

Acoustic Monitoring of Bat Echolocation Calls
on the Oak Ridge Reservation (Pilot Study)
2013 Environmental Monitoring Report

Abstract

Following emergence from winter hibernation, bats were monitored by conducting surveys to record echolocation calls using ultra-high frequency Anabat detectors. Bat call files obtained from the detectors were then analyzed with specialized bat identification software (i.e., BCID-East, Kaleidoscope PRO) to enable acoustic identification of species. A combination of active and passive ultrasonic field surveys were used beginning April 15, 2014, and continuing through October 31, 2014.

During 2013, TDEC processed 6,231 bat call files (out of >12,000 total files) collected from ≥75 nights of Anabat surveys at forty-seven (47) ORR sites. The Anabat files were analyzed using the automated software program: BCID-East (plus Kaleidoscope PRO for verification). Our analysis of identified calls suggests thirteen (13) bat species are present on the reservation including two federally endangered species (i.e., Gray Bat, Indiana Bat). Previous ORR bat studies were limited to 3-4 night mist-net and acoustic surveys. This study, along with a concurrent ORNL Environmental Science Division bat project, was the first comprehensive, large-scale (multi-nights) acoustic bat community investigation on the ORR.

Introduction

Little information is available regarding the distribution and occurrence of bats in the southeastern United States, including knowledge of bat species on the Oak Ridge Reservation (ORR). Although the presence of the federally endangered gray bat has been documented on the ORR, the status of the federally endangered Indiana bat and knowledge of the overall bat community is not well known. Previous ORR bat investigations have been limited to short term 2-4 night surveys of mist-netting and acoustic surveys, and thus no long term, intensive bat monitoring data is available. Our study is unique because the serious lack of bat community information was addressed by providing comprehensive, multi-night acoustic surveys thus allowing characterization of bat diversity and occurrence at numerous ORR sites.

Bats (Microchiropterans) are fundamental ecosystem components for insect suppression, pollination and seed dispersal (Britzke et al. 2011). Microchiropteran bats are also known as "echolocating bats" because they have the ability to use echolocation as a navigation tool in obstacle avoidance and hunting (Simmons and Conway 1997). Echolocating bats typically emit

an ultrasonic (over 15 kilohertz) pulse, and analyze the returning echo to determine the distance to the object as well as what type of object it is (Fenton 1992). Bats in the eastern United States use ultrasonic echolocation to locate prey and navigate in their surroundings. Echolocation calls of most bats are species specific. Ultrasonic detectors are widely used for bat censuses (i.e., inventory) and have improved conservation efforts by: (1) providing increased knowledge of bat ecology, and (2) characterizing bat communities (Britzke et al. 2011). Numerous researchers have used detectors to conduct bat species surveys and assess habitat use, and the method is especially valuable for species that are difficult to capture (Ahlen 1999, Murray et al. 1999, O'Farrell and Gannon 1999, Duffy et al. 2000, Russo and Jones 2003). The application of bat ultrasonic monitoring devices such as the Anabat™ SD-2 bat detector (Titley Scientific USA, Columbia, MO) has allowed ecologists to quickly and efficiently characterize and inventory bat communities at multiple areas (O'Farrell and Gannon 1999, Owen et al. 2004), and transform those calls into frequencies which are audible to humans (Parsons et al. 2000).

Microchiropteran bats use tonal signals that show structured change in frequency over time (Fenton 1984). Humans listening to slowed-down recordings of echolocating microchiropterans can readily distinguish between different sounding pulses allowing them to recognize the calls of different species. People also can recognize 'feeding buzzes'; attacks on prey that are signaled by high pulse repetition rates (Schnitzler & Kalko 2001).

The TDEC (Tennessee Department of Environment and Conservation) Division of Remediation, DOE-Oversight Office (DOEO), initiated a pilot project in 2013 to investigate the bat community present on the ORR. The Tennessee Oversight Agreement mandates a comprehensive and integrated monitoring and surveillance program for all media (i.e., air, surface water, soil sediments, groundwater, drinking water, food crops, fish and wildlife, and biological systems) and the emissions of any materials (hazardous, toxic, chemical, radiological) on the ORR and environs. Accordingly, monitoring the ecological recovery progress of wildlife and environmental restoration of habitat are important aspects of remedial activities on the ORR.

Following emergence from winter hibernation, bats were monitored by conducting surveys to record echolocation calls using ultra-high frequency Anabat detectors. Bat call files obtained from the detectors were then analyzed with specialized bat identification software (i.e., BCID-East, Kaleidoscope PRO) to enable acoustic identification of species. A combination of active and passive ultrasonic field surveys were used beginning April 15, 2014, and continuing through October 31, 2014.

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federally endangered species (i.e., Gray Bat, Indiana Bat). Previous ORR bat studies were limited to 3-4 night mist-net and acoustic surveys. This study, along with a concurrent ORNL Environmental Science Division bat project, was the first comprehensive, large-scale (multi-nights) acoustic bat community investigation on the ORR.

Study Site

The study was conducted on the Oak Ridge Reservation, Oak Ridge, Tennessee, which consists of approximately 34,500 acres (14,000 ha) within Anderson and Roane counties. The reservation is bound on the north and east by residential areas of the City of Oak Ridge and on the south and west by the Clinch River. The reservation is underlain predominantly by thrust-faulted Cambro-Ordovician sedimentary rocks (e.g., limestone, dolostone, siltstones, etc.). More than 20 caves have been identified on the ORR and most are developed within dolostones of the Knox Group. Mitchell et al. (1996) surveyed seven of the caves (Copper Ridge, Flashlight Heaven, Walker Branch, Big Turtle, Little Turtle, Pinnacle, and Bull Bluff), but no gray bats were found. There is an unverified report of ten gray bats roosting in Little Turtle Cave in September 1996 (Webb 2000). Therefore, Anabat surveys of ORR cave entrances were also conducted on multiple nights to determine species, if present. It should be noted that ORR caves will not be entered at any time due to wildlife health concerns.

Temperate bat species are nocturnal and exhibit nightly and seasonal activity patterns that vary among species and individuals (Hirshfield et al. 1977, Anthony et al. 1981). Bats in the eastern United States typically enter hibernation in mid-September and emerge in mid-April (Britzke et al. 2006). During summer nights, bat roost-emergence activity commonly peaks immediately after sunset and can continue for several hours (Kunz 1973, Barcla 1982). Typically, a lesser activity peak occurs before sunrise as bats return to their diurnal roosts after foraging (Kunz 1973). During the night, bats roost at intervals, either at their diurnal roosts or at night-roosts nearer their foraging areas (Adam and Hayes 2000, Johnson et al. 2002, Daniel et al. 2008). For example, *Myotis sodalis* (Indiana bat) may forage in forests with intact canopies, near headwater streams (Menzel et al. 2005, Schirmacher et al. 2007), and within riparian zones (Webb 2000, Ford et al. 2005). The Indiana bat may form maternity roosts in shaggy-barked trees and snags with exfoliating bark during summer and then hibernates in caves during winter (Menzel et al. 2001, Timpone et al. 2010). Prior to 2013, the occurrence of the Indiana Bat had not been documented on the ORR since 1950.

Females of many bat species form maternity colonies in anthropogenic (e.g., buildings, bridges) and/or natural (e.g., tree or snag, caves) structures (Barbour and Davis 1969, Lewis 1995). During the maternity season, particularly during the lactation period, females return to their diurnal roosts several times during the night to nurse their young (Henry et al. 2002; Ormsbee et al. 2007). Accordingly, the USFWS has developed bat monitoring guidelines and criteria for site

selection in the Indiana Bat Summer Survey Plan (USFWS 2013). Bat acoustic monitoring sites were selected based upon satellite imagery / topographic maps, consultation with the ORNL Environmental Sciences Division and TWRA, following the USFWS criteria, and the literature (LaVal et al. 1977, Racey 1998, Grindal and Brigham 1999, Menzel et al. 2005) to include:

- Mature forest corridors
- Forest/field edge
- Powerline ROWs
- Rocky bluffs & outcrops
- Forest access roads, hiking trails
- Open fields
- Waterway corridors (streams, ponds, wetlands, riparian, river shoreline)
- Anthropogenic structures (abandoned buildings, bridges, large culverts)
- Trees with exfoliating bark or dead snags (minimum diameter of 5 inches at breast height) exposed to direct sunlight
- Caves and karst features

Objectives

- Conducted passive overnight fixed-point Anabat surveys at multiple ORR sites
- Conducted active Anabat surveys for 4-5 hours, 30 minutes/station
- Focus on identifying the presence of federally endangered bats on the ORR
- Identify Indiana Bat roost trees and other roosting habitats (i.e., bridges, rock crevices, abandoned buildings, etc.)

Methods

Anabat SD-2 (Titley Electronics, Ballina, Australia) broadband, frequency-division, bat detectors were used to passively and actively monitor for bat echolocation passes, i.e., a series of echolocation pulses, at carefully selected ORR sites before, during, and after the pregnancy and lactation periods (Sasse and Pekins 1996). Microchiropterans use a wide range of frequencies in echolocation, from around 10 kHz to over 200 kHz. Bat calls are produced by a single mode of vibration and consist of a series of harmonics which are multiples of the sound frequencies used by the bat, further assisting in pinpointing the location of prey (flying insects). Bats emit echolocation sounds in pulses that vary in properties depending on the species, and can be correlated with different hunting strategies and mechanisms of information processing (Grinnell 1995). Echolocation calls of bats consist of three phases: search, approach, and terminal (Griffin et al. 1960). Search phase calls are produced to locate prey, approach phase calls are produced to identify exact locations of prey, and terminal phase calls are produced just prior to capture. Search phase calls are useful in the study of bat echolocation because they constitute a majority

(ca. 90%) of calls produced by bats, exhibit consistency in structure throughout the call sequence, and may possess species-specific characteristics (Betts 1998, Fenton and Bell 1981, O'Farrell et al. 1999). Most bat families use short, downward frequency-modulated (FM) sounds that sweep through about an octave. An example of an FM bat is the Big Brown Bat. Another common echolocation signal pattern is constant-frequency (CF) signals. Long CF/FM pulses are a hybrid of the two and are used by a much smaller number of species belonging to three different families. These signals have a long (10–100 ms) constant-frequency component preceding an FM sweep (Grinnell 1995).

The Anabat SD-2 uses an advanced form of frequency division without amplitude retention, to provide the cleanest output signals with the lowest possible data rate (Corben 2014). These are frequency dividing (FD) detectors which provide a broadband frequency down-conversion, which generates audio signals with frequencies directly related to those the bat is producing (Corben 2014). Furthermore, the nature of the data generated by Anabat detectors is ideally suited to analysis using Zero-Crossings Analysis (ZCA). The ZCA system counts incoming echolocation calls (pulses) along their oscillations between positive and negative values each time a sound wave passes the zero point at a present number of crossings (i.e., Division Ratio, often 8 or 16), and a time measurement (time-frequency) is made allowing representative species-specific frequencies to be recorded, thus providing efficient analysis of representative call parameters for species identifications (Corben 2014).

The quantity of echolocation passes recorded is an index of activity and does not necessarily reflect the quantity of bats being recorded, i.e., one bat can be recorded more than one time (Broders, 2003). Following the survey methods described by O'Farrell et al. (1999) and Johnson et al. (2002), TDEC actively monitored sites with Anabat detectors for 30-min periods between the end of twilight up to 5 hrs. thereafter (Sherwin et al., 2000). Staff slowly swept the detector back and forth to scan for activity under a closed forest, within a forest canopy gap or forest harvest area, or along a stream. When bat activity was detected, the Anabat was oriented and followed the flight path to capture as complete a call sequence as possible. Acoustical sampling during evenings when bat activity was likely to be low due to meteorological conditions such as high winds, precipitation or temperatures below 10 °C was avoided (Wear 2004, Ford et al. 2005, Schirmacher et al. 2007).

Bat echolocation calls were recorded passively with 1-3 Anabat™ SD-2 detectors at ORR study sites. It is recommended by the U.S. Fish and Wildlife Service (USFWS 2011) that a project area of suitable bat habitat (phase II) would require at least 3 detector sites per 124-acre area over the course of at least two survey nights per area. The Titley Roost Logger™ detector was also used to monitor bats at some ORR sites and usually deployed for 5-10 consecutive nights. The Anabat SD-2 unit (or its detached microphone) must be deployed on a tripod or on a long pole

so as to avoid ground surface clutter and insect ultrasonic clutter (Weller and Zabel 2002) whereas the Roost Logger can be easily strapped to a tree. Our passive Anabat surveys began approximately 30 minutes before sunset and ended 30 minutes after dawn (Martin and Britzke 2010). Anabat SD-2 detector systems placed into the field for remote, passive sampling are often housed in waterproof containers with an aperture through which the microphone can be fitted (Britzke et al. 2010).

This project will generally follow the bat monitoring guidance and protocols of Kuenzi and Morrison (1998), Murray et al. (1999), Jones et al. (2004), Szewczak 2004, Manley et al. (2006), Britzke et al. (2011), and the U.S. Fish and Wildlife Service (USFWS 2011, 2013). This research will be in cooperation with the Division of Natural Areas (TDEC Bureau of Parks and Conservation), Tennessee Wildlife Resources Agency, the Forestry, Wildlife and Fisheries Department of the University of Tennessee, the US Fish and Wildlife Service, and the Oak Ridge National Laboratory Environmental Sciences Division. Field work followed the guidance in the division's health and safety plan (Yard 2013).

White Nose Syndrome

White-nose Syndrome (WNS positive, WNS+) is a disease that has been implicated for the decimation of several million cave-hibernating bats in North America and is believed to be caused by the psychrophilic fungus, *Geomyces destructans* (Kannan et al. 2010, Figure 1). This pathogen first appeared in eastern New York in 2006 and has since spread throughout the Northeast (Ford et al. 2011), and unfortunately into cave populations of bats in several southern states including Tennessee. This fungus, which may appear as a white coating on the bat muzzle, invades the epidermis of the bats (causes damage to wing membranes), unlike many other fungal infections (Meteyer et al. 2009). A leading hypothesis is that *G. destructans* infections affect the arousal periods of hibernating bats, causing them to use their fat reserves prior to emergence, essentially starving the bats (TBWG 2014). Examples of East Tennessee hibernating cave bat colonies infected with WNS include: Grindstaff Cave (Carter County) and Worley's Cave (Sullivan County, Holliday 2012). Grindstaff Cave bat numbers were down 99.5% compared to 2010 when WNS was first discovered there. Worley's Cave hibernating bats were down 96.6% from 2011 (Holliday 2011). White Oak Blowhole Cave in the Great Smoky Mountains National Park is Tennessee's largest Indiana bat hibernaculum and the bats have been found to be WNS-positive. East Fork Saltpeter Cave in Fentress County has been surveyed and bats there have been documented to be WNS+ (Holliday 2012). Lastly, Figure 2 shows 33 Tennessee counties (red-shading) that contain WNS+ infected bats in caves (or other hibernacula).



Figure 1: Bat with wing damage due to WNS (Holliday 2012)

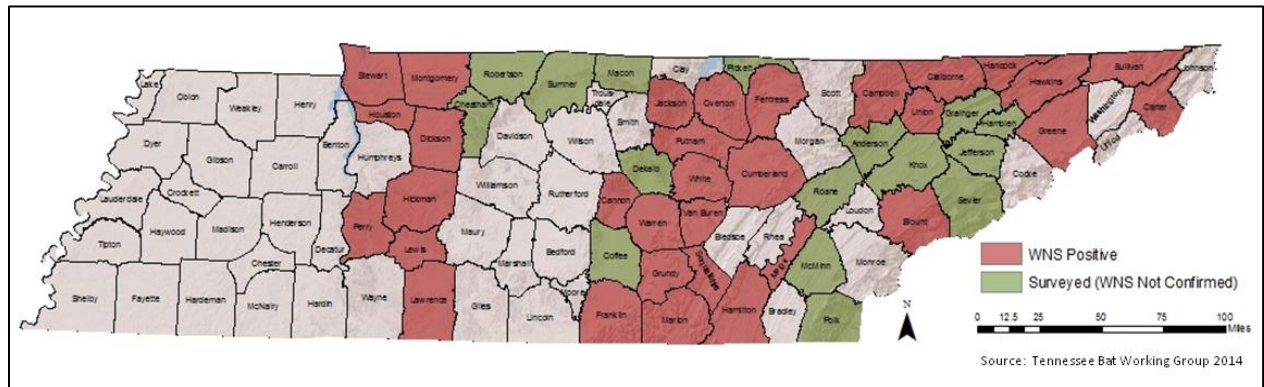


Figure 2: White Nose Syndrome Positive Counties 2013

Results and Discussion

For purposes of this report, the ORR was subdivided into 10 study sections (with 2-10 Anabat monitoring stations per section):

1. Bearden Creek / Park City Section (ORNL; 2 bat monitoring stations)
2. Bear Creek Burial Grounds / EMWMF Section (Y-12; 4 bat monitoring stations)
3. Bull Bluff / Freels Bend Section (TWRA Three Bends; 4 bat monitoring stations)
4. Duct Island / ETTP Ponds / Grassy Creek Section (ETTP; 10 bat monitoring stations)
5. Horizon Center / Lower East Fork Poplar Creek / White Wing Section (7 stations)
6. Jones Island / WAG 13 Section (ORNL; 4 bat monitoring stations)
7. Scarboro Disc Park / Turtle Park (City of Oak Ridge; 2 bat monitoring stations)
8. Solway Bend (TWRA Three Bends) / UT Arboretum Section (6 bat monitoring stations)
9. Walker Branch Section (ORNL; 3 bat monitoring stations)
10. West Bear Creek Valley Section (Y-12; 5 bat monitoring stations)

At the beginning of each section, a map of the site locations is provided plus a table is included summarizing the bat species detected at each Anabat survey station. In the summary tables, note that the numbers underneath each bat species represent number of bat calls, not the number of bats. The BCID-East and Kaleidoscope PRO software cannot quantify how many bats are present, but rather can only provide an analysis of the bat species that may be present at a site. The software programs utilize bat call libraries to analyze the Anabat files.

Following each section summary table, please find a representative graph detailing the bat species detected at each Anabat monitoring station. Some graphs represent passive overnight surveys (dusk until dawn) while others are active +/- 5 hour surveys (dusk until 1-2 am).

1. BEARDEN CREEK / PARK CITY SECTION



Figure 3: Bearden Creek / Park City Section (ORNL)

** The exact location of bat detector site #2 is not shown due to its ecological sensitivity.

	BAT TAXA DETECTED													ADDITIONAL SOFTWARE OUTPUT					
Bat Monitor Station ID	COTO	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR	UNKN	LOW FREQ	MID FREQ	MYOTIS	NUMBER OF BAT CALLS	TOTAL PULSES
Park City Bat Site 1		6	3			11	6	41	12	17	15	27		8	6	49	91	146	2407
Park City Bat Site 2			12			1		17	1	3	2	16		6		36	22	58	1146

Table 1: Summary Table of Bats Detected
Bearden Creek / Park City Section

Note: The numbers in each *bat taxa detected* column represent the number of bat calls recorded at each monitoring station, **not** the number of bats present. A call is the series of frequency sweeps which a bat emits for navigation or location of a prey item (McCracken et al. 2013). Pulses are a rapid series of echolocation vocalizations emitted during the search, approach and feeding buzz phases as a bat searches

and locates prey items. All Anabat files were processed using the BCID-East software program (validated with Kaleidoscope PRO program).

Taxonomic Codes: COTO = *Corynorhinus townsendii* (Townsend's Big-eared Bat), EPFU = *Eptesicus fuscus* (Big Brown Bat), LABO = *Lasiurus borealis* (Eastern Red Bat), LACI = *Lasiurus cinereus* (Hoary Bat), LANO = *Lasionycteris noctivagans* (Silver-haired Bat), MYGR = *Myotis grisescens* (Gray Bat), MYLE = *Myotis leibii* (Eastern Small-footed Bat), MYLU = *Myotis lucifugus* (Little Brown Bat), MYSE = *Myotis septentrionalis* (Northern Long-eared Bat), MYSO = *Myotis sodalis* (Indiana Bat), NYHU = *Nycticeius humeralis* (Evening Bat), PESU = *Perimyotis subflavus* (Tricolored Bat; Eastern Pipistrelle), TABR = *Tadarida brasiliensis* (Brazilian Free-tailed bat).

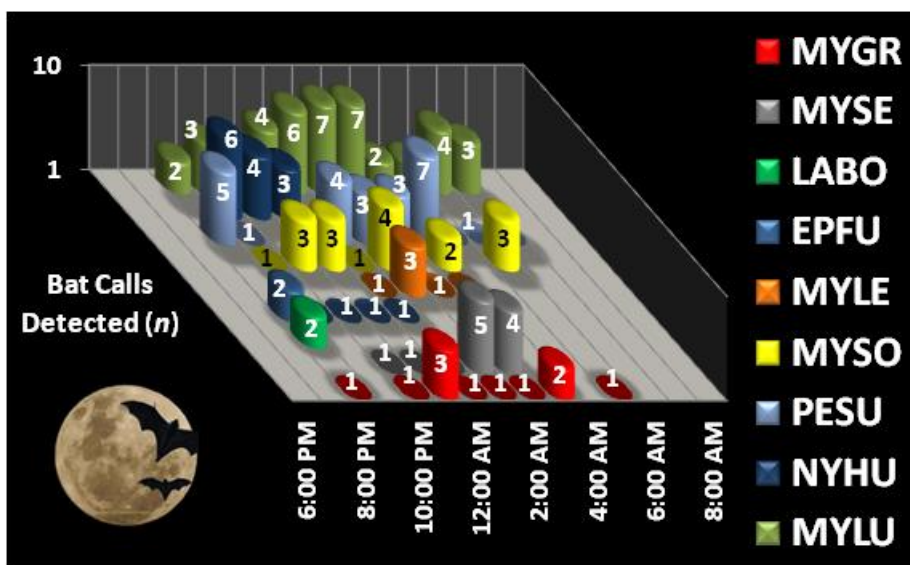


Figure 4: Bat Detector Site 1— Park City / Shagbark Hickory Site
Anabat Data / 9-19-2013
(Passive Survey: Dusk until Dawn)
Bat calls/hour per species

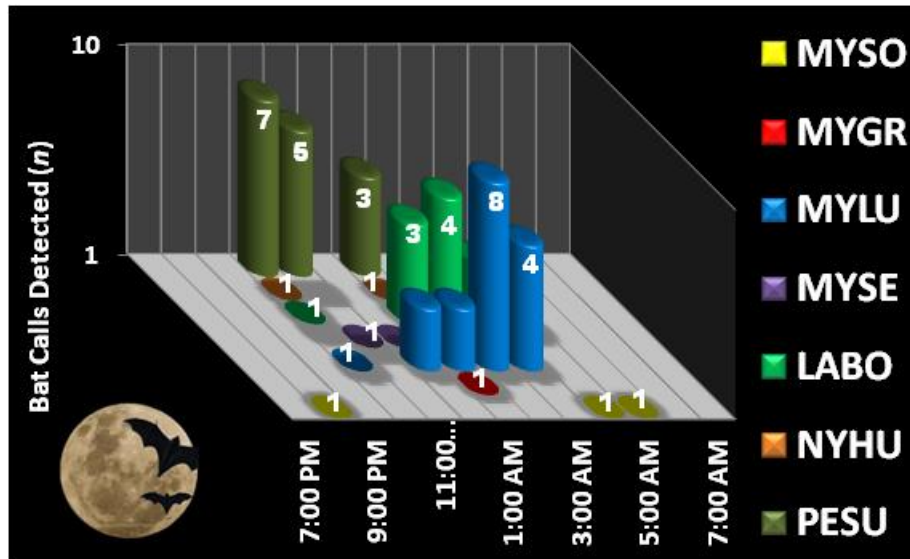


Figure 5: Bat Detector Site 2— Park City Area (Pinnacle Cave entrance)
 Anabat Data / 9-19-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

2. BEAR CREEK BURIAL GROUNDS / EMWMF SECTION

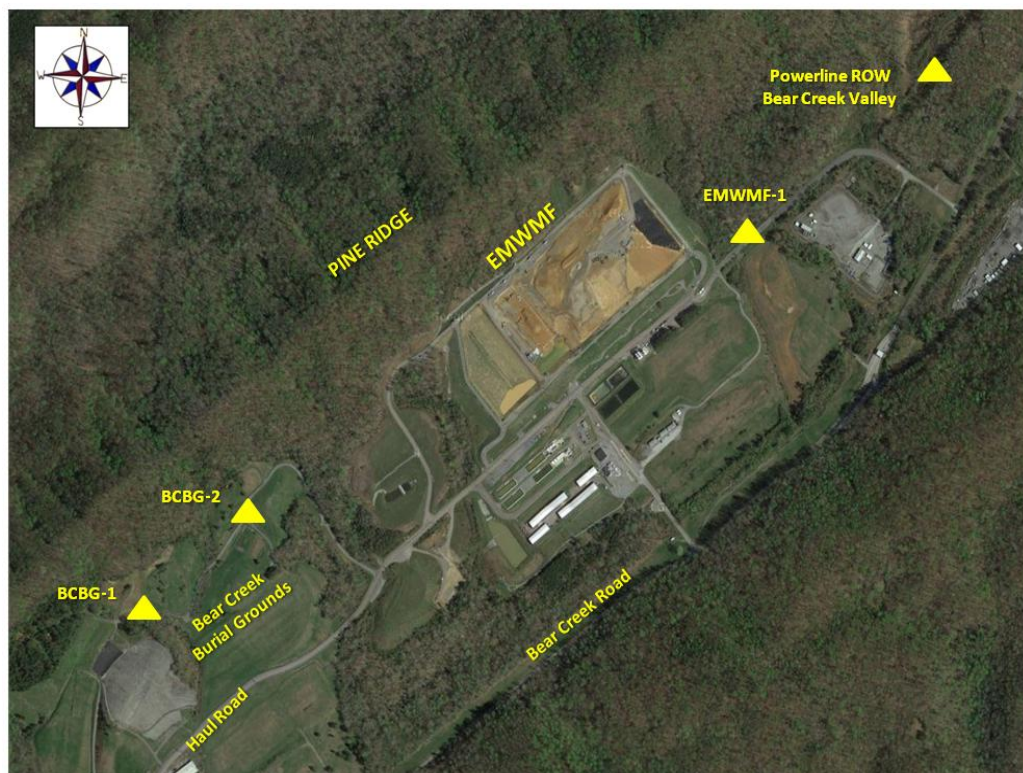


Figure 6: Bear Creek Burial Grounds / EMWMF (Y-12) Section

	BAT TAXA DETECTED													ADDITIONAL SOFTWARE OUTPUT					
Bat Monitor Station ID	COTO	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR	UNKN	LOW FREQ	MID FREQ	MYOTIS	NUMBER OF BAT CALLS	TOTAL PULSES
BCBG-1		3	1	1	8	4		39		4	5	29		1	13	35	47	95	1418
BCBG-2				1							1	3			1	4		5	47
EMWMF-1		1	6	2	9	11		2			4	20		3	12	31	14	58	624
BCK Valley Powerline ROW		1	1		2							3			3	4		7	66

Table 2: Summary Table of Bats Detected
Bear Creek Burial Grounds / EMWMF Section

Note: The numbers in each *bat taxa detected* column represent the number of bat calls recorded at each monitoring station, **not** the number of bats present. A call is the series of frequency sweeps which a bat emits for navigation or location of a prey item (McCracken et al. 2013). Pulses are a rapid series of echolocation vocalizations emitted during the search, approach and feeding buzz phases as a bat searches and locates prey items. All Anabat files were processed using the BCID-East software program (validated with Kaleidoscope PRO program).

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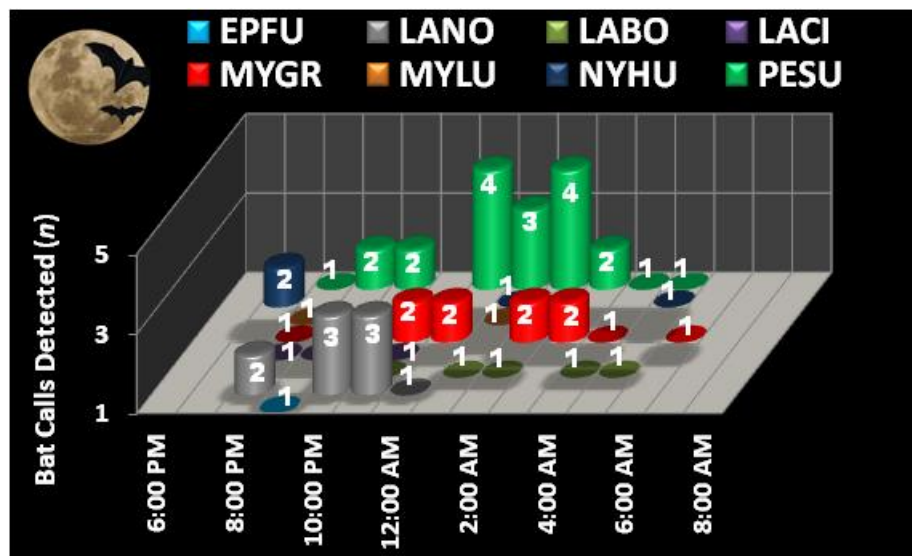


Figure 7: EMWMF-1: East end of EMWMF access road @ barrier
Anabat Data / 9-19-2013
(Passive Survey: Dusk until Dawn)
Bat calls/hour per species

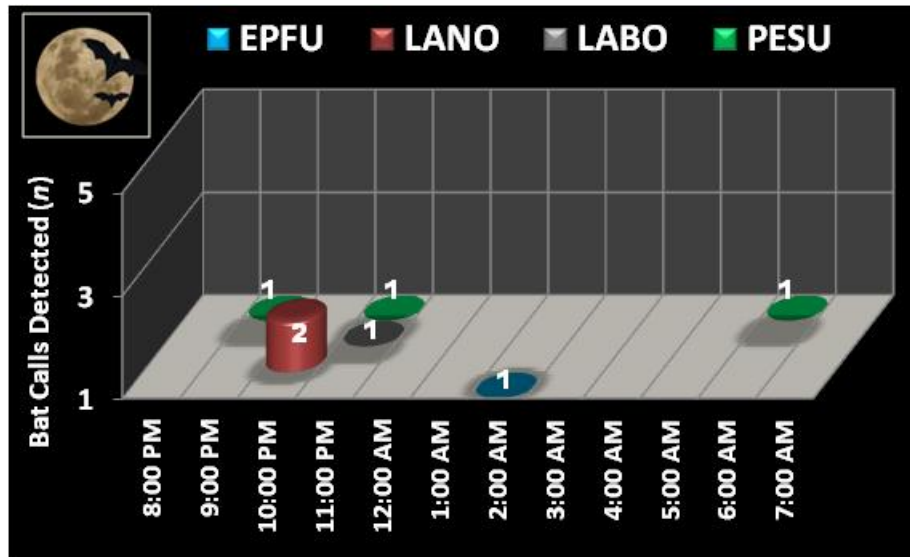


Figure 8: Bear Creek Valley @ powerline ROW (E/NE of EMWMF)
 Anabat Data / 9-24-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

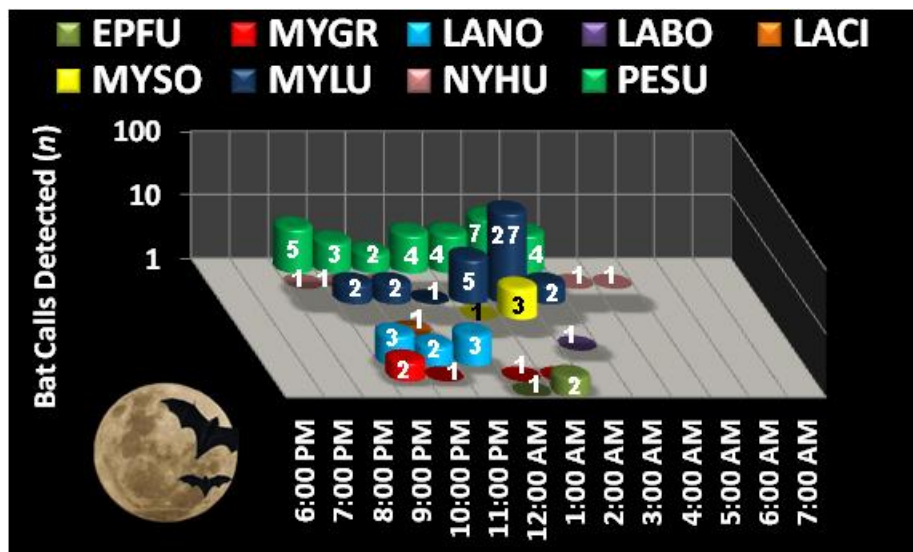


Figure 9: BCBG-1 — Bear Creek Burial Grounds / Walk-In-Pits
 Anabat Data / 9-17-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

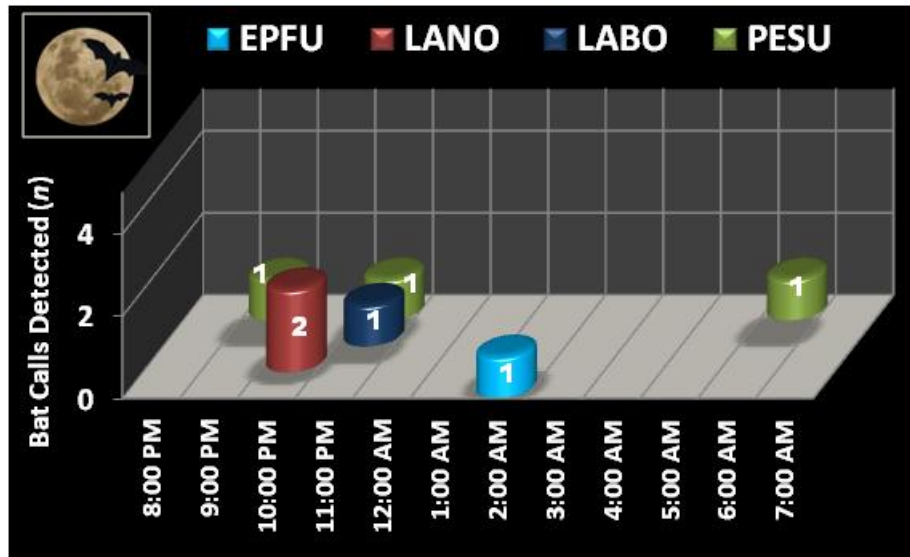


Figure 10: BCBG-2 — Bear Creek Burial Grounds (West of EMWMF)
 Anabat Data / 9-24-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

3. BULL BLUFF / FREELS BEND SECTION

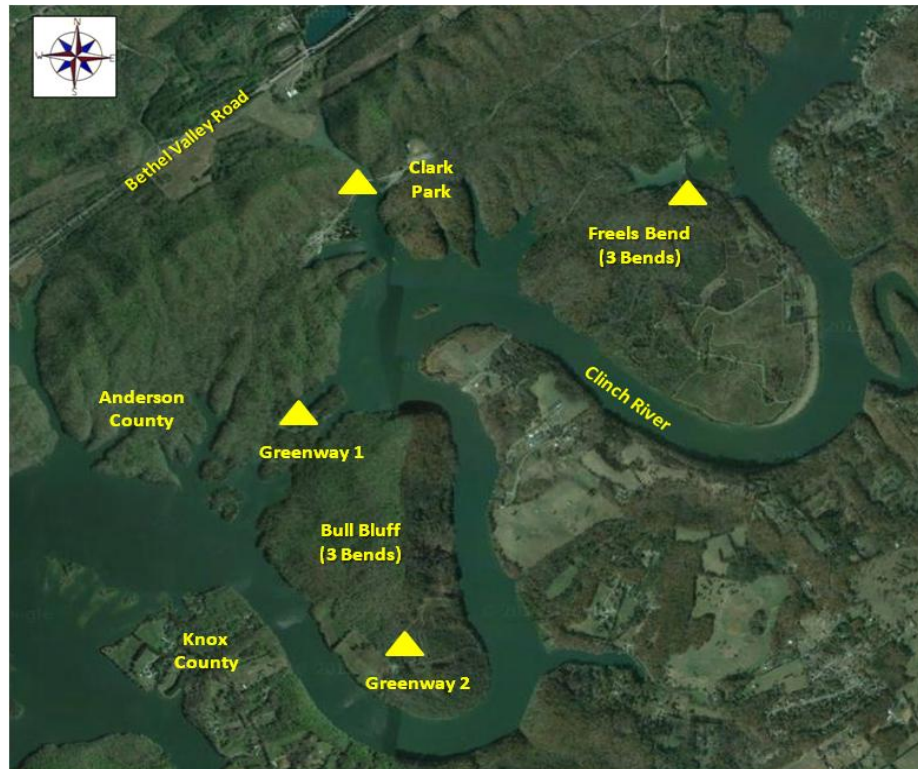


Figure 11: Bull Bluff / Freels Bend (TWRA 3 Bends) Section

	BAT TAXA DETECTED													ADDITIONAL SOFTWARE OUTPUT					
Bat Monitor Station ID	COTO	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR	UNKN	LOW FREQ	MID FREQ	MYOTIS	NUMBER OF BAT CALLS	TOTAL PULSES
Greenway-1		4	1	2		2					2			1	6	4	2	12	180
Greenway-2		2		3	4						1				9	1		10	234
Clark Park			2					1			6	2				10	1	11	133
Freels Bend			1	1		8	1	70	2	31	32	6		2	1	39	113	154	3829

Table 3: Summary Table of Bats Detected
Bull Bluff / Freels Bend (TWRA 3 Bends) Section

Note: The numbers in each *bat taxa detected* column represent the number of bat calls recorded at each monitoring station, **not** the number of bats present. A call is the series of frequency sweeps which a bat emits for navigation or location of a prey item (McCracken et al. 2013). Pulses are a rapid series of echolocation vocalizations emitted during the search, approach and feeding buzz phases as a bat searches and locates prey items. All Anabat files were processed using the BCID-East software program (validated with Kaleidoscope PRO program).

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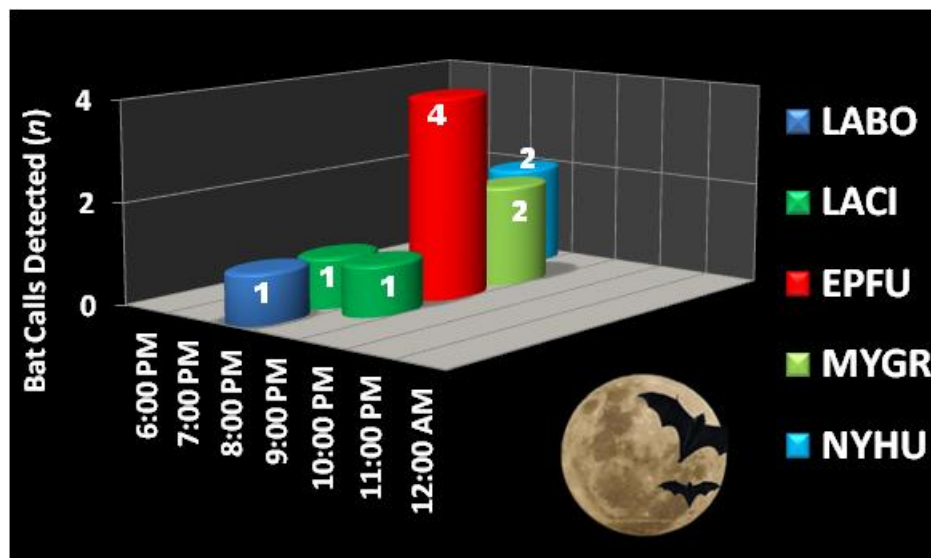


Figure 12: Greenway-1 – Bull Bluff Greenway
(Isthmus / Melton Lake backwater cove) Anabat Data / 4-26-2013
(Active Survey: Dusk until Midnight)
Bat calls/hour per species

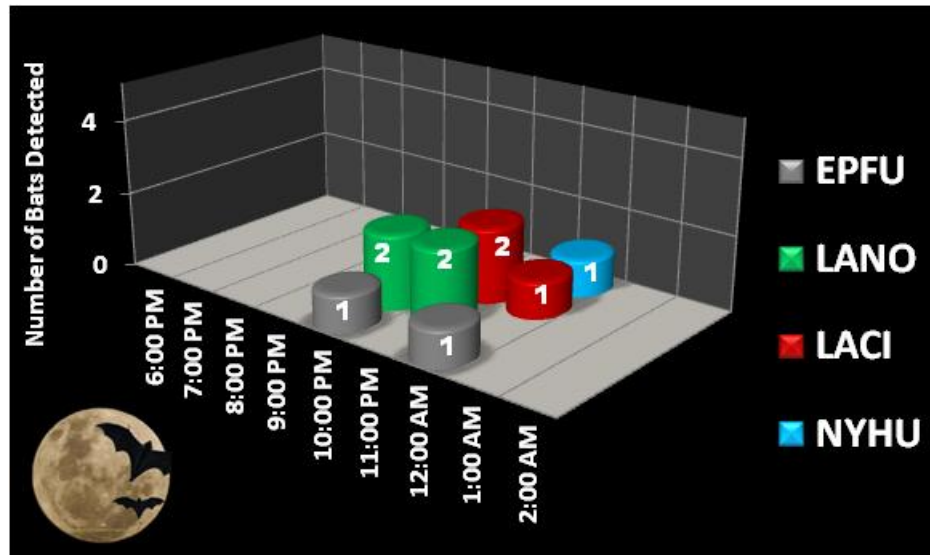


Figure 13: Greenway-2 – Bull Bluff Greenway
 (open field on ridge top at trail terminus) Anabat Data / 4-26-2013
 (Active Survey: Dusk until 2:00 am)
 Bat calls/hour per species



Figure 14: Clark Park (Carbide Park)
 (McCoy Branch backwater causeway) Anabat Data / 10-26-12
 (Active Survey: Dusk until Midnight)
 Bat calls/hour per species



Figure 15: Freels Bend / Melton Lake backwater causeway
 (south of Freels cabin) Anabat Data / 6-23-2013
 (Active Survey: Dusk until Midnight)
 Bat calls/hour per species

4. DUCT ISLAND/ETTP PONDS/GRASSY CREEK SECTION

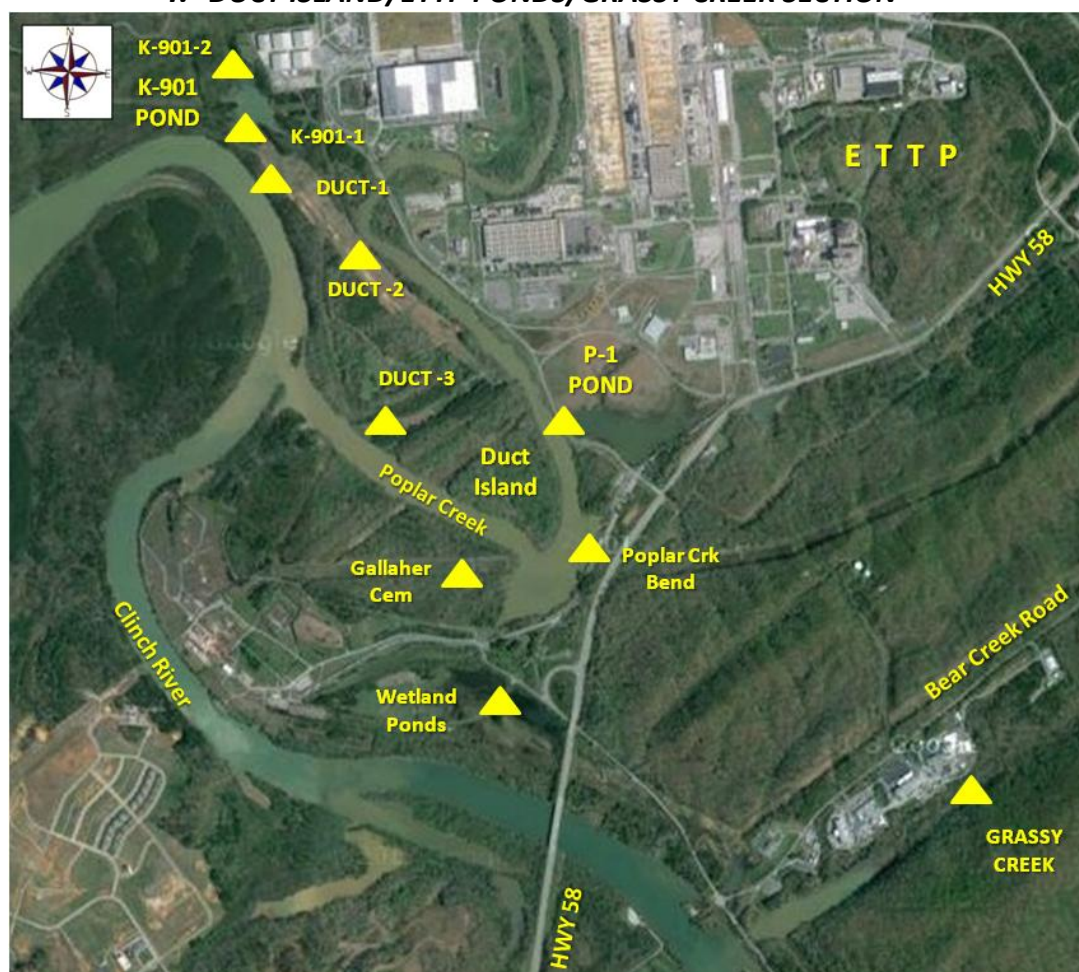


Figure 16: Duct Island / ETTP Ponds / Grassy Creek (ETTP) Section

Bat Monitor Station ID	BAT TAXA DETECTED													ADDITIONAL SOFTWARE OUTPUT					
	COTO	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR	UNKN	LOW FREQ	MID FREQ	MYOTIS	NUMBER OF BAT CALLS	TOTAL PULSES
BCK Wetlands			17		1						10	199		4	1	230		231	8620
DUCT-1		1			1	2				1		17			2	17	3	22	297
DUCT-2						7						3		1		4	7	11	121
DUCT-3			1			6						2		2		4	7	11	138
Gallaher Cem			1	1		6		1		1	15			1	1	16	9	26	266
Grassy Creek			6			22	7	2	11	6		88		6		95	50	148	1579
K-901-1 Pond		2			1	1		4		3	1	68		1	3	69	8	81	1551
K-901-2 Pond		3	1		2	2		3			1	13		1	5	16	5	26	286
P-1 Pond				2		3					2	30			2	32	3	37	601
Poplar Cr			34		1			1			10	372		7	1	423	1	425	14435

Table 4: Summary Table of Bats Detected
Duct Island / ETTP Ponds / Grassy Creek Section

Note: The numbers in each *bat taxa detected* column represent the number of bat calls recorded at each monitoring station, **not** the number of bats present. A call is the series of frequency sweeps which a bat emits for navigation or location of a prey item (McCracken et al. 2013). Pulses are a rapid series of echolocation vocalizations emitted during the search, approach and feeding buzz phases as a bat searches

and locates prey items. All Anabat files were processed using the BCID-East software program (validated with Kaleidoscope PRO program).

Taxonomic Codes: COTO = *Corynorhinus townsendii* (Townsend's Big-eared Bat), EPFU = *Eptesicus fuscus* (Big Brown Bat), LABO = *Lasiurus borealis* (Eastern Red Bat), LACI = *Lasiurus cinereus* (Hoary Bat), LANO = *Lasionycteris noctivagans* (Silver-haired Bat), MYGR = *Myotis grisescens* (Gray Bat), MYLE = *Myotis leibii* (Eastern Small-footed Bat), MYLU = *Myotis lucifugus* (Little Brown Bat), MYSE = *Myotis septentrionalis* (Northern Long-eared Bat), MYSO = *Myotis sodalis* (Indiana Bat), NYHU = *Nycticeius humeralis* (Evening Bat), PESU = *Perimyotis subflavus* (Tricolored Bat; Eastern Pipistrelle), TABR = *Tadarida brasiliensis* (Brazilian Free-tailed bat).

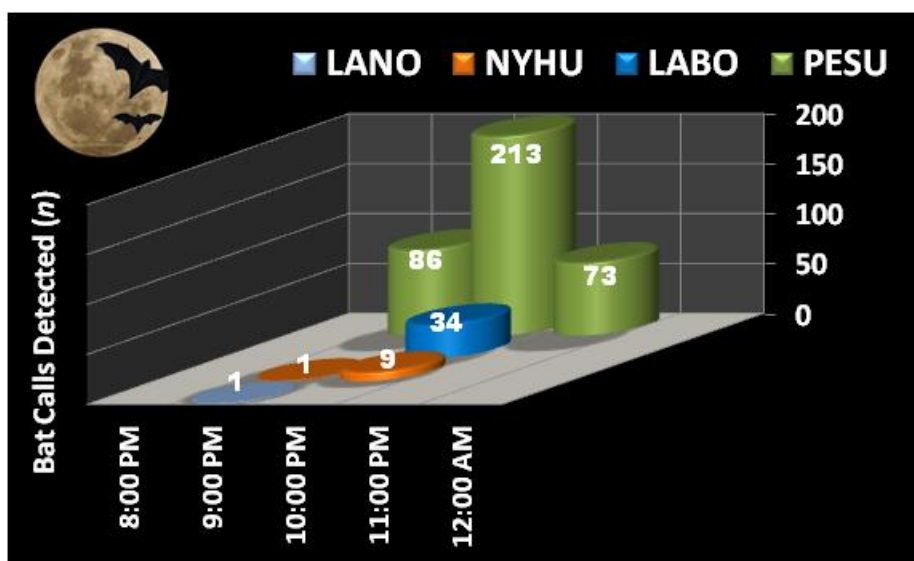


Figure 17: Poplar Creek ("big bend" south of Duct Island)
Anabat Data / 6-4-2013
(Active Survey: Dusk until Midnight)
Bat calls/hour per species

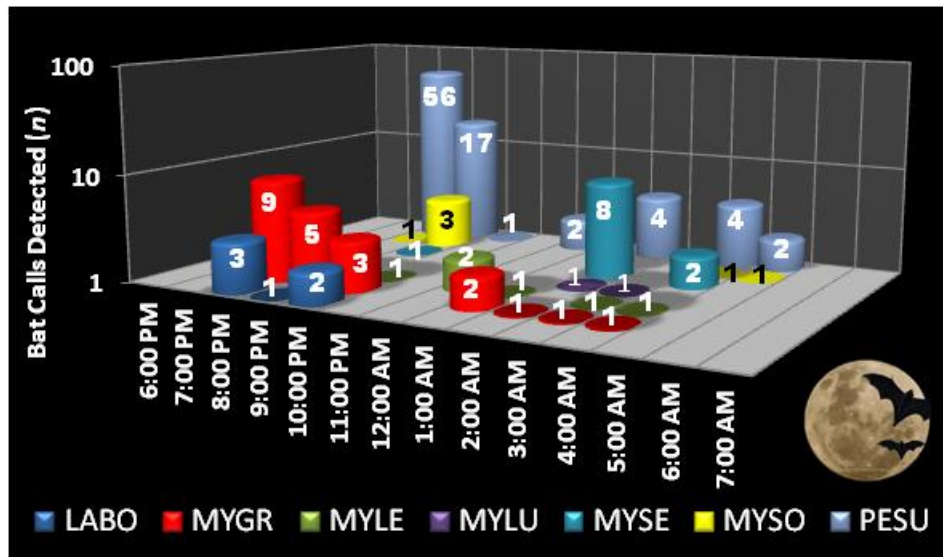


Figure 18: Grassy Creek (TDEC surface water station)
 Anabat Data / 5-25-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

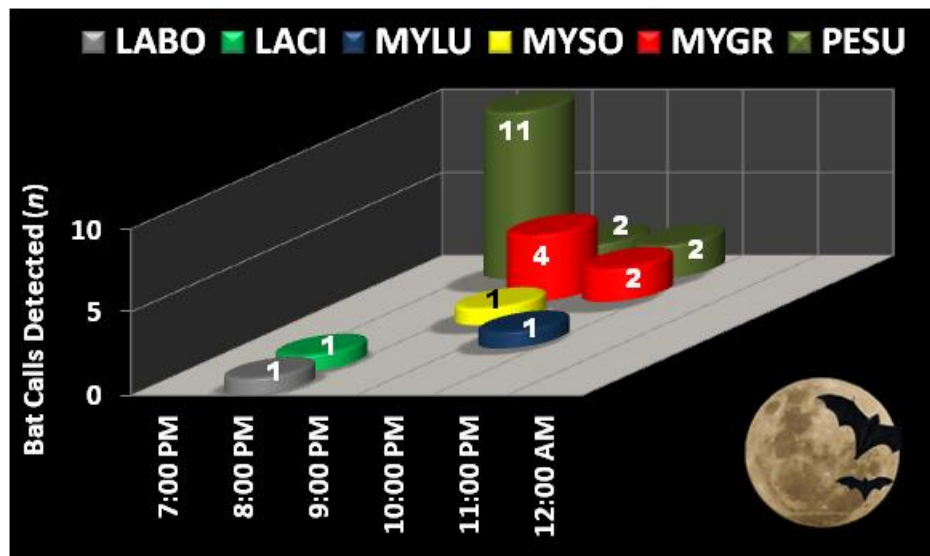


Figure 19: Gallaher Cemetery/Powerline ROW (ETTP)
 Anabat Data / 9-18-2013
 (Active Survey: Dusk until Midnight)
 Bat calls/hour per species

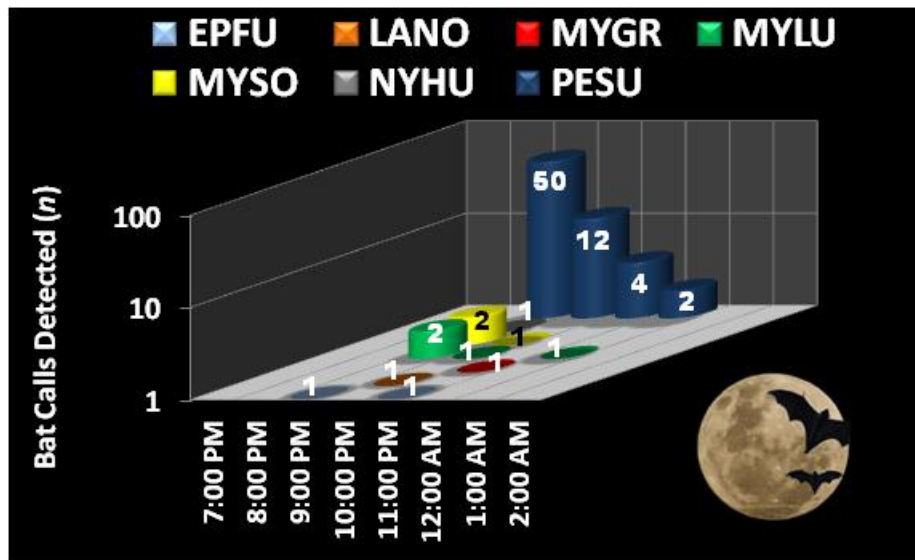


Figure 20: K-901-1 (K-901 Pond)
 (Weir outfall at Clinch River; ETPP) Anabat Data / 7-11-2013
 (Active Survey: Dusk until 2:00 am)
 Bat calls/hour per species

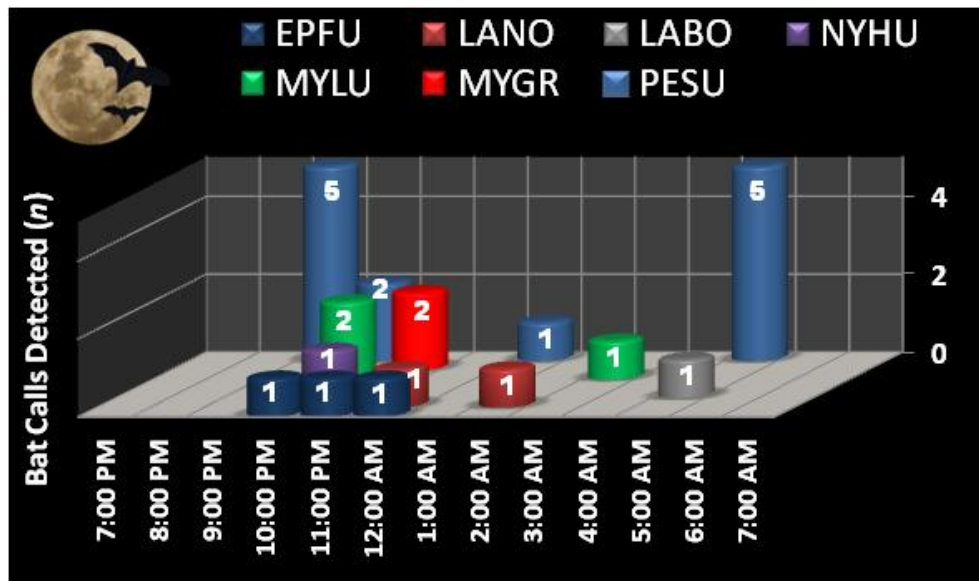


Figure 21: K-901-2 (K-901 Pond)
 (North end of pond on hill above backwater area; ETPP)
 Anabat Data / 7-11-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

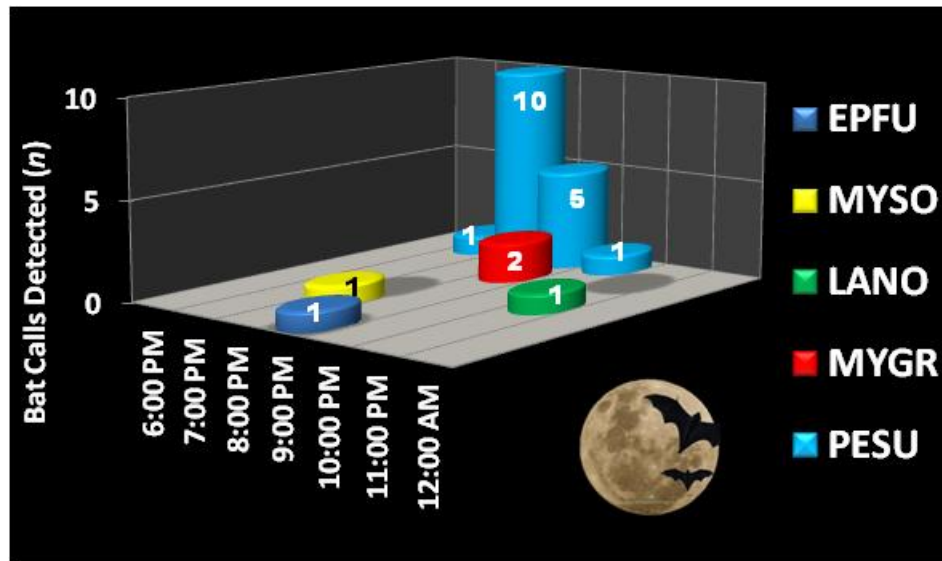


Figure 22: DUCT-1 (weir station on bluff above Clinch River / ETPP)
 Anabat Data / 9-28-2013
 (Active Survey: Dusk until Midnight)
 Bat calls/hour per species

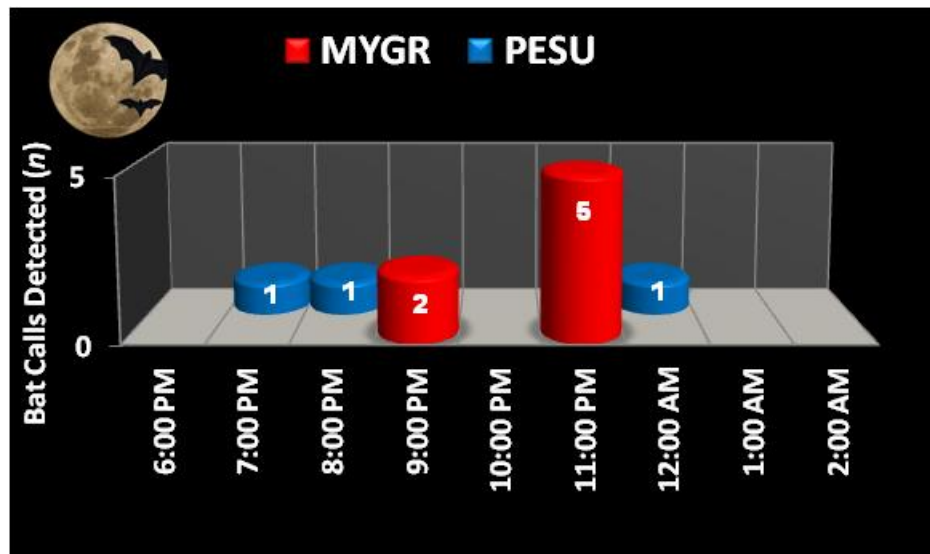


Figure 23: DUCT-2 (powerline ROW on Poplar Creek floodplain / ETPP)
 Anabat Data / 9-28-2013
 (Active Survey: Dusk until 2:00 am)
 Bat calls/hour per species

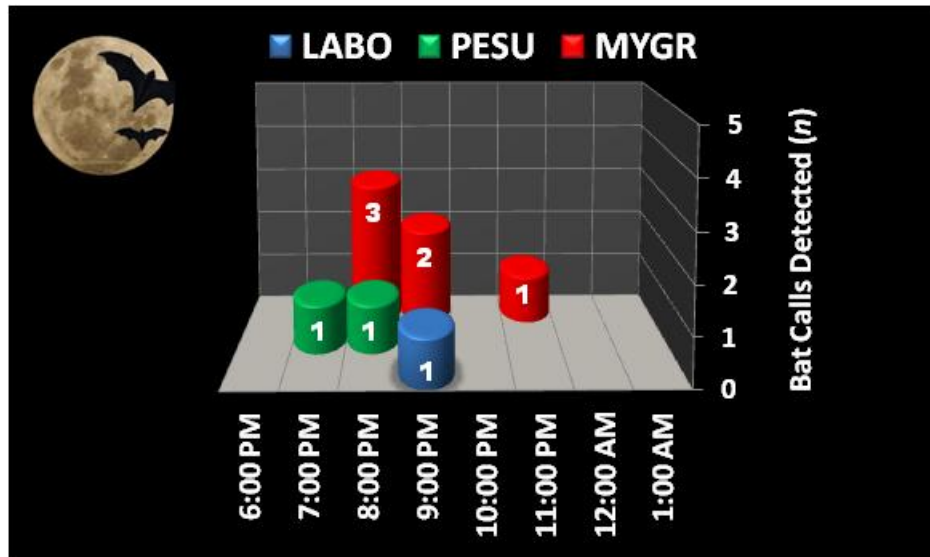


Figure 24: DUCT-3 (shoreline / duct crossing @ Poplar Creek / ETP)
 Anabat Data / 9-28-2013
 (Active Survey: Dusk until 2:00 am)
 Bat calls/hour per species

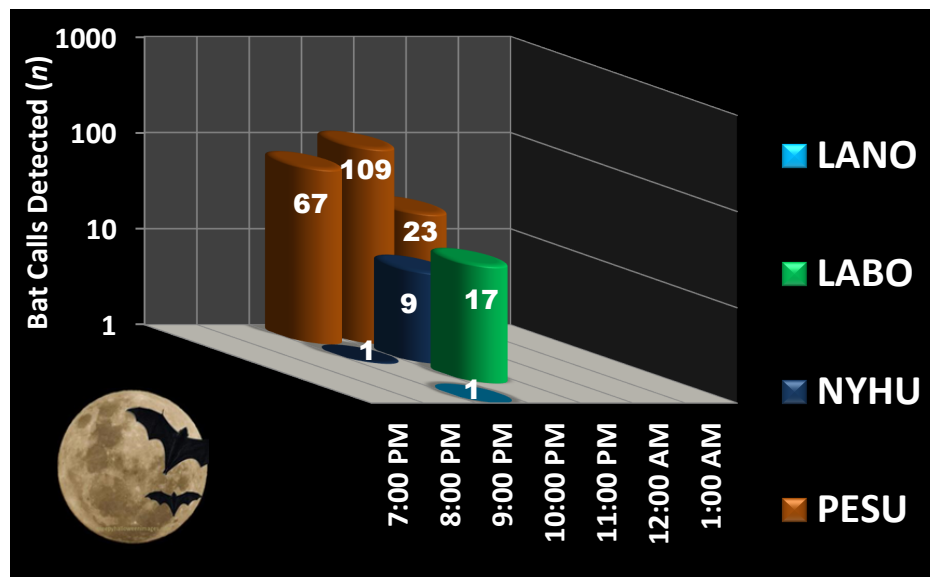


Figure 25: Bear Creek Road Wetland Ponds/ETTP (north of HWY 58)
 Anabat Data / 6-4-2013
 (Active Survey: Dusk until 2:00 am)
 Bat calls/hour per species

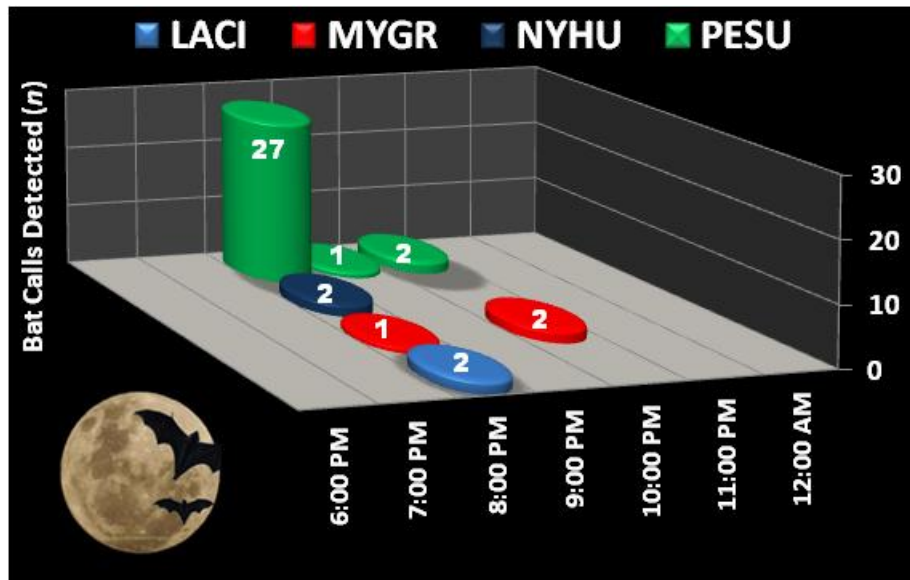


Figure 26: P-1 Pond
 (Weir outfall at Clinch River / ETP) Anabat Data / 7-9-2013
 (Active Survey: Dusk until 2:00 am)
 Bat calls/hour per species

5. HORIZON CENTER / LEFPC / WHITE WING SECTION

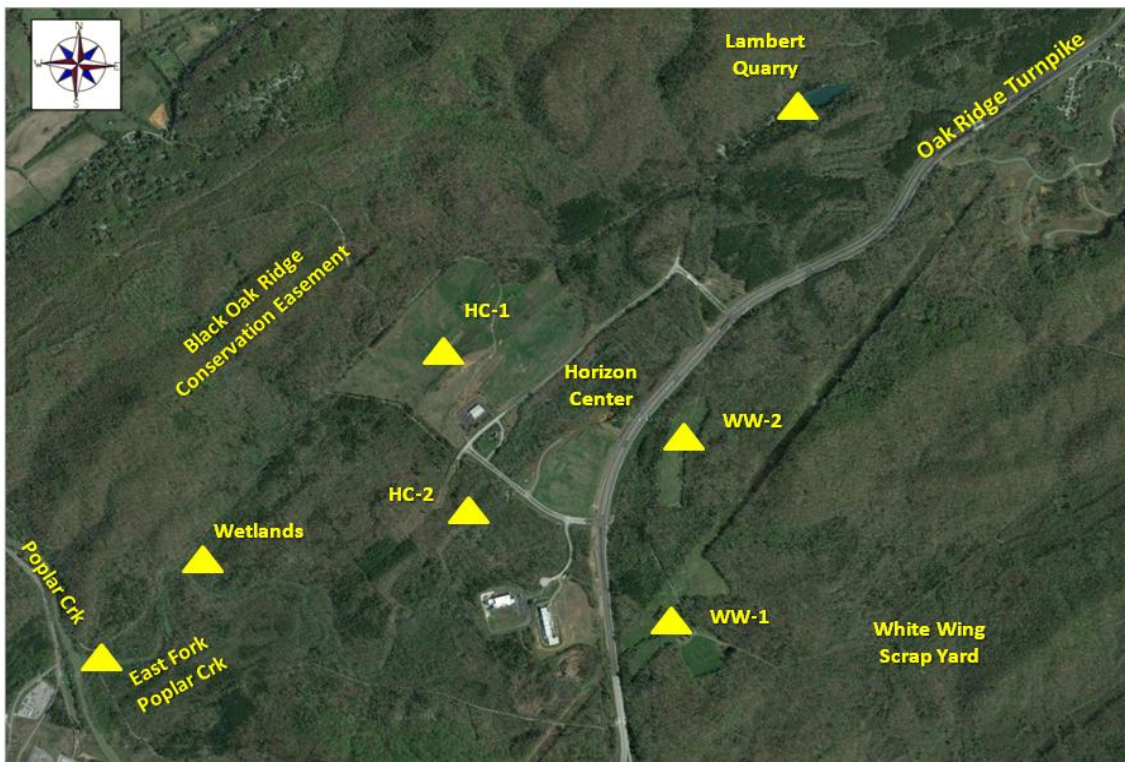


Figure 27: Horizon Center / Lower East Fork Poplar Creek / White Wing Section

	BAT TAXA DETECTED													ADDITIONAL SOFTWARE OUTPUT					
Bat Monitor Station ID	COTO	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR	UNKN	LOW FREQ	MID FREQ	MYOTIS	NUMBER OF BAT CALLS	TOTAL PULSES
EFPC Wetlands		2	6		1	16		1			19	308		10	3	337	22	363	4633
EFPC/Poplar Cr Confluence			35			116						271		21		307	116	443	20867
Horizon Ctr HC-1		11		1	1	10						4			13	4	10	27	661
Horizon Ctr HC-2		7	8		12	2					6	18		2	19	33	3	55	1160
Lambert Quarry	3	14	6		8	98					3	201		2	22	215	98	335	14987
White Wing WW-1		36	17	1	15	8		4			14	72		3	52	106	12	170	5256
White Wing WW-2		45	12	4	3	29			1			26		3	52	41	30	123	2413

Table 5: Summary Table of Bats Detected

Horizon Center / Lower East Fork Poplar Creek / White Wing Section

Note: The numbers in each *bat taxa detected* column represent the number of bat calls recorded at each monitoring station, **not** the number of bats present. A call is the series of frequency sweeps which a bat emits for navigation or location of a prey item (McCracken et al. 2013). Pulses are a rapid series of echolocation vocalizations emitted during the search, approach and feeding buzz phases as a bat searches and locates prey items. All Anabat files were processed using the BCID-East software program (validated with Kaleidoscope PRO program).

Taxonomic Codes: COTO = *Corynorhinus townsendii* (Townsend's Big-eared Bat), EPFU = *Eptesicus fuscus* (Big Brown Bat), LABO = *Lasiurus borealis* (Eastern Red Bat), LACI = *Lasiurus cinereus* (Hoary Bat), LANO = *Lasionycteris noctivagans* (Silver-haired Bat), MYGR = *Myotis grisescens* (Gray Bat), MYLE = *Myotis leibii* (Eastern Small-footed Bat), MYLU = *Myotis lucifugus* (Little Brown Bat), MYSE = *Myotis septentrionalis* (Northern Long-eared Bat), MYSO = *Myotis sodalis* (Indiana Bat), NYHU = *Nycticeius humeralis* (Evening Bat), PESU = *Perimyotis subflavus* (Tricolored Bat; Eastern Pipistrelle), TABR = *Tadarida brasiliensis* (Brazilian Free-tailed bat).

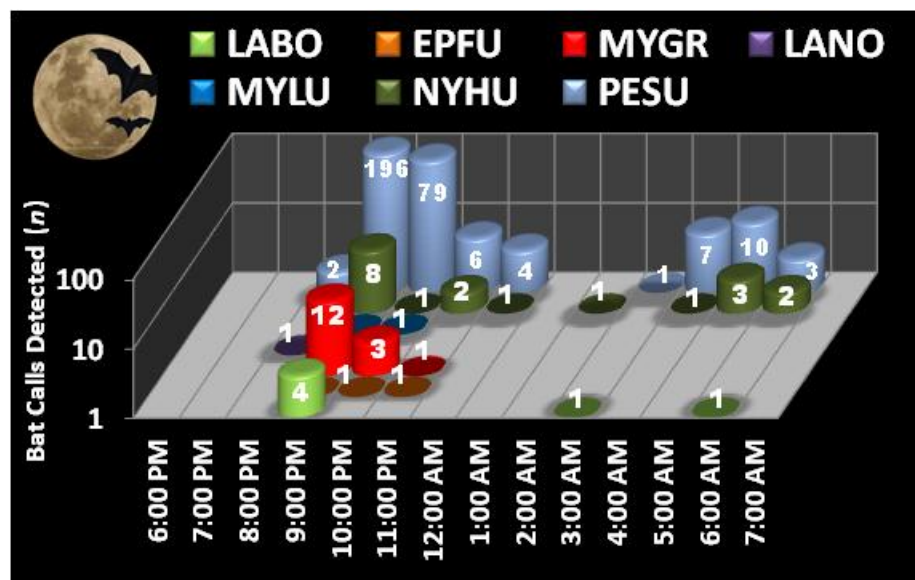


Figure 28: East Fork Road Wetlands (ED-1 Site)

Anabat Data / 7-19-13

(Passive Survey: Dusk until Dawn)

Bat calls/hour per species

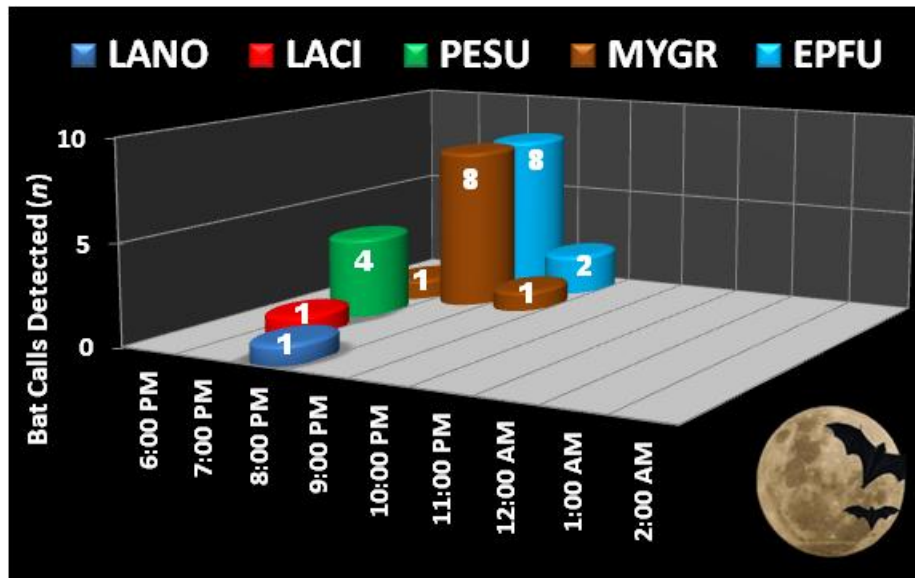


Figure 29: HC-1 — Horizon Center expansion area (north of center)
 Anabat Data / 9-27-12
 (Active Survey: Dusk until 2:00 am)
 Bat calls/hour per species

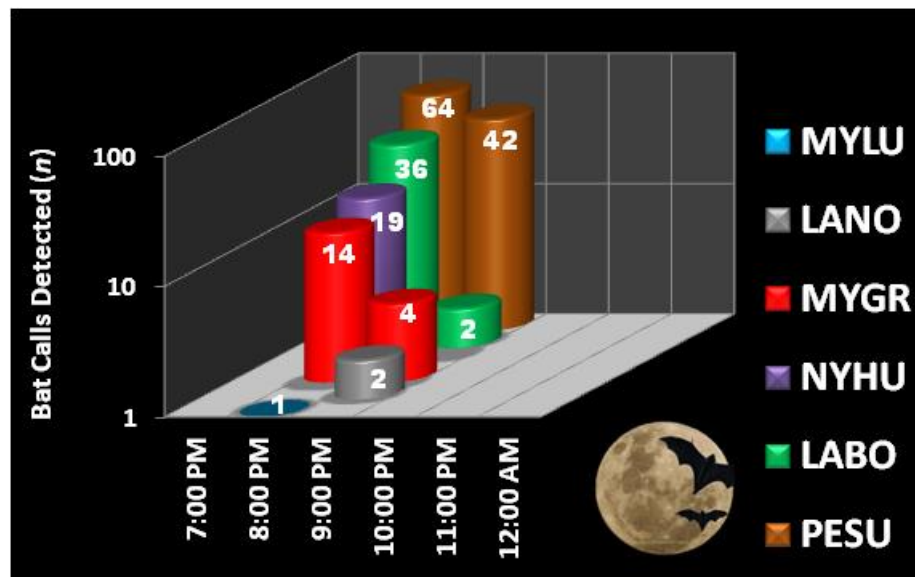


Figure 30: HC-2 — Horizon Center /Lower East Fork Poplar Creek
 (Near Novus Dr. bridge at record Sycamore) Anabat Data / 8-30-2013
 (Active Survey: Dusk until Midnight)
 Bat calls/hour per species

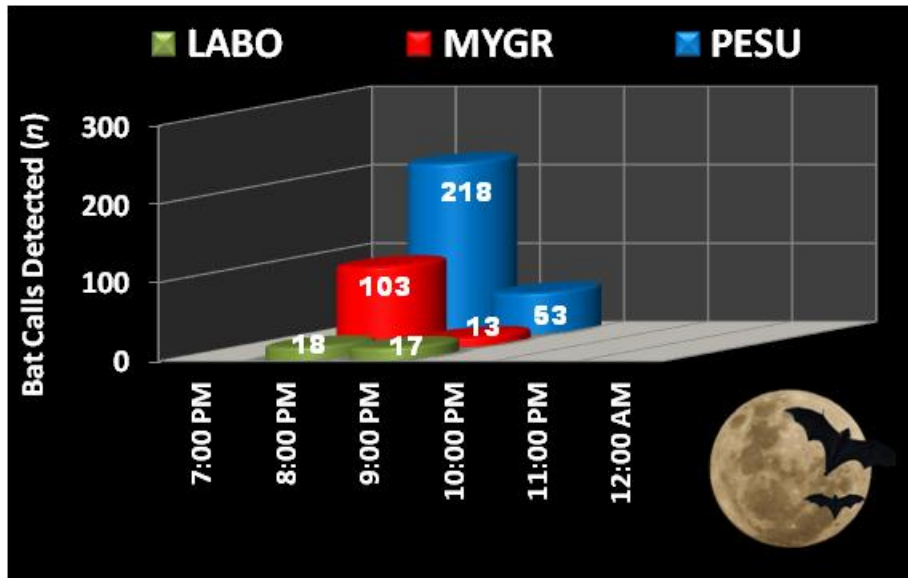


Figure 31: Poplar Creek Bridge / North Boundary Greenway
(confluence of EFPC with Poplar Creek) Anabat Data / 9-3-12
(Active Survey: Dusk until Midnight)
Bat calls/hour per species

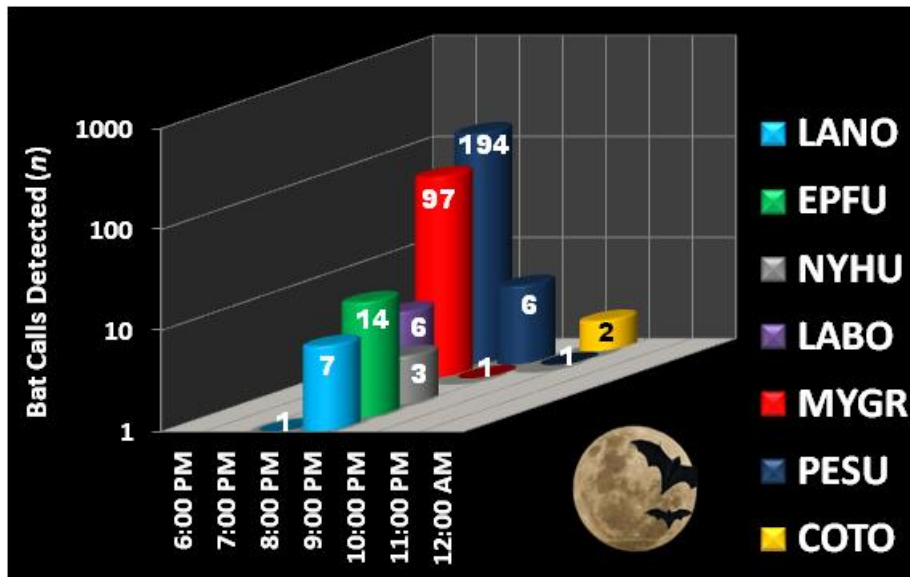


Figure 32: Lambert Quarry (west end ramp at shoreline)
Anabat Data / 9-11-2013
(Active Survey: Dusk until Midnight)
Bat calls/hour per species

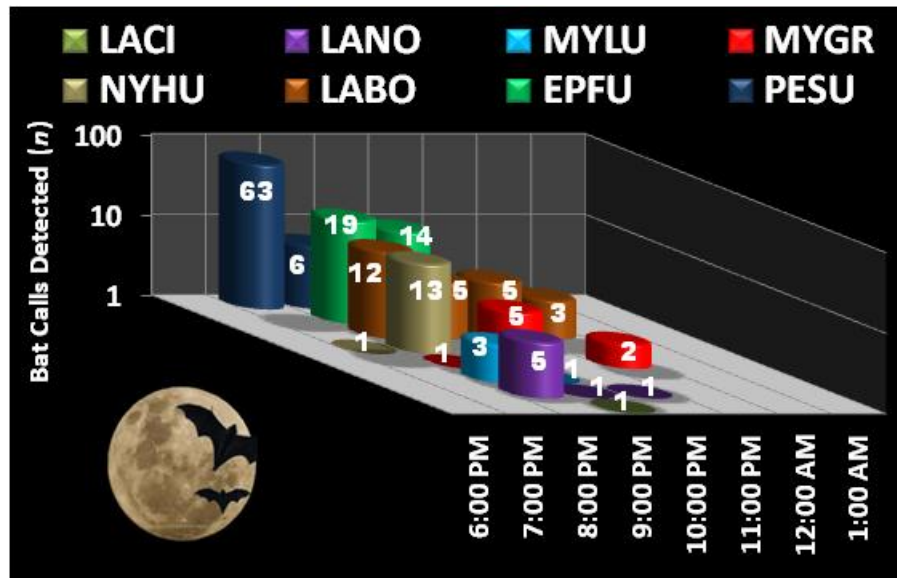


Figure 33: WW-1 — White Wing open grassy fields /forest edge
(City of Oak Ridge sludge application fields) Anabat Data / 9-24-2013
(Active Survey: Dusk until 2:00 am)
Bat calls/hour per species

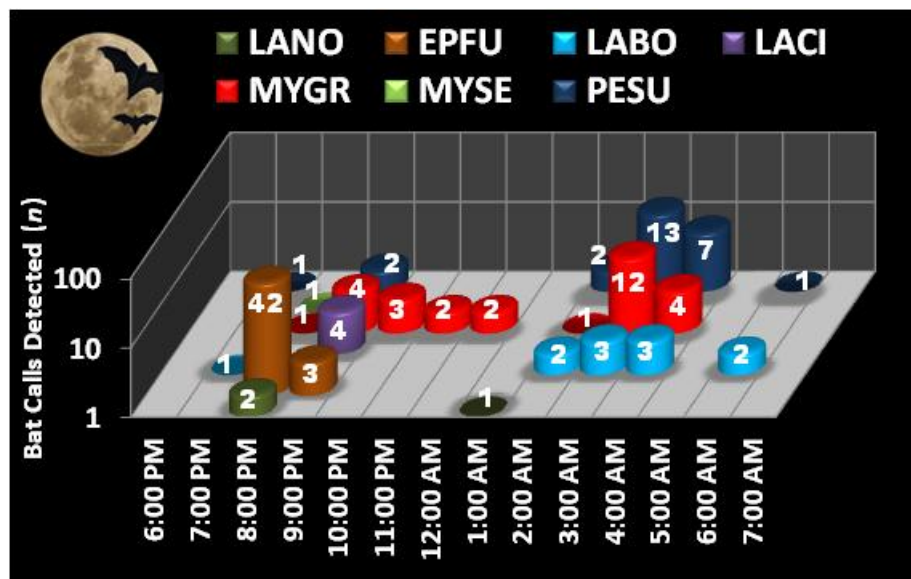


Figure 34: WW-2— White Wing Cemetery
(Forested hill above City Oak Ridge sludge fields) Anabat Data / 9-24-2013
(Passive Survey: Dusk until Dawn)
Bat calls/hour per species

6. JONES ISLAND / WAG 13 SECTION

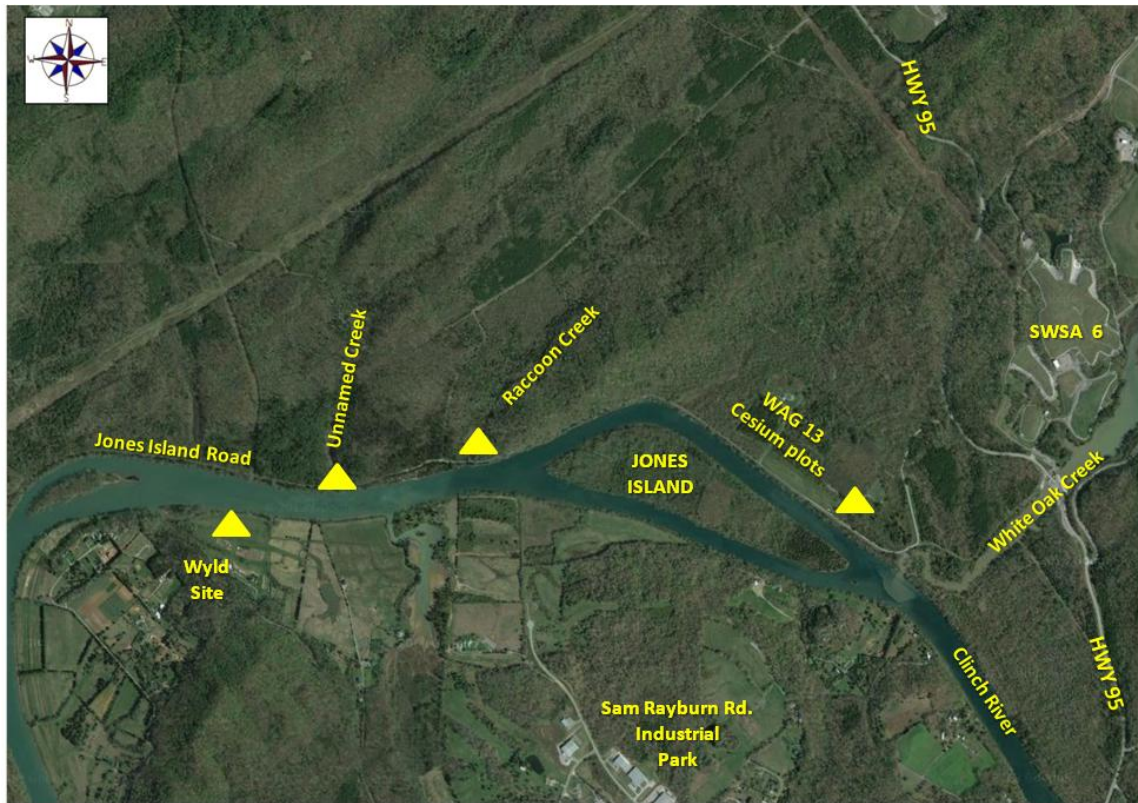


Figure 35: Jones Island / WAG 13 Section (ORNL)

	BAT TAXA DETECTED													ADDITIONAL SOFTWARE OUTPUT					
Bat Monitor Station ID	COTO	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR	UNKN	LOW FREQ	MID FREQ	MYOTIS	NUMBER OF BAT CALLS	TOTAL PULSES
Raccoon Cr		1	27	1	4						3	214		11	6	254	1	261	7578
Unnamed Cr		3	4	2	5	1					8	66		2	10	78	2	90	2415
WAG 13 Site			11	1	8	3		3			15	27		5	9	56	8	73	983
Wyld Site		3	5			2		3			1	40		1	3	47	5	55	499

Table 6: Summary Table of Bats Detected

Jones Island / WAG 13 Section

Note: The numbers in each *bat taxa detected* column represent the number of bat calls recorded at each monitoring station, **not** the number of bats present. A call is the series of frequency sweeps which a bat emits for navigation or location of a prey item (McCracken et al. 2013). Pulses are a rapid series of echolocation vocalizations emitted during the search, approach and feeding buzz phases as a bat searches and locates prey items. All Anabat files were processed using the BCID-East software program (validated with Kaleidoscope PRO program).

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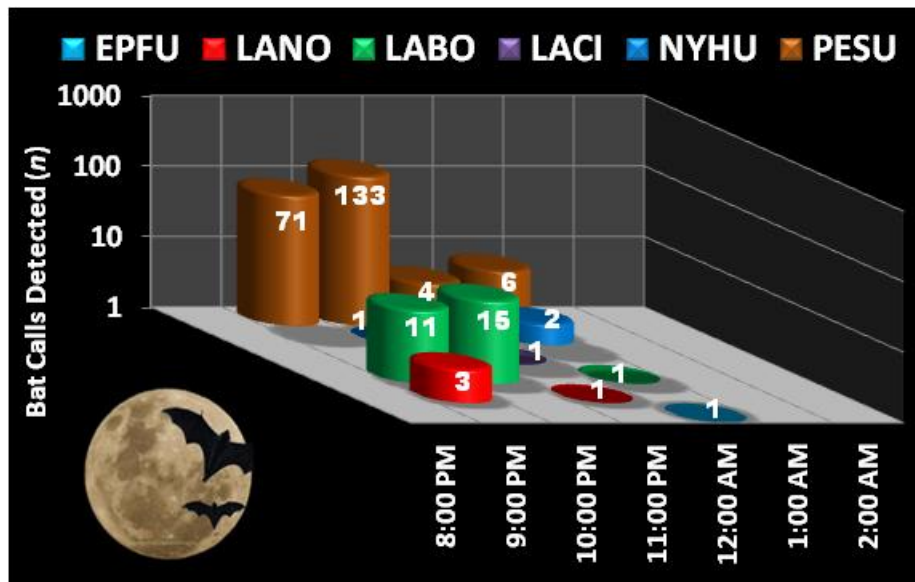


Figure 36: Jones Island— Raccoon Creek at Jones Island Road
 Anabat Data / 5-31-2013
 (Active Survey: Dusk until 2:00 am)
 Bat calls/hour per species

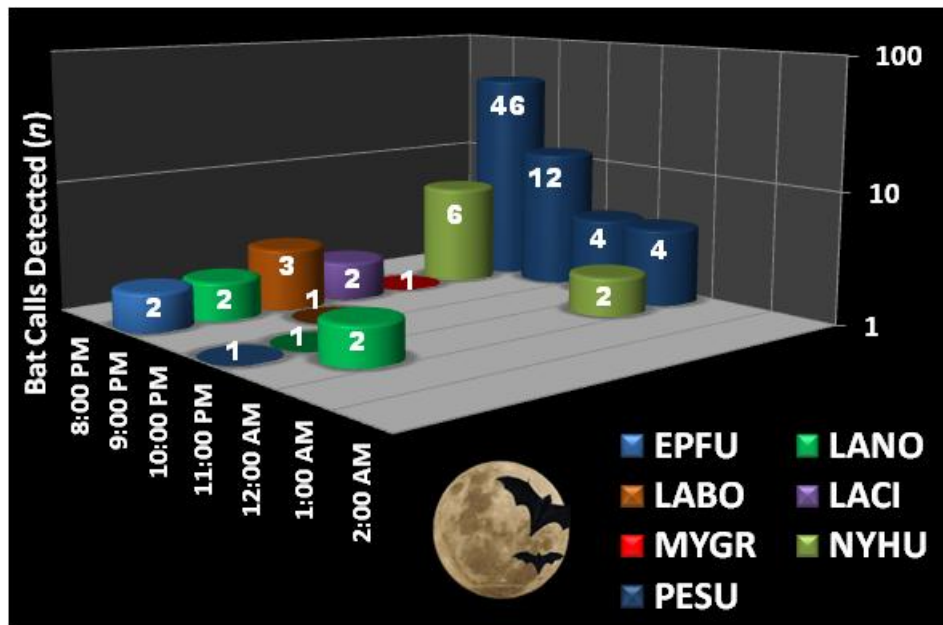


Figure 37: Jones Island— Unnamed Creek at Jones Island Road
 Anabat Data / 5-31-2013
 (Active Survey: Dusk until 2:00 am)
 Bat calls/hour per species

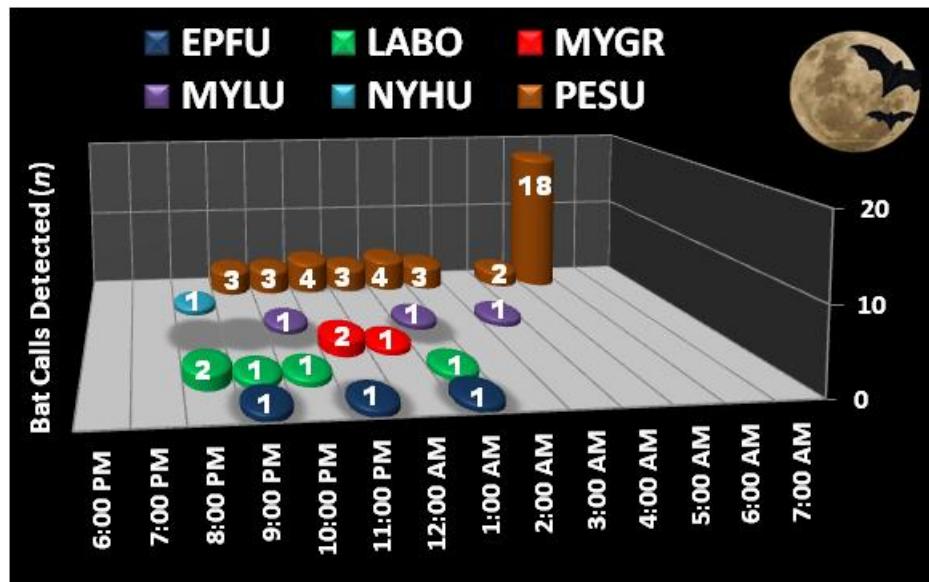


Figure 38: Jones Island (Wylde site – Roost Logger-2)
 Anabat Data / 8-21-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

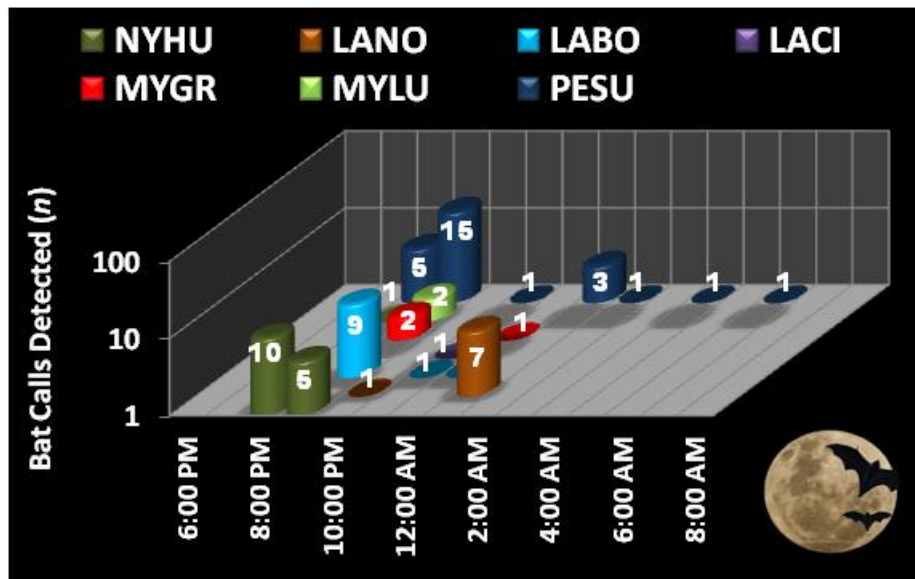


Figure 39: Jones Island WAG 13 Area (near Clinch River)
 Anabat Data / 5-31-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

7. SCARBORO DISC PARK / TURTLE PARK SECTION



Figure 40: Scarboro Disc Park / Turtle Park Section (City Oak Ridge) Section

Bat Monitor Station ID	BAT TAXA DETECTED													ADDITIONAL SOFTWARE OUTPUT					
	COTO	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR	UNKN	LOW FREQ	MID FREQ	MYOTIS	NUMBER OF BAT CALLS	TOTAL PULSES
Scarboro Park			17	1	5	8					4	203		4	6	227	8	242	8009
Turtle Park		10			9	1					2	46			19	48		68	2734

Table 7: Summary Table of Bats Detected

Scarboro Disc Park / Turtle Park (City of Oak Ridge) Section

Note: The numbers in each *bat taxa detected* column represent the number of bat calls recorded at each monitoring station, **not** the number of bats present. A call is the series of frequency sweeps which a bat emits for navigation or location of a prey item (McCracken et al. 2013). Pulses are a rapid series of echolocation vocalizations emitted during the search, approach and feeding buzz phases as a bat searches and locates prey items. All Anabat files were processed using the BCID-East software program (validated with Kaleidoscope PRO program).

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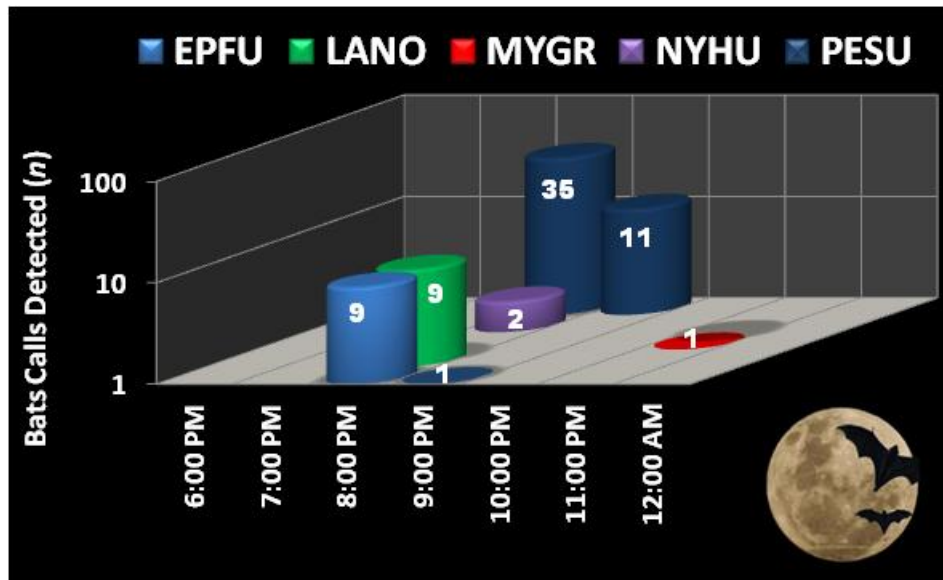


Figure 41: Turtle Park / East Fork Poplar Creek Bridge
(City of Oak Ridge) Anabat Data / 4-10-2013
(Active Survey: Dusk until Midnight)
Bat calls/hour per species

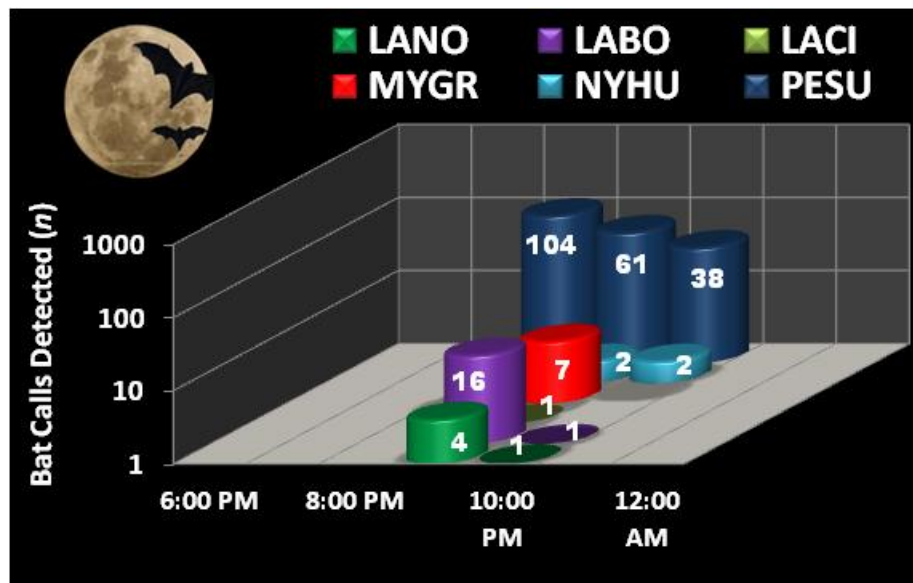


Figure 42: Scarboro Disc Park (City of Oak Ridge)
Anabat Data / 5-2-2013
(Active Survey: Dusk until Midnight)
Bat calls/hour per species

8. SOLWAY BEND / UT ARBORETUM SECTION

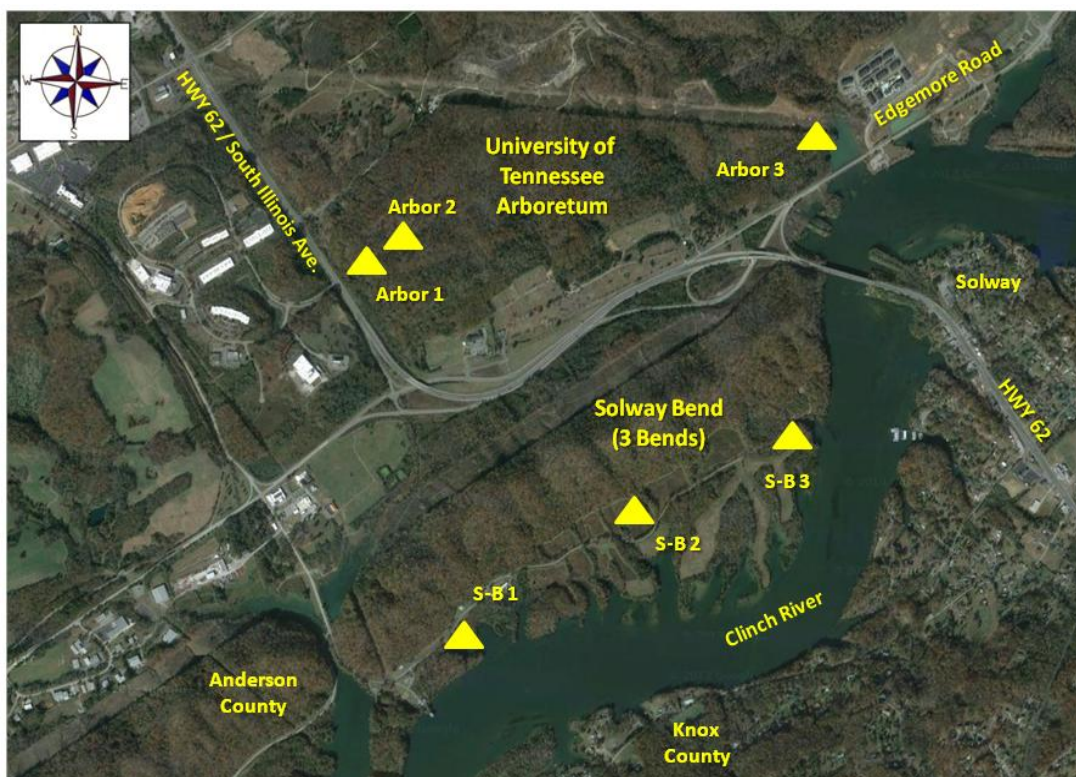


Figure 43: Solway Bend (TWRA 3 Bends) / UT Arboretum Section

Bat Monitor Station ID	BAT TAXA DETECTED														ADDITIONAL SOFTWARE OUTPUT				
	COTO	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR	UNKN	LOW FREQ	MID FREQ	MYOTIS	NUMBER OF BAT CALLS	TOTAL PULSES
Arbor-1		1	11			5	2	16	1	9	13	14		4	1	39	36	76	1333
Arbor-2		6				1		7	11	85	15	25		7	6	40	110	157	3348
Arbor-3			5			13	1	77		2	2	81		2		89	94	183	11852
Solway SB-1		22	11		10			3			15	146		1	32	173	3	208	7662
Solway SB-2			7		2	2		3			1	7	1		5	12	5	23	192
Solway SB-3		42	2	2	51	3		1			3	128		1	95	134	4	233	4483

Table 8: Summary Table of Bats Detected
Solway Bend (TWRA 3 Bends) / UT Arboretum Section

Note: The numbers in each *bat taxa detected* column represent the number of bat calls recorded at each monitoring station, **not** the number of bats present. A call is the series of frequency sweeps which a bat emits for navigation or location of a prey item (McCracken et al. 2013). Pulses are a rapid series of echolocation vocalizations emitted during the search, approach and feeding buzz phases as a bat searches and locates prey items. All Anabat files were processed using the BCID-East software program (validated with Kaleidoscope PRO program).

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Bat), PESU = *Perimyotis subflavus* (Tricolored Bat; Eastern Pipistrelle), TABR = *Tadarida brasiliensis* (Brazilian Free-tailed bat).

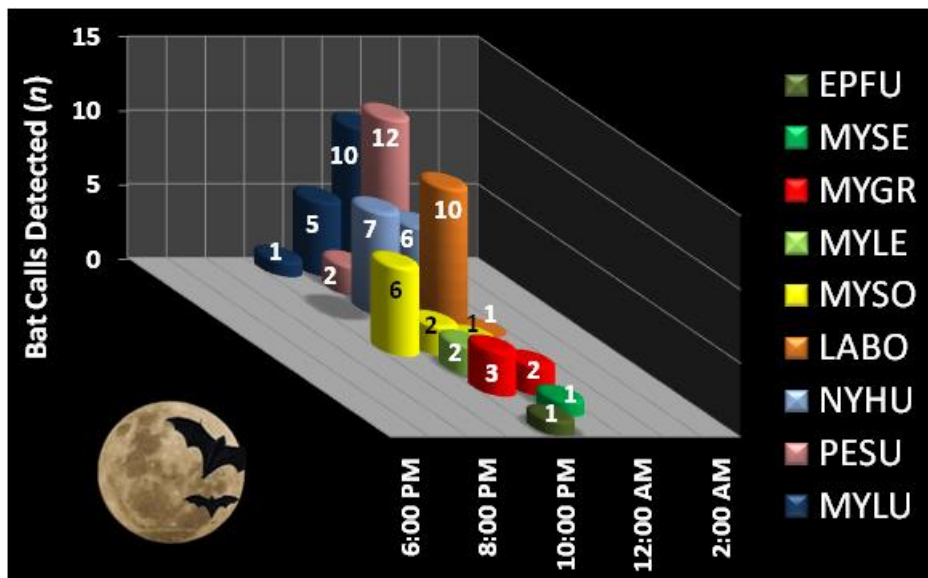


Figure 44: Arbor-1 (UT Arboretum)
Anabat Data / 6-3-2013
(Active Survey: Dusk until 2:00 am)
Bat calls/hour per species

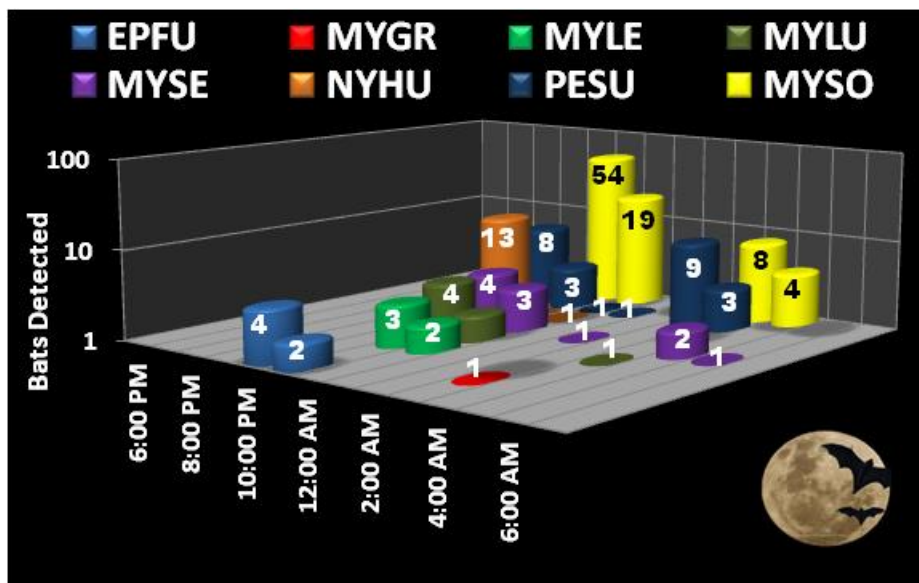


Figure 45: Arbor-2 (UT Arboretum)
Anabat Data / 7-8-2013
(Passive Survey: Dusk until Dawn)
Bat calls/hour per species

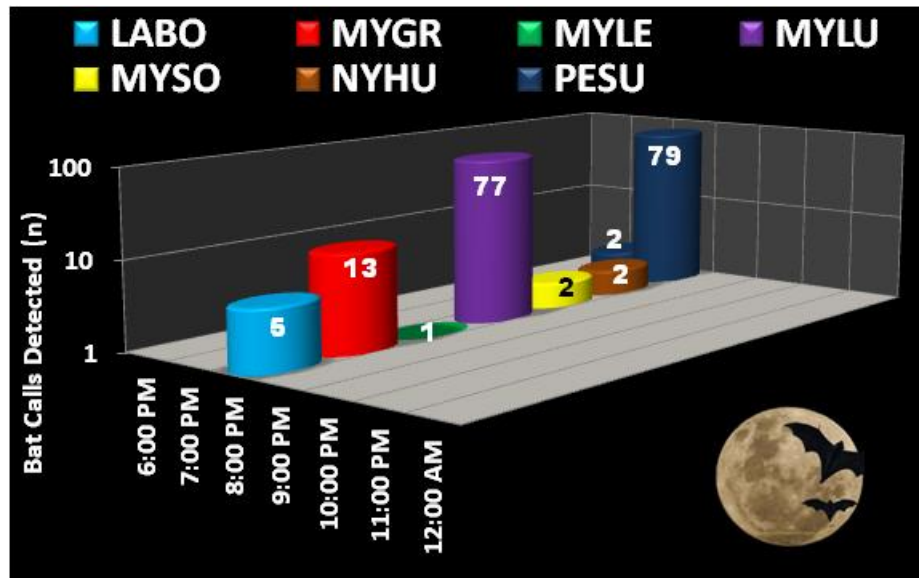


Figure 46: Arbor-3 (UT Arboretum)
 Anabat Data / 9-13-12
 (Active Survey: Dusk until Midnight)
 Bat calls/hour per species

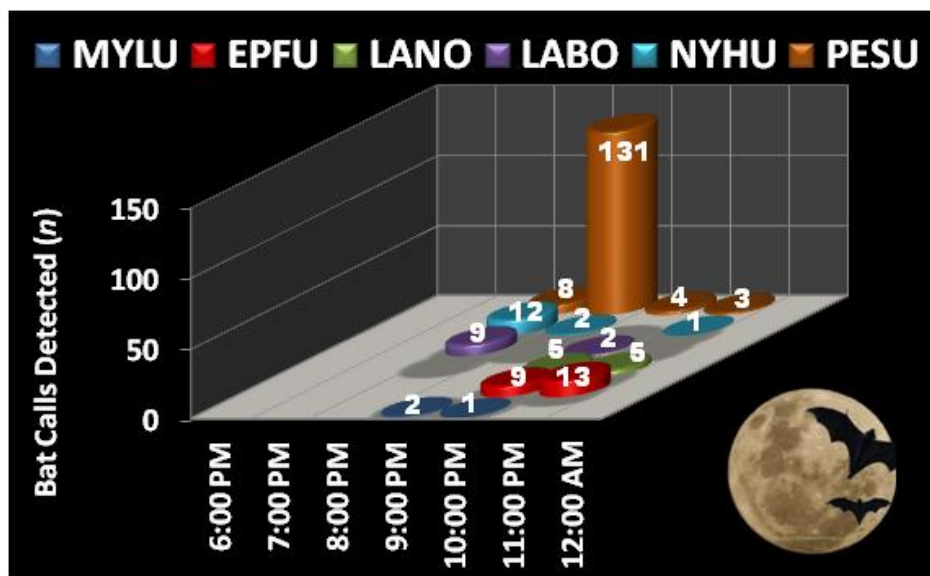


Figure 47: SB-1 (Solway Bend)
 Anabat Data / 8-25-2013
 (Active Survey: Dusk until Midnight)
 Bat calls/hour per species

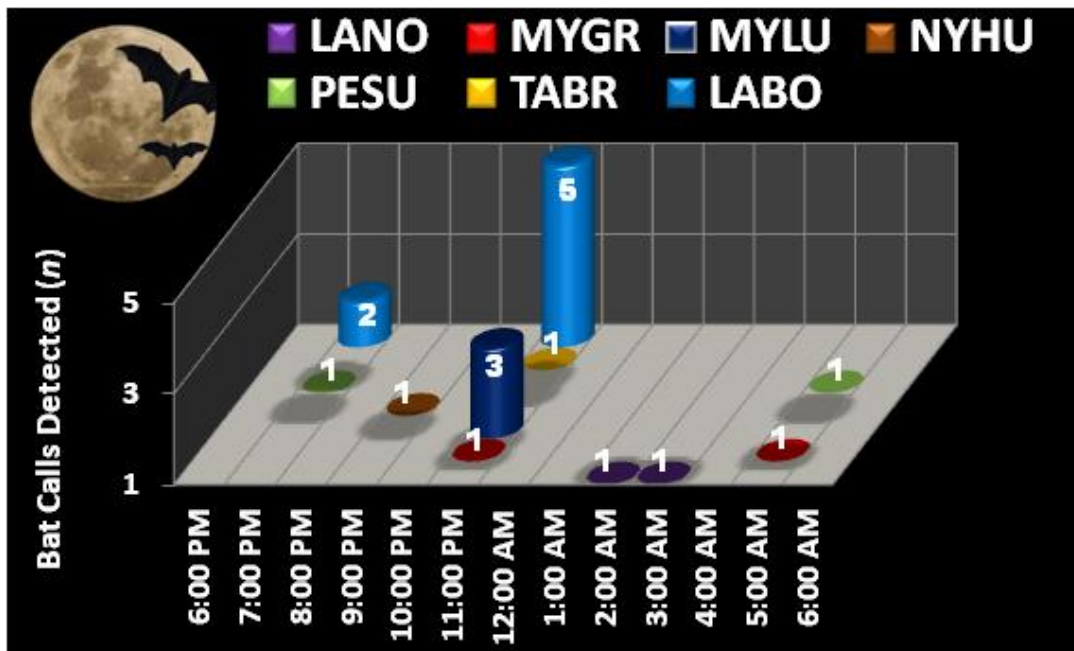


Figure 48: SB-2 (Solway Bend)
 Anabat Data / 10-11-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

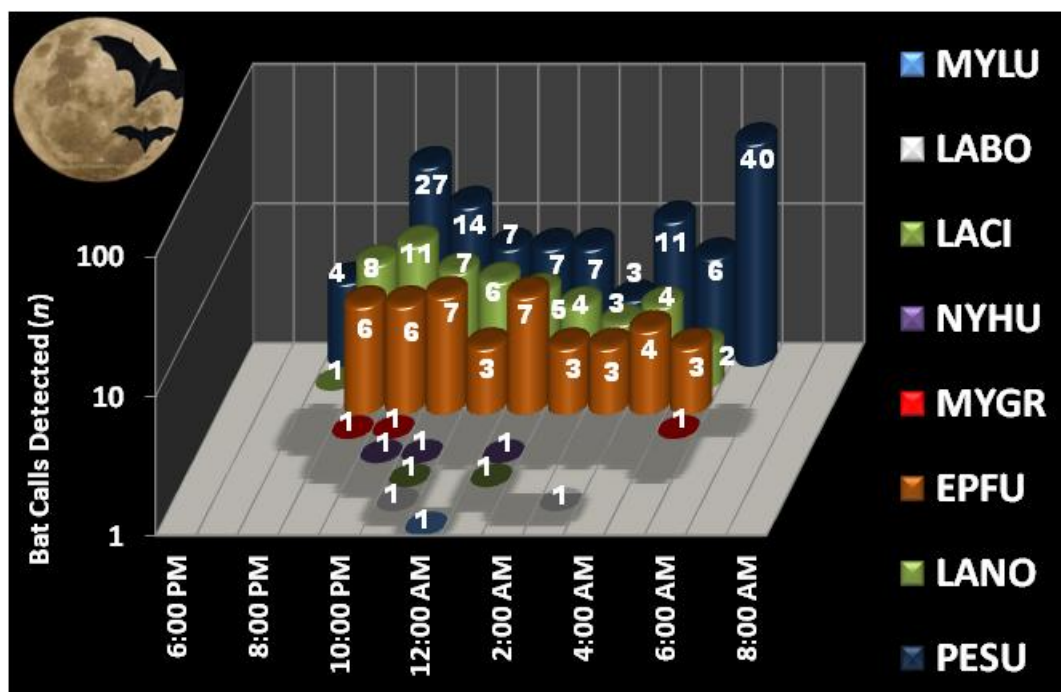


Figure 49: SB-3 (Solway Bend)
 Anabat Data / 8-15-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

9. WALKER BRANCH SECTION

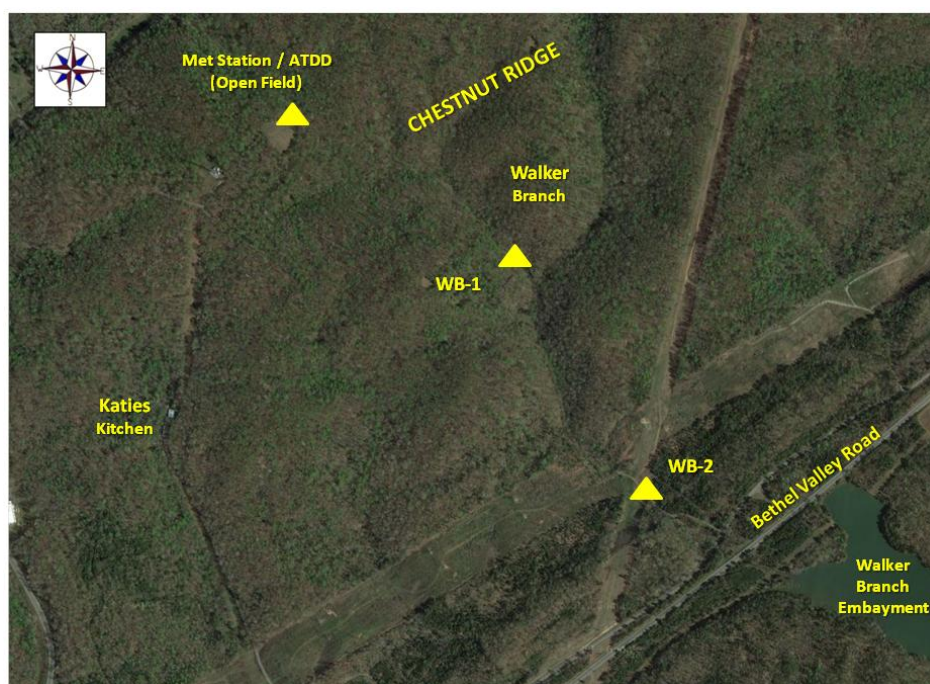


Figure 50: Walker Branch (ORNL) Section

	BAT TAXA DETECTED													ADDITIONAL SOFTWARE OUTPUT					
Bat Monitor Station ID	COTO	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR	UNKN	LOW FREQ	MID FREQ		NUMBER OF BAT CALLS	TOTAL PULSES
MET / ATDD			1		39			2			2	8		2	40	11	2	54	523
WB-1		1				33	5	21	2	13	1	23		7	1	25	80	106	1835
WB-2	1	18			3	1			3		2	1		3	21	4	4	32	262

Table 9: Summary Table of Bats Detected
Walker Branch (ORNL) Section

Note: The numbers in each *bat taxa detected* column represent the number of bat calls recorded at each monitoring station, **not** the number of bats present. A call is the series of frequency sweeps which a bat emits for navigation or location of a prey item (McCracken et al. 2013). Pulses are a rapid series of echolocation vocalizations emitted during the search, approach and feeding buzz phases as a bat searches and locates prey items. All Anabat files were processed using the BCID-East software program (validated with Kaleidoscope PRO program).

Taxonomic Codes: COTO = *Corynorhinus townsendii* (Townsend's Big-eared Bat), EPFU = *Eptesicus fuscus* (Big Brown Bat), LABO = *Lasiurus borealis* (Eastern Red Bat), LACI = *Lasiurus cinereus* (Hoary Bat), LANO = *Lasionycteris noctivagans* (Silver-haired Bat), MYGR = *Myotis grisescens* (Gray Bat), MYLE = *Myotis leibii* (Eastern Small-footed Bat), MYLU = *Myotis lucifugus* (Little Brown Bat), MYSE = *Myotis septentrionalis* (Northern Long-eared Bat), MYSO = *Myotis sodalis* (Indiana Bat), NYHU = *Nycticeius humeralis* (Evening Bat), PESU = *Perimyotis subflavus* (Tricolored Bat; Eastern Pipistrelle), TABR = *Tadarida brasiliensis* (Brazilian Free-tailed bat).

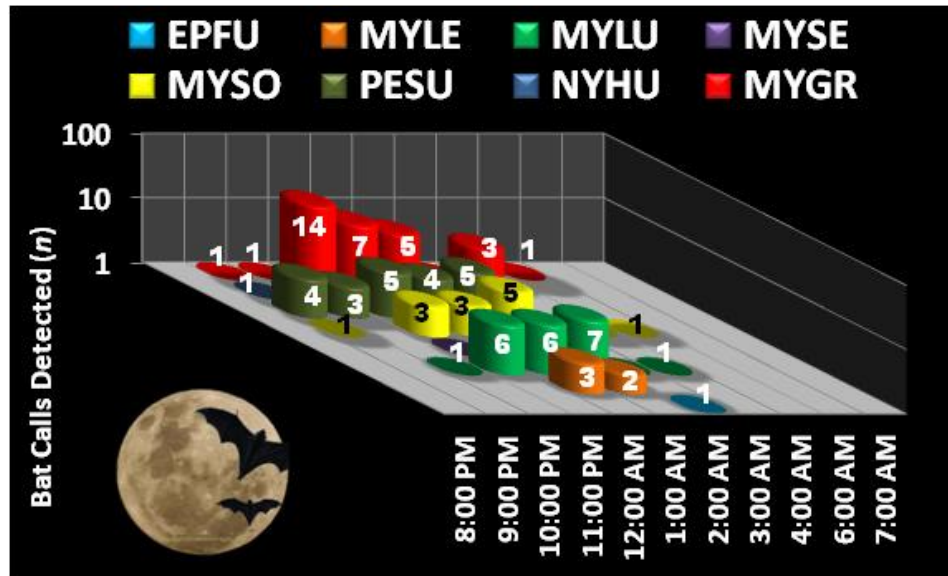


Figure 51: WB-1— Walker Branch (west fork; 100 yards north of weir)
 Anabat Data / 6-21-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

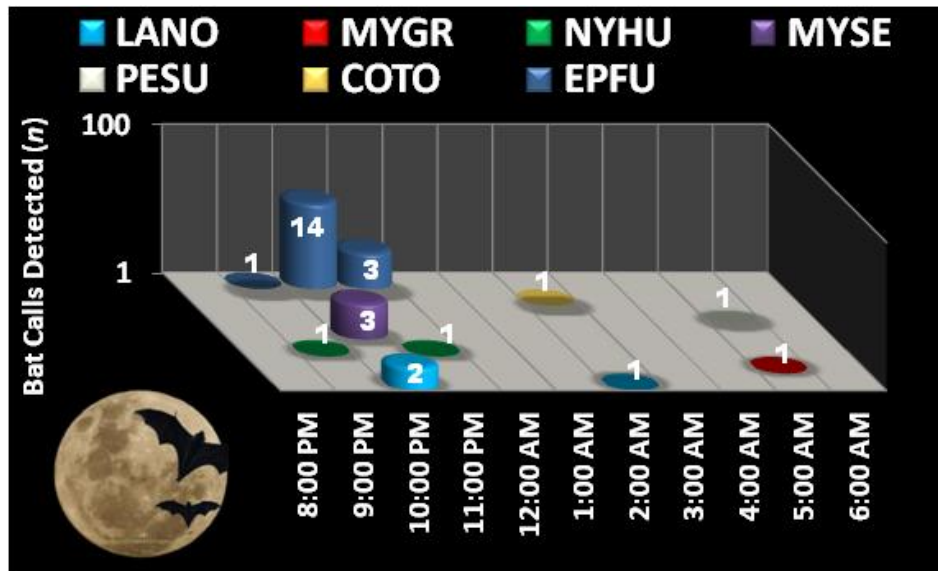


Figure 52: WB-2— Walker Branch (Powerline ROW—access road/forest edge)
 Anabat Data / 7-24-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

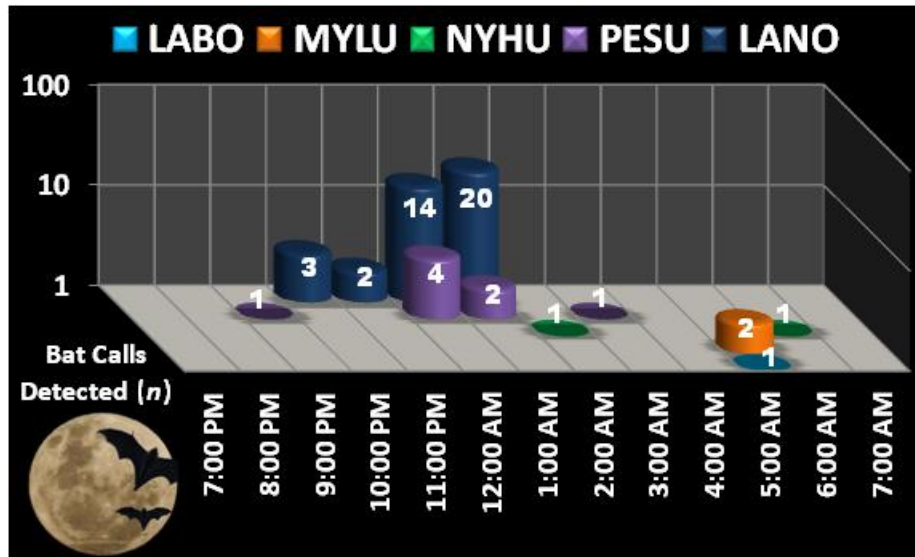


Figure 53: Meteorological / ATDD Station (open field)
 Anabat Data / 6-21-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

10. WEST BEAR CREEK VALLEY SECTION

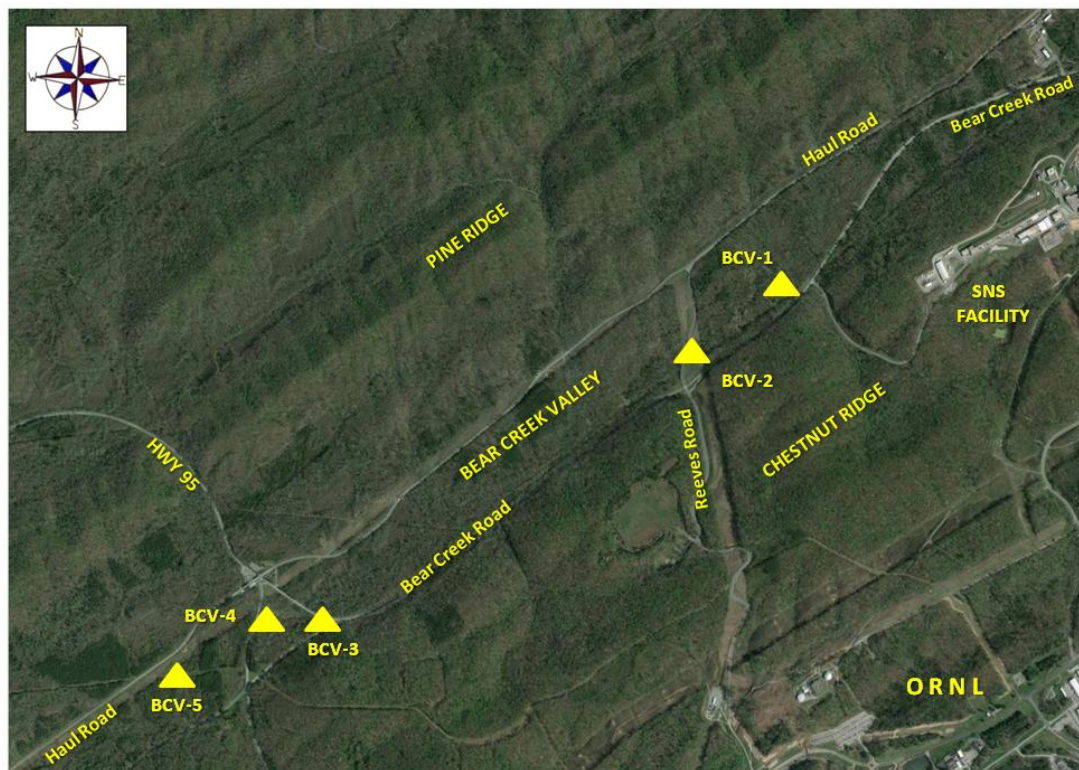


Figure 54: West Bear Creek Valley (Y-12) Section

Bat Monitor Station ID	BAT TAXA DETECTED													ADDITIONAL SOFTWARE OUTPUT					
	COTO	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR	UNKN	LOW FREQ	MID FREQ	MYOTIS	NUMBER OF BAT CALLS	TOTAL PULSES
BCV-1		144	37	1	297	21	1	23	2	1	18	479		19	443	542	56	1043	22209
BCV-2		8			9	1		2		2	1	6			17	7	5	29	278
BCV-3		5			4	5			1		2	68		5	9	71	8	90	1537
BCV-4		10	2	1	7	13		7		1	10	30		10	18	51	22	91	1029
BCV-5		1	1		5	2		2		2	1	13			6	15	6	27	285

Table 10: Summary Table of Bats Detected
West Bear Creek Valley (Y-12) Section

Note: The numbers in each *bat taxa detected* column represent the number of bat calls recorded at each monitoring station, **not** the number of bats present. A call is the series of frequency sweeps which a bat emits for navigation or location of a prey item (McCracken et al. 2013). Pulses are a rapid series of echolocation vocalizations emitted during the search, approach and feeding buzz phases as a bat searches and locates prey items. All Anabat files were processed using the BCID-East software program (validated with Kaleidoscope PRO program).

Taxonomic Codes: COTO = *Corynorhinus townsendii* (Townsend's Big-eared Bat), EPFU = *Eptesicus fuscus* (Big Brown Bat), LABO = *Lasiurus borealis* (Eastern Red Bat), LACI = *Lasiurus cinereus* (Hairy Bat), LANO = *Lasionycteris noctivagans* (Silver-haired Bat), MYGR = *Myotis grisescens* (Gray Bat), MYLE = *Myotis leibii* (Eastern Small-footed Bat), MYLU = *Myotis lucifugus* (Little Brown Bat), MYSE = *Myotis septentrionalis* (Northern Long-eared Bat), MYSO = *Myotis sodalis* (Indiana Bat), NYHU = *Nycticeius humeralis* (Evening Bat), PESU = *Perimyotis subflavus* (Tricolored Bat; Eastern Pipistrelle), TABR = *Tadarida brasiliensis* (Brazilian Free-tailed bat).

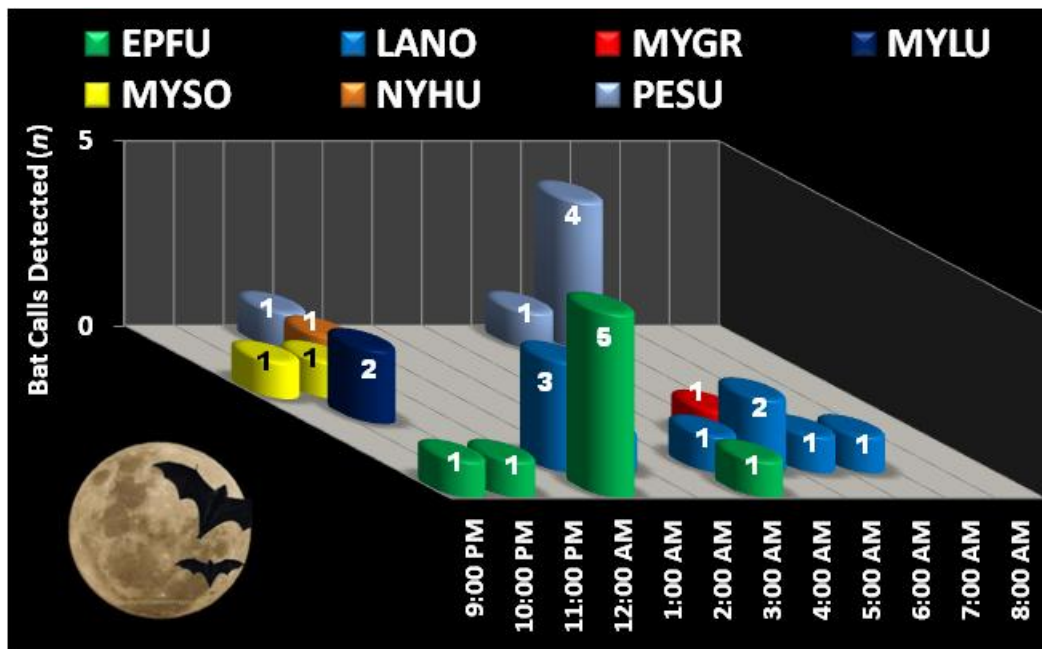


Figure 55: BCV-1—Bear Creek Wetland (SS-6 spring)
Anabat Data / 8-9-2013
(Passive Survey: Dusk until Dawn)
Bat calls/hour per species

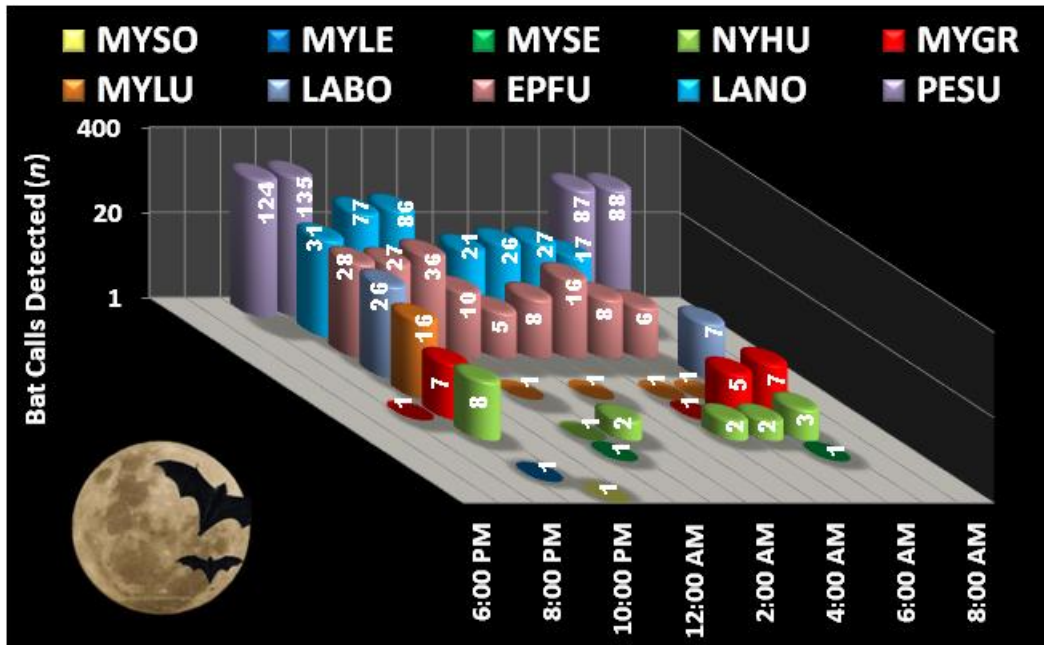


Figure 56: BCV-2— Bear Creek at Reeves Road bridge
 Anabat Data / 8-9-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

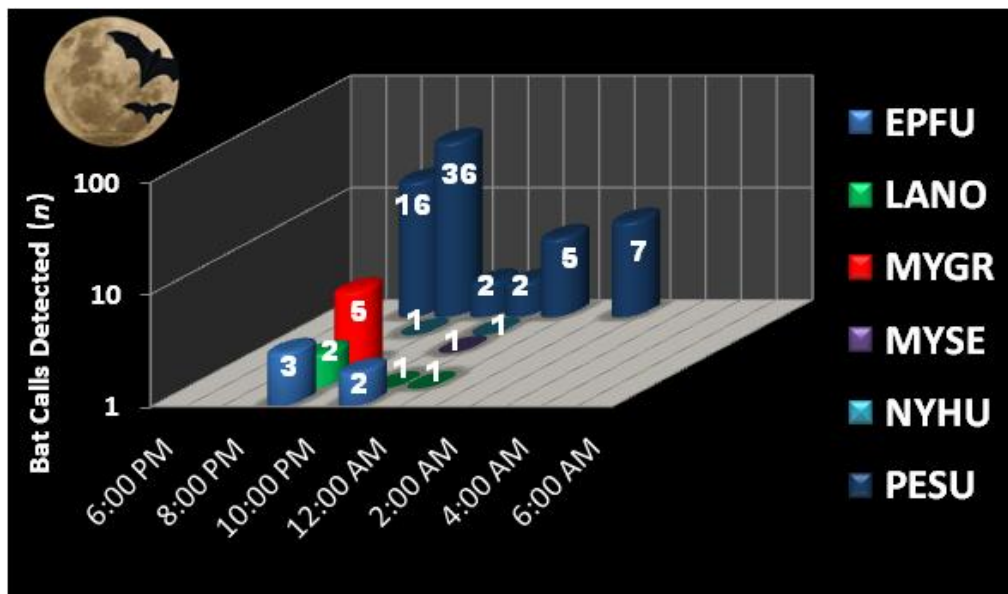


Figure 57: BCV-3—Bear Creek Wetland
 (east side BCK 4.5 km @ SS-7 spring) Anabat Data / 7-26-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

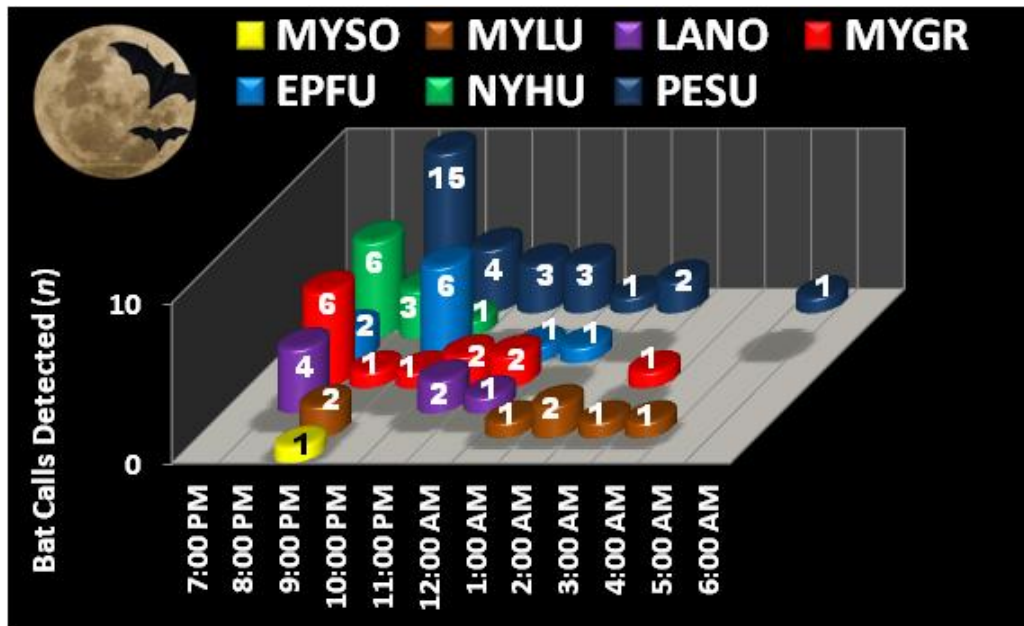


Figure 58: BCV-4—Bear Creek Wetland
 (West side BCK 4.5 km @ old weir) Anabat Data / 9-28-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

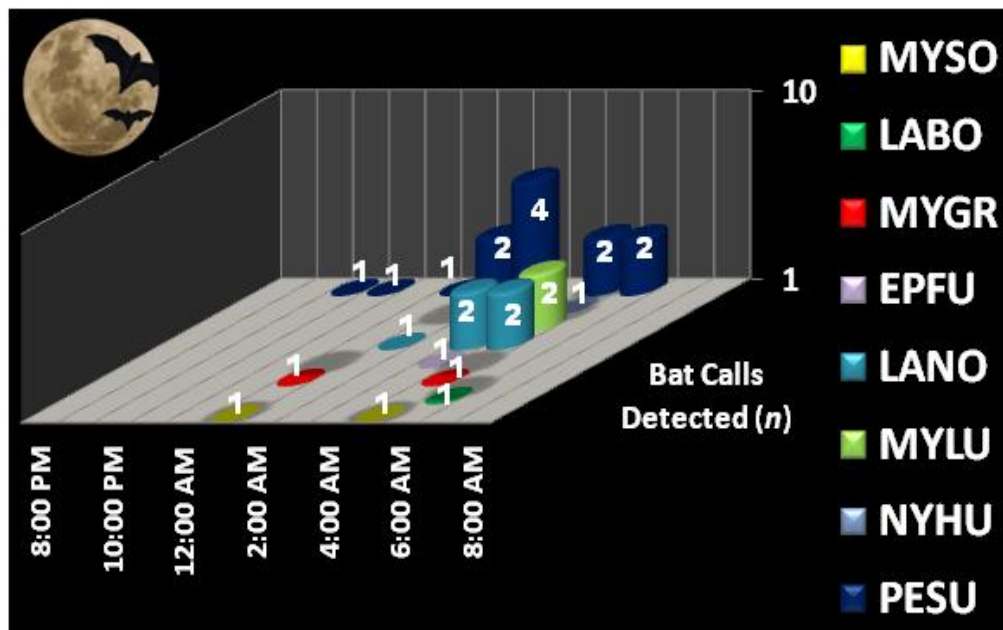


Figure 59: BCV-5— Haul Road
 (West of HWY 95 overpass/pipeline ROW) Anabat Data / 8-30-2013
 (Passive Survey: Dusk until Dawn)
 Bat calls/hour per species

Results Summary

During 2013, DOEO processed 6,231 bat call files (167,001 total pulses) collected from 47 Anabat monitoring sites on the ORR. Although we monitored bats for ≥ 75 survey nights (between April 15-October 31), and due to the tremendous volume of bat files about 50% of the data is actually recorded ($>12,000$ bat call files). Twenty-three (23) survey sites were passively monitored from dusk until dawn and 24 sites were actively monitored between dusk until midnight (or dusk until 2:00 am). DOEO used the automated software program: BCID-East (plus Kaleidoscope PRO for verification) for analysis of the Anabat files. Our analysis of identified calls suggests thirteen (13) bat species are present on the reservation including two federally endangered species (i.e., Gray Bat, Indiana Bat). DOEO also detected *Myotis leibii* (Eastern Small-footed bat) and *Myotis septentrionalis* (Northern Long-eared Bat) which have been under consideration by the USFWS for listing as federally endangered species. Although *M. leibii* has been temporarily dropped from consideration for listing, *M. septentrionalis* continues in the process of becoming listed as federally endangered. Moreover, DOEO collected 4 bat calls identified as *Corynorhinus townsendii* (Townsend's Big-eared Bat) recorded at Lambert Quarry and Walker Branch, and a single call identified as *Tadarida brasiliensis* (Brazilian Free-tailed Bat) recorded at Solway Bend. Approximately 66% of all bat calls recorded were mid frequency calls. *Perimyotis subflavus* (Tricolored Bat) calls represented 56% (3423 calls) of all bat calls recorded followed by *Lasionycteris noctivagans* (Silver-haired Bat) = 9% (525 calls), *Myotis grisescens* (Gray Bat) = 8% (480 calls), *Eptesicus fuscus* (Big Brown Bat) = 7% (413 calls), *Myotis lucifugus* (Little Brown Bat) = 6% (356 calls), *Lasiurus borealis* (Eastern Red Bat) = 5% (312 calls), *Nycticeius humeralis* (Evening Bat) = 4% (268 calls), and *Myotis sodalis* (Indiana Bat) = 3% (181 calls). This study, along with a concurrent ORNL Environmental Science Division bat project, was the first long term, large-scale acoustic bat community investigation on the ORR.

														LOW	MID	MYOTIS	NO. OF	
COTO	EPFU	LABO	LACI	LANO	MYGR	MYLE	MYLU	MYSE	MYSO	NYHU	PESU	TABR	UNKN	FREQ	FREQ	FREQ	BAT	TOTAL
4	413	312	28	527	480	23	356	47	181	268	3423	1	169	974	4085	1133	6231	167001

Table 11: Summary Table (Combined Bat Calls for All Taxa)

Taxonomic Codes: COTO = *Corynorhinus townsendii* (Townsend's Big-eared Bat), EPFU = *Eptesicus fuscus* (Big Brown Bat), LABO = *Lasiurus borealis* (Eastern Red Bat), LACI = *Lasiurus cinereus* (Hoary Bat), LANO = *Lasionycteris noctivagans* (Silver-haired Bat), MYGR = *Myotis grisescens* (Gray Bat), MYLE = *Myotis leibii* (Eastern Small-footed Bat), MYLU = *Myotis lucifugus* (Little Brown Bat), MYSE = *Myotis septentrionalis* (Northern Long-eared Bat), MYSO = *Myotis sodalis* (Indiana Bat), NYHU = *Nycticeius humeralis* (Evening Bat), PESU = *Perimyotis subflavus* (Tricolored Bat; Eastern Pipistrelle), TABR = *Tadarida brasiliensis* (Brazilian Free-tailed bat).

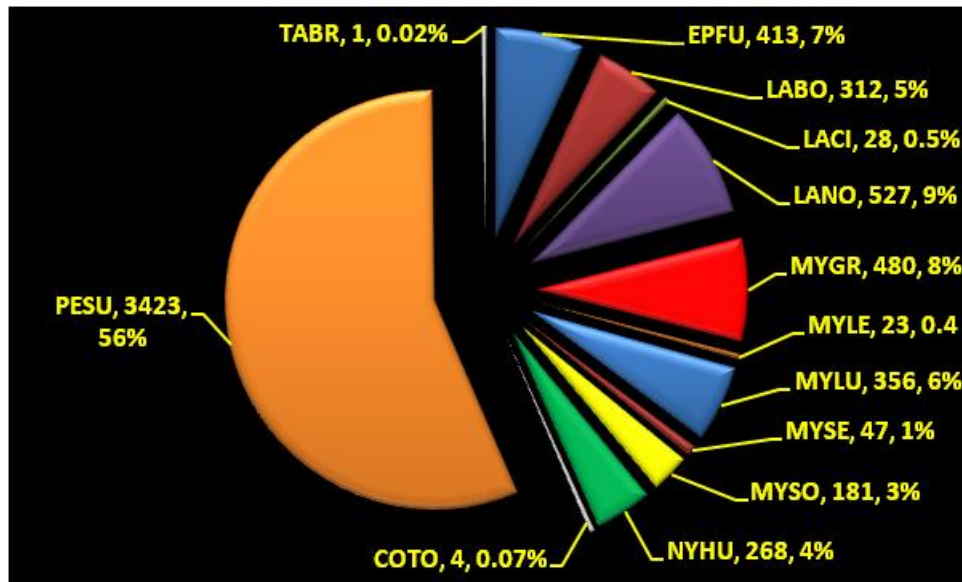


Figure 60: Summary Pie Chart

Combined 2013 Anabat Data (Total Bat Calls Per Taxon)

Taxonomic Codes: COTO = *Corynorhinus townsendii* (Townsend's Big-eared Bat), EPFU = *Eptesicus fuscus* (Big Brown Bat), LABO = *Lasiurus borealis* (Eastern Red Bat), LACI = *Lasiurus cinereus* (Hoary Bat), LANO = *Lasionycteris noctivagans* (Silver-haired Bat), MYGR = *Myotis grisescens* (Gray Bat), MYLE = *Myotis leibii* (Eastern Small-footed Bat), MYLU = *Myotis lucifugus* (Little Brown Bat), MYSE = *Myotis septentrionalis* (Northern Long-eared Bat), MYSO = *Myotis sodalis* (Indiana Bat), NYHU = *Nycticeius humeralis* (Evening Bat), PESU = *Perimyotis subflavus* (Tricolored Bat; Eastern Pipistrelle), TABR = *Tadarida brasiliensis* (Brazilian Free-tailed bat).

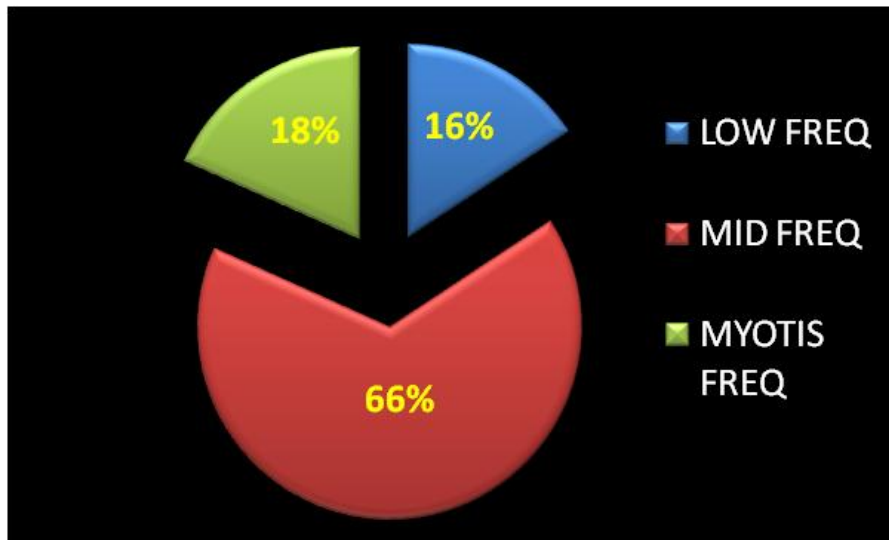


Figure 61: Summary Pie Chart

Combined 2013 Anabat Data (Total Bats Per Frequency)

Although the federally endangered *M. sodalis* (Indiana Bat) has not been documented on the ORR since 1950, DOEO detected this bat at 16 of our 47 study sites during 2013 Anabat surveys. Further supporting our analysis, a male Indiana Bat was captured on the ORR during a mist-net survey at Freels Bend in June 2013 (McCracken et al. 2013). DOEO also detected the federally endangered *Myotis grisescens* (Gray Bat) at 38 of 47 sites and *Myotis septentrionalis* (Northern Long-eared Bat) at 11 of 47 sites during 2013 Anabat surveys. The Northern Long-eared Bat is currently under consideration by the US Fish & Wildlife Service for listing as a federally endangered species.

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