Eastern Whip-poor-will Survey:

Lake Memphremagog Basin

Orleans and Essex Counties



Annual Report to Vermont Fish and Wildlife

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Volunteer Spencer Hardy's digiscoped photo of an Eastern Whip-poor-will along the West Haven Route © Spencer Hardy

Introduction

The Eastern Whip-poor-will (*Antrostomus vociferus*) is a nocturnal aerial insectivore found in edge habitats across eastern North America. Seldom seen yet well known for its distinctive call, the male Eastern Whip-poor-will (WPW) will call continuously throughout clear, moonlit nights during breeding season (usually late May through early July) (Cink 2002). Habitat requirements for this species are complex and necessitate a mix of open-understory forest, for breeding and rearing young, and large tracts of open land, in order to forage successfully (Hunt 2006). Examples of breeding habitat include forests with dry, nutrient poor soils such as Pine Barrens and Pine-oak Woodlands. Suitable foraging habitats include fields, power-line rights-of-way, agricultural settings, and recently logged or burned areas (Hunt 2013).

Due in part to loss of this composite habitat, the geographic range of WPW has contracted and populations have declined (Sauer et al. 2011). Forest maturation, urbanization, and industrialization have been cited as causal factors in WPW decline (Environment Canada 2015). As agriculture decreases and parts of Vermont revert back to their initial, more forested state, early successional habitat necessary to host a robust WPW population is lost. In addition to habitat loss, WPW declines have also been attributed to population declines in large-bodied moths (possibly due to pesticide use), and collisions with cars (COSEWIC 2009).

WPW numbers declined by 77% between the first (1976-1981) and second (2002-2007) Vermont Breeding Bird Atlas (Renfrew 2013). Other breeding bird atlases (MD, NY, ON, PA) showed an average decline of 54% between their first and second atlases. However, most bird surveys are carried out during the day and associated data may fail to accurately represent nocturnal bird populations. This lack of standardized and consistent nocturnal bird surveys prompted Pam Hunt of New Hampshire Audubon to commence the Northeast Nightjar Survey in

2007. Now coordinated by the Vermont Center for Ecostudies (VCE), this statewide, annual survey is carried out by volunteers who survey routes within regions exhibiting habitat characteristics considered potentially suitable for WPWs (low elevation, matrix of field and forest). These surveys suggest changes in the Vermont WPW population and contribute to broader efforts to detect regional changes in the northeastern population. In particular, data from these surveys suggest steep declines in Vermont WPW populations. In 2011, in response to data collected from bird surveys, the Northeast Nightjar Survey, and years of anecdotal accounts of population decline in Vermont, the WPW was listed as Threatened in the state.

In order to better understand habitat requirements of this species and obtain more precise counts, VCE has conducted WPW surveys for the past four summers in different regions of Vermont. These surveys are a first step toward determining where additional survey effort may be focused and providing more thorough population estimates for the state.

Methods

Our objective was to obtain an estimate of the number of WPWs in Vermont by surveying areas where the species is known to be relatively abundant, areas with suitable habitat but from which we have few records, or areas in which we think WPWs may have been more abundant in the past.

2018 Methods

Starting in the summer of 2015, in an effort to produce standardized, replicable surveys, we implemented a set of point-count protocols on routes that had been predetermined by Pamela Hunt during the 2007 Northeast Nightjar Survey and continued those protocols from 2016 through 2018. If a WPW was heard at one of the original points, cluster sampling would have been employed. In 2018, no

WPWs were heard on the standardized routes within our focus area so no cluster sampling occurred.

Since implementation in 2007, volunteers have routinely surveyed most routes for WPWs and other nightjars. In 2016 and 2017, two surveyors created, mapped, provided route descriptions, and surveyed new routes in addition to volunteer surveys. In 2018, one or two surveyors created, mapped, provided route descriptions, and surveyed six new routes in addition to volunteer surveys – Holland, Brownington, Coventry, Troy, Irasburg and Derby. VCE also created, mapped, provided a route description, and partially surveyed Brighton as time and weather permitted.

Similar to the generation of the original routes, new routes were loosely based on habitat associations derived from work done in New Hampshire (Hunt 2006) or other data (e.g., Cink 2002, Hunt pers. obs.). In general, routes were placed in areas that met all or most of the following criteria:

1. Away from major roads and developed areas

2. Lower elevation river valleys

3. Habitat mosaic of forest and open areas (latter including old fields, utility rights of way, and barren lands)

4. Pine or pine/oak forest (though this was often not apparent from Google Earth images)

5. Presence of gravel pits as indicator of well-drained soils

Suitable habitat was identified using Google Earth, then a route consisting of 10 points spaced 1.6 km apart was placed so as to fall as completely within the appropriate habitat as possible.

Our surveys were conducted from 29 May through 5 July, on nights with at least

50% moon illumination, during the full moon or waxing and waning gibbous moons, when WPWs are known to call more frequently. One or two observers arrived at a predetermined site approximately 15 minutes prior to beginning the survey, to organize data sheets and equipment and allow birds to settle. In the evening, surveys started 20 - 30 minutes after sunset and continued through the specified end point, as long as the moon was visible and the weather was suitable. During the waning moon, surveys began after sunset, continued until it was dark, then were delayed varying amounts of time until the moon rose above the horizon. Early morning surveys ended 15 minutes before sunrise and were often used to complete roadside surveys from the previous night or used for ad hoc surveys. Surveys were not conducted if conditions were windy (wind speed > 8 mph), cloudy (> 50% cloud cover), or rainy.

Each survey consisted of point counts at 10 locations along six pre-established routes in Holland, Brownington, Coventry, Troy, Derby and Irasburg. Survey point locations were each spaced one mile apart. For all surveys, routes were followed in order, from point one to point ten. If there was no safe or quiet parking at a point, the point was moved as far up the road as needed to be safe, but no further than 0.24 km.

Each point on a given route included a six-minute count, during which time observers listened silently and recorded birds independently. Latitude, longitude, wind speed, cloud cover, and noise were noted at each point along the route prior to the start of the count. Passing cars were noted during the course of the survey. The survey consisted of one-minute intervals for six minutes, with a compass bearing and qualitative proximity assessment (very close, close, far, very far) if a WPW was heard. If a WPW was detected at one of the 10 original points, a supplemental point survey would have been completed at least 0.8 km, and no more than 1.2 km away, using the same point-count protocol. Ideally, there would have been two to three supplemental points available for each original point if a

WPW was heard at an original point.

If a WPW was detected at an original point on a standardized route, each observer would have noted a bearing to better determine (and potentially triangulate) the location of the individual bird. Any WPW detections by observers were mapped to 1 km along the compass bearing noted, with the understanding that the location of the individual WPW was somewhere between the observer and the 1 km marker.

Each route was surveyed to completion, points 1 through 10, twice by one or two VCE observers. Volunteers did not survey these newly created routes. Several surveys were aborted mid survey due to inclement weather, but all points within the route were visited at least twice. Ideally, repeat surveys would have been conducted within the same lunar cycle so as to reduce variability in counts that might arise due to immigration or emigration into the survey area. We were able to adhere to this protocol for all routes except for Coventry. For Coventry, the first survey was completed on the last night of the first acceptable survey window, so the replicate survey was completed during the sequential lunar cycle.

When time allowed, ad hoc surveys were completed to find WPWs in locations outside the survey routes. Similar to our 2014 methods, we scouted habitat during the day in order to pinpoint suitable locations for ad hoc surveys. These surveys consisted of walking or driving in potential habitat and listening for singing birds. At each site we listened for WPWs for six minutes, then proceeded to the next location. If we did not hear a WPW, we proceeded to the next point until the survey window closed or unsuitable weather forced us to end the ad hoc survey. In addition to surveying ad hoc points, we also surveyed supplemental points, even when no WPWs were detected on a route. Unlike ad hoc points, supplemental points were chosen based on the original route rather than suitable WPW habitat. Supplemental points were located at least 0.8 km, and no more than 1.2 km away from original points along the route.

In 2018, there were many surveys completed with one observer rather than two. Late in the season, ten of VCE's SongMeter SM4 (Table 1) Automated Recording Units (ARUs) became available when a second observer was unable to survey. Whenever possible and as time permitted, one ARU was placed at each survey point. However, ARUs were not placed at points that were on a busy highway, on private property, in a busy town, in thickly settled residential areas, or in large open fields without a tree in close proximity. ARUs were placed on a tree out of sight and as close to the point as possible with a cable lock and a lock on the housing to prevent tampering or theft (Image 1). Each ARU was scheduled to start recording at 21:00, recording continuously until 4:45 for one night. Data was immediately transferred to a laptop but analysis did not occur until after the field work was complete.

Image 1. SongMeter SM4 with locks



Analysis of the data was completed by visually scanning spectrograms and listening to potential areas of interest after review of Macaulay Library of Natural Sounds at Cornell. Audacity was then used to view and scan the spectrogram. The frequency range was set from 1100 to 3300 Hz (based on the Macaulay Library WPW sonograms viewed) and the time was set to 1 second intervals. The window size was set to 1024 and the window type was set to Hanning. At each survey point in which we obtained a recording, we analyzed one hour of recordings near sunset (21:00 - 22:00) and one hour when the moon was greater than 50% illuminated and well above the treelines (2:00 - 3:00) with good weather conditions.

In addition to the surveys conducted by VCE, volunteers completed the following roadside surveys, using the Northeast Nightjar Survey protocols, once during the 2018 breeding season and under suitable weather and lunar conditions (as detailed above): Bennington, Brandon, Brattleboro, Concord, Corinth, Fair Haven, Ferrisburg, Hartland, Hinesburg, Orwell, Pawlet, Peacham, Randolph, Rutland, Salisbury, Shoreham, Snake Mountain, South Tunbridge, Springfield, Underhill, Vernon, Wells, and West Haven. The West Haven route was surveyed except for point 7, which was flooded.

Results and Discussion

2018 Results and Discussion

The 2018 WPW breeding season was completed using the improved and more systematic protocol implemented in 2015. In order to produce standardized, replicable surveys with more reliable results, we conducted surveys on pre-established Northeast Nightjar Survey routes using point counts, which were augmented with cluster sampling using point counts at supplemental points. Our survey efforts were focused in 2 counties in northern Vermont where there were no previous records of WPW.

Holland:

The Holland route was surveyed by two observers completely twice during the 2018 breeding season by VCE. The first survey started after sunset (29 May) and was completed in good weather conditions with an additional four ad hoc points, finishing near midnight. The second survey (3 June) began at approximately 1:00 am and was surveyed completely in good weather conditions. In addition, we surveyed two supplemental points and one ad hoc point before sunrise. Despite good weather and quiet survey conditions, there were no WPW detections along the route or at any of the ad hoc points.

This route is near the Canadian border, between large forested tracts of land to the east and the fairly developed town of Derby along Lake Memphremagog to the west. It consists primarily of rural areas, a mosaic of fields and forests, with many large dairy farms surrounded by primarily spruce forests on dirt roads. There are no large rivers or large sand pits in the area but much of the route follows small brooks with some small sandy areas, recently logged areas, and several cemeteries. Many of the forested areas in Holland are similar to that of the Concord route which supports several WPWs currently.

Brownington:

The Brownington route was attempted three times, each time with two observers. The first survey (30 May) started after sunset but was cancelled due to excessive wind after the third point. The second survey (22 June) began after sunset and was completed before midnight with one supplemental point and two ad hoc points. The third survey (26 June) started after sunset and was completed before midnight in good weather conditions and little noise. No WPWs were detected at any point.

The Brownington route represents rural Vermont, with rolling hills, open hay fields and dirt roads. The route travels over hills and crosses small brooks, past several sand pits, and then parallels near the Willoughby River. There are large forested

areas, many with evidence of logging on Google Earth. Five of the ten points have forests consisting primarily of pine, spruce, cedar and tamarack. The combination of pine forests and open habitat consisting of fields and sand pits make this good potential habitat for WPWs.

Coventry:

The Coventry route was surveyed a total of two times during the 2018 breeding season. The first survey (6/7 June) was completed by one observer only. The first three points and one ad hoc point were surveyed after sunset. Due to the waning moon, the remaining points and one supplemental point with were surveyed once the moon rose over the trees after 3:00 am. The entire route was completed more than 30 minutes before sunrise with no WPW detections. The second survey (21/22 June) started after sunset and was completed with two supplemental points and three ad hoc points just after midnight. The second survey was completed with two observers without any WPW detections. The Coventry route is unique in the Lake Memphremagog Basin because there are numerous large sand pits from point one through point six. Although Rt. 14 that travels along these pits is a busy highway with some residential areas, there are many open areas with pine forests, making it good WPW habitat. Points seven through ten also provides good WPW habitat with its dirt roads, open fields and marshes along a river valley with pine forests surrounding. There was a historical five mile Coventry route created in 2006 by Pam Hunt, which also followed many of the same sand pits along Rt. 14. However, no volunteers successfully completed the survey in 2006 or 2007 and the route was eliminated. Due to its proximity to many sand pits, the Barton River Valley, South Bay WMA and a small airport, finding a volunteer to survey this route in the future could provide valuable data.

Troy:

The Troy route was surveyed twice by VCE during the 2018 breeding season. The

first attempt (20 June) began after sunset with two observers and continued through point seven. Due to increasing cloud cover, the survey was cancelled. We resumed the survey at point eight and completed the survey with one ad hoc point under better cloud cover before sunrise. There were some moderate winds throughout the survey, but not enough to cancel the survey according to the Northeast Nightjar Survey protocol. No WPWs were detected at the ad hoc point or along the route. The second survey (25/26 June) was completed with two observers, clear skies, and almost no wind. We started the survey after the moon rose above the trees and completed the entire route with two supplemental points by approximately 1:00 am. Once again, there were no WPW detections at any of these points.

The Troy route follows the Missisquoi River valley from North Troy near the Canadian border south to Westfield mostly along quiet dirt roads. To the west of the route are relatively high elevation forested mountains in Jay State Forest and to the east is Newport and Lake Memphremagog. Most of the points have pine forest and spruce forests bordering open areas. Most of the open areas are hay fields or shrubby fields. There are several sand pits along the route that indicated sandy soil during mapping. Considering the sandy soil and low elevation river valley with little development, this route has good potential WPW habitat.

Derby:

The first attempt of the Irasburg Route (30 June) began after midnight with one observer. Points one and two were completed under mostly to partly clear skies. However the survey was cancelled at point three due to excessive cloud cover. The survey was resumed near sunrise when WPWs call reliably despite cloud cover and only points seven through ten were completed before sunrise. Prior to this survey, ARUs were set up near points at eight points in order to account for the lack of a second observer. The points that did not have recorders were because they were in somewhat busy residential areas. Although much of the

night was cloud covered, recordings were captured near sunrise and sunset for eight points simultaneously when WPWs are known to call reliably despite cloud cover. No WPWs were detected by the analysis of recordings from ARUs near sunrise and sunset (Table 2). The second survey attempt (3 July) was delayed well beyond sunset due to severe thunderstorms. One observer started the survey after 2:00 am and completed the survey with two supplemental points before sunrise in good weather conditions. No WPWs were detected. The next survey (5 July) was also completed by one observer. Points one through ten were surveyed after 1:00 am to completion with a supplemental point. Neither primary points nor the supplemental point yielded any WPW detections.

The Derby route starts at Eagle Point WMA, which is adjacent to the Canadian border and Lake Memphremagog and contains both marshy areas and state managed grasslands. Beyond the first two points at Eagle Point WMA, the route follows the narrow Johns River Valley through some residential areas on paved roads. There are large quarries in Canada just north of Eagle Point WMA and sand pits near points seven and eight indicating sandy soils. Many of the forests along the route are hardwood forests, with only four points consisting of primarily pine forests. Much of Derby is very developed, however the route is not on a major highway and could provide some potential WPW habitat.

Irasburg:

The Irasburg route was surveyed (1/2 July) by one observer starting after sunset continuing to completion before sunrise. In addition to the primary points, three supplemental points and two ad hoc points were surveyed in good weather conditions. No WPWs were detected. Prior to this survey, ARUs audio recorders were set up near seven of the ten points in order to account for the lack of a second observer. The points that did not have recorders were due to location, such as residential areas with many houses, on a busy highway, large agricultural fields with few trees, or houses with dogs outside in close proximity. No WPWs

were detected by the analysis of recordings from ARUs (Table 3). The second survey (3/4 July) started after sunset with one observer but due to excessive noise was halted until the moon rose over the trees. Points three to ten and an ad hoc point were surveyed with two observers before sunrise.

The Irasburg route starts with large open hay fields and shrubby fields on dirt roads with more pine forests than hardwood forests. Points seven through ten are on a quiet road which follows a narrow creek valley with dairy farms, shrubby fields, and pine forests with spruce and cedar. This creek parallels the busier highway and larger Black River Valley to the west. There are several sand pits in close proximity to the route, indicating sandy soil. Seven of the 10 points have pine forests. Overall, this route has good WPW habitat and should be surveyed by volunteers in future years if possible.

Brighton:

The Brighton route was created after an incidental finding of a calling WPW at Brighton State Park campground where we were camping. We observed sandy soils along roads and in fields near Brighton Pond, Island Pond and the surrounding areas. Upon review of Google Earth for the Brighton area, we determined that the area could provide suitable WPW habitat, so a route was created and mapped. With limited time to focus on Brighton specifically, we only surveyed two primary points and six ad hoc points at sunrise or sunset as time allowed. Point one was surveyed (2 June) by two observers after sunset. Both observers detected one calling WPW. No cluster sampling occurred with this WPW detection. One ad hoc point was surveyed with no WPW detections. The following night after sunset (3 June), three ad hoc points were surveyed by one observer. No WPWs were detected. Fourth of July fireworks and traffic along the Derby route would have caused excessive noise as it is a more developed area. Since Brighton is less developed, point one and an ad hoc point were surveyed after sunset by one observer. Firework noise prevented more points from being

surveyed after sunset, despite the rural setting of Brighton. The following morning (5 July) two ad hoc points were surveyed before sunrise by one observer. Neither the sunset or sunrise surveys yielded any WPW detections.

In addition to these partial Brighton surveys by observers, ARUs were placed at eight Brighton primary points (3/4 July). The two primary points without ARUs were in densely populated areas, point 5 and point 6. Analysis of the ARU recordings revealed a WPW calling nearly continuously from 2:27 to 2:39 (4 July) at point three. Because the recordings provided only presence/absence data, not distance or direction, it was not included on the Brighton map. Locations of ARUs (Table 4) are provided with the number of WPWs detected at each ARU.

The Brighton route starts at a small airport with sandy fields, a pond with marshes surrounding and abundant pine forests. It follows spruce and pine forests with many sandpits. The route ends near a wide river valley with marshy areas surrounding the river. Overall, Brighton consists primarily of large forests with small amounts of open areas including sand pits, logged areas, marshes and only a few fields. Upon further research of historical WPW data, we found several WPW records spanning from 1978 to 2013. Considering habitat, historical data, and the current presence of WPWs, more in depth surveys should be completed by VCE in the future. In addition, finding a volunteer to survey this route on a regular basis could provide valuable data.

Conclusion

While VCE's 2014 and 2015 surveys and cluster sampling produced a large number of WPW detections, the 2016 - 2018 breeding season yielded few. No historic WPW records exist for areas in which the new routes were created in 2018, except for Brighton. Though there was only one WPW detection by observers on the new routes, the value of these surveys exists in their generation of data for areas in which there is sparse historical data, ultimately providing more insight into the overall WPW populations in Vermont. The land surrounding the seven new routes possesses potential WPW habitat. If possible, Coventry, Irasburg, Brighton and Troy could be surveyed by volunteers. Derby's Eagle Point Wildlife Management area would also be a good area to survey. Since these routes lie in rural areas, finding volunteers for these routes may be a challenge.

VCE's recent WPW surveys have been highly constrained due to the limited number of sites and routes that could be surveyed during a short breeding season and under conditions in which WPWs are known to call. To acquire more robust and comprehensive data, we continue to suggest use of automated recording units (e.g., Digby et al. 2013), which allows for more extensive surveys. ARUs might prove especially useful in surveying areas that are difficult to access, such as power-line rights-of-way and recently logged areas. In 2018, ARUs were found to be useful when only one observer was available to survey or when cloudy conditions prevented observers from completing all points on a survey. ARUs also allowed more data to be collected in areas outside of the primary focus area and provided larger presence/absence data sets at all locations where they were placed. If ARUs are used in the future, the use of automated recognition programs should be considered if larger data sets are collected. Automated recognition programs have been found to be more efficient than human listening for data sets larger than 36 hours of audio (Knight et al. 2017).

Though the 2018 survey season yielded only one detection by observers with our standardized protocol, the protocol is sound and comparably rigorous surveying protocols in other parts of Vermont are warranted, particularly in areas without established routes (i.e. areas with little historical data). In addition to continuing the survey protocol implemented in 2015, as well as the establishment of new routes around the state, we also suggest conducting an analysis of habitat use, which would better enable assessment of WPW habitat capacity in Vermont and permit fine-tuning of route designations for regular monitoring. This should include not only analyzing habitat relationships along existing survey routes, but also in other potentially suitable environments that are not well covered by roadside surveys. For example, expanding surveys to include power lines, quarries, and recently logged areas would allow us to evaluate use of these disturbed areas by WPW and to determine whether they constitute an important source of habitat that might play a critical role in recovery efforts.

 Table 1. SongMeter SM4 Specifications

Specification	Measurement/units
Recording Technology	2 channel, 16 bit .wav
Recording Bandwidth	20Hz – 48kHz
Sample Rate used	24000 Hz
Triangulation Technology	no triangulation*
Microphone directional capabilities	omni-directional
Microphone sensitivity	-33.5 dB +/- 3 dB at 1 kHz (0 dB=1 V/Pa)
Microphone signal to noise ratio	80 dB Typ. at 1kHz (1 Pa, A weighted network)
Microphone max input sound level	122 dB SPL Typ.
Internal power	4 D-size alkaline or NiHM batteries
Run time	Up to 400 hours with 4 D-cell Alkaline or 250 hours with NiHM batteries. Run times can vary based on temp., SD cards.
Storage	> 1 terabyte total capacity using (2) 512GB SanDisk SDHC/SDXC cards
Dimensions	Height: 8.6" / 218 mm Width: 7.3" / 186 mm Depth: 3.1" / 78 mm
Weight	2.9 lbs / 1.3 kg with batteries
Enclosure material/protection	Polycarbonate/weather resistant
Operating Temperature	-4°F to +122°F or -20°C to 50°C

*The Song Meter SM4 does not provide triangulation capabilities. If triangulation capabilities are needed, the Song Meter SM3 is an alternative.

Date	Time	Route and Point	XCOORD	YCOORD	# WPW
29-June-18	21:00 - 22:00	Derby 1	-72.197980	45.003211	0
30-June-18	4:00 - 4:12	Derby 1	-72.197980	45.003211	0
29-June-18	21:00 - 22:00	Derby 2	-72.185642	44.998862	0
30-June-18	4:00 - 4:12	Derby 2	-72.185642	44.998862	0
29-June-18	21:00 - 22:00	Derby 3	-72.168611	45.005493	0
30-June-18	4:00 - 4:12	Derby 3	-72.168611	45.005493	0
29-June-18	21:00 - 22:00	Derby 5	-72.134531	44.997575	0
30-June-18	4:00 - 4:12	Derby 5	-72.134531	44.997575	0
29-June-18	21:00 - 22:00	Derby 6	-72.125914	44.984851	0
30-June-18	4:00 - 4:12	Derby 6	-72.125914	44.984851	0
29-June-18	21:00 - 22:00	Derby 7	-72.127820	44.970174	0
30-June-18	4:00 - 4:12	Derby 7	-72.127820	44.970174	0
29-June-18	21:00 - 22:00	Derby 8	-72.121823	44.959250	0
30-June-18	4:00 - 4:12	Derby 8	-72.121823	44.959250	0
29-June-18	21:00 - 22:00	Derby 9	-72.105123	44.951334	0
30-June-18	4:00 - 4:12	Derby 9	-72.105123	44.951334	0

Table 2. Date, time of recordings analyzed, and location of Automated Recording

 Units (ARUs) with number of WPWs detected at Derby

Date	Time	Route and Point	XCOORD	YCOORD	# WPW
1-July-18	21:00 - 22:00	Irasburg 1	-72.276234	44.860289	0
2-July-18	2:00 - 3:00	Irasburg 1	-72.276234	44.860289	0
1-July-18	21:00 - 22:00	Irasburg 2	-72.291098	44.850848	0
2-July-18	2:00 - 3:00	Irasburg 2	-72.291098	44.850848	0
1-July-18	21:00 - 22:00	Irasburg 3	-72.304144	44.840591	0
2-July-18	2:00 - 3:00	Irasburg 3	-72.304144	44.840591	0
1-July-18	21:00 - 22:00	Irasburg 6	-72.290342	44.810840	0
2-July-18	2:00 - 3:00	Irasburg 6	-72.290342	44.810840	0
1-July-18	21:00 - 22:00	Irasburg 9	-72.290758	44.770710	0
2-July-18	2:00 - 3:00	Irasburg 9	-72.290758	44.770710	0
1-July-18	21:00 - 22:00	Irasburg 10	-72.299699	44.756756	0
2-July-18	2:00 - 3:00	Irasburg 10	-72.299699	44.756756	0

Table 3. Date, time of recordings analyzed, and location of Automated Recording

 Units (ARUs) with number of WPWs detected at Irasburg

Date	Time	Route and Point	XCOORD	YCOORD	# WPW
3-July-18	21:00 - 22:00	Brighton 1	-71.822436	44.787097	0
4-July-18	2:00 - 3:00	Brighton 1	-71.822436	44.787097	0
3-July-18	21:00 - 22:00	Brighton 2	-71.838052	44.795841	0
4-July-18	2:00 - 3:00	Brighton 2	-71.838052	44.795841	0
3-July-18	21:15 - 22:00	Brighton 3	-71.851191	44.806666	0
4-July-18	2:00 - 3:00	Brighton 3	-71.851191	44.806666	1
3-July-18	21:00 - 22:00	Brighton 4	-71.865466	44.815485	0
4-July-18	2:00 - 3:00	Brighton 4	-71.865466	44.815485	0
3-July-18	21:00 - 22:00	Brighton 7	-71.914067	44.829369	0
4-July-18	2:00 - 3:00	Brighton 7	-71.914067	44.829369	0
3-July-18	21:00 - 22:00	Brighton 8	-71.931886	44.83145	0
4-July-18	2:00 - 3:00	Brighton 8	-71.931886	44.83145	0
3-July-18	21:00 - 22:00	Brighton 9	-71.94877	44.825892	0
4-July-18	2:00 - 3:00	Brighton 9	-71.94877	44.825892	0
3-July-18	21:00 - 22:00	Brighton 10	-71.968828	44.828532	0
4-July-18	2:00 - 3:00	Brighton 10	-71.968828	44.828532	0

Table 4. Date, time of recordings analyzed, and location of Automated Recording

 Units (ARUs) with number of WPWs detected at Brighton

Key for Figures 1 - 7

Red pins indicate original points along survey route. Blue pins indicate supplemental points for cluster sampling. Yellow pins indicate ad hoc points. Red lines indicate direction from observer to WPW and continue for 1 km, regardless of actual distance from observer to WPW. Does not include detections from ARUs.



Figure 1. Points surveyed Holland route



Figure 2. Points surveyed Brownington route



Figure 3. Points surveyed Coventry route



Figure 4. Points surveyed Troy route



Figure 5. Points surveyed Derby route



Figure 6. Points surveyed Irasburg route



Figure 7. Points surveyed Brighton route

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