

A Survey of Colorado's Caves for Bats

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Prepared for:
Colorado Division of Wildlife

2002



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Introduction

Although caves represent a critical habitat component for most bats in Colorado, few caves in Colorado have been surveyed for use by bats. At least twelve of Colorado's eighteen bat species make use of caves during some phase of their annual cycle (Fitzgerald *et al.* 1994). The environmental stability and protection provided by caves make them highly suitable for roosting throughout the year. The availability of suitable roosts is a limiting resource in the distribution and abundance of some cave-dwelling bats (Humphrey 1975). The, often specialized, physiological roosting requirements of bats dictate the environments in which a bat can or cannot successfully roost. During summer, caves are used as day roosts, night roosts, and maternity roosts. Caves are used as hibernacula during winter and as migratory resting areas in the spring and fall.



Spring Cave (photo by S. Carroll)

Documentation of cave use by bats in Colorado is necessary to refine our knowledge of species' ranges, to monitor populations, and to identify preferred habitat characteristics. Information on seasonal variation in cave use can be used to guide management recommendations for bats. Although caves are relatively persistent structures, their use by bats can be influenced by many factors. Frequent disturbance or alteration of a cave's microclimate can decrease or eliminate use by bats. Disruption of roost sites during hibernation can be especially detrimental to bat colonies (Thomas 1995; Pierson *et al.* 1999) because of the energy expended during arousal.

Inventory and monitoring of caves, with an emphasis on learning more about the roosting requirements of bats (of *Corynorhinus townsendii* in particular) in caves was ranked as a high priority by the Colorado Committee of the Western Bat Working Group (2002). The paucity of information on cave use presents difficulties in the effective management and evaluation of bats. This study was initiated with the purpose of learning more about where and when bats are using caves throughout Colorado. Because of the concern surrounding the status of *C. townsendii* in Colorado and throughout its range and its dependence upon caves (Pierson *et al.* 1999; Colorado Committee of the Western Bat Working Group 2002), this species was of particular interest during this project.

Methods

Caves within Colorado were assessed for use by bats by means of internal surveys and external capture surveys (Navo 1994) in late Summer 2001 and early Summer 2002. Internal surveys were made to the extent that the biologist performing the survey was comfortable with the technical aspects of caving. The safety of each biologist was of

primary concern. If bats were discovered roosting within a cave during an internal survey, a count and an attempt at species identification was made. Some species (*e.g. Corynorhinus townsendii*) can be identified while roosting without handling individuals. When bats were found to be roosting within a cave, care was always taken to minimize disturbance. External trapping was performed at caves that appeared to be adequate for bat roosting. Harp traps were erected at cave openings just prior to sunset and were monitored throughout the night. Measurements were made on each bat captured including the collection of morphological data (hindfoot length, forearm length, ear length, tragus length and weight), of data on sex and reproductive status and of species determination.



Harp trap assembly at Myotis Cave (photo by S. Smith & C. Wilkey)

Physical parameters (temperature, airflow, relative humidity, opening size, passage dimensions) of each cave were measured. Elevation was measured with a handheld GPS unit with a barometric altimeter at each cave opening (or nearby where satellite connection could be made). Other data recorded were any evidence of human visitation and the presence of standing water, of internal crevices, and of guano deposits.

Caves were surveyed opportunistically as they were located. We found cave locations by researching maps and gazetteers, caving reports and books (Parris 1973) as well as interacting with local cavers and grottos. Other factors in cave selection included ease of access, proximity to dense human population centers (*i.e.* caves with a higher potential for human visitation) and likelihood of observing *C. townsendii*. Because *C. townsendii* does not typically roost at above 10,000 feet in elevation, caves above this altitude were not considered a high priority.

Results

Cave Locations

Ninety-nine caves were found and surveyed in 11 counties throughout Colorado (Figure 1). Caves surveyed ranged in elevation from approximately 5,700 feet to 11,500 feet. No relationships between bat presence and temperature, relative humidity or passage dimensions were found. The temperature ranges of roosting areas for bats observed during internal surveys are included in the species accounts below.

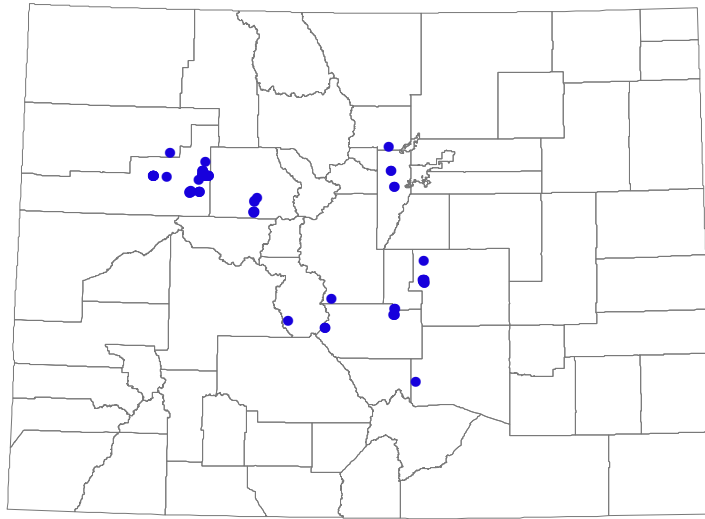


Figure 1. Caves surveyed (99 total)

Bat Use

Eight bat species were observed during the course of the project. They include: *Corynorhinus townsendii*, *Eptesicus fuscus*, *Lasionycteris noctivagans*, *Myotis ciliolabrum*, *M. evotis*, *M. lucifugus*, *M. volans*, and *M. yumanensis*. Bats were found in 19 caves (Figure 2).

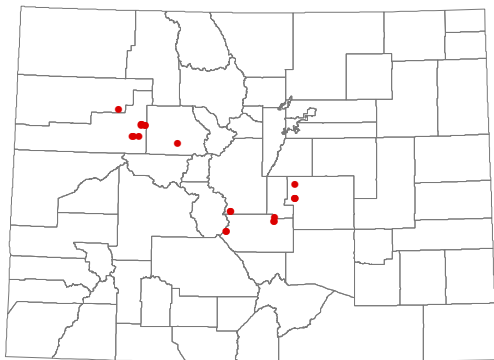


Figure 2. Caves with bats (19)

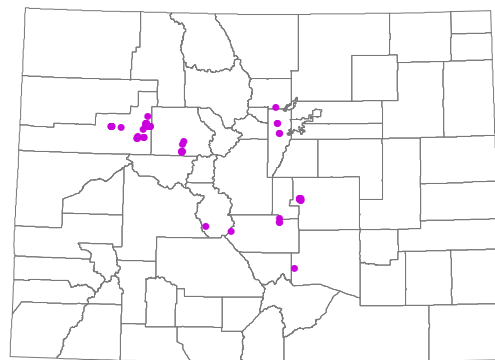


Figure 3. Caves without bats (80)

Corynorhinus townsendii

Corynorhinus townsendii was found at 12 caves ranging in elevation from 6122 feet to 9890 feet. In caves occupied by *C. townsendii*, the average number of individuals was 2.77 (range: 1 - 6). Eight of the 12 caves are previously unknown roosts for *C. townsendii* (Table 1). Air temperature near roosting individual(s) ranged between 9.5 and 20 degrees Celsius (average = 15.6° C, n = 9).

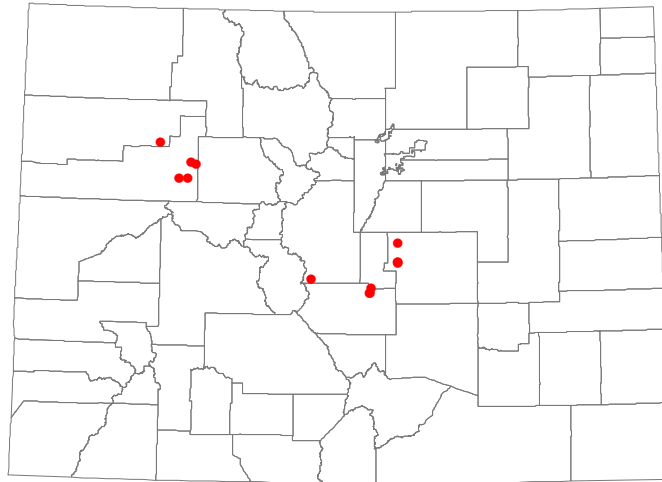


Figure 4. Geographic distribution of caves occupied by *Corynorhinus townsendii*.

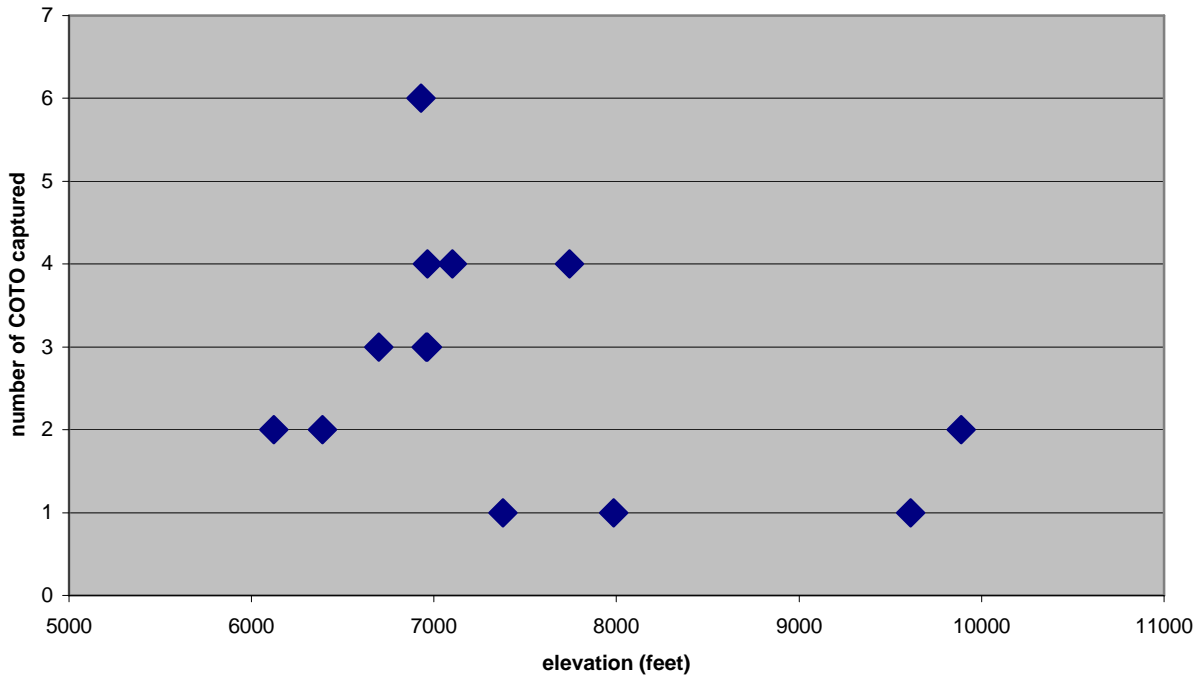


Figure 5. Elevational distribution of caves with COTO captures (n=12).

Eptesicus fuscus

Eptesicus fuscus was found at 2 caves at elevations of 7116 feet and 7742 feet. One individual was found at each cave. Both bats were exiting the cave at the time of capture, indicating that these caves were being used as day roosts by this species.

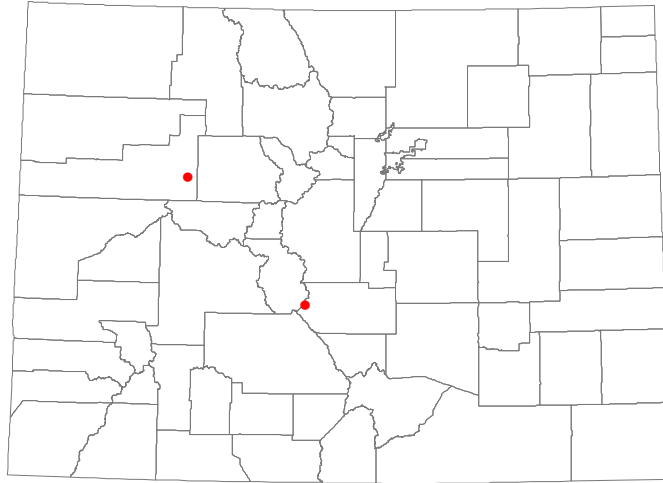


Figure 6. Geographic distribution of caves occupied by *Eptesicus fuscus*.

Lasionycteris noctivagans

Lasionycteris noctivagans was found at 2 caves at elevations of 7116 feet and 7985 feet. One individual was found at each cave. Both bats were entering the cave at the time of capture, indicating that these caves were being used as night roosts by this species.

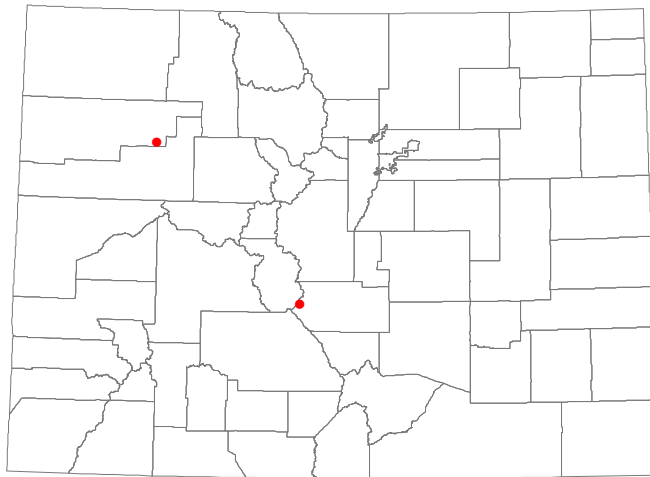


Figure 7. Geographic distribution of caves occupied by *Lasionycteris noctivagans*.

Myotis ciliolabrum

Myotis ciliolabrum was found at 8 caves ranging in elevation from 6930 feet to 9611 feet. When *M. ciliolabrum* was found, the average number of individuals was 2. The greatest number of *M. lucifugus* at any one cave was 5.

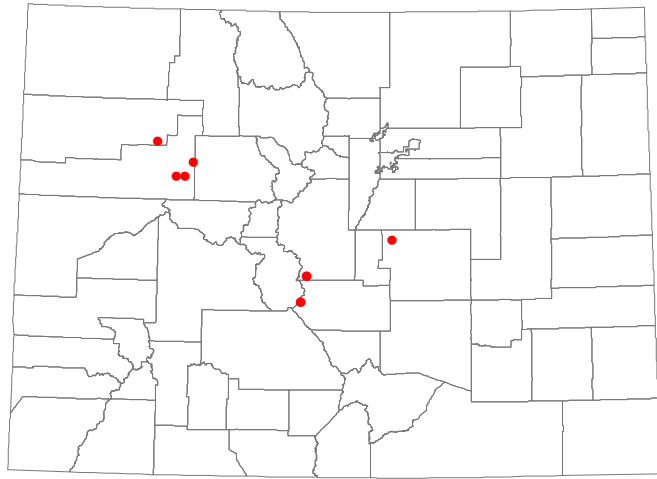


Figure 8. Geographic distribution of caves occupied by *Myotis ciliolabrum*.

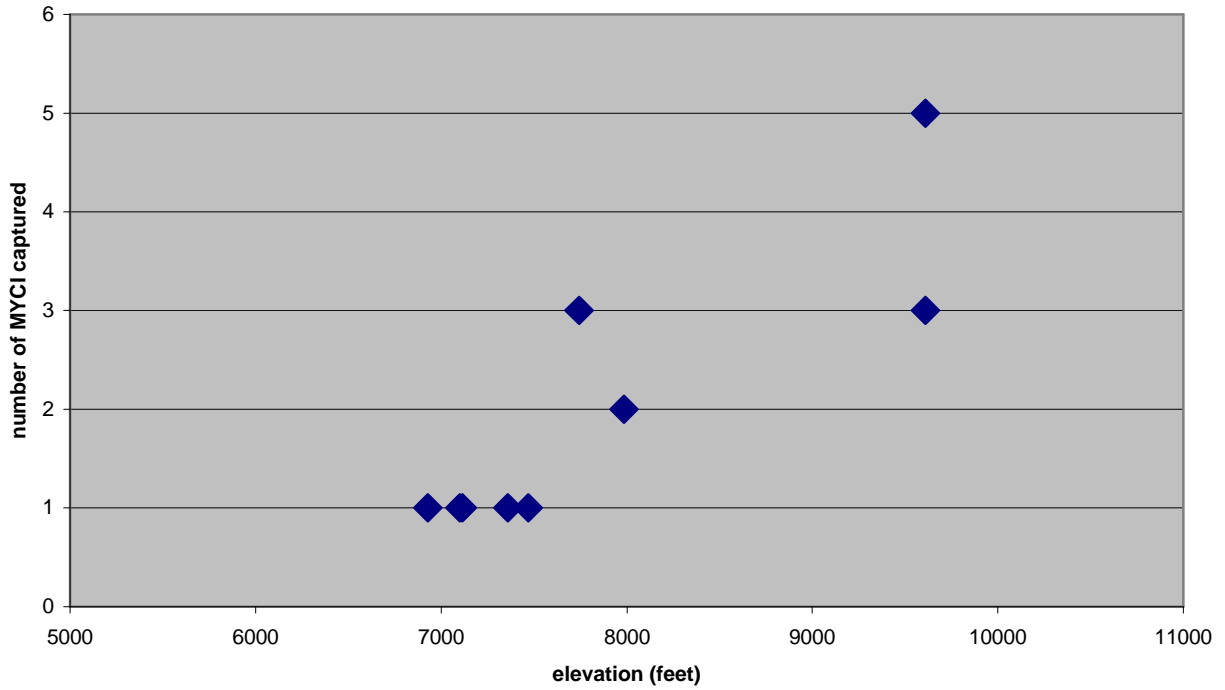


Figure 9. Elevational distribution of caves with MYCI captures (n=8).

Myotis evotis

Myotis evotis was found at 6 caves ranging in elevation from 7100 feet to 9915 feet. When *M. evotis* was found, the average number of individuals was 4. The greatest number of *M. evotis* at any one cave was 8.

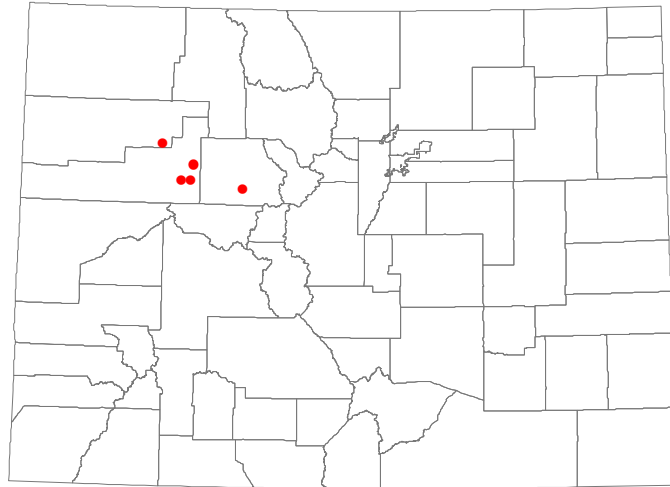


Figure 10. Geographic distribution of caves occupied by *Myotis evotis*.

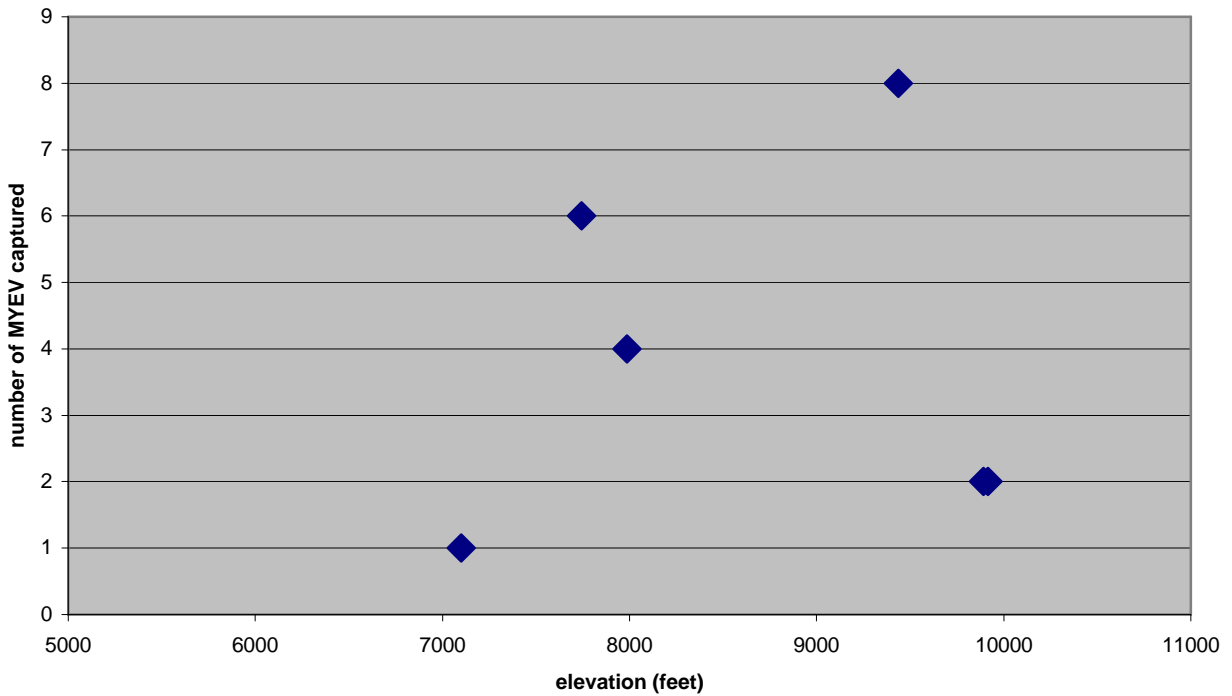


Figure 11. Elevational distribution of caves with MYEV captures (n=6).

Myotis lucifugus

Myotis lucifugus was found at 6 caves surveyed ranging in elevation from 7742 feet to 9915 feet. When *M. lucifugus* was found, the average number of individuals was 6. The greatest number of *M. lucifugus* at any one cave was 14.

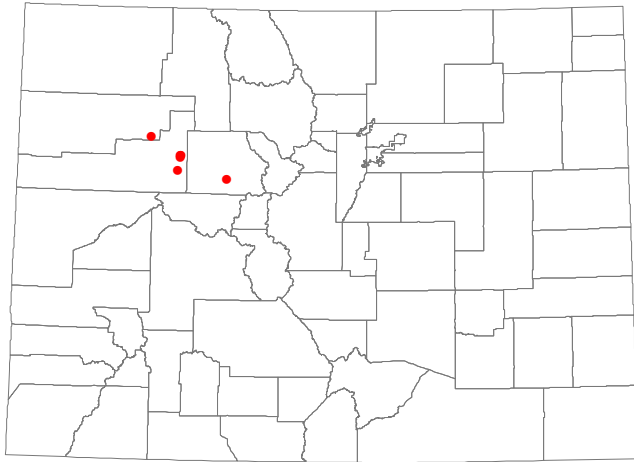


Figure 12. Geographic distribution of caves occupied by *Myotis lucifugus*.

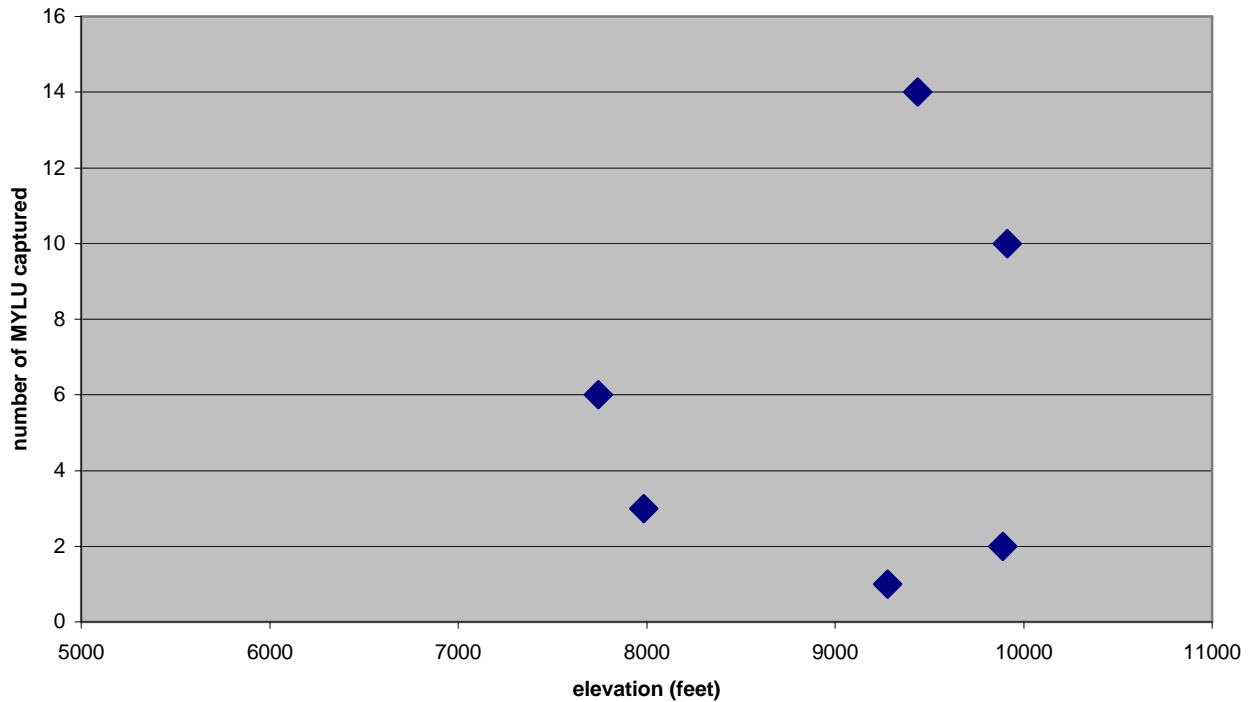


Figure 13. Elevational distribution of caves with MYLU captures (n=6).

Myotis volans

Myotis volans was found at 5 caves surveyed ranging in elevation from 6696 feet to 9890 feet. When *M. volans* was found, the average number of individuals was 1 (excluding the 76 individuals captured at Groaning Cave from this calculation).

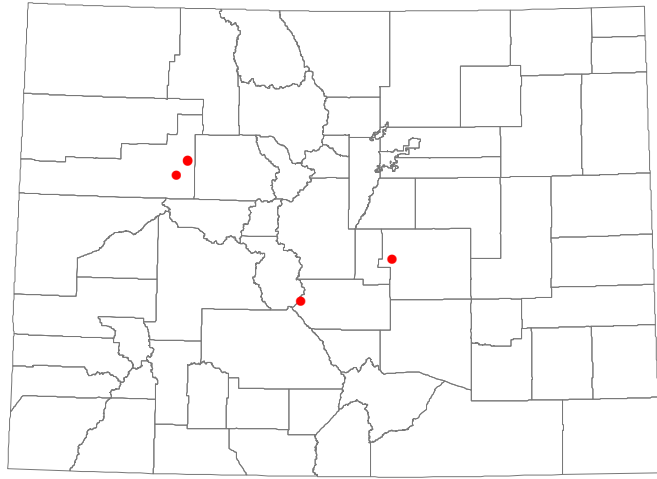


Figure 14. Geographic distribution of caves occupied by *Myotis volans*.

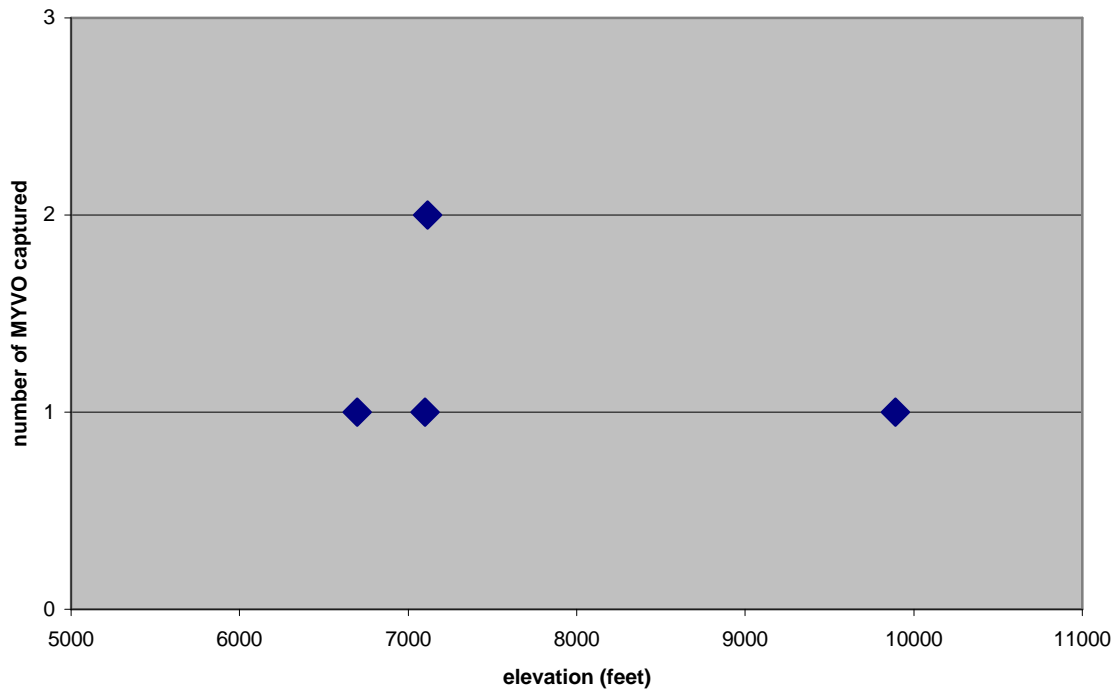


Figure 15. Elevational distribution of caves with MYVO captures (excluding Groaning Cave which had 76 individuals at 9438 feet.) (n=4).

Myotis yumanensis

Myotis yumanensis was found at 2 caves at elevations of 9438 feet and 9890 feet. These two occurrences are at the highest elevation documented for this species. When *M. yumanensis* was found, the average number of individuals was 9. The greatest number of *M. yumanensis* at any one cave was 14.

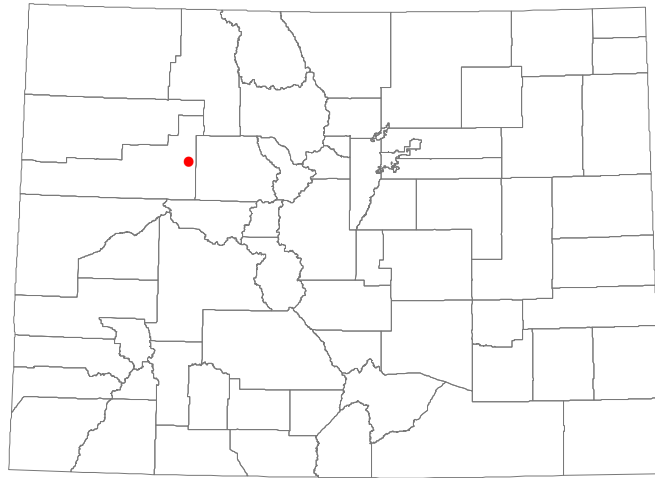


Figure 16. Geographic distribution of caves occupied by *Myotis yumanensis*.

Bat Use Summary

Of the 19 caves that were discovered to support bat activity, *Corynorhinus townsendii* was found at 12 (Figure 17 & Table 1). This frequency was greater than any other bat species encountered in this survey. The next most frequently observed species was *Myotis ciliolabrum*, which occurred at 8 of the caves surveyed.

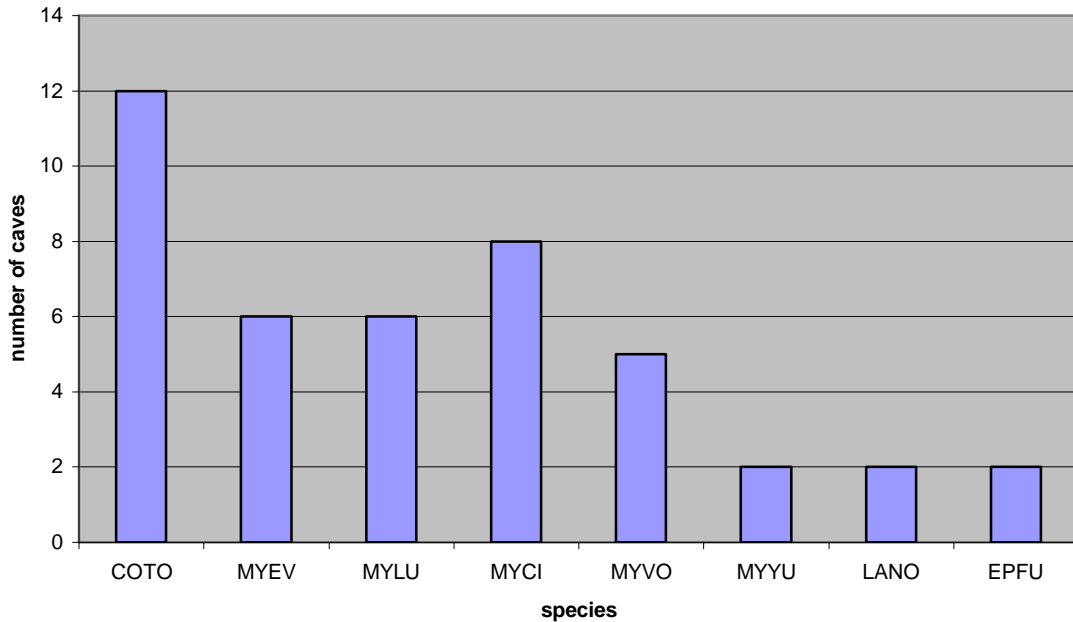


Figure 17. Frequency of bat presence in surveyed caves by species (many caves were used by >1 species).

The largest aggregation of bats was found at Groaning Cave (Eagle County). Four bat species and over 100 individuals were observed in one night of trapping. Bat activity (Goat 1982) and swarming behavior (Navo *et al.* 2002) have been documented at this cave previously. After Groaning Cave, Fulford Cave (Garfield County) had the largest number of captures of a single species with 10 *M. lucifugus*. The majority of caves with bats had less than 5 individuals of any one species. Spring Cave (Rio Blanco County), Hubbard's Cave (Garfield County) and Honkey Cave (Garfield County) each exhibited the highest species richness with 5 species, although less than 6 individuals represented each species.

The elevational ranges of species captures are within those previously published (Armstrong *et al.* 1994; Fitzgerald *et al.* 1994) except for two occurrences of *C. townsendii* and two occurrences of *Myotis yumanensis* (Table 2). Sources referring to *C. townsendii*'s range within Colorado place its upper elevational limit at 9,500 feet (Armstrong *et al.* 1994; Fitzgerald *et al.* 1994). The two high-elevation *C. townsendii* captures occurred at 9,611 feet and 9,890 feet. *Myotis yumanensis* was documented at two caves with elevations of 9,438 feet and 9,890 feet. These two occurrences represent high-elevation roosting records for this species in Colorado.

Table 1. Bat captures by species name.

bat species	cave name	# of individuals
<i>Corynorhinus townsendii</i>	Myotis Cave*	6
	Fairy Cave	4
	Hubbard's Cave	4
	Natural Bridges*	4
	Narrows Cave*	3
	Wilson's Cave*	3
	Fly Cave	2
	Honkey Cave*	2
	Marble Cave*	2
	Porcupine Cave*	1
	Spinster's Cave*	1
	Spring Cave	1
	<i>Eptesicus fuscus</i>	Bat Cave
Hubbard's Cave		1
<i>Lasionycteris noctivagans</i>	Bat Cave	1
	Spring Cave	1
<i>Myotis ciliolabrum</i>	Porcupine Cave	5
	Hubbard's Cave	3
	Spring Cave	2
	Bat Cave	1
	Fairy Cave	1
	LaSunder Cave	1
	Myotis Cave	1
	Scorpion Cave	1
<i>Myotis evotis</i>	Groaning Cave	8
	Hubbard's Cave	6
	Spring Cave	4
	Fulford Cave	2
	Honkey Cave	2
	Fairy Cave	1
<i>Myotis lucifugus</i>	Groaning Cave	14
	Fulford Cave	10
	Hubbard's Cave	6
	Spring Cave	3
	Honkey Cave	2
	Fixin'-to-die Cave	1
<i>Myotis volans</i>	Groaning Cave	76
	Bat Cave	2
	Fairy Cave	1
	Honkey Cave	1
	Narrows Cave	1
<i>Myotis yumanensis</i>	Groaning Cave	14
	Honkey Cave	3

* Previously unknown roost sites for *Corynorhinus townsendii*.

Table 2. Bat captures by cave name.

cave name	county	elevation (feet)	bat species	# of individuals
Bat Cave	Fremont	7116	<i>Myotis ciliolabrum</i>	1
			<i>M. volans</i>	2
			<i>Lasionycteris noctivagans</i>	1
			<i>Eptesicus fuscus</i>	1
Cave of the Clouds	Garfield	6126	unknown	1+
Fairy Cave	Garfield	7100	<i>Corynorhinus townsendii</i>	4
			<i>M. evotis</i>	1
			<i>M. ciliolabrum</i>	1
			<i>M. volans</i>	1
Fixin'-to-die Cave	Garfield	9278	<i>M. lucifugus</i>	1
Fly Cave	Fremont	6388	<i>C. townsendii</i>	2
Fulford Cave	Eagle	9915	<i>M. evotis</i>	2
			<i>M. lucifugus</i>	10
Groaning Cave	Garfield	9438	<i>M. evotis</i>	8
			<i>M. lucifugus</i>	14
			<i>M. volans</i>	76
			<i>M. yumanensis</i>	14
Honkey Cave	Garfield	9890	<i>C. townsendii</i>	2
			<i>M. evotis</i>	2
			<i>M. lucifugus</i>	2
			<i>M. volans</i>	1
			<i>M. yumanensis</i>	3
Hubbard's Cave	Garfield	7742	<i>C. townsendii</i>	4
			<i>M. evotis</i>	6
			<i>M. lucifugus</i>	6
			<i>M. ciliolabrum</i>	3
			<i>E. fuscus</i>	1
LaSunder Cave	Garfield	7469	<i>M. ciliolabrum</i>	1
Marble Cave	Fremont	6122	<i>C. townsendii</i>	2
Myotis Cave	El Paso	6930	<i>C. townsendii</i>	6
			<i>M. ciliolabrum</i>	1
Narrows Cave	El Paso	6696	<i>C. townsendii</i>	3
			<i>M. volans</i>	1
Natural Bridges	El Paso	6963	<i>C. townsendii</i>	4
			unknown	10-15
Porcupine Cave	Park	9611	<i>C. townsendii</i>	1
			<i>M. ciliolabrum</i>	5
Scorpion Cave	Fremont	7360	<i>M. ciliolabrum</i>	1
Spinster's Cave	Garfield	7376	<i>C. townsendii</i>	1
Spring Cave	Rio Blanco	7985	<i>C. townsendii</i>	1
			<i>M. evotis</i>	4
			<i>M. lucifugus</i>	3
			<i>M. ciliolabrum</i>	2
Wilson's Cave	Teller	6958	<i>L. noctivagans</i>	1
			<i>C. townsendii</i>	3

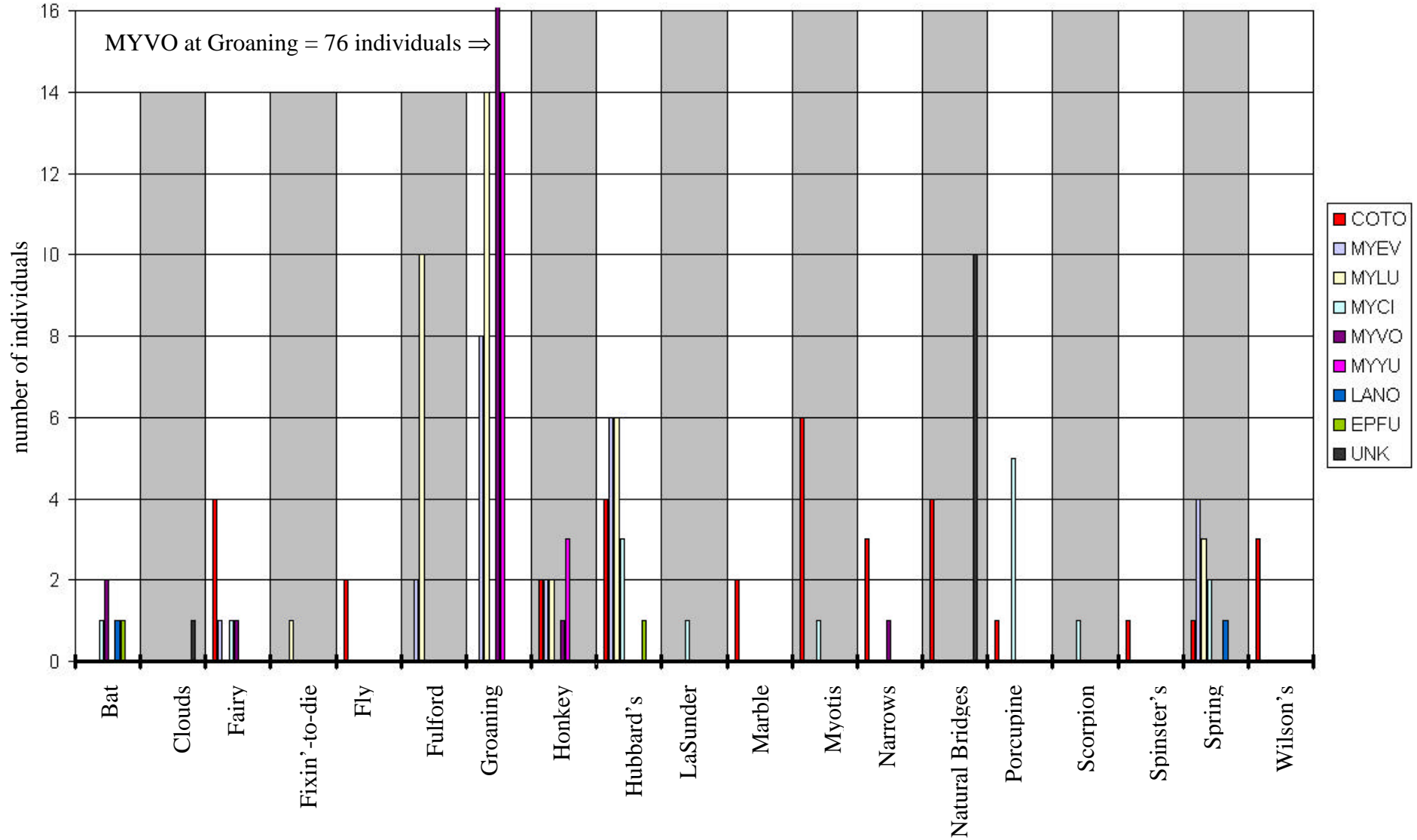


Figure 18. Number of bats by species and cave name. The 76 *Myotis volans* captured at Groaning Cave are not fully depicted on this chart. If individuals of the same species were observed on multiple occasions at a single cave, the greatest number observed is shown.

Discussion

The documentation of cave use is instrumental in the effective management of bat species. The majority of caves surveyed in this effort were visited once and seasonal differences in roost utilization were not addressed. The details of roost fidelity for many bat species in Colorado remain unclear. While *Corynorhinus townsendii* was shown to exhibit relatively high fidelity toward cave roosts (or group of roosts) in Utah and Nevada (Sherwin *et al.* 2000), many bat species use multiple roosts throughout the year and may switch roosts during a particular season (*e.g.* maternity season) (Lewis 1995). Different roosting environments are utilized during different portions of the year. Maternity roosts and hibernacula likely have the most stringent environmental constraints for bat use.



Corynorhinus townsendii (photo by J. Siemers)

Corynorhinus townsendii was the most frequently encountered bat during this survey. The largest aggregation of *C. townsendii* contained six individuals. Twelve percent of the caves surveyed had *C. townsendii* in them and of the caves at which bats were found (19), 63% of them (12) supported *C. townsendii* to some degree. Sherwin *et al.* (2000) found *C. townsendii* to be occupying 33 of 39 caves (84.6%) and 126 of 676 mines (24%) in Utah. Compared to caves, mines are a relatively recent roost structure available for bats. The comparison of bat use of mines and caves, as well as comparisons of bat populations and biology in these two habitats, need further investigation.

Because of the lack of cave surveys in Colorado and the relative difficulty of accessing higher elevation caves (especially in the winter), little information is known about the seasonal use of caves by bats at higher elevations. *Corynorhinus townsendii* was found above 9,500 feet in elevation at Honkey Cave and at Porcupine Cave. These records are above the general elevation range published for the species in Colorado. The average elevation of *C. townsendii* roosts in mines is about 7,000 feet and this species has been found in 16 mines at elevations greater than 9,000 feet (K. Navo, pers. comm.). *Myotis yumanensis* was found at Groaning Cave and at Honkey Cave in September 2001. These two occurrences are high-elevation roosting records for this species in Colorado. *Myotis yumanensis* has previously been documented at Groaning Cave (Navo *et al.* 2002), but there are no prior records of this species at Honkey Cave. Many bat species will move to colder roost sites in the fall in preparation for hibernation (Twente 1955). High-elevation caves may provide the cooler environments needed for hibernation. In addition, swarming behavior may attract bats to higher elevations, which has been documented at Groaning Cave (Navo *et al.* 2002). The relatively high species richness (5 species) that was observed at Honkey Cave and its close proximity to Groaning Cave (<1 mile separation) suggest that Honkey Cave may be used as a pre-swarming roost or swarming may occur here during different portions of the year.

By no means was the full extent of cave and karst areas in Colorado surveyed during this effort (Figure 19). Additional surveys over multiple seasons and multiple years are needed to obtain a clearer picture of how caves are used by bats in Colorado. Sizeable areas in and around Dinosaur National Monument, in the San Juan Mountains and in the Sawatch Range and Elk Mountains were not inventoried to any degree. A large number of caves also exist on and near the White River Plateau that were not evaluated. This area appears to have the highest density of caves in Colorado. The complex of over sixty caves that exists within Williams Canyon (Rhinehart 2000), currently owned by Cave of the Winds, also warrants further study. *Corynorhinus townsendii* was found at three caves within this canyon and other roost locations are known from this area.

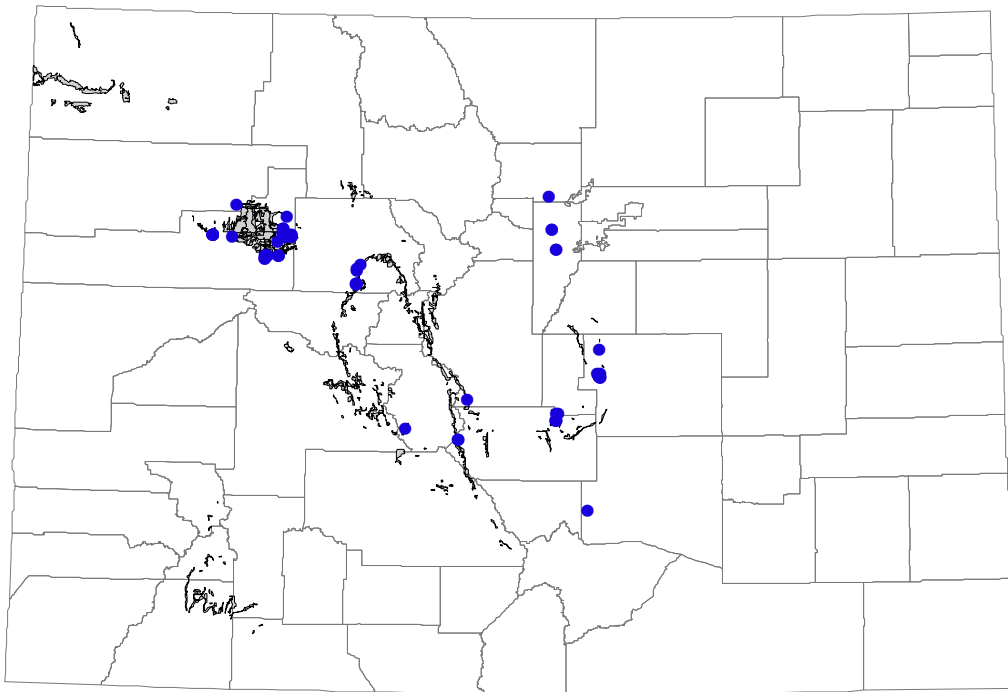


Figure 19. Cave and karst areas of Colorado and locations of surveyed caves.

Acknowledgements

Steve Carroll, Sarah Lant, Stephanie Smith and Carole Wilkey skillfully performed fieldwork. Advice, direction and mine data were provided by Kirk Navo. The Colorado Committee of the Western Bat Working Group initiated discussions about the need for cave surveys like this one. Rob Schorr and Mike Wunder provided useful comments on the report. Thanks to the Colorado caving community, especially Sean McDonough of Cave of the Winds and Hazel Barton, who provided assistance and support. Funding was provided by the Colorado Division of Wildlife.

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