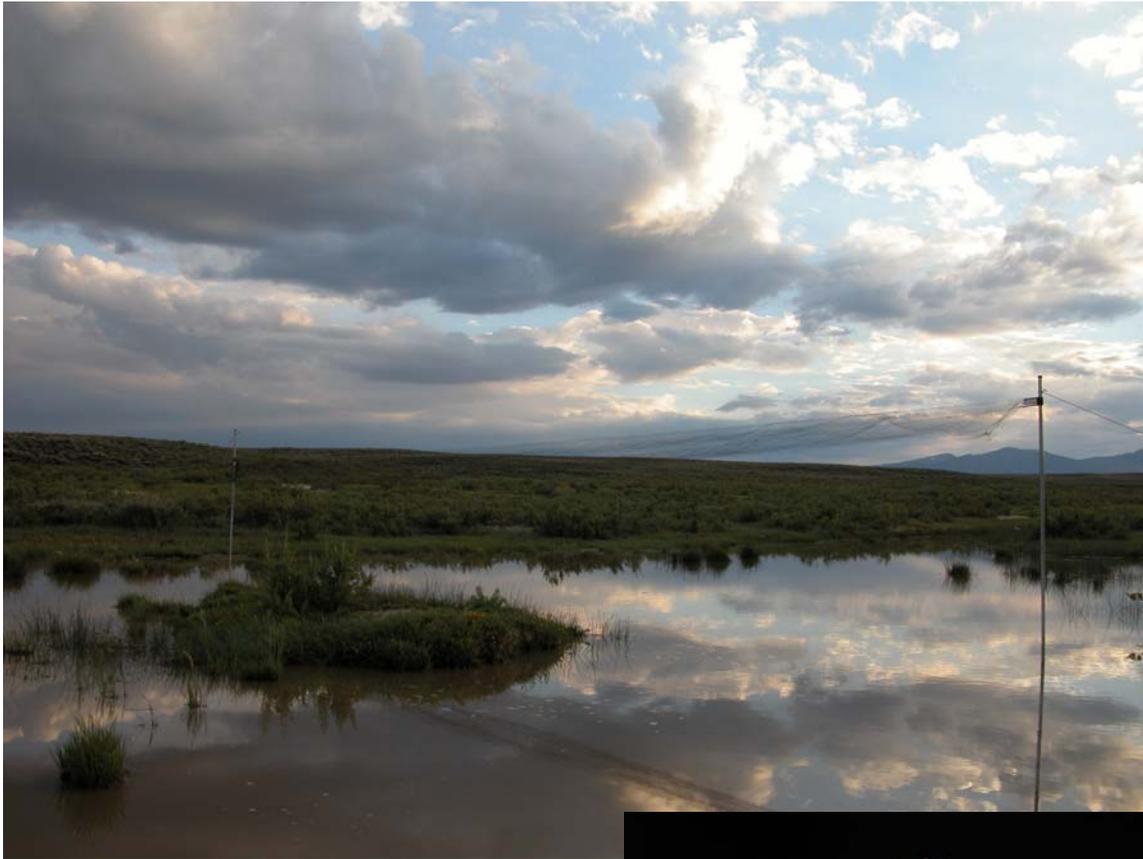




Survey for Bats in Jackson County, Colorado

Colorado Natural Heritage Program
Warner College of Natural Resources
Colorado State University
Fort Collins, Colorado



**Colorado
State**
University
Knowledge to Go Places



Survey for Bats in Jackson County, Colorado

Robert A. Schorr
Zoologist

Cover photographs:

1. Mist nets over pond near North Platte River, Jackson County, Colorado
2. Long-eared myotis (*Myotis evotis*) in hand

INTRODUCTION

Bats, as a group, are of conservation concern in much of the United States. Because bats have low reproductive rates, undergo major physiological stress (from hibernation and/or migration), are susceptible to human disturbance at roost sites, and may be disproportionately impacted by some energy development, they are receiving ever-increasing levels of conservation attention (Racey and Entwistle 2003). One of the primary facets of most conservation strategies is the need to obtain better distributional information (Racey and Entwistle 2003, Fenton 2003). Bats pose a particularly difficult information gap because of the lack of survey effort and the inherent difficulty of surveying for nocturnal, volant species.

Of the approximately 126 species of mammals found in Colorado, bats, with approximately 20 species, are second only to the rodents in diversity. Despite being a large component of the mammalian fauna, the distribution, abundance, and ecology of most bats species is poorly understood. Much of the absence of biological information is driven by the paucity of survey effort dedicated to bats. In turn, the lack of distributional information has raised concern that many bat species in Colorado are of conservation concern. In the recent development of the State of Colorado's wildlife conservation strategy, 20% of the mammal species believed to be of conservation concern were bats (Colorado Division of Wildlife 2005). This represents a quarter of all bat species known or believed to be found in Colorado.

Certain geographic areas of Colorado (north-central, south-central and eastern plains) have few records of bats, and some of these regions may provide exceptional habitat for bats. To assist in setting bat conservation planning priorities it is important to adequately conduct bat surveys in these regions where information is scarce. As part of the Colorado Division of Wildlife's Colorado Wildlife Conservation Grants, the Colorado Natural Heritage Program (CNHP) was granted funding to conduct a targeted bat survey of Jackson County in north-central Colorado.

Jackson County covers nearly 4,200 km² (>1600 sq. mi.) and includes a large, high-elevation basin surrounded by mountain ranges on three sides. The basin, at an elevation of approximately 8,200 ft., is known as North Park and is dominated by sagebrush (*Artemisia* spp.) shrublands and irrigated agricultural lands. Much of North Park is privately owned, but there are substantial amounts of Colorado Division of Wildlife leased land for hunting and fishing access, state-managed wildlife areas, and Bureau of Land Management properties. The surrounding mountains exceed 12,000 feet and include the Medicine Bow Mountains, the Sierra Madre (Park Range), and the Rabbit Ears Range. Much of the forests are comprised of lodgepole pine (*Pinus contorta*) with scattered groves of aspen (*Populus tremuloides*), and some spruce-fir (*Picea engelmannii*-*Abies lasiocarpa*) mixes at higher elevations. The forests east of North Park are predominately managed by the Colorado State Forest and State Parks, while much of the other forests surrounding North Park are managed by the Routt National Forest, U.S. Forest Service. The Canadian, Michigan, and Illinois rivers feed the North Platte River as it flows north into Wyoming. The county seat, Walden, is approximately 100 miles west of Fort Collins and approximately 50 miles east of Steamboat Springs.

At least six species of bats have predicted range maps that include Jackson County (Fitzgerald *et al.* 1994), but, there is only one occurrence of one species recorded from the county (Armstrong *et al.* 1994). The silver-haired bat (*Lasionycteris noctivagans*) was collected from North Park by

Elliott Coues in 1876 (Specimen Number 012827, Smithsonian Institute, National Museum of Natural History), but no other bats have been documented since that time. Only a few mountain counties and the eastern counties in Colorado are as depauperate of bat location information. Compared to other counties with limited bat distribution information, Jackson County may be of greater priority for bat survey information because several priority species are found in nearby Larimer, Grand, and Routt counties. The Western Bat Working Group (1998) has determined that the fringed myotis (*Myotis thysanodes*), the silver-haired bat (*Lasionycteris noctivagans*), the hoary bat (*Lasiurus cinereus*) and the Townsend's big-eared bat (*Corynorhinus townsendii*) are some of the highest bat conservation priorities within the ecoregions of Colorado. These four bats were the species of primary interest during the inventory.

The objectives of this project were threefold:

- (1) Conduct a targeted inventory for bats in or around caves, mines, and water bodies within Jackson County.
- (2) Compile survey information into a geo-referenced database that can be used in conjunction with geographic information systems to develop more complete bat distribution models.
- (3) Provide the Colorado Division of Wildlife with relevant information of the distribution of rare bat species in Jackson County. These data can be used to inform current assessments of mammal conservation priorities for the State of Colorado.

METHODS

Site selection

This inventory targeted bat habitats that were accessible to biologists and sampling equipment. Thus, biologists spent time searching for caves, mines, cattle troughs, ponds, and broad, relatively-shallow, slow-moving creeks and rivers. Because of contract timing, the inventory did not begin until August, allowing little time for private landowner contact. Thus, all areas accessed were owned by state or federal entities. All mines found were owned by private citizens and were not accessed.

Sampling equipment

Harp traps are an effective method of capturing bats at cave and mine entrances (Francis 1989), but no caves or mines were accessed during this inventory. All surveying was conducted using mist nets. Mist nets are fine nets that were first used to capture migratory birds, but have become one of the most common capture methods for wild bats. Mist nets of 2.6-m, 6-m, 9-m, or 12-m lengths were stretched taut between aluminum poles at dusk and left open during primary bat activity times (typically 8:30 pm to 12:00 am). When nets were placed over creeks, they were oriented perpendicular to the flow of the creek. When nets were placed over cattle troughs, nets either bisected the trough or were stretched around the perimeter of the trough.

In addition to physical capture effort using mist nets, a Pettersson D240x ultrasound detector (Pettersson Elektronik AB, Uppsala, Sweden) was used to convert bat ultrasonic vocalization to frequencies audible to the human ear. This was used to confirm bat activity in an area being sampled, even if bats were not captured in the nets. Attempts to identify species or species groups were made by recording ultrasonic bat vocalizations to a Nobilis N5001 laptop computer

(Equus Computer Systems, Minneapolis, MN) using Sonobat v2.5.6 (Sonobat, Arcata, CA) software.

Captured bats were carried to a processing location where critical measurements and physical features were recorded. Individuals that represented species not known to occur in Jackson County were euthanized using Halothane (Halocarbon Laboratories, River Edge, NJ), prepared as museum specimens, and submitted to the Museum of Southwestern Biology (University of New Mexico, Albuquerque, NM). Geographic location, elevation, habitat description, time of capture, and pertinent climatic information were recorded.

RESULTS

Survey locations

Surveys were conducted at 12 locations in Jackson County. Mist-netting was conducted over 13 nights with two additional nights attempted but not completed because of precipitation. Four ponds, three cattle troughs, and nine stretches of creeks or rivers were surveyed. One area (North Platte River Boat Launch) was surveyed twice because of the large amount of bat activity coinciding with mayfly (Order Ephemeroptera) and caddisfly (Order Tricotera) hatches that occurred between 9 pm and 10 pm. Elevations of survey locations ranged from 7,900 ft. to 9,300 ft. Reference Figure 1 for the location of each survey in Jackson County.

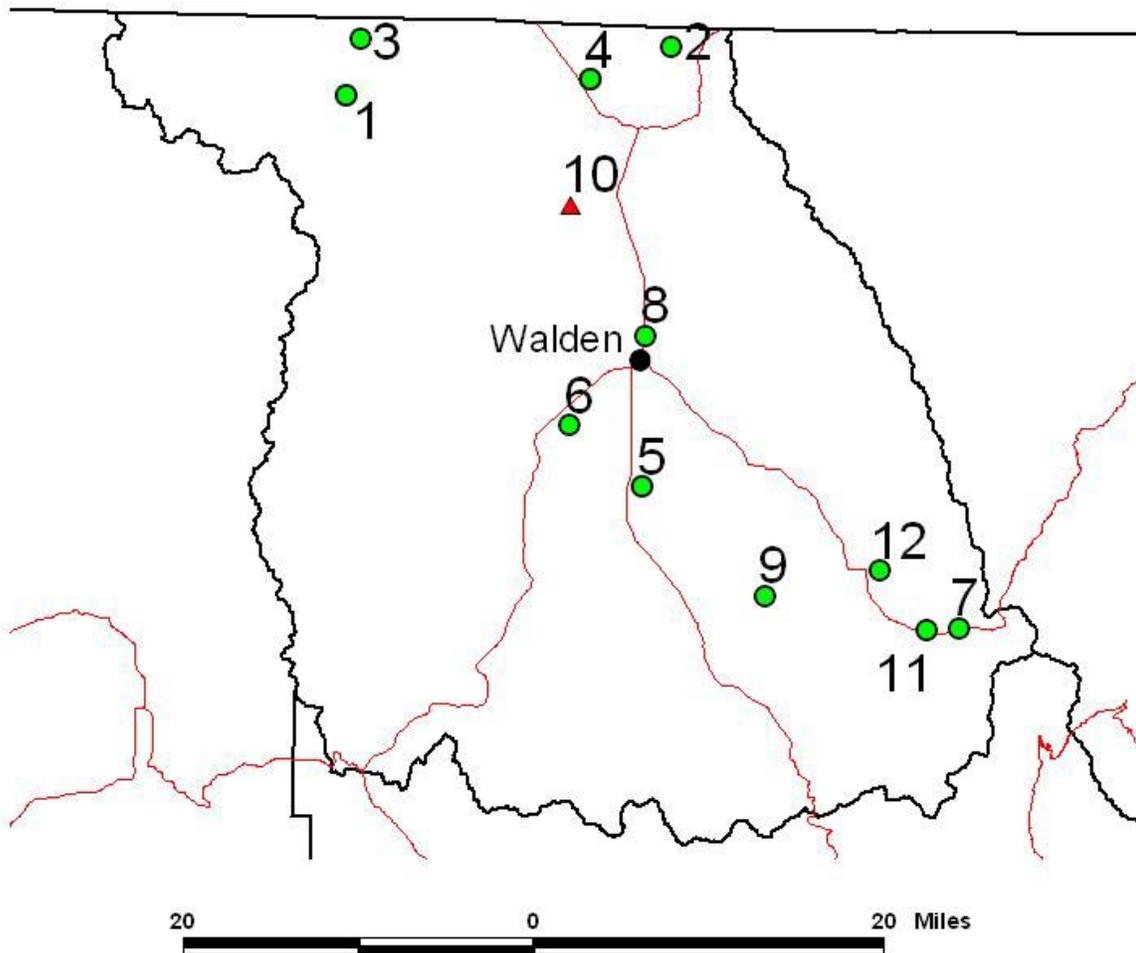
South Fork Big Creek near Big Creek Lake (Site 1)

At the headwaters of the South Fork of Big Creek, adjacent to the northeast section of Big Creek Lake Campground, there is a stretch of creek that is slowed by a check dam and some beaver activity (Figure 2). Much of the surrounding forest is lodgepole pine and the riparian area is dominated by lush grasses. The elevation at this site is 9,100 ft. This area was surveyed using a 12-m and a 9-m mist net.



Figure 2. Mist net over South Fork of Big Creek.

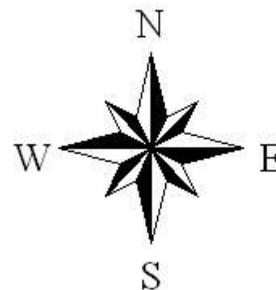
Figure 1. Bat surveying locations in Jackson County, Colorado



Numbers represent bat trapping locations

Bat vocalization locations

- ▲ No
- Yes
- highways
- county boundary



Camp Creek (Site 2)

Beaver ponds along Camp Creek in northeast Jackson County, are narrow and not well maintained by the resident beavers. The willow is very dense and the surrounding upland is comprised of sagebrush shrublands, with conifer forests at higher elevations. The short cliffs and rock formations on the north side of the valley may provide roosting habitat for bats in the area. The elevation at this site is 8,580 ft. A 2.6-m mist net and 6-m mist net were used at this location.

Beaver Creek along FR 80 near Pearl Reclamation Pit (Site 3)

Along Beaver Creek there appears to be a long history of beaver activity with some pond complexes stretching nearly 100 m, and other, more historic ponds, overgrown with willow and grasses. Near the Pearl Reclamation Pit along Forest Service Road 80 there is a stretch of Beaver Creek with modest beaver ponds (Figure 3). This area is dominated by thick willows and lush grass with intermixed lodgepole pine. The surrounding forest is predominately lodgepole pine. The elevation at this site is 8,580 ft. This area was surveyed using a 9-m net and a 6-m net.



Figure 3. Mist nets along Beaver Creek.

North Platte River Boat Launch (Site 4)

The North Platte River near the U.S. Forest Service Boat Launch is relatively shallow and slow moving. The surrounding area is a mix of sagebrush shrublands and grasslands with riparian trees and willow along the river. To the south the floodplain is used for agricultural purposes. The elevation here is 7,900 ft., the lowest elevation surveyed during the study. Because of the tremendous insect hatches that occurred after dusk and the unique rock features in northern Jackson County this area was surveyed twice. During the first visit a 9-m net and a 12-m net were implemented approximately ¼ mile east of the boat launch. On the subsequent visit, 2 9-m nets stacked on top of one another and a 12-m net were placed at the beaver ponds near the boat launch.

Illinois River on Arapaho National Wildlife Refuge (Site 5)

The Illinois River was surveyed at the bridge near the Arapaho National Wildlife Refuge headquarters. This riparian area is dominated by dense, tall mesic grasses with interspersed, large willow shrubs, and the uplands were short sagebrush and xeric grasses. The elevation at this location is 8,265 ft. Surveys were conducted using two 9-m mist nets.

Pond along Potter Creek (Site 6)

The ponds along the western boundary of the Arapaho National Wildlife Refuge are spring fed and house a diversity of bird life. The area is used for grazing horses and housing temporary U.S. Fish and Wildlife Service employees. The meadows surrounding the ponds are lush sedge meadows with a mix of various grasses (Figure 4). The upland shrubs more distant from the ponds are sagebrush and greasewood dominated. The elevation is 8,180 ft. Three nets (12-m, 9-m, and 6-m) were used at this area.



Figure 4. Pond along Potter Creek

North Fork Michigan River (Site 7)

The North Fork Michigan River was surveyed near the Seven Utes Trailhead on the Colorado State Forest. This area has several well-developed beaver ponds. The forests above the river are predominately spruce/fir with lodgepole pine. The river was surrounded by dense willow and lush grasses. The bench above the river was a mix of low shrubs and xeric grasses. The elevation at this survey site is 9,010 ft. The river was surveyed using a 9-m net and a 12-m net.

Michigan River north of Walden (Site 8)

Because there have been several reports of bats detected in Walden (little brown bats and silver-haired bats), a stretch of the Michigan River north of Walden was surveyed. This area is surrounded by tall, dense willow, but is commonly used as a fishing and hunting access point and there is much evidence of human impact, including trampling of vegetation, erosion, and litter. The area also is used as a rest stop along Highway 125. The immediate upland to the north is used for recreation (extensive trails along the ridge) and to the south is used for agriculture and hunting/fishing leases. The ridge to the north has rock and crevice features that may be roosting habitat for bats. The elevation at this location is 8,590 ft. Three nets of 9-m, 9-m, and 12-m lengths were used.

Owl Mountain State Wildlife Area (Site 9)

There are three cattle troughs within the Owl Mountain State Wildlife Area north of Rand. Much of this area is dominated by sagebrush and xeric grasses. Upslope of the troughs are large stands of aspen. Each of the three troughs was mist-netted using three different sized nets. A 3-m and 6-m net were stretched over each of two troughs, and a 9-m net was used to encircle another trough. The elevation at this location is 8,530 ft.

Pond near North Platte River (Site 10)

Along County Road 9A south of County Road 5W rainfall and runoff have established a relatively large pond (Figure 5). This pond is surrounded by short (less than 2 ft. tall) sagebrush and intermittent greasewood. The elevation at this site is 7,940 ft. This area was surveyed using a 9-m net and a 12-m net.

Ranger Lakes (Site 11)

Between the larger Ranger Lakes on Colorado State Forest land is a pond encroached by grasses and the surrounding spruce, fir, and lodgepole forest. This pond is situated along the Ranger Lakes trail and is adjacent to a mesic meadow to the north (Figure 6). This area was surveyed using a 9-m and a 12-m mist net. The elevation at this location is 9,250 ft. and is the highest survey site in the study area.

North Fork Michigan River below North Michigan Lake (Site 12)

Below North Michigan Lake the North Fork of the Michigan River flows west and is interspersed with beaver ponds. The habitat is dominated by dense willow and mesic grasses, but the upland is sagebrush with lodgepole pine above (Figure 7). Surveys were conducted at the bridge using a 9-m and a 6-m net. The elevation at this location is 8,850 ft.



Figure 5. Mist net over pond along County Road 9A.



Figure 7. Mist net along North Fork of Michigan River



Figure 6. Mist net over pond at Ranger Lakes.

Weather conditions during surveying

Most evenings were cloudy or partly cloudy with high humidity (45-90%) during mist-netting efforts. On one occasion rain fell hard enough to interrupt the survey effort and nets were closed after 1 hour of surveying (15 August 2006). In early September two efforts were canceled because it began to sleet or rain prior to opening the nets.

Capture effort

The types of nets used were determined by access, water depth, and dimensions of water bodies. When multiple researchers with pre-exposure to the rabies vaccine were available and the habitat allowed it, two nets were set on top of each other to add height to survey nets and increase likelihood of capturing bats. At least two nets were set each night of surveying and nets were left open until after 10:30 pm (weather permitting) even if no bat activity was detected (Table 1). The length of survey depended on bat activity, weather conditions, and observer fatigue. When temperatures dropped below 5° C, researchers closed the nets.

On warm nights, bats were active for much of the evening, but few bats were active after 12:00 am. Average time of bat emergence was 8:52 pm (\pm 17 minutes).

Table 1. Mistnetting effort in Jackson County, Colorado. Times are in 24 hour format.

Site	Date	General Location	Time Nets Set	Time Nets Closed	Time of First Bat	
					Emergence	Nets Set
1	1-Aug-06	South Fork Big Creek near Big Creek Lake	2045	2330	2048	12 m, 9 m
2	8-Aug-06	Camp Creek	2045	2330	2057	6 m, 2.6 m
3	2-Aug-06	Beaver Creek along FR 80 near Pearl Reclamation Pit	2030	2330	2056	9 m, 6 m
4	9-Aug-06	North Platte River Boat Launch (1st visit)	2100	2430	2100	12 m, 9 m
4	18-Aug-06	North Platte River Boat Launch (2nd visit)	2030	2330	2035	12 m, 9 m, 9 m
5	10-Aug-06	Illinois River on Arapaho National Wildlife Refuge	2030	2330	2045	9 m, 9 m
6	11-Aug-06	Pond along Potter Creek	2030	2300	2100	12 m, 9 m, 6 m
7	15-Aug-06	North Fork Michigan River near 7 Utes Trailhead	2015	2133	2035	12 m, 9 m
8	16-Aug-06	Michigan River north of Walden	2015	2400	2130	12 m, 9 m, 9 m
9	17-Aug-06	Troughs on Owl Mt. State Wildlife Area	2030	2400	2038	9 m, 6 m, 3 m
10	3-Aug-06	Pond near North Platte River	2045	2400	unknown	12 m, 9 m
11	5-Sep-06	Ranger Lakes	1945	2200	1950	12 m, 9 m
12	6-Sep-06	North Fork Michigan River below N. Michigan Lake	1945	2230	1959	9 m, 6 m

Bats captured/detected

Ten bats of five species were captured over 13 nights of mist-netting (Table 2). Bats were captured at seven of the 12 mist-netting locations, and bat vocalizations were detected at 11 of the 12 mist-netting locations (Figure 1). At Site 10, no vocalizations were recorded but a bat was detected in the net. The long-eared myotis (*Myotis evotis*), the little brown bat (*Myotis lucifugus*), the long-legged myotis (*Myotis volans*), and the hoary bat were not known from Jackson County prior to this survey. The silver-haired bat, first documented by Elliott Coues in 1876, was encountered twice during the inventory. The capture of a lactating female and a breeding colony of little brown bats provides evidence that Jackson County is home to a breeding population of this species. In mid-August at least three dead little brown bats were found in the town of Walden. At the time of writing this report the cause of death was still undetermined (personal communication, Josh Dille, Colorado Division of Wildlife, Walden).

Bat vocalizations were recorded at six of the mist-netting locations. Because not all recorded individuals were captured it is difficult to determine which species were vocalizing at each

location. However, these recordings can be compared to other recordings whose species identity has been confirmed. The only species to be recorded and have its identity confirmed during the survey was the long-eared myotis (Figure 8). As a library of Colorado bat vocalizations develops the recordings from this study will be compared to the recorded calls in the library.

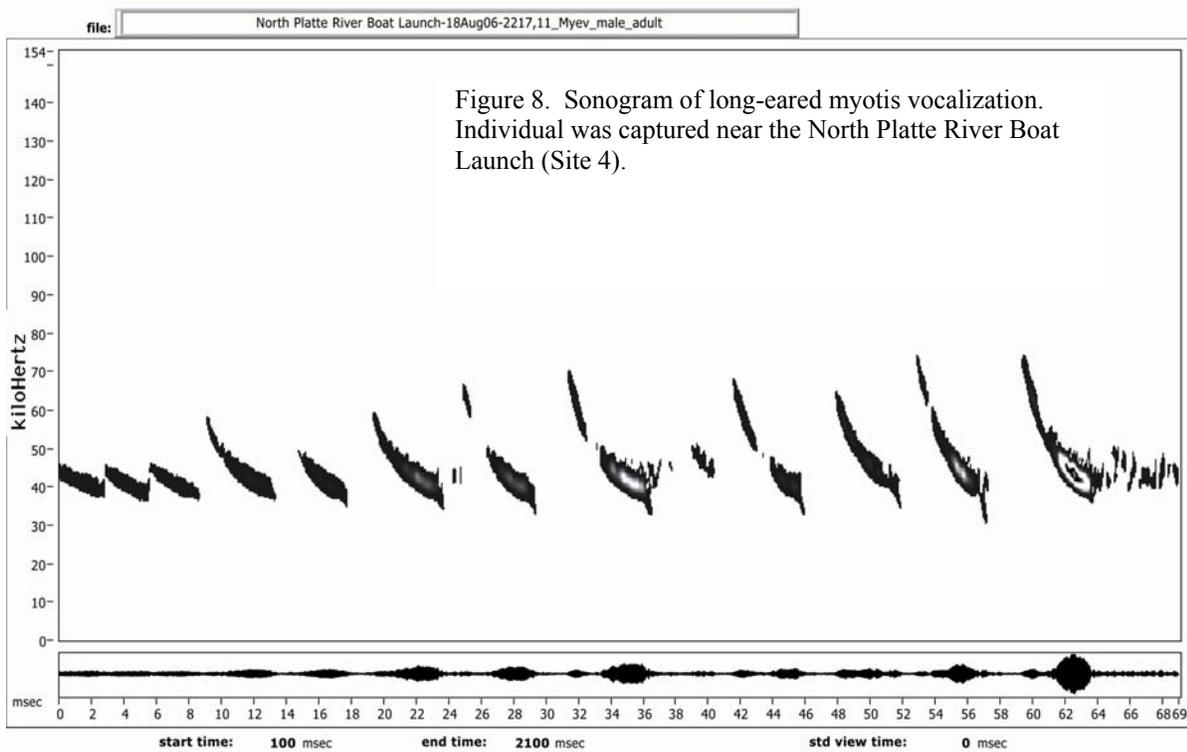


Table 2. Bat species captured in Jackson County, Colorado.

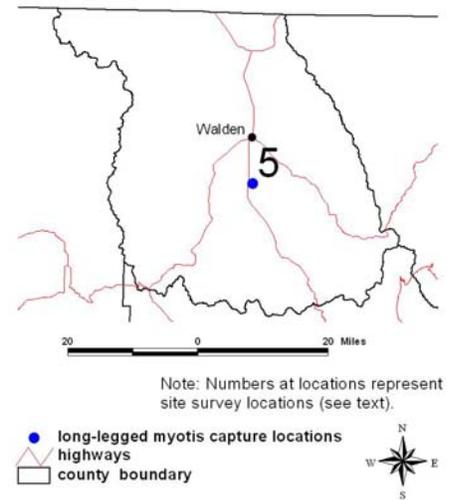
Site	Date	Species	Common Name	Number of Individuals	Sex	Age	Repro. evidence	Bats Audible?
1	1-Aug-06	<i>Lasionycteris noctivagans</i>	silver-haired bat	1	F	Juv.	None	Y
1	1-Aug-06	<i>Myotis lucifugus</i>	little brown bat	2	F	Adult	Lactating	Y
10	3-Aug-06	<i>Lasiurus cinereus</i>	hoary bat	1	M	Adult	Scrotal	N
4	9-Aug-06	<i>Myotis lucifugus</i>	little brown bat	1	F	Juv.	None	Y
5	10-Aug-06	<i>Myotis lucifugus</i>	little brown bat	1	F	Adult	None	Y
5	10-Aug-06	<i>Myotis volans</i>	long-legged myotis	1	F	Adult	None	Y
6	11-Aug-06	<i>Lasionycteris noctivagans</i>	silver-haired bat	1	M	Adult	None	Y
9	17-Aug-06	<i>Myotis evotis</i>	long-eared myotis	2	F	Adult	Lactating	Y
4	18-Aug-06	<i>Myotis evotis</i>	long-eared myotis	1	M	Adult	None	Y
4	18-Aug-06	<i>Lasiurus cinereus</i>	hoary bat	1	F	Juv.	None	Y

Bat profiles

Myotis volans (long-legged myotis)

The long-legged myotis is one of the more common myotis in western North America, found in a variety of habitats. In Colorado its range includes most of the western half of Colorado and the southern Great Plains in the eastern part of the state. This species can be found in and around coniferous forests and pinyon-juniper woodlands. It roosts in trees, buildings, rock crevices and caves (Fitzgerald *et al.* 1994). The long-legged myotis will migrate short distances to hibernacula (Schowalter 1980), but few hibernacula have been confirmed in Colorado (Kirk Navo, CDOW, pers. comm.). They feed on a variety of moths (Freeman 1984), and typically hunt early in the evening (Warner and Czaplewski 1984). This species typically rears one offspring. The long-legged myotis was captured at Site 5 (Figure 9).

Figure 9. Capture locations of the long-legged myotis in Jackson County, Colorado



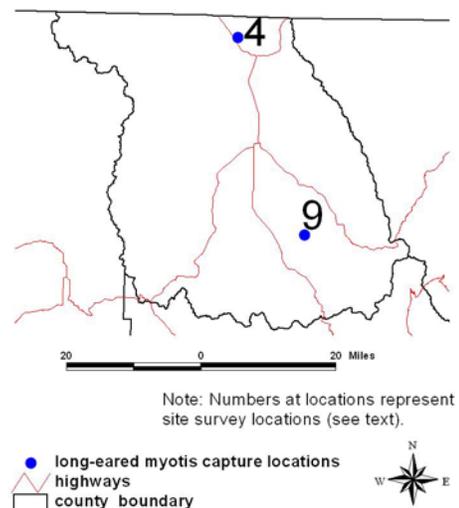
Myotis evotis (long-eared myotis) (Figure 10)

The long-eared myotis ranges from the Pacific States eastward to the Dakotas and Nebraska, and southward to Baja California (Armstrong *et al.* 1994). Found in the coniferous woodlands of the foothills, plateaus, and lower mountains of Colorado, the long-eared myotis can be found up to 9,000 ft. in elevation (Fitzgerald *et al.* 1994). It roosts in buildings, mines, and under bark. The long-eared myotis feeds on moths, beetles, and flies, but prefers to glean insects off of substrates (Freeman 1984). This species was captured at Sites 4 and 9 (Figure 11).



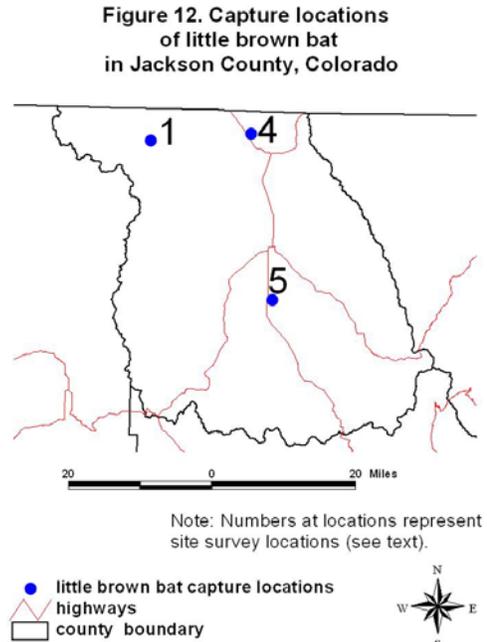
Figure 10. *Myotis evotis*

Figure 11. Capture locations of long-eared myotis in Jackson County, Colorado



***Myotis lucifugus* (little brown bat)**

The little brown bat is probably the most common bat in North America, and is found in most habitats in Colorado. It roosts under bark, in trees, under rocks, in man-made structures, and in caves and mines (Armstrong *et al.* 1994). The little brown bat has been found at elevations up to 11,000 ft. in Lake County, Colorado (Armstrong *et al.* 1994). In Colorado, nursery colonies are typically smaller than 200 bats, but one home in Walden is believed to house over 300 individuals. The little brown bat is believed to be a moth specialist, but will eat other flying insects. This species was captured at Sites 1, 4, 5, and specimens were collected in the Town of Walden (Figure 12).

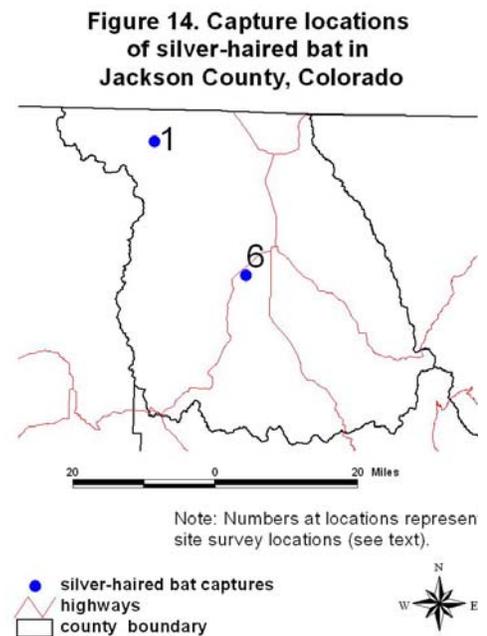


***Lasionycteris noctivagans* (silver-haired bat) (Figure 13)**

The silver-haired bat is a common, forest-roosting bat found in all but the most southern latitudes of North America. It roosts in tree cavities, under bark (especially of aspen), and in buildings and caves during migration (Fitzgerald *et al.* 1994). They feed on moths, beetles, flies, wasps, mayflies, and termites, sometimes foraging on the ground. The silver-haired bat is a long-distance migrant, and individuals have been captured in early spring and late fall as they migrate (Armstrong 1972). Females give birth to two young in mid-summer. Female silver-haired bats from the eastern part of North America migrate north and east from over-winter grounds, but many males remain in the lower latitudes. Western silver-haired bats seem more evenly distributed latitudinally without the striking segregation of sexes seen in the East (Cryan 2003). This species was captured at sites 1 and 6 (Figure 14).



Figure 13. *Lasionycteris noctivagans* on author's thumb.



***Lasiurus cinereus* (hoary bat)**
(Figure 15)

The hoary bat is one of the largest bats in Colorado and is found throughout North America. This migratory, tree-roosting bat is found in coniferous and deciduous stands. Individuals feed on moths, wasps, beetles, and other flying insects (Freeman 1984). Females give birth to two young throughout the summer months (Adams 1988).



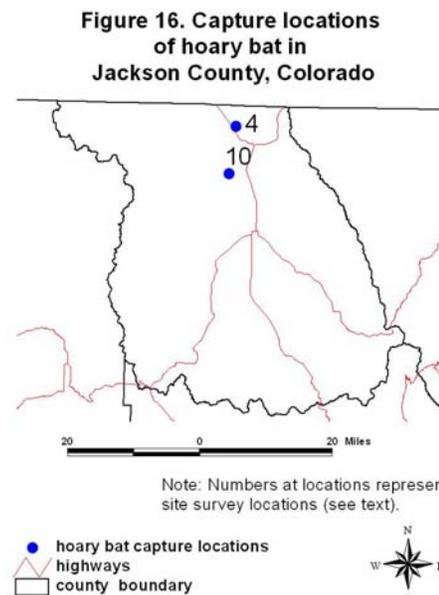
Figure 15. *Lasiurus cinereus*

Hoary bat are long-distance migrants, with evidence that they migrate up to 1200 miles (Cryan *et al.* 2004).

Migration in spring initiates in California and Mexico, but summer records of male and female hoary bats shows that males stay west of the Rocky Mountains and females migrate to east of the Rockies (Cryan 2003). Both sexes intermix in the southwestern part of the United States during the autumn breeding season. This species was captured at sites 4 and 10 (Figure 16).

DISCUSSION

During the month of surveying in Jackson County water resources in a variety of habitats were surveyed, but no caves or mines were accessed. To fully understand the diversity of bat species found in Jackson County it is essential that survey efforts at caves and mines be completed. Future follow-up surveys should prioritize gaining access to these areas and attempting to sample these bat roosting resources.



Because Jackson County contains reservoirs, creeks, rivers, ponds, and lakes throughout North Park, it was difficult to concentrate bats sufficiently for capture. During some mist-netting efforts (especially along the North Platte River) bat activity was constant and dense, but because water resources were abundant bats had numerous areas to feed over and drink from. Not being able to place nets in an area of concentrated bat use may have lowered capture success. During most mist-netting efforts bat activity was minimal, with bats being detected infrequently using ultrasonic equipment. Even in areas where water resources appeared isolated (water troughs), bat activity was minimal. The average number of bat captures during mist-netting was one, with a maximum of three encountered at one location.

Several species expected to be captured during the survey were not detected. The Townsend's big-eared bat is the bat of greatest conservation concern in Colorado, and there are records from Larimer and Boulder counties. The nearest record of Townsend's big-eared bat is 36 miles due

east of Walden in the Cache la Poudre River Canyon, Larimer County. This species roosts in caves, mines, and rock crevices, and feeds on most flying insects, with caddisflies being a regular diet item (Freeman 1984). Townsend's big-eared bats are found in coniferous forest and woodlands, riparian woodlands, and xeric shrublands. It is possible that this bat is found in the mountains surrounding North Park, and future survey effort should prioritize surveys at mines and water resources along the eastern edge of Jackson County.

Two of the four species of conservation concern were found during this survey effort. The silver-haired and the hoary bat are two species of conservation interest because of their tree-roosting preference. The Western Bat Working Group has identified these species as conservation priorities because modifications to forest systems may impact the abundance and distribution of these species. The fringed myotis and the Townsend's big-eared bats are the two species of high conservation interest that were not detected during survey efforts.

This survey effort documented four new bat species to Jackson County. These species likely have existed in Jackson County for many years, but have gone undetected because little bat surveying effort has been dedicated to this area. With bats being volant, nocturnal species, it is difficult to assess species diversity without using bat-specific sampling techniques. This study points to the value of conducting bat sampling in under-sampled regions of Colorado and the West. Such efforts may elucidate the true distribution and relative abundance of western bat species.

Because of the timing of the grant award, all of the surveying was conducted in the last half of the summer. Thus, many possible activity areas went unsurveyed. The southwestern section of county was not surveyed and future bat survey efforts in Jackson County should attempt to access Grizzly Creek, Arapaho Creek, Colorado Creek and their tributaries. Additionally, areas around unique land forms, such as the creeks and waterbodies around Delaney Buttes and Sheep Mountain should be surveyed.

ACKNOWLEDGMENTS

I would like to thank Jeremy Siemers and Bobby Weidmann of CNHP for their assistance in the field. Much thanks to Paula Guenther-Gloss of The Nature Conservancy, Amy Bauer of the Owl Mountain Partnership, and Matt Landis of the North Platte School District for their assistance in providing match and landowner contacts to make this project successful. I thank Carl Nilson and Tim Metzger of the Colorado State Forest Service and State Park for their input on survey site selection and for providing housing during the project. I thank Marcia Pfleiderer of the U.S. Forest Service and Anne Timberman of the U.S. Fish and Wildlife Service for their support and assistance with access. Much appreciation to Josh Dilley and Justin Foster of the Colorado Division of Wildlife for assistance in landowner contacts and allowing access to the bats collected in Walden. Finally, much thanks to my son, Jackson Davis, for inspiring and encouraging this inventory.

LITERATURE CITED

- Adams, R. A. 1988. Trends in reproductive biology of some bats in Colorado. *Bat Research News* 29:21-25.
- Armstrong, D. M. 1972. The distribution of mammals in Colorado. University of Kansas Natural History Museum, Lawrence, Kansas. 413 pp.
- Armstrong, D. M., R. A. Adams, and J. Freeman. 1994. Distribution and ecology of bats of Colorado. *University of Colorado Museum Natural History Inventory of Colorado* 15:1-83.
- Colorado Division of Wildlife. 2005. Colorado's Comprehensive Wildlife Conservation Strategy. Denver, Colorado. 78 pp.
- Cryan, P. M. 2003. Seasonal distribution of migratory tree bats (*Lasiurus* and *Lasionycteris*) in North America. *Journal of Mammalogy* 84:579-593.
- Cryan, P. M., M. A. Bogan, R. O. Rye, G. P. Landis, and C. L. Kester. 2004. Stable hydrogen isotope analysis of bat hair as evidence for seasonal molt and long-distance migration. *Journal of Mammalogy* 85:995-1001.
- Fenton, M. B. 2003. Science and the conservation of bats: where to next? *Wildlife Society Bulletin* 31:6-15.
- Fitzgerald, J. P., C. A. Meaney, and D. M. Armstrong. 1994. *Mammals of Colorado*. University of Colorado Press, Niwot. 467 pp.
- Francis, C. M. 1989. A comparison of mist nets and two designs of harp traps for capturing bats. *Journal of Mammalogy* 70:865-890.
- Freeman, G. E. 1984. Ecomorphological analysis of an assemblage of bats: resource partitioning and competition. PhD. Dissertation, University of Colorado, Boulder. 131 pp.
- Racey, P. A. and A. C. Entwistle. 2003. Conservation ecology of bats. Pp. 680-743 *in* *Bat Ecology* (T. H. Kunz and M. B. Fenton, eds.). University of Chicago Press, Chicago, Illinois. 779 pp.
- Schowalter, D. B. 1980. Swarming, reproduction, and early hibernation of *Myotis lucifugus* and *M. volans* in Alberta. *Journal of Mammalogy* 61:350-354.
- Warner, R. M., and N. J. Czaplewski. 1984. *Myotis volans*. *Mammalian Species* 224:1-4.
- Western Bat Working Group. 1998. Western bat species: regional priority matrix. Western Bat Working Group Workshop, 9-13 February 1998, Reno, Nevada.