

Appendix J: 2016 Northern Long-eared Bat Acoustic Survey

**Northern Long-eared Bat Acoustic Survey
I-93 Exit 4A Interchange Project,
Derry and Londonderry, NH**

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TABLE OF CONTENTS

Summary	1
1.0 Project Overview	1
2.0 Methods.....	1
3.0 Results	3
3.1 Overall Habitat Assessment	3
3.2 Deployment Details.....	3
3.3 Survey Results	7
Appendix A Figures.....	9
Appendix B Weather	12
Appendix C Photos of Detector Set-up & Habitat	19
Resumes	38

Summary

Ultrasonic acoustic surveys were conducted to inventory the federally threatened northern long-eared bat (NLEB; *Myotis septentrionalis*) within the I-93 Exit 4A interchange project area, located in the towns of Derry and Londonderry, New Hampshire (NH). The project route and route alternatives primarily follow existing ROW and road networks, spanning roughly 13 kilometers in length. Twelve of these kilometers were determined to potentially provide habitat for NLEB based on on-site visual assessments. Surveys were conducted from August 8 through August 15, 2016 within 12 pre-determined 1 kilometer segments. All segments were required to be surveyed a minimum of two detector nights, achieved with one detector per kilometer for two nights. Six of the segments were surveyed from Aug 8 to Aug 10, and six were surveyed from August 10 to August 12. The detector from Segment 3 (surveyed Aug 8-Aug 10) malfunctioned, and an additional two survey nights were needed. Bat calls were recorded at eleven of the twelve Segments, none of which returned positive results for NLEB. Other species likely to be present include big brown bat, eastern red bat, hoary bat, silver-haired bat, little brown bat, and tricolored bat.

1.0 Project Overview

The Project consists of constructing the on and off ramps to I-93 and a connector road, and improvements to the existing roadway that the connector will join into. Five alternatives are under consideration, four of which would require varying amounts of tree clearing. Surveys assessed potentially suitable habitat for all four tree-clearing alternatives.

The project is within the range of the federally threatened and state threatened NLEB. This tree-roosting bat uses forested habitats during its active season, from April 15 – October 31. The project has the potential to affect this species via tree clearing, which could reduce roosting habitat or potentially cause direct mortality if an occupied roost tree is felled when bats are present. Therefore, a survey compliant with the USFWS' 2016 *Range-wide Indiana Bat Summer Survey Guidelines* (Guidelines), which are also applicable to summer survey for NLEB, was conducted to determine if NLEB are present. Results of the survey are summarized below, and these results include all the elements requested in Appendix C of the 2016 Guidelines.

2.0 Methods

The survey was conducted in conformance with the methods and approach outlined in the Guidelines. The field survey and the data analysis were conducted by personnel trained and qualified to conduct their respective tasks. Staff resumes are attached at the end of this document.

Habitat Assessment

The general suitability of the habitat on this site was assessed by examining recent aerial photography of the site (Google Earth™) prior to deploying the detectors. In the field, the characteristics of the habitat were examined in all locations where acoustic detectors were placed, to confirm that suitable habitat was present. The desktop assessment was conducted by Sarah Barnum, Ph.D., CWB®, and the on-site observations of the surrounding vegetation within the project area were conducted by acoustic survey technician Jamie O'Brien. Their resumes are attached to the end of this document, and results of the assessment are presented in Section 3.1.

Detector Deployment

Normandeau conducted the survey using full-spectrum ultrasonic acoustic detectors. As defined by the Guidelines, this project was categorized as linear; therefore it was surveyed as 12 1-kilometer segments, requiring a minimum of two survey nights each. Detectors placed for Segments 1, 2, 4 through 7, and 9 were placed along existing power line right-of-ways. Detectors surveying Segments 3, 10, and 12 were placed along roadsides, and detectors for segments 8 and 11 were placed along a small bike/foot path and the edge of town-owned recreation fields, respectively. All acoustic detectors were left in place to collect data on sequential nights with suitable weather conditions described in the Guidelines, yielding two detector nights of data for each segment.

The sampling locations were selected based on a combination of factors including access, best site conditions to deploy the equipment so that it would not be disturbed, an open cone of detection for the microphones to sample, and apparent bat habitat quality (e.g., mature trees, snags, hollows and crevices, and wetland habitat). The detector set-up adhered to specifications detailed in the Guidelines.

To ensure that the detectors were functioning correctly during every survey period, settings were checked upon retrieval of the detectors in a similar fashion as to when they are deployed: 1) the microphones were checked for proper recording of sounds and archival of data onto the internal drive/USB; and 2) the program recording times, detector limits, and acoustic range were verified.

Call Analysis

The entire call analysis process was managed via Normandeau's ReBAT® data management system, which tracks each acoustic recording file after upload throughout the call analysis process and stores all results in a MySQL database. Each acoustic file was processed as required by the 2016 Guidelines using Kaleidoscope Pro v 3.1.4, zero crossing, which is one of the USFWS-approved automated bat call classification software packages. The software analyzes bat calls and determines the probability (or "likelihood of presence p (probability) value") that they were made by a certain bat species. Any probability less than 0.05 is statistically interpreted to mean that the call belongs to that species. Probabilities <1 but >0.05 indicate that calls of certain species were identified but the probabilities were not low enough to confirm presence, or that no calls of that specie were detected. If bat call files were identified by the

software package as belonging or potentially belonging to the NLEB, they were manually examined for final determination by Stephen Lindsay, a trained bat acoustic expert and call analyst. His resume is attached at the end of this document.

3.0 Results

3.1 Overall Habitat Assessment

The general location of the survey site is depicted in Figure A-1, Appendix A. Overall, the Project area consists of developed roads bordered by commercial and residential lots, as well as existing right-of-ways and undeveloped forest in the southwestern corner of the project area (Segments 7 and 8). A mix of forest cover types are present, but predominantly were composed of a hardwood/softwood tree mixture. Varying wetland cover types were also present, including emergent marshes and vernal pools close to some of the detector locations. Snags were present at many of the chosen survey locations, and structures such as an old bridge, residential houses, and commercial buildings provided potential roost alternatives. The on-site trees consisted primarily of northern red oak (*Quercus rubra*), Eastern white pine (*Pinus strobus*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), and white oak (*Quercus alba*).

3.2 Deployment Details

The survey was conducted from August 8 through August 15, 2016 and the detectors were programmed to run from 19:32 UTC (coordinated universal time) until 6:01 UTC the following morning. One acoustic detector was placed in each of the 12 1-kilometer segments for two nights to capture a total of two detector nights per segment (Figure A-1, Appendix A). Detectors are placed at least 200 m apart, as per USFWS guidelines. Photos of the detector set-ups are presented in Appendix C. Details of the survey for each of the recording nights are summarized in Table 1 and specifications of the detectors and microphones used are summarized in Table 2.

Hourly weather conditions from Manchester Airport (KMHT), the NOAA weather reporting station nearest to Derry and Londonderry, are presented in Appendix B for each of the survey nights. Although weather was acceptable for each of the first four survey nights (Aug 8-Aug 12), malfunctions with the IFR unit at Segment 3 (i.e. recording device) added an additional three survey nights, as one of the additional nights failed due to weather.

Table 1. Deployment Details

Detector	Date	Lat	Long	Begin	End	Sunset	Hi Temp*	Low Temp*	Max Wind*	Weather
Segment 1	10-Aug-16	42.897556	-71.359398	19:32	6:01	19:55	80	75	S 8	A Few Clouds
	11-Aug-16	42.897556	-71.359398	19:32	6:01	19:54	93	80	W 7	Mostly Cloudy
Segment 2	8-Aug-16	42.901321	-71.350533	19:32	6:01	19:58	84	68	W 10	Fair
	9-Aug-16	42.901321	-71.350533	19:32	6:01	19:57	86	72	SW 8	Mostly Cloudy
Segment 3	8-Aug-16	42.898766	-71.336708	19:32	6:01	19:58	84	68	W 10	Fair
	9-Aug-16	42.898766	-71.336708	19:32	6:01	19:57	86	72	SW 8	Mostly Cloudy
	12-Aug-16	42.898766	-71.336708	19:32	6:01	19:53	90	80	W 12	Mostly Cloudy
	13-Aug-16	42.898766	-71.336708	19:32	6:01	19:51	71	67	E 9	Light Rain
	14-Aug-16	42.898766	-71.336708	19:32	6:01	19:50	88	79	W 7	Mostly Cloudy
Segment 4	10-Aug-16	42.903927	-71.327835	19:32	6:01	19:55	80	75	S 8	A Few Clouds
	11-Aug-16	42.903927	-71.327835	19:32	6:01	19:54	93	80	W 7	Mostly Cloudy
Segment 5	10-Aug-16	42.909554	-71.318184	19:32	6:01	19:55	80	75	S 8	A Few Clouds
	11-Aug-16	42.909554	-71.318184	19:32	6:01	19:54	93	80	W 7	Mostly Cloudy
Segment 6	10-Aug-16	42.912567	-71.311035	19:32	6:01	19:55	80	75	S 8	A Few Clouds
	11-Aug-16	42.912567	-71.311035	19:32	6:01	19:54	93	80	W 7	Mostly Cloudy
Segment 7	8-Aug-16	42.887005	-71.348640	19:32	6:01	19:58	84	68	W 10	Fair
	9-Aug-16	42.887005	-71.348640	19:32	6:01	19:57	86	72	SW 8	Mostly Cloudy
Segment 8	8-Aug-16	42.892834	-71.337456	19:32	6:01	19:58	84	68	W 10	Fair
	9-Aug-16	42.892834	-71.337456	19:32	6:01	19:57	86	72	SW 8	Mostly Cloudy
Segment 9	8-Aug-16	42.888718	-71.338760	19:32	6:01	19:58	84	68	W 10	Fair
	9-Aug-16	42.888718	-71.338760	19:32	6:01	19:57	86	72	SW 8	Mostly Cloudy
Segment 10	8-Aug-16	42.898724	-71.321800	19:32	6:01	19:58	84	68	W 10	Fair
	9-Aug-16	42.898724	-71.321800	19:32	6:01	19:57	86	72	SW 8	Mostly Cloudy
Segment 11	10-Aug-16	42.904358	-71.317345	19:32	6:01	19:55	80	75	S 8	A Few Clouds
	11-Aug-16	42.904358	-71.317345	19:32	6:01	19:54	93	80	W 7	Mostly Cloudy
Segment 12	10-Aug-16	42.904816	-71.310257	19:32	6:01	19:55	80	75	S 8	A Few Clouds
	11-Aug-16	42.904816	-71.310257	19:32	6:01	19:54	93	80	W 7	Mostly Cloudy

*High temp, low temp, and max wind within the first five hours after sunset.

Gray rows indicate detector nights from which data was unacceptable due to weather or detector malfunctions.

Table 2. Acoustic Monitoring Equipment Settings

Detector Setting	Specification	Microphone Setting	Specification
Threshold	21	Frequency range	1 to 125 KHz
TE	1	Dynamic range	> 90 dB (Full BW); > 96 dB (Audio BW)
Dur	1.7	Range limits	(SPL +/- 3 dB); Max: 90 dB
Idle	1.7	Min	0 dB (Full) / -6 dB (audio) Interface: USB 2.0
Delay	0	Output format	16-bit offset binary, 250Ksps
Low F	15		
High F	125		
PopFilt	On		
PwrSave	On		

Individual descriptions of the habitat in the locations where each detector was placed follow below, and pictures of the habitat are presented in Appendix C.

- Segment 1** – The detector at Segment 1 was deployed in an existing power line right-of-way facing northeast. The right-of-way had a well-established maintenance road throughout, and woody vegetation was generally less than five feet tall. Interstate 93 runs almost perpendicular to the right-of-way, approximately 330 feet west of the unit. Adjacent tree cover was a mix of hardwood and softwood trees. Species include eastern white pine (dominant), red maple, paper birch, northern red oak, and white oak. Average DBH was about 4-12" with larger trees scattered throughout.
- Segment 2** – The unit at Segment 2 was deployed in a forest patch approximately 15 feet from an existing power line right-of-way and roughly 150 feet from Rockingham Road. Along the forest edge, adjacent to the right-of-way, there was considerable slash, which prevented the detector being placed along this forest edge. The understory in the forest patch interior was mostly open with a 60-80 percent closed canopy. The detector, facing northwest, pointed toward a dry vernal pool. Tree species in the surrounding area included northern red oak (dominant), eastern white pine, white oak, red maple, and paper birch. Average DBH was about 3-10".
- Segment 3** – The unit was deployed in a small woodland patch between two commercial lots, off of Manchester Road. This forest patch was the best available survey location in this highly commercialized segment. The detector faced west away from the road and towards a more forested area approximately 200 feet from the unit. Trees were almost exclusively sugar maple, with a few eastern white pine, white ash, and northern red oak in the surrounding area. Average DBH was roughly 8-18", with an open understory.
- Segment 4** – The unit at Segment 4 was placed along the edge of an existing power line right-of-way facing northeast over an emergent marsh, which was dry at the time of

survey. Surrounding forests were a mix of hardwood and softwood trees, with an average DBH of 6-12". Tree species included eastern white pine (dominant), red maple, yellow birch, and northern red oak. Snags were present at this location.

- **Segment 5** – The unit at Segment 5 was placed facing northeast along an existing power line right-of-way. The adjacent forest cover was a mix of hardwood and softwood trees. A stand of snags was located approximately 100 feet southwest of the unit. Dominant tree species within the area included northern red oak, followed by eastern white pine, sugar maple, and white birch. Average DBH was approximately 8-16".
- **Segment 6** – The unit was placed along an existing power line right-of-way facing east towards an emergent marsh. Roughly one half-dozen snags were located within 50 feet of the detector. Surrounding forest area was a mix of hardwood and softwood trees, with an average DBH of 6-12". Tree species included eastern white pine (dominant), ash, yellow birch, eastern hemlock, red maple, and northern red oak.
- **Segment 7** – The detector at Segment 7 was placed along an existing power line right-of-way facing east in a large emergent marsh and connecting (dry) vernal pool. This location was approximately 350 feet from Interstate 93. Adjacent forest cover included a mix of hardwood and softwood trees, including eastern hemlock (dominant), yellow birch, eastern white pine, red maple, northern red oak, and paper birch. Snags were scattered throughout and average DBH was about 5-12".
- **Segment 8** – The unit was deployed along a small foot/bike path facing northwest. In this direction was a wooden bridge approximately 500 feet from the detector. Habitat surrounding the unit was a mix of hardwood and softwood trees, with hardwoods being more abundant. Dominant tree species were northern red oak, followed by quaking aspen, American elm, eastern hemlock, sugar maple, and eastern white pine. Average DBH was about 8-14", with a 60-80 percent closed canopy.
- **Segment 9** – The detector was placed along the west side of an existing power line right-of-way, facing southeast. Forest cover toward the south was predominantly hardwood trees with a closed canopy and moderately dense understory. Some snags were present, and a vernal pool was across the right-of-way, about 300 feet east of the detector. Tree species included northern red oak (dominant), sugar maple, eastern white pine, hickory, and sweet birch. Average DBH was roughly 8-14".
- **Segment 10** – The unit was deployed off of Tsienneto Road in a small clearing surrounded by shrubs and saplings, facing south toward a stand of eastern white pine trees. The area adjacent to these softwoods was shrubby and overgrown with lots of clutter, making deployment closer to these trees unsuitable. Snags were also present near the pines. Dominant species included quaking aspen, mostly 3" DBH or less, eastern white pine (10-24" DBH), and red maple (3"DBH or less).

- **Segment 11** – The habitat along Segment 11 was primarily residential, which limited available locations for deployment. The unit was placed on town property near recreational fields along Tsienneto Road, facing west towards mature forest. The surrounding trees were a mix of hardwoods and softwoods, including White ash (dominant), quaking aspen, northern red oak, eastern white pine, and red maple. Average DBH was 3-10”.
- **Segment 12** – The detector was deployed along Tsienneto Road facing north over an emergent marsh/dry storm water retention pond. The surrounding forest was a mix of hardwood and softwood trees, with snags present throughout. The dominant tree species were red maple, followed by eastern white pine, American elm, northern red oak, white oak, ash, and black birch. The average DBH was 8-12”.

3.3 Survey Results

The number of calls recorded by species and location are presented in Table 3. Table 4 contains corresponding likelihood values. Blue cells are those with likelihood of presence values <0.05 and correspond to species considered by Kaleidoscope Pro to be present. Bat calls were recorded at all Segments except for Segment 2. Calls from six species, big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), little brown bat (*Myotis lucifugus*), and tricolored bat (*Perimyotis subflavus*) were recorded with p-values of less than 0.05. **Although Kaleidoscope Pro software identified four NLEB calls (one each at Segments 9 and 12, and both nights at Segment 7) the P-values for these calls are not below the required threshold to confirm this identification.**

Table 3. Number of Calls by Date, Segement, and Species

	Date	EPFU	LABO	LACI	LANO	MYLE	MYLU	MYSE	PESU
Segment 1	10-Aug-16	148	11	2	32	0	2	0	2
	11-Aug-16	192	23	1	51	0	6	0	0
Segment 2	8-Aug-16	0	0	0	0	0	0	0	0
	9-Aug-16	0	0	0	0	0	0	0	0
Segment 3	12-Aug-16	3	0	0	0	0	1	0	0
	14-Aug-16	0	0	0	0	0	0	0	0
Segment 4	10-Aug-16	451	25	11	60	0	1	0	2
	11-Aug-16	939	26	6	73	0	3	0	0
Segment 5	10-Aug-16	226	10	5	41	0	1	0	0
	11-Aug-16	223	8	1	31	0	4	0	0
Segment 6	10-Aug-16	225	35	5	115	0	2	0	0
	11-Aug-16	687	54	5	204	1	4	0	0
Segment 7	8-Aug-16	28	13	3	13	0	2	1	0
	9-Aug-16	119	6	8	57	0	4	1	0

	Date	EPFU	LABO	LACI	LANO	MYLE	MYLU	MYSE	PESU
Segment 8	8-Aug-16	4	0	0	0	0	0	0	0
	9-Aug-16	1	0	0	0	0	0	0	0
Segment 9	8-Aug-16	1734	52	56	881	1	7	0	1
	9-Aug-16	1410	22	46	750	0	3	1	0
Segment 10	8-Aug-16	10	6	2	7	0	0	0	0
	9-Aug-16	25	5	1	9	0	1	0	0
Segment 11	10-Aug-16	203	28	58	109	0	3	0	1
	11-Aug-16	227	19	25	122	0	2	0	1
Segment 12	10-Aug-16	172	91	2	57	0	0	1	4
	11-Aug-16	256	16	8	62	0	0	0	3

Table 4. Likelihood Values by Date, Segment and Species

	Date	EPFU	LABO	LACI	LANO	MYLE	MYLU	MYSE	PESU
Segment 1	10-Aug-16	0	0	0.99916	0.951099	1	0.723559	1	0.134804
	11-Aug-16	0	0	1	0.244045	1	0.083411	1	1
Segment 2	8-Aug-16	1	1	1	1	1	1	1	1
	9-Aug-16	1	1	1	1	1	1	1	1
Segment 3	12-Aug-16	0.004672	1	1	1	1	0.081101	1	1
	14-Aug-16	1	1	1	1	1	1	1	1
Segment 4	10-Aug-16	0	0	0.181832	1	1	1	1	0.420288
	11-Aug-16	0	0	1	1	1	0.939572	1	1
Segment 5	10-Aug-16	0	0	0.559256	1	1	0.993353	1	1
	11-Aug-16	0	1.56E-05	1	1	1	0.044483	1	1
Segment 6	10-Aug-16	0	0	0.741076	0	1	1	1	1
	11-Aug-16	0	0	1	8.3E-06	1	1	1	1
Segment 7	8-Aug-16	0	0	0.0412	0.112729	1	0.731274	0.146266	1
	9-Aug-16	0	0.000709	0.003519	1.53E-05	1	0.018856	0.274476	1
Segment 8	8-Aug-16	1	1	1	1	1	1	1	1
	9-Aug-16	1	1	1	1	1	1	1	1
Segment 9	8-Aug-16	0	0	3.4E-06	0	1	0.999271	1	1
	9-Aug-16	0	0	3.32E-05	0	1	0.990892	0.11788	1
Segment 10	8-Aug-16	0.000154	6E-07	0.049901	0.116874	1	1	1	1
	9-Aug-16	0	3.53E-05	0.683937	0.406323	1	0.759838	1	1
Segment 11	10-Aug-16	0	0	0	1E-07	1	0.969507	1	1
	11-Aug-16	0	0	0	0	1	0.992172	1	1
Segment 12	10-Aug-16	0	0	1	0.004223	1	1	1	0.818781
	11-Aug-16	0	0	0.109827	0.554516	1	1	1	0.040982

EPFU= *Eptesicus fuscus*, LABO = *Lasiurus borealis*, LACI = *Lasiurus cinereus*, LANO = *Lasionycteris noctivagans*, MYLE= *Myotis leibii*, MYLU= *Myotis lucifugus*, MYSE = *Myotis septentrionalis*, PESU= *Perimyotis subflavus*.

Appendix A Figures

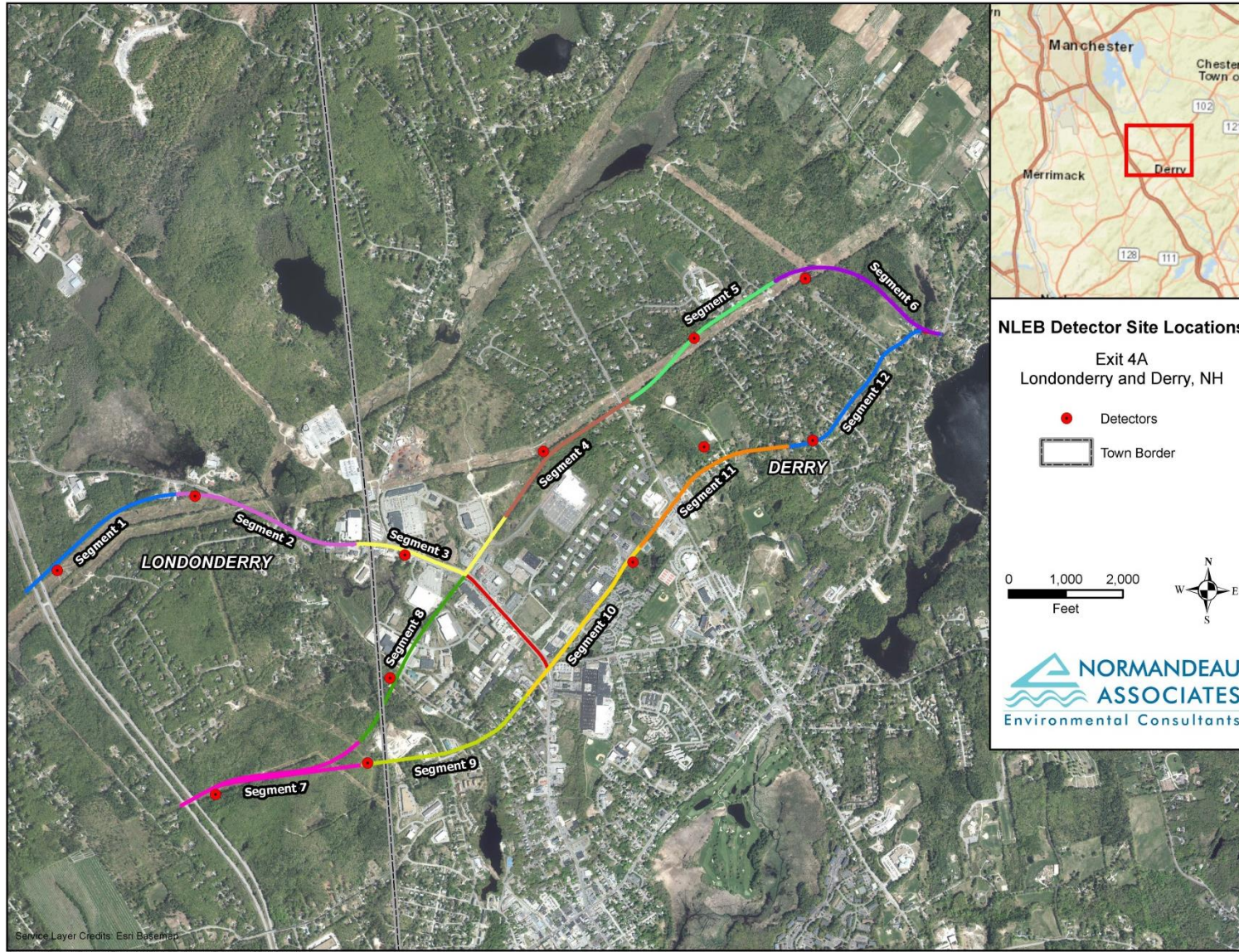


Figure A-1. Locations of detector deployment sites within the project area.

Table A-1. Geographical coordinates of bat detector survey locations

Segments	Coordinates	
	<i>Latitude</i>	<i>Longitude</i>
Segment 1	42.897556	-71.359398
Segment 2	42.901321	-71.350533
Segment 3	42.898766	-71.336708
Segment 4	42.903927	-71.327835
Segment 5	42.909554	-71.318184
Segment 6	42.912567	-71.311035
Segment 7	42.887005	-71.348640
Segment 8	42.892834	-71.337456
Segment 9	42.888718	-71.338760
Segment 10	42.898724	-71.321800
Segment 11	42.904358	-71.317345
Segment 12	42.904816	-71.310257

Appendix B Weather

Table B-1. Hourly weather conditions during the survey period, as reported by the NOAA weather station in nearby Manchester, NH: Manchester Airport (KMHT).

Date	Time (edt)	Wind (mph)	Vis. (mi.)	Weather	Sky Cond.	Temperature (°F)				Relative Humidity	Wind Chill (°F)	Heat Index (°F)	Pressure		Precipitation (in.)		
						Air	Dwpt	6 hour					altimeter (in)	sea level (mb)	1 hr	3 hr	6 hr
								Max.	Min.								
15	6:53	NW 5	10	Mostly Cloudy	SCT180 BKN250	73	64			74%	NA	NA	30.07	1019.2			
15	5:53	NW 6	10	Mostly Cloudy	SCT180 BKN250	73	64			74%	NA	NA	30.06	1018.7			
15	4:53	NW 9	10	Partly Cloudy	SCT180	74	64			71%	NA	NA	30.03	1017.6			
15	3:53	NW 7	10	Partly Cloudy	SCT180	76	65			69%	NA	78	29.99	1016.3			
15	2:53	W 9	10	A Few Clouds	FEW250	76	66			72%	NA	78	29.98	1015.9			
15	1:53	W 3	10	A Few Clouds	FEW250	77	67	86	77	71%	NA	79	29.98	1016			
15	0:53	W 3	10	Partly Cloudy	FEW080 SCT250	79	67			67%	NA	81	29.97	1015.6			
14	23:53	Calm	10	Mostly Cloudy	FEW080 BKN250	80	67			64%	NA	82	29.96	1015.3			
14	22:53	Vrbl 3	10	Mostly Cloudy	BKN085 BKN250	82	67			60%	NA	84	29.95	1014.9			
14	21:53	W 6	10	Overcast	BKN085 OVC250	83	67			59%	NA	86	29.96	1015.2			
14	20:53	W 7	10	Mostly Cloudy	SCT080 BKN100 BKN250	84	66			55%	NA	86	29.93	1014.4			
14	19:53	W 5	10	Mostly Cloudy	BKN085 BKN220	86	67	94	86	53%	NA	89	29.9	1013.5			
14	18:53	W 5	10	Mostly Cloudy	FEW060 SCT085 SCT200 BKN250	88	67			50%	NA	91	29.89	1013			
14-August																	
14	6:53	S 6	10	Mostly Cloudy	FEW003 SCT120	71	68			90%	NA	NA	29.85	1011.8			

Date	Time (edt)	Wind (mph)	Vis. (mi.)	Weather	Sky Cond.	Temperature (°F)				Relative Humidity	Wind Chill (°F)	Heat Index (°F)	Pressure		Precipitation (in.)		
						Air	Dwpt	6 hour					altimeter (in)	sea level (mb)	1 hr	3 hr	6 hr
								Max.	Min.								
					BKN250												
14	5:53	S 8	10	Mostly Cloudy	FEW003 SCT080 BKN200	70	67			90%	NA	NA	29.85	1011.7			
14	4:53	S 3	8	Overcast	OVC003	69	67			93%	NA	NA	29.83	1011			
14	3:53	S 5	9	Overcast	OVC004	69	67			93%	NA	NA	29.84	1011.5			
14	2:53	Calm	10	Overcast	OVC004	69	66			90%	NA	NA	29.82	1010.6			
14	1:53	SW 5	10	Mostly Cloudy	BKN003	69	66	70	66	90%	NA	NA	29.86	1011.9	0.01		
14	0:53	SW 5	7	Light Rain	SCT007 SCT080 BKN110	68	66			93%	NA	NA	29.89	1012.9	0.07		
13	23:53	Vrbl 5	6	Thunderstorm Light Rain Fog/Mist	SCT004 BKN090CB OVC120	67	65			93%	NA	NA	29.9	1013.5			
13	22:53	S 8	4	Thunderstorm Light Rain Fog/Mist	SCT006 BKN045CB OVC110	67	64			91%	NA	NA	29.96	1015.5	0.05	0.33	
13	21:53	SE 3	3	Thunderstorm Heavy Rain Fog/Mist	FEW007 BKN020CB OVC035	67	64			91%	NA	NA	29.94	1014.7	0.28		
13	20:53	E 9	10	Thunderstorm Light Rain	BKN020 BKN035CB OVC050	69	62			78%	NA	NA	29.93	1014.5			
13	19:53	E 6	10	Overcast	OVC023	70	60	82	70	71%	NA	NA	29.92	1014.1			
13	18:53	E 9	10	Overcast	OVC025	71	61			71%	NA	NA	29.91	1013.8			
13-August																	
13	6:53	E 9	10	Mostly Cloudy	BKN015 BKN070	68	61			78%	NA	NA	29.93	1014.3			
13	5:53	E 8	10	Mostly Cloudy	BKN015 BKN065	69	62			78%	NA	NA	29.9	1013.4			

Date	Time (edt)	Wind (mph)	Vis. (mi.)	Weather	Sky Cond.	Temperature (°F)				Relative Humidity	Wind Chill (°F)	Heat Index (°F)	Pressure		Precipitation (in.)		
						Air	Dwpt	6 hour					altimeter (in)	sea level (mb)	1 hr	3 hr	6 hr
								Max.	Min.								
13	4:53	E 7	10	Mostly Cloudy	BKN012	70	63			79%	NA	NA	29.88	1012.8			
13	3:53	E 6	10	Partly Cloudy	SCT006	72	66			82%	NA	NA	29.87	1012.2			
13	2:53	E 8	10	Mostly Cloudy	SCT120 BKN200	74	69			85%	NA	NA	29.85	1011.6			
13	1:53	Calm	10	Mostly Cloudy	SCT120 BKN200	77	70	88	77	79%	NA	79	29.84	1011.1			
13	0:53	Vrbl 3	10	Overcast	BKN100 OVC200	80	71			74%	NA	83	29.84	1011.3			
12	23:53	Calm	10	Overcast	BKN070 OVC200	81	71			72%	NA	85	29.83	1010.9			
12	22:53	S 6	10	Overcast	BKN080 OVC200	82	71			69%	NA	86	29.82	1010.3			
12	21:53	S 6	10	Mostly Cloudy	BKN110	83	70			65%	NA	87	29.82	1010.6			
12	20:53	SW 6	10	Mostly Cloudy	BKN250	85	70			61%	NA	90	29.8	1009.7			
12	19:53	SW 9	10	Overcast	FEW045 BKN110 OVC250	88	72	96	88	59%	NA	95	29.78	1009.2			
12	18:53	W 12	10	Mostly Cloudy	FEW045 BKN140 BKN250	90	72			56%	NA	98	29.77	1008.7			
12-August																	
12	6:53	S 7	10	Mostly Cloudy	SCT090 BKN180 BKN250	77	71			82%	NA	79	29.84	1011.3			
12	5:53	S 3	10	Mostly Cloudy	SCT090 BKN180 BKN250	78	71			79%	NA	80	29.84	1011.2			
12	4:53	S 5	10	Mostly Cloudy	FEW060 BKN100 BKN200	78	71			79%	NA	80	29.85	1011.4			

Date	Time (edt)	Wind (mph)	Vis. (mi.)	Weather	Sky Cond.	Temperature (°F)				Relative Humidity	Wind Chill (°F)	Heat Index (°F)	Pressure		Precipitation (in.)		
						Air	Dwpt	6 hour					altimeter (in)	sea level (mb)	1 hr	3 hr	6 hr
								Max.	Min.								
12	3:53	Calm	10	Mostly Cloudy	SCT180 BKN200	78	71			79%	NA	80	29.85	1011.5			
12	2:53	S 6	10	Partly Cloudy	SCT250	79	71			77%	NA	82	29.86	1011.9			
12	1:53	S 5	10	Partly Cloudy	FEW080 SCT250	79	71	90	79	77%	NA	82	29.87	1012.1			
12	0:53	Vrbl 3	10	Mostly Cloudy	BKN080 BKN250	80	71			74%	NA	83	29.9	1013.1			
11	23:53	S 6	10	Partly Cloudy	SCT250	81	71			72%	NA	85	29.91	1013.5			
11	22:53	S 6	10	A Few Clouds	FEW250	83	71			67%	NA	88	29.92	1014			
11	21:53	S 6	10	A Few Clouds	FEW250	84	70			63%	NA	88	29.92	1014.1			
11	20:53	SW 5	10	Partly Cloudy	SCT250	87	69			55%	NA	91	29.92	1014.1			
11	19:53	SW 6	10	Mostly Cloudy	BKN250	90	68	97	90	48%	NA	94	29.91	1013.7			
11	18:53	W 7	10	Mostly Cloudy	FEW065 BKN250	93	67			42%	NA	96	29.93	1014.2			
11-August																	
11	6:53	Calm	0.5	Fog	VV002	71	69			94%	NA	NA	30.05	1018.6			
11	5:53	Calm	0.06	Fog	VV002	71	69			94%	NA	NA	30.05	1018.5			
11	4:53	S 3	0.06	Fog	VV002	72	70			94%	NA	NA	30.04	1018.1			
11	3:53	N 5	0	Fog	VV002	72	71			97%	NA	NA	30.04	1018.1			
11	2:53	Calm	0.5	Fog	BKN001	73	71			94%	NA	NA	30.03	1018			
11	1:53	Calm	3	Fog/Mist	FEW002	75	72	79	75	90%	NA	NA	30.04	1018.1			
11	0:53	S 3	3	Fog/Mist	FEW002 SCT015	75	72			90%	NA	NA	30.05	1018.4			
10	23:53	S 3	10	Fair	CLR	76	73			91%	NA	76	30.05	1018.7			
10	22:53	S 5	10	Fair	CLR	76	73			91%	NA	76	30.06	1018.9			
10	21:53	S 5	10	A Few Clouds	FEW020	77	73			88%	NA	78	30.07	1019.2			
10	20:53	S 5	10	A Few Clouds	FEW070 FEW250	78	73			85%	NA	80	30.06	1019			

Date	Time (edt)	Wind (mph)	Vis. (mi.)	Weather	Sky Cond.	Temperature (°F)				Relative Humidity	Wind Chill (°F)	Heat Index (°F)	Pressure		Precipitation (in.)		
						Air	Dwpt	6 hour					altimeter (in)	sea level (mb)	1 hr	3 hr	6 hr
								Max.	Min.								
10	19:53	S 5	10	Mostly Cloudy	FEW020 FEW055 BKN070 BKN250	79	73	81	76	82%	NA	82	30.05	1018.6			
10	18:53	S 8	10	Mostly Cloudy	FEW015 FEW035 BKN070 BKN250	80	73			79%	NA	84	30.05	1018.6			
10-August																	
10	6:53	S 7	10	Overcast	BKN070 OVC090	72	57			59%	NA	NA	30.16	1022.2			
10	5:53	S 7	10	Mostly Cloudy	BKN050 BKN080	72	55			55%	NA	NA	30.16	1022.2			
10	4:53	S 6	10	Mostly Cloudy	BKN080	72	54			53%	NA	NA	30.17	1022.3			
10	3:53	S 3	10	Mostly Cloudy	BKN065 BKN250	71	54			55%	NA	NA	30.17	1022.6			
10	2:53	S 3	10	A Few Clouds	FEW270	71	56			59%	NA	NA	30.18	1022.7			
10	1:53	S 3	10	Partly Cloudy	SCT270	71	56	84	70	59%	NA	NA	30.18	1023			
10	0:53	SW 3	10	Partly Cloudy	SCT270	72	56			57%	NA	NA	30.19	1023			
9	23:53	S 6	10	Mostly Cloudy	BKN270	72	55			55%	NA	NA	30.18	1022.8			
9	22:53	S 6	10	Partly Cloudy	SCT270	75	55			50%	NA	NA	30.17	1022.6			
9	21:53	SE 6	10	Mostly Cloudy	BKN250	75	57			54%	NA	NA	30.16	1022.3			
9	20:53	Calm	10	Partly Cloudy	SCT250	77	57			50%	NA	79	30.15	1022			
9	19:53	Calm	10	Mostly Cloudy	BKN250	84	47	91	84	27%	NA	82	30.13	1021.3			
9	18:53	SW 8	10	Mostly Cloudy	BKN250	86	49			28%	NA	84	30.13	1021.3			
9-August																	
9	6:53	N 3	10	Fair	CLR	64	54			70%	NA	NA	30.19	1023.2			
9	5:53	Calm	10	Fair	CLR	61	54			78%	NA	NA	30.16	1022.4			

Date	Time (edt)	Wind (mph)	Vis. (mi.)	Weather	Sky Cond.	Temperature (°F)				Relative Humidity	Wind Chill (°F)	Heat Index (°F)	Pressure		Precipitation (in.)		
						Air	Dwpt	6 hour					altimeter (in)	sea level (mb)	1 hr	3 hr	6 hr
								Max.	Min.								
9	4:53	Calm	10	Fair	CLR	62	54			75%	NA	NA	30.15	1021.8			
9	3:53	Calm	10	Fair	CLR	63	52			68%	NA	NA	30.13	1021.2			
9	2:53	Calm	10	Fair	CLR	64	52			65%	NA	NA	30.12	1020.7			
9	1:53	SE 3	10	Fair	CLR	66	52	80	65	61%	NA	NA	30.09	1019.9			
9	0:53	SE 3	10	Fair	CLR	68	52			57%	NA	NA	30.08	1019.5			
8	23:53	S 3	10	Fair	CLR	71	51			49%	NA	NA	30.07	1019.2			
8	22:53	Calm	10	Fair	CLR	73	51			46%	NA	NA	30.06	1018.8			
8	21:53	Calm	10	Fair	CLR	75	50			42%	NA	NA	30.05	1018.5			
8	20:53	Calm	10	Fair	CLR	78	49			36%	NA	78	30.03	1017.7			
8	19:53	W 5	10	Fair	CLR	80	48	86	80	33%	NA	79	30.01	1017			
8	18:53	W 10	10	A Few Clouds	FEW090 FEW250	84	46			27%	NA	82	29.99	1016.6			
8-August																	

Appendix C Photos of Detector Set-up & Habitat



Figure C-1. Segment 1 – overview of set-up.



Figure C-2. Segment 1 – cone of detection.



Figure C-3. Segment 1 – facing north.



Figure C-4. Segment 1 – facing east.



Figure C-5. Segment 1 – facing south.



Figure C-6. Segment 1 – facing west.



Figure C-7. Segment 2 – overview of set-up.



Figure C-8. Segment 2 – cone of detection.



Figure C-5. Segment 9 – facing north.



Figure C-10. Segment 2 – facing east.



Figure C-11. Segment 2 – facing south.



Figure C-12. Segment 2 – facing west.



Figure C-63. Segment 3 – overview of set-up.



Figure C-14. Segment 3 – cone of detection.



Figure C-15. Segment 3 – facing north.



Figure C-16. Segment 3 – facing east.



Figure C-17. Segment 3 – facing south.



Figure C-18. Segment 3 – facing west.



Figure C-79. Segment 4 – overview of set-up.



Figure C-80. Segment 4 – cone of detection.



Figure C-21. Segment 4 – facing north.



Figure C-22. Segment 4 – facing east.



Figure C-23. Segment 4 – facing south.



Figure C-24. Segment 4 – facing west.



Figure C-25. Segment 5 – overview of set-up.



Figure C-96. Segment 5 – cone of detection.



Figure C-27. Segment 5 – facing north.



Figure C-28. Segment 5 – facing east.



Figure C-29. Segment 5 – facing south.



Figure C-30. Segment 5 – facing west.



Figure C-310. Segment 6 – overview of set-up.



Figure C-311. Segment 6 – cone of detection.



Figure C-123. Segment 6 – facing north.



Figure C-313. Segment 6 – facing east.



Figure C-35. Segment 6 – facing south.



Figure C-36. Segment 6 – facing west.



Figure C-37. Segment 7 – overview of set-up.



Figure C-38. Segment 7 – cone of detection.



Figure C-149. Segment 7 – facing north.



Figure C-150. Segment 7 – facing east.



Figure C-41. Segment 7 – facing south.



Figure C-42. Segment 7 – facing west.



Figure C-43. Segment 8 – overview of set-up.

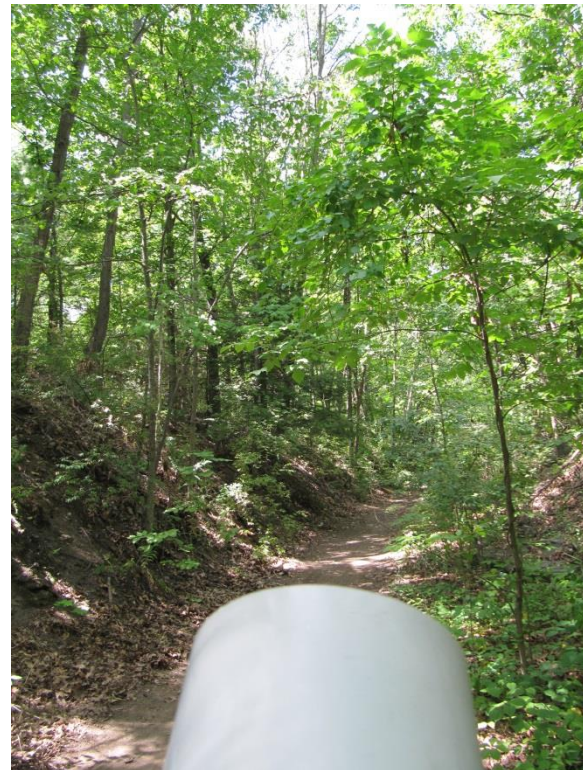


Figure C-44. Segment 8 – cone of detection.



Figure C-45. Segment 8 – facing north.



Figure C-166. Segment 8 – facing east.



Figure C-47. Segment 8 – facing south.



Figure C-48. Segment 8 – facing west.



Figure C-49. Segment 9 – overview of set-up.



Figure C-50. Segment 9 – cone of detection.



Figure C-51. Segment 9 – facing north.



Figure C-52. Segment 9 – facing east.



Figure C-53. Segment 9 – facing south.



Figure C-54. Segment 9 – facing west.



Figure C-55. Segment 10 – overview of set-up.



Figure C-56. Segment 10 – cone of detection.



Figure C-57. Segment 10 – facing north.



Figure C-58. Segment 10 – facing east.



Figure C-59. Segment 10 – facing south.



Figure C-60. Segment 10 – facing west.



Figure C-617. Segment 11 – overview of set-up.



Figure C-618. Segment 11 – cone of detection.



Figure C-619. Segment 11 – facing north.



Figure C-620. Segment 11 – facing east.



Figure C-65. Segment 11 – facing south.



Figure C-66. Segment 11 – facing west.



Figure C-67. Segment 12 – overview of set-up.



Figure C-68. Segment 12 – cone of detection.



Figure C-69. Segment 12 – facing north.



Figure C-70. Segment 12 – facing east.



Figure C-71. Segment 12 – facing south.



Figure C-72. Segment 12 – facing west.

Resumes

SARAH A. BARNUM, CWB® Senior Wildlife Ecologist

Dr. Barnum is a Senior Wildlife Ecologist at Normandeau with over 20 years of professional experience. Her background includes providing expertise to the transportation and energy sectors, as well as a variety of general development projects. She has hands-on experience with a wide range of species including forest birds, waterfowl, raptors, small mammals, large mammals, amphibians, and reptiles. Dr. Barnum's projects have emphasized examining habitat relationships, impact assessment for threatened and endangered species, mitigation planning, and Federal Endangered Species Act (ESA) compliance. Dr. Barnum also has extensive experience in project planning, project management, experimental design, and data analysis.

REPRESENTATIVE PROJECT EXPERIENCE

Northeast Energy Direct Pipeline, Kinder Morgan, New Hampshire, Massachusetts, Connecticut, New York (2015-Present). Planning and coordination of surveys and reporting for state and federally listed wildlife to support state and federal permitting for installation of a new, 400-mile long natural gas pipeline. Focal species include New England cottontail, songbirds, marsh birds, raptors, turtles, snakes, and lepidopterans. All tasks conducted to meet the Federal Energy Regulatory Commission (FERC) permitting requirements. Wildlife Task Manager.

Northern Pass Transmission Project, Eversource Energy, Canadian Border to Deerfield, New Hampshire (2010-Present). Conducting wildlife assessments, impact analysis, and mitigation planning in support of state and federal permitting for installation of a new, 200-mile long HVDC line in New Hampshire. Tasks include consultation with state and federal agencies (ESA, NEPA), desktop analysis, design and coordination of field surveys, writing the wildlife section of the SEC Natural Resources Report, and providing expert testimony. Focal species include Canada lynx, American marten, bats, raptors, song birds, turtles, snakes, and Karner blue butterfly. Wildlife Task Manager.

The Balsams Grand Resort, Dixville LLC, New Hampshire (2014 - Present). Planned and coordinated surveys and reporting for general wildlife issues and northern long-eared bat acoustic surveys. Wildlife Task Manager.

Boston Convention and Events Center Gull Dissuasion Study, Massachusetts Convention Center Authority, Boston, Massachusetts (2014-2016). Designed and oversaw field surveys of gull activities on

EDUCATION

Ph.D., Conservation Planning, University of Colorado
M.S., Wildlife Biology, Utah State University
B.S., (cum laude) Wildlife Biology, University of Vermont

PROFESSIONAL EXPERIENCE

2007-Present	Normandeau Associates
2005-2007	New Hampshire Audubon
2004-2005	Baystate Environmental Consultants
2001-2003	Environmental Planning and Policy Unit, Colorado DOT
1998-2000	Office of Environmental Services, Colorado DOT
1996-1998	Dames & Moore 1993-1994 Bio-Resources, Inc.

PROFESSIONAL CERTIFICATIONS

- Certified Wildlife Biologist
- AAE's Airport Wildlife Manager's Course and Wildlife Management Techniques Course
- Cyber Tracker Level III Tracking Certification

PROFESSIONAL AFFILIATIONS

- The Wildlife Society
- New Hampshire Association of Natural Resource Scientists
- Epsom, NH Conservation Commission
- Bear-Paw Regional Greenways Land Conservation Committee

the BCEC roof, and assisted in identification and evaluation of dissuasion strategies. Project Manager and Avian Biologist.

Post-Construction Mortality Monitoring, Pheasant Run Wind LLC, Huron County, Michigan (2014-2015). Conducted bird and bat post-construction fatality monitoring, coordinated data analysis and report writing. Project Manager.

Loon Pond Dam Reconstruction, Town of Lincoln, Lincoln, New Hampshire (2015-2016). Conducted habitat suitability assessment for Canada lynx and forest roosting bats for project located on Forest Service Land; coordinated rare plant surveys and wrote the Biological Evaluation. Project Manager and Wildlife Biologist.

Acoustic Northern Long-eared Bat Surveys, MassDOT, Massachusetts (2015). Planned and coordinated USFWS-compliant surveys and reporting for 20 separate MassDOT projects across MA. Project Manager.

Habitat Assessment and Acoustic Northern Long-eared Bat Surveys, Various, New Hampshire (2015). Planned and coordinated USFWS compliant surveys and reporting for four separate development projects in southern NH. Project Manager.

Northern Long-eared Bat Habitat Assessment, Horizons Engineering, Loudon, New Hampshire (2015). Conducted USFWS compliant habitat assessment and reporting for the proposed Liberty Pipeline. Project Manager and Bat Biologist

Fowler's Toad Study for Hydro Dam Relicensing, TransCanada, Connecticut River, New Hampshire and Vermont (2013-2014). Designed and conducted habitat suitability evaluation and toad survey; reporting. All tasks conducted to meet the FERC permitting requirements. Task Manager and Amphibian Biologist.

Loon Mountain Ski Area Expansion Biological Evaluation, US Forest Service, White Mountain National Forest, New Hampshire (2013-2014). Conducted habitat suitability assessment for Canada lynx, forest roosting bats, and black bear and wrote the Biological Evaluation. Wildlife Task Manager and Mammal Biologist.

New England Cottontail Permitting, Tidewater Landing, LLC, Wells, Maine (2013). Wrote the New England cottontail related permitting documents for the Tidewater Landing sub-division. Assessed habitat suitability and negotiated with MDIFW. Wrote the Habitat Management Plan and Incidental Take Plan required for the project permit. Project Manager and NEC Biologist.

Waterville Valley Ski Area Expansion Biological Evaluation, US Forest Service, White Mountain National Forest, New Hampshire (2012-2013). Conducted habitat suitability assessment for Canada lynx, forest roosting bats, and black bear, and wrote the Biological Evaluation. Wildlife Task Manager and Mammal Biologist.

Rare Species Surveys, Tennessee Gas Pipeline Co., various locations in Massachusetts and Connecticut (2012 - 2013). Rare species surveys in support of pipeline repair activities. Various surveys for rare turtles and rare plants prior to pipeline repair projects. Project Manager and Turtle Biologist.

Winthrop Beach Piping Plover Management Plan, MA Department of Conservation and Recreation, Winthrop, Massachusetts (2012). Designed and wrote the piping plover management plan required as part of the permitting effort for the Winthrop Beach re-nourishment project. Project Manager and Avian Biologist.

Roseate Tern Expert Testimony, Entergy Nuclear Generation Company, Plymouth, Massachusetts (2012). Provided expert testimony summarizing potential impacts of relicensing of Pilgrim Nuclear Power Station in Plymouth, MA on roseate terns. Avian Biologist.

The Effect of Roadside Mowing Practices on Deer-Vehicle Collision Rates, Federal Highway Administration (2009-2012) Nationwide. Conducted literature review and interviews with State DOT personnel to summarize any known effects of roadside mowing regimes on DVC rates, followed by a quantitative analysis of DVC rates as a function of mowing regime. Project responsibilities include acquiring data from State DOTs, data management and analysis, and report writing. Data Analysis Task Manager.

Madaket Wind Permitting Assessment, Town of Nantucket, Nantucket, Massachusetts (2010-2011). Assessed avian and T&E resources in the proposed project area to determine potential impacts and permitting requirements for 1-3 utility scale wind turbines on Nantucket DPW lands. Focal species included long-tailed duck, northern harrier, and night migrants (birds and bats). Work includes both desktop and field assessment. Project Manager, Wildlife Biologist.

Post-Construction Mortality Monitoring, First Wind, Stetson Wind Power Facility, Washington County, Maine (2010-2011). Managed personnel to search turbines for bird and bat fatalities, spring through fall and estimate fatality rates. Coordinated searcher efficiency trials and scavenger trials to estimate true number of fatalities; supervised and quality-checked fatality estimation and report writing. Project Manager.

Analysis of Methods to Identify Deer-Vehicle Collision Hotspot, Federal Highway Administration (2009-2011) Nationwide. Compared qualitative and quantitative methods to identify DVC hotspots, based on data needs, ease of implementation, expertise required, and relevancy to solving safety and ecological issues. Project responsibilities included review of methods through literature review and interviews with DOT staff, creating and implementing comparison protocols, staff management and report writing. Principle Investigator and Project Manager.

Brimfield Wind Avian and Bat Surveys, First Wind, Brimfield, Massachusetts (2009-2010). Avian and acoustic bat surveys to support environmental permitting for a proposed 20 MW project in southwestern MA. Avian surveys include raptor surveys and breeding bird surveys. Project Manager and Avian Biologist.

Avian Impact Assessment, Town of Saugus, Saugus, Massachusetts (2009-2010). Desktop analysis of biological and permitting issues associated with a proposed municipal, utility-scale wind development on the abandoned I-95 road bed Saugus, MA. Species of interest include neotropical migrants, wintering ducks, terns, and other shore birds. Project Manager and Avian Biologist.

Mitigation Wetland Functional Assessment, Federal Highway Administration, various nationwide locations (2008-2010). Wetlands constructed to mitigate for highway project-related

impacts and reference wetlands were surveyed, and levels of invasive cover and wildlife functions compared. Project responsibilities included interviewing state DOT staff to identify and select study sites, conducting surveys, semi-quantitative analysis, report writing, and managing staff. Project Manager.

Seabrook Nuclear Facility Relicensing, Florida Power and Light, Seabrook, New Hampshire (2008-2010). Reviewed and summarized all terrestrial ecology issues associated with facility construction and operations with a focus on threatened and endangered species, and impact assessment; results presented in a NRC compliant Environmental Report format to support relicensing. Task Manager.

Nine Mile Point Nuclear Facility Expansion, Constellation Energy, Scriba, New York (2007-2010). Wildlife studies to support expansion of an energy facility in Oswego NY. Tasks included field review of the site, evaluation of the habitat's ability to support potential threatened and endangered species, and impact assessment; results presented in a NRC compliant Environmental Report format to support licensing. Wildlife Task Manager.

Mount Snow Resort Snow Making Upgrade Biological Evaluation, US Forest Service, Green Mountain National Forest, Vermont (2008). Review all threatened and endangered species issues associated with a snow making upgrade; analyzed impacts and summarize results in a Forest Service Biological Assessment and a NEPA Environmental Assessment. Senior Wildlife Ecologist.

Casco Bay Fuel Line Removal, U.S. Navy, in Brunswick and Harpswell, Maine (2008). Wildlife studies to support Corps 404 and Maine NRPA permitting. Conducted habitat survey of project area, mapped wildlife habitat, and assessed impacts, with a focus suitable habitat for and presence of species listed by the State of Maine and /or USFWS. Compiled results in a report to support all local and federal permitting efforts. Senior Wildlife Ecologist.

Canada Lynx and American Marten Habitat Assessment, Mount Washington Resort, Bretton Woods, New Hampshire (2007-2008). Provided expert opinion regarding the suitability of the resort's property for Canada lynx and American marten. Tasks included field assessment of the property, review of current literature, producing a written report detailing analysis approach and findings, and ongoing consultation with regulating agencies. Senior Wildlife Ecologist.

NH Route 2 Wildlife Crossing Investigation, New Hampshire Audubon, Jefferson and Randolph, New Hampshire (2005-2007). Designed, implement and managed a tracking study to identify the locations where wildlife crossed the highway, and to determine the characteristics of preferred crossing locations. Tasks included extensive quantitative and qualitative analysis of GIS based data sets. Principle Investigator and Project Manager.

Runway Expansion Feasibility Study, Town of Montague Airport Commission, Montague, Massachusetts (2004-2005). Analyses of potential impacts to birds, sensitive habitats, and special status species including grasshopper sparrows, box turtles, rare plants, and pine-barrens associated insects present in the project area. Tasks included field surveys, literature reviews, report writing and general project management. Project Manager.

Runway Expansion Feasibility Study, Martha's Vineyard Airport Commission, West Tisbury, Massachusetts (2004-2005). Conducted analyses and mitigation planning for potential impacts to birds, sensitive habitats, and special status species, including grasshopper sparrows, rare plants, and pine-barrens associated insects. Tasks included consultations with the MA Natural heritage and Endangered Species Program, field surveys, impact assessments, mitigation planning, literature reviews, report writing and general project management. Project Manager.

Programmatic Section 7 Consultation Regarding Impacts to Canada Lynx, Colorado Department of Transportation (2001-2002). Researched and wrote the document that served as the basis for a programmatic agreement between the USFWS and CDOT. Tasks included analysis of habitat and highway conflicts, analysis of likely impacts to lynx resulting from highway projects, development of a formalized impact assessment procedure, and literature review. Environmental Planner.

US 40 Rabbit Ears Pass Upgrade, Colorado Department of Transportation, Grand and Jackson Counties, Colorado (2001). Assessed project area for wildlife corridors and use by Canada lynx and large ungulates. Worked with project engineers and USFS to develop design recommendations, including locations for potential under passes, to improve motorist safety, reduce wildlife mortality and provides habitat connectivity. Environmental Planner.

US 9 Upgrade, Colorado Department of Transportation, Silverthorne, Colorado (1999-2000). Assessed project area for wildlife corridors and use by Canada lynx and large ungulates. Developed recommendation to improve motorist safety, reduce wildlife mortality and provides habitat connectivity. Worked with project engineers and designers to design and locate two wildlife underpasses. Endangered Species Specialist.

US 40 Berthoud Pass Upgrade, Colorado Department of Transportation, Clear Creek and Grand Counties, Colorado (1997-1998). Habitat assessment at the local and landscape scale to determine the best locations for wildlife underpasses to benefit mule deer, elk, Canada lynx and other species. Coordinated with project planners and designers to design underpasses that were appropriate for the target species and that provided engineering feasibility. Endangered Species Specialist.

REPRESENTATIVE PRESENTATIONS

Barnum, S. A., Alt, G. 2013. The effect of reduced mowing on rate of deer-vehicle collisions. 2013 Transportation Research Board Annual Meeting. Washington, D.C.

Barnum, S. A., Gray, M. 2011. A comparison of methods to identify deer-vehicle crash hotspots. 2011 Transportation Research Board Annual Meeting. Washington, D.C.

Barnum, S. A. 2008. Habitat, highway features, and animal-vehicle collision locations as indicators of wildlife crossing hotspots *in* Proceedings of the 2007 International Conference on Ecology and Transportation. Center for Transportation and the Environment, North Carolina State University.

Barnum, S. A. 2007. Habitat, highway features, and animal-vehicle collision locations as indicators of wildlife crossing hotspots. 2007 International Conference on Ecology and Transportation. Little Rock, AR.

Barnum, S. A. 2003. Identifying the best locations to provide safe highway crossing opportunities for wildlife. Society for Conservation Biology 17th Annual Meeting. Duluth, MN.

Barnum, S. A. 2001. Preliminary analysis of locations where wildlife crosses highways in the Southern Rocky Mountains 2001 International Conference on Ecology and Transportation. Keystone, CO.

Barnum, S. A. 2001. Preliminary analysis of locations where wildlife crosses highways in the Southern Rocky Mountains *in* Proceedings of the 2001 International Conference on Ecology and Transportation. Center for Transportation and the Environment, North Carolina State University.

Barnum, S. A. 1999. A programmatic approach to minimize highway project impacts on Canada Lynx (*Lynx canadensis*) in Colorado. Third International Conference on Wildlife Ecology and Transportation. Missoula, MT.

PEER-REVIEWED ARTICLES AND PUBLICATIONS

Barnum, S. A. 2003. Identifying the best locations along highways for wildlife under- and overpasses: a handbook for highway planners and designers. Colorado Department of Transportation Research Report 2003-9.

Barnum, S. A., C. J. Mannville, J. R. Tester, and W. J. Carmen. 1992. Path selection by *Peromyscus leucopus novaboracensis* in the presence and absence of vegetative cover. *J. Mammal.* 74:797-801.



JAMIE L. O'BRIEN

Biologist/Data Analyst

Ms. O'Brien is a biologist with six years of professional experience in wildlife research, conservation, and natural resource management throughout New England. Her projects have emphasized protecting and managing threatened and endangered species, assessing environmental impacts, regulating and managing natural resources and wildlife, and ensuring Federal Endangered Species Act compliance. Her diverse wildlife background includes experience with forest, wetlands, and marsh birds, shorebirds, waterfowl, songbirds, raptors, amphibians, and small mammals, including bats. In addition to her field skills, Ms. O'Brien possesses a strong foundation in project planning and implementation, project management and organization, and data analysis and quality control.

Additionally, Ms. O'Brien is a SAS programmer in the Technical Data Processing group. In this capacity she is responsible for the integrity and quality of data and for the generation of final data deliverables.

REPRESENTATIVE PROJECT EXPERIENCE

Balsams Ski Resort Expansion, Northern Long-eared Bat Surveys Dixville LLC, Dixville, NH (2015-Present).

Dixville LLC is proposing to revive and expand the deteriorated Balsams Grand Resort and Wilderness Ski Area into a year-round resort. The project includes restoring the original resort and facilities, constructing new facilities, and increasing the ski terrain from approximately 100 acres to 1200 acres. Normandeau was retained to undertake natural resources data collection efforts and to assist with environmental State and Federal permitting. Ms. O'Brien played a large role in the 2015 Northern long-eared bat surveys, where, in addition to deployment and retrieval of detectors, she coordinated site access and field crew schedules, and was responsible for data reporting, and habitat assessments. Biologist.

Pike Industries Northern Long-eared Bat Surveys, Hooksett, New Hampshire (2015). Normandeau is conducting Northern long-eared bat survey work for a proposed quarry expansion. Ms. O'Brien conducted the Northern long-eared bat surveys, which involved deployment and retrieval of acoustic detectors and habitat analysis of detector sites. Biologist.

Socha Companies Northern Long-eared Bat Surveys, Hooksett, New Hampshire (2015).

Normandeau is providing delineation and natural resource survey work for a proposed apartment complex. Ms. O'Brien participated in Northern long-eared bat surveys, which involved the deployment and retrieval of acoustic detectors. Biologist.

EDUCATION

M.S.E.S., Applied Ecology, Indiana University, Bloomington

M.P.A., Environmental Policy and Natural Resource Management, Indiana University, Bloomington

B.A., (cum laude) Biology, Saint Anselm College

PROFESSIONAL EXPERIENCE

2013-Present Normandeau Associates

2011-2013 U.S. Fish & Wildlife Service, Umbagog National Wildlife Refuge

2012 Ducks Unlimited, Inc. U.S. Great Lakes Region

2009-2011 Office of Sustainability, Indiana University, Bloomington

2008 Dickinson College Biodiesel Shop

PROFESSIONAL AFFILIATIONS

- New Hampshire Audubon
- Loon Preservation Committee
- New Hampshire Association of Natural Resource Scientists



Northern Pass Transmission Line Project Northern Long-eared Bat Surveys, Northeast Utilities, NH (2014-present). Northeast Utilities is proposing the Northern Pass Transmission Line, a 180-mile HVDC and AC Transmission project to bring hydropower from Quebec into New Hampshire and the New England region. Ms. O'Brien is involved with various aspects of this project, including wetland mitigation research and permit preparation for NH Department of Environmental Services Shorelands, Wetlands, and Alteration of Terrain Permits. Ms. O'Brien is also providing GPS support for delineated wetland boundaries, and participating in natural resource surveys including rare plants, vernal pools, and bats. Ms. O'Brien was especially involved with Northern Long-eared Bat surveys, where she managed scheduling for up to five people, conducted habitat analysis, deployed and retrieved detectors, and wrote code to filter call data for target species identification. Biologist.

Confidential Client, (2014-2015). This is a confidential energy project. Ms. O'Brien was involved with various aspects of this project, including wetlands and mitigation in a fatal flaw analysis, map revisions in ArcGIS for presentation at state and local meetings, wetland compensatory mitigation research and ARM fund numbers. Ms. O'Brien is also providing GPS support for delineated wetland boundaries, and participating in natural resource surveys including vernal pools, turtles, snakes, Northern Harriers, and bat hibernacula. Additionally, Ms. O'Brien helped with the creation of public outreach documents involving tourism in associated project areas. Biologist.

Bat Monitoring, U.S. Fish & Wildlife Service, Umbagog National Wildlife Refuge, NH/ME (2011-2013). Ms. O'Brien evaluated resident bat populations adjacent to Lake Umbagog. Monitoring activities included conducting maternity roost emergence surveys and acoustic driving transect surveys. Coordinating volunteer efforts, completing required documentation following each survey, maintaining and preserving accurate records, and updating database records was also practiced. Biological Technician.

SPECIAL TRAINING

Motor Boat Operator Certification (Department of the Interior), valid through 06/2016

Defensive Driving (Department of the Interior), valid through 06/2016

CPR/AED (American Red Cross), valid through 02/2017

SAS System programming

ArcGIS 9.2-10.3

Normandeau's 1 week Bat Acoustic Training course

Stephen R. Lindsay Wildlife Biologist, Bat Specialist

Stephen Lindsay is a wildlife biologist with special expertise in bats, raptors, grassland birds, and endangered species, particularly in the northeastern United States. His experience working with and studying bats includes mist netting, harp trapping, affixing transmitters and pit tags, banding and handling, performing hibernacula surveys, using acoustic monitoring devices, and analyzing acoustic results. He is also experienced in radio telemetry and GIS.

While working for the New York State Department of Environmental Conservation (NYSDEC), Stephen handled hundreds of bats, identifying them to species, assessing reproductive status, determining sex and age, and banding and attaching pit tags. He also monitored Indiana and northern long-eared bats, deploying acoustic devices and analyzing results to identify species using full spectrum programs.

SELECTED PROJECT EXPERIENCE

Reassessing Summer Range of Indiana Bats (*Myotis sodalis*) in the Hudson Valley, New York, NYSDEC (2013–2015)—Assess previous summer range use of Indiana bats using previously collected data. Used GIS and areal mapping to determine detector location and gain access to private and public location for detector deployment. Deployed acoustic detectors at sites throughout the Hudson Valley to detect Indiana bats. Collected, sorted, and filter collected data. Ran data through call analysis software and verified that the species determinations were correct for *Myotis* species. Set and monitored triple high mist nets at high priority sites. Determined species, sex, and age of captured bats and attached radio transmitters to captured Indiana bats. Perform exit counts at discovered maternity colonies. Wildlife Technician.

Monitor Cave Ecosystems and White-Nose Fungus Presence in Bat Hibernacula, New York, NYSDEC (2013–2015)—Accessed known hibernacula of Indiana bats and determined the number present. Used caving gear, including caving suits and ropes/harnesses, to enter natural cave formations and abandoned mining sites. Took swabs from the ceiling of the cave at various locations using climbing and ladders. Took soil samples from the floor at various locations. Retrieved temperature and humidity monitoring buttons and collected data from them. Replaced and reported missing detectors. Wildlife Technician.

Bi-yearly Winter Survey of Indiana Bat (*Myotis sodalis*) Hibernacula, New York, NYSDEC (2013–2015)—Accessed known hibernacula of Indiana bats and determined the number present. Used caving gear, including caving suits and ropes/harnesses, to enter natural

EDUCATION

B.S.	2011, Wildlife Management, Paul Smith's College
A.S	2007, Individual Studies

PROFESSIONAL EXPERIENCE

2015–Present	Normandeau Associates
2013–2015	New York State Department of Environmental Conservation
2014	Vesper Environmental
2012	New Jersey Audubon
2011	Penn State University

cave formations and abandoned mining sites. Navigated through complex tunnel systems and used caving maps. Photographed and visually counted the number of Indiana bats and other species present. Wildlife Technician.

Determining Range of Wintering Raptors Throughout the Hudson Valley, New York, NYSDEC (2013–2015)—Performed wintering raptor surveys in areas of the Hudson Valley known and suspected to be occupied to determine roost locations and sites used by wintering raptors. Used bi-weekly surveys to determine presence of winter raptors with special interest in Short-eared Owl (*Asio flammeus*) and Northern Harriers (*Circus cyaneus*). Used bow nets and live bait to lure and capture both species near roost locations. Handled, banded, collected biological data, and affixed tail-mount radio transmitters to captured birds. Performed radio telemetry on birds to determine roost locations and foraging data. Wildlife Technician.

Aeolas Cave Winter Mortality Survey, Vermont, Vesper Environmental (Summer 2014)—Helped determine the survival rate of hibernating bats at Aeolas cave using pit tags and mark and capture. Deployed harp traps at cave mouth and nearby. Assessed species, age, sex, and reproductive status of captured bats. Affixed pit tags and wing bands. Bat Technician.

Assessment of Grassland Bird Nesting Success and Survival at PAX Naval Air Station, Maryland, New Jersey Audubon (Summer 2012)—Located and monitored grassland birds, with emphasis on eastern meadowlarks and grasshopper sparrows, on grassland plots at air bases to determine effects of mowing on productivity and survival. Performed nest searches using roping and sticking, nest monitoring, band resighting, nestling banding, and vegetation surveys. Maintained a professional working relationship with Patuxent Air Naval Station base officials. Field Technician.

Assessment of Grassland Bird Community response to Habitat Manipulation at Reclaimed Strip Mine Mountains, Pennsylvania State University (Summer 2011)—Assisted with PhD research on grassland bird community response to habitat manipulation on reclaimed surface mine grasslands in west-central Pennsylvania. Assessed changes in survival, apparent return rates, and population sizes for these areas following vegetation removal. Assisted with capturing (via playback) and banding adult and nestling Grasshopper, Henslows, Savannah, and Vesper Sparrows. Performed nest searches and monitoring, and re-sighted color-banded birds to estimate population sizes. Research Assistant.

SPECIAL TRAINING

- Chemical Immobilization Training, Safe Capture International