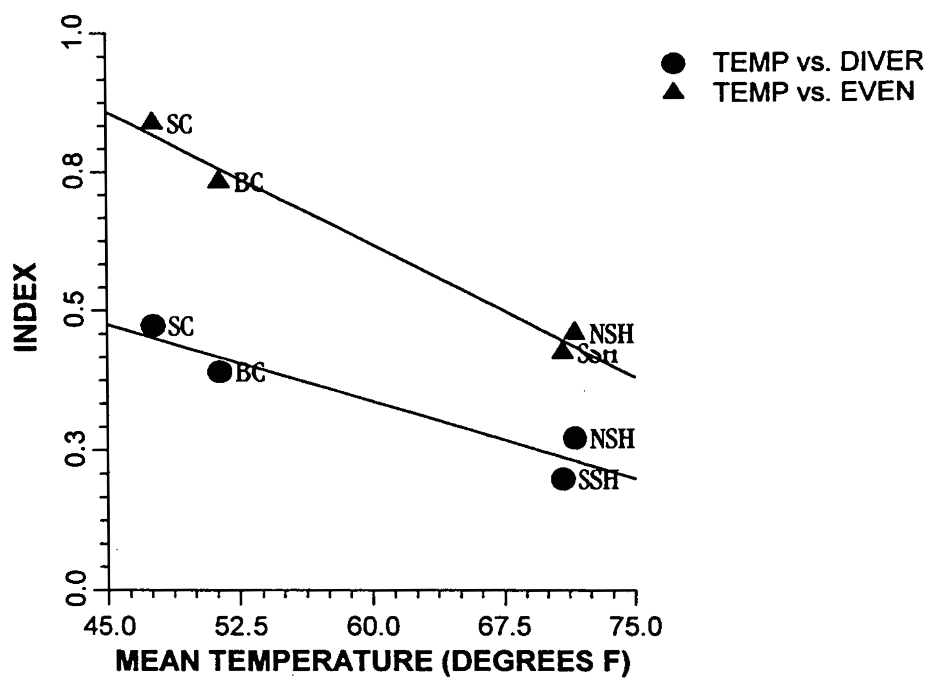

Figure 7. Relationship between water temperature and species diversity (H') and species evenness (E3).

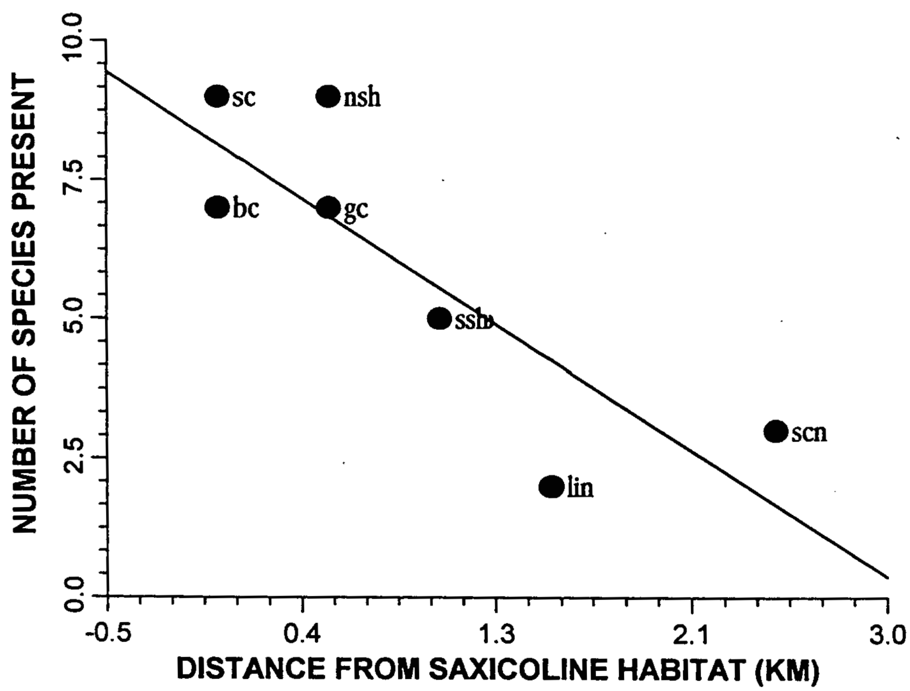

Figure 8. Relationship between species presence and distance of waterhole from major roosting habitat, $r = -0.85$, $p < 0.01$

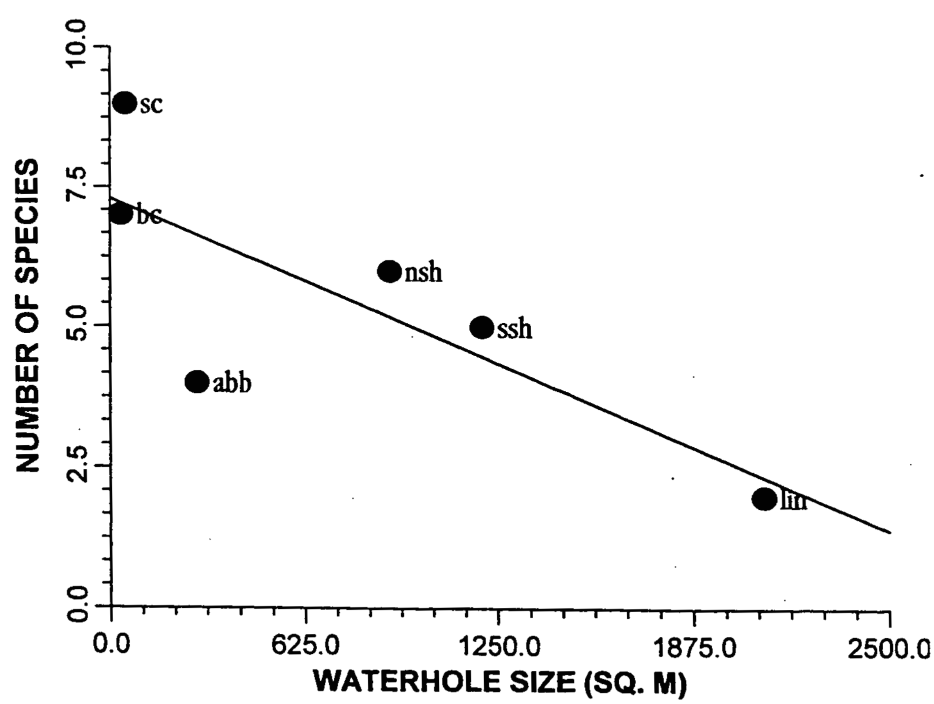

Figure 9. Relationship between waterhole size and species presence, $r = -0.57$, $p < 0.05$.