Bat Acoustical Surveys at the National Renewable Energy Laboratory, National Wind Technology Center

July 2010 – November 2010

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Walsh Environmental Scientists and Engineers, LLC
Boulder, Colorado

NREL Technical Monitor: Tom Ryon

NREL is a national laboratory of the U.S. Department of Energy
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Subcontract Report
NREL/SR-1900-70461
July 2018

Contract No. DE-AC36-08GO28308

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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Bat Acoustical Surveys at the National Renewable Energy Laboratory, National Wind Technology Center

Jefferson County, Colorado

May 5, 2011

Prepared for

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Prepared by

Walsh
an ecology and environment company

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LIST OF ACRONYMS

CDOW	Colorado Division of Wildlife
CF	compact flash
NWTC	NREL's National Wind Technology Center
Mic	microphone
Walsh	Walsh Environmental Scientists and Engineers

EXECUTIVE SUMMARY

An acoustical bat use survey was conducted at the NWTC from July 6, 2010 to November 7, 2010, using a passive acoustical method with AnaBat Systems Bat Detectors (Titley Electronics). The purpose of this survey was to obtain information about use by bats within the Project area.

All data were collected from one bat detector was mounted on a fence post within the conservation easement in the northwest portion of the site. Bat activity was determined by the number of bat passes (number of echolocation calls recorded with ≥ 2 chirps) per detector night. Species composition, temporal distribution (by month), and peak activity levels were analyzed.

A total of 12,425 bat passes was recorded during the survey period for an index of activity of 99.40 bat passes per detector night. Of the 12,425 total bat passes, 8,772 passes could be identified to species (70.18 identified bat passes per detector night).

Species identified included big brown bat, eastern red bat, fringed myotis, hoary bat, silver-haired bat, and Myotis bat group (which may include western small-footed myotis, western long-eared myotis, little brown myotis, and long-legged myotis).

Most bats were detected in July (3,952 total bat passes) and August (5,058 total bat passes). The Myotis bat group was most the most frequently detected (4,373 identified bat passes).

There were no peaks of activity during the monitoring period, but rather constant fluctuation.

No Federally- or state-listed threatened, endangered, or candidate species or species of special concern were identified during surveys (USFWS 2010, CDOW 2010).

INTRODUCTION

Walsh Environmental Scientists and Engineers, LLC (Walsh) was retained by the National Renewable Energy Laboratory (NREL) to conduct acoustic bat surveys at the National Wind Technology Center (NWTC). This effort involved using passive acoustical detectors that recorded bat echolocation calls from July to November 2010. This report presents the results of these surveys.

NWTC is located on approximately 320 acres in Jefferson County, Colorado, on State Highway 128 between the cities of Boulder and Golden, Colorado adjacent to the eastern foothills of the Rocky Mountains. The legal description of the current boundary is: T2N, R70W, portions of Sections 3 and 4.

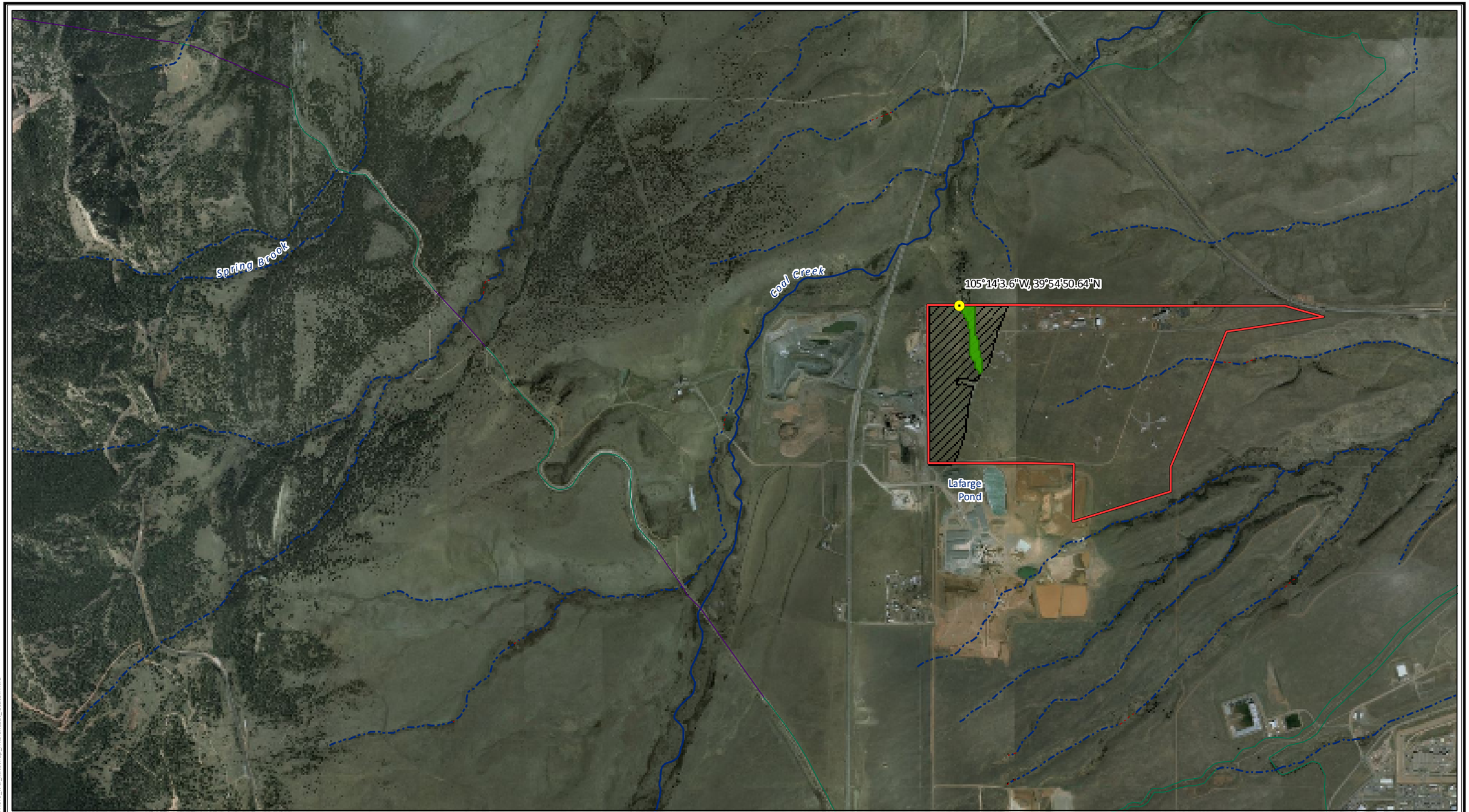
The site is largely composed of Xeric mixed grassland. The bat monitoring unit was located in a draw within a conservation easement in the western portion of the site. There is a small stand of ponderosa pines directly east of the unit, a small ephemeral pond a few hundred yards south, and a larger, long-lasting pond one-half mile south (Figure 1).

METHODS

Field Work

Bat echolocation calls were recorded from July 6 to November 7, 2010, using an AnaBat SD2 ultrasonic detector from Titley Electronics, Ballina, Australia. One AnaBat detector was installed on a fencepost within the conservation easement at roughly 0.5 meters above the ground. It is recognized that attenuation of bat calls occurs at roughly 30 meters from the unit, indicating that the detector was able to capture calls about 30 meters above the ground.

Data collection methods followed Kunz et al. (2007). Call recording was conducted during crepuscular and nocturnal hours (about one hour before sunset to one hour after sunrise) to capture peak times of bat activity (Reynolds 2006). All files recorded during the survey period were saved to 1 gigabyte compact flash (CF) cards that were collected at two- to three-week intervals and downloaded to a computer using Titley's CF card reader software.



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- Anabat Location
- NWTC Boundary
- Ponderosa Pine Woodland
- Conservation Area

National Hydrography Dataset
- Artificial Path
- Canal Ditch
- Pipeline
- Intermittent Stream/River
- Perennial Stream/River

1:18,000
0 0.25 0.5 1 Miles
1 in = 1,500 feet

Figure 1. AnaBat Detector Location
NREL National Wind Technology Center
Jefferson County, CO
May 3, 2011 | 900758.0001.020

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Data Management and Analysis

Data gathered from the AnaBat detector were analyzed using Analook software. A preliminary analysis was run to separate extraneous noise files (which may include noise created by weather, radio or microwaves, insects, birds, etc.) from bat echolocation call files. The number of bat calls could then be determined and reported using the metric "bat pass." A bat pass is an accepted measure of bat activity defined as an echolocation sequence of at least two echolocations pulses, or chirps, with a minimum pulse duration of 10 milliseconds within each sequence, separated by more than one second (Gannon et al. 2003, Kunz et al. 2007). Bat call files were further identified and segregated into species groups to show species composition of bats on the site. A number of calculated variables are derived from the bat pass data and are described below.

Bat passes were identified to species or species group when possible, and this subset of bat passes is termed "identified bat pass." Identified bat passes included all bat passes that had five or more clear echolocation calls, or chirps. Myotis bats are a group whose individual species' calls are difficult to distinguish. These calls are therefore lumped as Myotis bats, and may include one or more of the following species known to occur along the Front Range of Colorado: western small-footed myotis (*Myotis ciliolabrum*), western long-eared myotis (*Myotis evotis*), little brown myotis (*Myotis lucifugus*), and long-legged myotis (*Myotis volans*). The fringed myotis (*Myotis thysanodes*) is an exception as its calls are distinct.

An index of relative bat activity, or activity index, was calculated as the number of bat passes per detector night (the number of nights the detector was recording data). Additionally, an activity index was determined per species by using the number of identified bat passes for each species per detector night. Other metrics calculated from the data include temporal distribution of bat activity by month and peak activity.

Two important assumptions are required for these data analyses that may not be completely supported:

> 1) Each bat pass accounts for a single bat recorded only once by the AnaBat detector. One bat pass may actually contain more than one individual bat echolocating, or alternatively, multiple bat passes may be the same bat circling around and echolocating. However, recognition of individuals cannot be determined using AnaBat detectors, so the analysis must be conducted with one bat pass equivalent to one bat.
>
> 2) All species are equally well detected by AnaBat detectors. Different species of bats echolocation calls attenuate at differing distances, with some species of bats whose calls attenuate at shorter distances being recorded less often than those whose calls carry further. For example, Townsend's big-eared bat (*Corynorhinus townsendii*) has a weak call that attenuates quickly and is not as readily detected as many other species (Piaggio 2005). Furthermore, behavioral differences may result in certain species being recorded more often than others. Since there is no appropriate way to correct for these differences, detection equality must be assumed (Gannon et al. 2003).

During data analysis, any special status species, i.e., Federally- or state-listed threatened, endangered, or candidate species, or species of special concern were noted (USFWS 2010, CDOW 2010).

RESULTS

Detector Nights

One AnaBat detector recorded data for 125 detector nights, every night from July 6 to November 7, 2010 (Table 1).

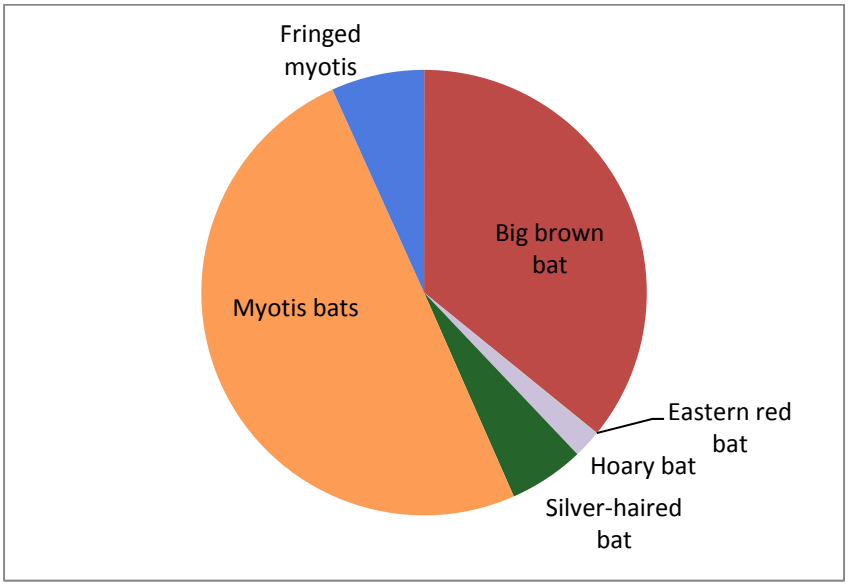
Table 1. Detector Nights, NWTC, Jefferson County, Colorado 2010.

Month	Detector Nights
July	26
August	31
September	30
October	31
November	7
Total	**125**

Bat Passes and Species Composition

A total of 12,425 bat passes were recorded during the survey period. Of those, 8,772 were identified to species. Species composition is summarized in Figure 2 and included 50 percent Myotis bats (*Myotis* sp.) (4,373 identified bat passes), 36 percent big brown bat (*Eptesicus fuscus*) (3,145 passes), 7 percent fringed myotis (592 passes) (*Myotis thysanodes*), 5 percent silver-haired bat (*Lasionycteris noctivagans*) (481 passes), 2 percent hoary bat (*Lasiurus cinereus*) (179 passes), and less than 1 percent eastern red bat (*Lasiurus borealis)* (2 passes).

Figure 2. Bat Species Composition by Identified Bat Passes, NWTC, Jefferson County, Colorado 2010.



Activity Index

There are two indices of bat activity: total bat passes, which includes all echolocation calls with two or more chirps, and identified bat passes, which is limited to those with five or more chirps (see Methods). The overall activity index recorded at the AnaBat detector was 99.40 total bat passes per detector night and 70.18 identified bat passes per detector night (Table 1). The species of bat with the highest activity index is the Myotis bat group (34.98 bat passes per detector night). Big brown bat also had comparatively high levels of activity (25.15 bat passes per detector night). Fringed myotis, silver-haired bat, and hoary bat had comparatively moderate levels of activity, between 1.43 to 4.74 identified bat passes per detector night. Eastern red bat had a comparatively low level of activity (0.02 identified bat passes per detector night) (Table 2).

Table 2. Identified Bat Passes and Index of Activity, NWTC, Jefferson County, Colorado 2010.

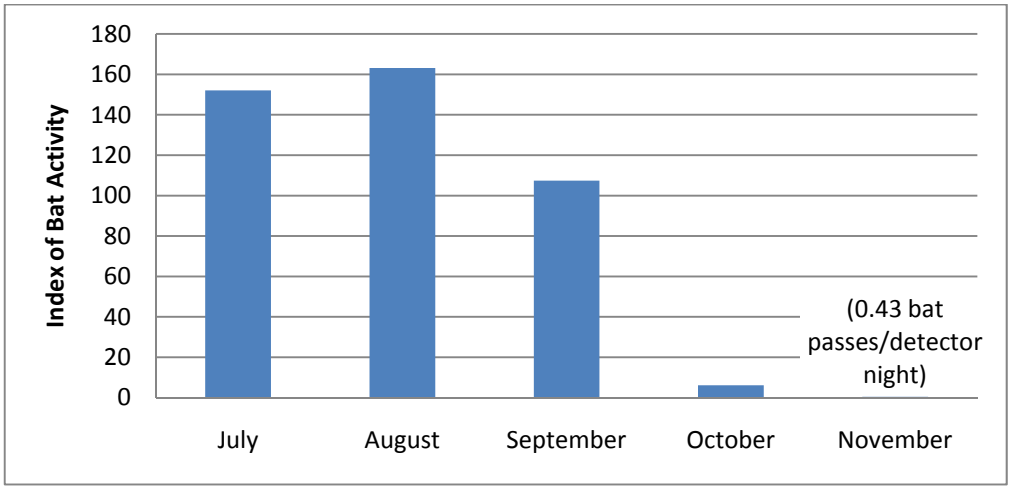
Common Name	Scientific Name	Number Identified	Index of Activity (Number Identified/Detector Nights)
Myotis bats*	*Myotis* sp.	4,373	34.98
Big brown bat	*Eptesicus fuscus*	3,145	25.15
Fringed myotis	*Myotis thysanodes*	592	4.74
Silver-haired bat	*Lasionycteris noctivagans*	481	3.85
Hoary bat	*Lasiurus cinereus*	179	1.43
Eastern red bat	*Lasiurus borealis*	2	0.02
Total Identified Bat Passes		**8,772**	**70.18**
Total Bat Passes		**12,425**	**99.40**

*Included in this group may be one or more of the following species: western small-footed myotis, western long-eared myotis, little brown myotis, and long-legged myotis.

Temporal Distribution

Total bat activity was highest in July (3,952 bat passes) and August (5,058 bat passes) with an activity index of 152.04 and 163.16 total bat passes per detector night, respectively. September was also a month of high bat activity (3,221 bat passes) with an activity indices of 107.37 total bat passes per detector night. October and November had relatively low levels of bat activity (190 and 3 bat passes) with activity indices of 6.13 and 0.43 total bat passes per detector night, respectively (Figure 3, Table 3).

Figure 3. Index of Bat Activity by Month, NWTC, Jefferson County, Colorado 2010.



Note: Index of bat activity is determined by number of bat passes per detector night for that month; detector nights are shown in Table 1.

Identified bat passes were also highest in July (3162) and August (3,299 bat passes) with an activity index of 121.62 and 106.42 identified bat passes per detector night, respectively. Bat activity was moderate in September, lower in October, and very low in November.

Big brown bats, Myotis bats, and hoary bats experienced their highest activity in July and August (Table 3), with hoary bats active at much lower frequencies than the other two species/groups. Fringed myotis were active in July, August and September; silver-haired bats were most active in September but maintained a presence in July and August as well. Eastern red bats had very low activity, though were present in July and August.

Table 3. Temporal Distribution of Bat Activity, NWTC, Jefferson County, Colorado 2010.

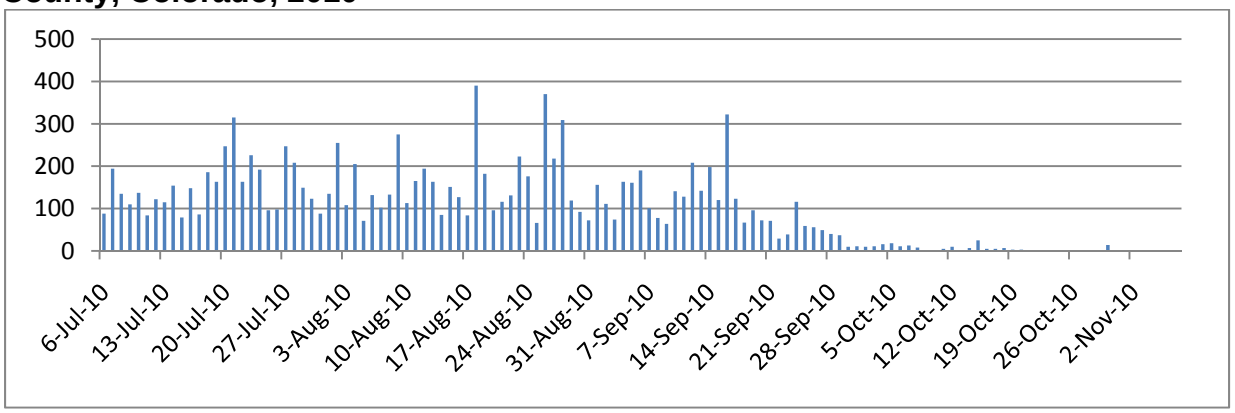
Species	July	Aug	Sept	Oct	Nov
Big brown bat	58.15	39.97	12.37	0.68	0.14
Eastern red bat	0.04	0.03	0.00	0.00	0.00
Fringed myotis	6.38	6.74	7.13	0.10	0.00
Hoary bat	2.53	3.03	0.63	0.00	0.00
Myotis bats	51.19	52.06	46.13	1.42	0.00
Silver-haired bat	3.31	4.55	6.37	1.97	0.29
Total Identified Bat Passes	**121.62**	**106.41**	**72.63**	**4.16**	**0.43**
Total Bat Passes	**152.04**	**163.16**	**107.16**	**6.13**	**0.43**

Note: Bat activity determined by number of identified bat passes per detector night for that month.

Peak Activity Levels

The level of bat activity fluctuates consistently from the beginning of monitoring in July through the end of September, when levels drop off (Figure 4). Although there are no true peaks of activity, which would be indicated by a fairly steady rise to a high point in activity, there are several spikes in activity that can be seen on July 21 (315 bat passes), August 18 (390 bat passes), August 26 (370 bat passes), August 28 (309 bat passes) and September16 (322 bat passes).

Figure 4. Peak Activity Levels, by Total Bat Passes, NWTC, Jefferson County, Colorado, 2010



Special Status Species

No Federally-listed threatened, endangered or candidate bat species listed by the Endangered Species Act are known to occur in Colorado (USFWS 2010). No state-listed threatened or endangered species or species of special concern were identified during surveys (CDOW 2010).

DISCUSSION

Detector Nights

The AnaBat detector ran every night without obvious problems from July 6, 2010 to November 7, 2010.

Bat Passes and Species Composition

The Myotis bat group was the most commonly detected group during monitoring with 4,373 identified bat passes, or nearly half of all identified bats. Since it is very difficult to differentiate echolocation calls of the species in this group, they were not identified to species. The species of Myotis that are known to inhabit this region include western small-footed myotis, western long-eared myotis, little brown myotis, and long-legged myotis. The Myotis group may be made up of any of these species. Since this group was detected throughout July, August, and September, they are most likely resident bats. Big brown bats were the second most commonly detected group with 3,144 identified bat passes. Their presence throughout July, August, and September also shows that they are most likely resident bats.

Of the 18 species of bats documented in Colorado (Armstrong et al. 1994; Fitzgerald et al. 1994), a minimum of 6 species and up to 9 species were identified on site (depending on how many Myotis species are present in the Myotis bat group). Several calls recorded may have been pallid bat calls (*Antrozous pallidus*), but due to the unlikely event that this species would occur along

the foothills, and that aspects of pallid bat calls look very similar to either big brown bats or little brown myotis, these calls were not identified as pallid bats. Although Colorado bat populations and distribution have not been thoroughly studied, these results are consistent with what is generally known about the bat populations within the state (Adams 2003, Armstrong et al. 1994).

Activity Index

Total bat passes for the survey period was 99.40 per detector night. Although data may not be perfectly comparable with monitoring done at wind farms, this level of activity is much higher than what has been found for projects in this and other regions of the U.S (Table 4). It is not known why the levels of activity on this site are so high. Several hypotheses include:

1) The Ponderosa pines, shrubs, and grasses in the draw where the AnaBat unit was located provide good foraging for bats, as well as potential roosting sites in the trees;

2) The large pond on the Lafarge mining property (Spicer) 0.5 mile to the south of the AnaBat unit is the best quality and closest water source to bat roosts, and this water source is available through the summer, when smaller water sources will become dry;

3) The rocky ridgeline of the foothills, roughly two miles to the west, provides good roosting habitat, a limiting factor for bats; and

4) Vacant buildings on Lafarge's property may provide good roosting habitat for big and little brown bats.

Table 4. Baseline Bat Activity at NWTC Compared with Wind Energy Facilities.

Wind Energy Facility	Bat Activity (total bat passes/detector night)	Reference
Colorado Highlands, CO	0.23	Walsh 2010
Top of the World, WY	0.58	Rintz and Kimberly 2009
Dunlap Ranch, WY	1.67	Johnson et al. 2009
Campbell Hill, WY	2.03	Taylor et al. 2008
Buffalo Mountain, TN	23.70	Fiedler 2004
Mountaineer, WV	38.30	Arnett et al. 2005
NWTC, CO	99.40	This report

Temporal Distribution

For all species combined, the highest number of bat passes was recorded in July and August. This suggests that the majority of recorded bat passes are from local, resident bats. Bat passes recorded in late August, September, and October may be related to fall migration. This coincides with other studies that have found high levels of bat activity in the late summer and early fall (Erickson et al. 2002, Cryan 2003, Kunz et al. 2007).

Big brown bats appear to be resident, as they are most active in July and August. Myotis bats, active July through September on site, may delay migration until later in September. Fringed myotis is also likely resident, with activity from July through September and their known presence in the general vicinity (Rick Adams, personal communication, March 11, 2011). Silver-haired bats show some resident activity with a presence in July and August; the higher activity in September is indicative of their migratory behavior. Hoary bats are solitary and seldom abundant, suitably reflected in their low abundance in July and August. The eastern red bat was present in July and August but very infrequently and is uncommon in Colorado.

Peak Activity levels

Bat activity fluctuated from July to September and then decreased until the end of the monitoring period with no true peaks of activity. This, again, suggests that most of the bat activity captured during the summer was of resident bats. The fluctuation of activity levels, as well as the spikes of activity, may be due to weather or other factors that influence the activity of bats.

Special Status Species

No special status species were identified during acoustical bat surveys. Townsend's big-eared bat, the only state-listed bat species, is known to occur near this area (Adams 2003). Maternity colonies have been identified and are protected at Harmon and Mallory caves on City of Boulder Open Space and Mountain Parks land roughly 5 miles to the north/northwest (http://www.bouldercolorado.gov/files/openspace/closure_documents/MalloryHarmonCave_WhiteNoseSyndrome.pdf).

RECOMMENDATIONS

Walsh recommends several additional surveys which will help to better understand bat movement and activity at NWTC.

- Continued passive acoustical monitoring of bats from April 1 to July 6 to complete a full year of monitoring.
- Continued monitoring in subsequent years to substantiate patterns seen in this study as well as provide year-to-year comparisons.
- Additional passive acoustical monitoring at different locations and heights to see the movement of bats through the site
- Mist netting surveys can better identify which species are using the site
- Putting radio-tags on some bats can show where they are roosting.

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