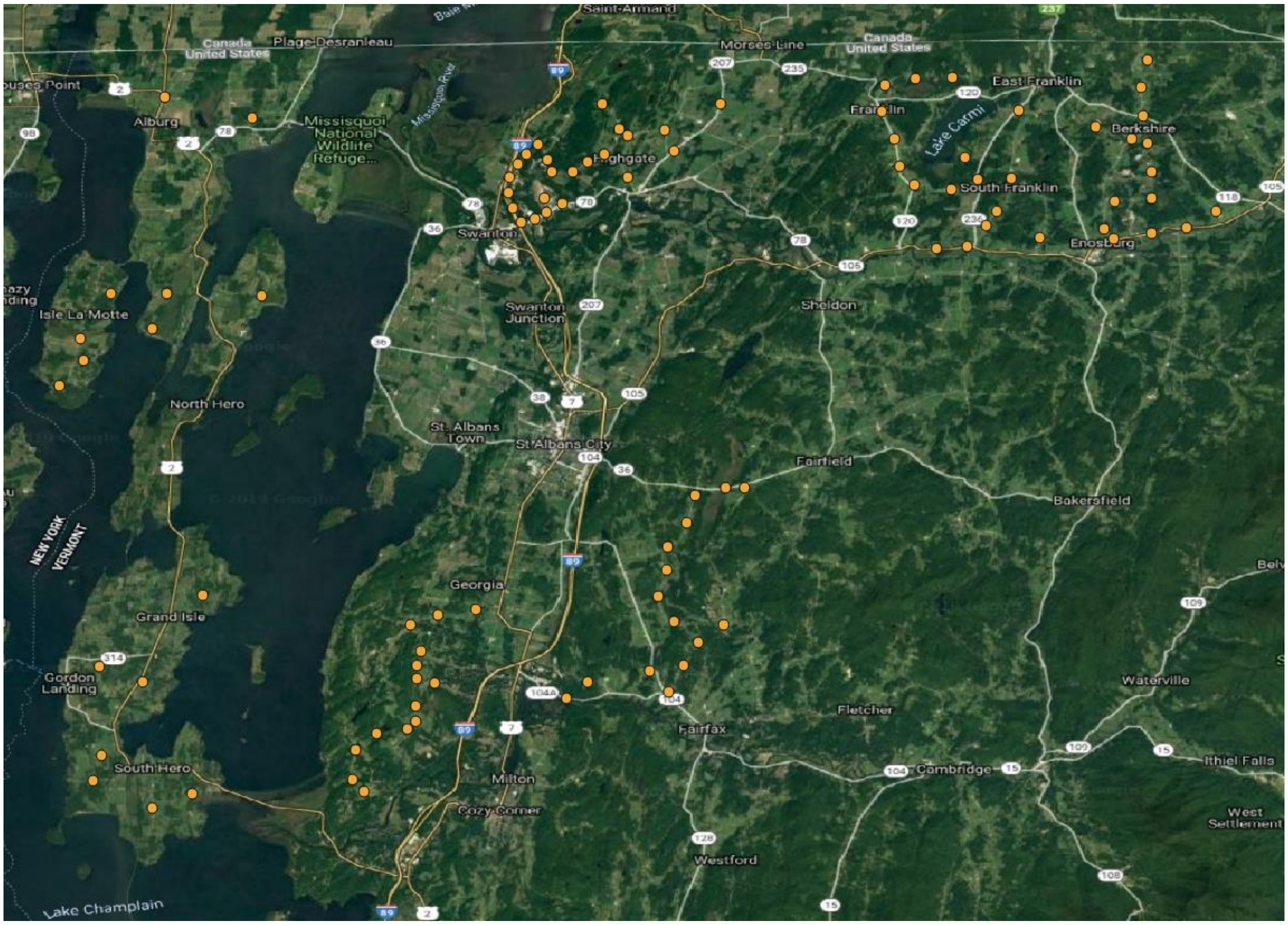
Eastern Whip-poor-will Survey:

Franklin and Grande Isle Counties



Annual Report to Vermont Fish and Wildlife

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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 Pamela 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 six 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.

2019 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 2019. If a WPW was heard at one of the original ten points, cluster sampling would have been employed.

Since implementation in 2007, volunteers have routinely surveyed most routes for WPWs and other nightjars. In 2016 through 2019, VCE created, mapped, provided route descriptions, and surveyed new routes consisting of 10 points each, in addition to volunteer surveys. This was completed for five new routes in 2019 – Franklin, Berkshire, Highgate, Fairfax and Georgia. In addition, VCE also mapped and surveyed 16 ad hoc points in Grande Isle counties, which focused on specific areas with a matrix of both fields and forest.

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.

VCE surveys were conducted from 10 Jun through 9 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. 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 five pre-established routes in Franklin, Berkshire, Highgate, Fairfax and Georgia. 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 and recorded birds independently of one another. 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 listening for 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 be 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, observers would take 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 VCE staff 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 Fairfax. For Fairfax, the first survey was completed on 18 June, and the replicate survey was completed during the sequential lunar cycle on 9 July.

When time allowed, ad hoc surveys were completed to find WPWs in locations outside of 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 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 2019, occasionally surveys were completed with one observer rather than two, specifically for the Berkshire route and several ad hoc points. Ten of VCE's SongMeter SM4 (Table 1) Automated Recording Units (ARUs) were available for the Berkshire route for one night when a second observer was unable to survey. Additionally, one ARU was placed at each survey point on the Fairfax and Georgia routes. 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). Recorders were set to record near sunset for an hour, near sunrise for 45 minutes and one to two hours overnight when the moon was visible. The overnight recording times depended on the moon phase. 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 areas of interest. We first reviewed Macaulay Library of Natural Sounds at Cornell's spectrograms. Audacity audio processing software 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 sonogram frequencies) and the time was set to one second intervals. The window size was set to 1024 and the window type was set to Hanning. We listened to any areas on the spectrogram with a similar frequency and interval. 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 (23:00 to 00:00 or 3:00 to 4:00) with good weather conditions.

In addition to the surveys of new routes conducted by VCE, volunteers completed the following roadside surveys, using the Northeast Nightjar Survey protocols, once during the 2019 breeding season and under suitable weather and lunar conditions (as detailed above): Bennington, Concord, Corinth, Coventry, Fair Haven, Ferrisburg, Monkton, Panton, Pawlet, Peacham, Randolph, Rockingham, Rutland, Salisbury, Shoreham, Snake Mountain, South Tunbridge, Springfield, Wells, and West Haven. The West Haven route was partially surveyed due to flooded roads.

Results and Discussion

2019 Results and Discussion

The 2019 WPW breeding season survey 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 two counties in northwestern Vermont where the only previous records of WPW were at one location during the breeding season. Volunteers surveyed pre-established routes across the state.

Franklin:

The Franklin route was surveyed by two observers completely twice during the 2019 breeding season (Figure 1). The first survey started after sunset (10 June) and was cancelled due to wind. The second survey (11 June) began after sunset and was surveyed completely in good weather conditions. In the morning just before sunrise (12 June), we surveyed an ad hoc point on Gilman Road, where a WPW was detected. We employed cluster sampling and surveyed a second point .8 km north, where the same WPW was heard (Figure 2). The third survey (17 June) started after sunset and was completed under a bright moon on a clear, windless night. After the survey, two ad hoc points were completed on Route

105. Despite good weather conditions, there were no WPW detections on the third survey. Additional ad hoc points were surveyed as time allowed (12 June, 17 June), without WPW detections.

The Franklin route encompasses most of Lake Carmi, which is located in central Franklin County between the Canadian border to the north and the Missisquoi River to the south. Lake Carmi has a 140-acre peat bog on its southern end, wetland forests, and fields with large adjacent forested areas, providing ample edge habitat for foraging. Pine forests are the predominant forest type along four of the primary points. An approximately 50-meter wide power line cut parallels the Missisquoi River one to three kilometers to the north of the river. The combination of a power line cut in a river valley with open fields, pine forests, and early successional habitat provides good WPW habitat.

Berkshire:

The Berkshire route was surveyed twice in the 2019 breeding season (Figure 3). Prior to these surveys, ARUs were set to record set to record (11 June) near all points along the route. No WPWs were detected by the analysis of recordings from ARUs from 21:00 to 22:00 (near sunset) or from 23:00 to midnight (when the moon was above the trees). The first survey (12 June) started after sunset and was surveyed in good weather conditions with one observer. However, the timing of the survey coincided with the first cut of hay after a lengthy rainy period, with large trucks delivering hay and heavy machinery in the fields through most of the survey. No WPWs were detected at any point. The second survey (19 June) was completed by one observer in the waning moon with four points completed after sunset, then the survey resumed after the moon rose above the trees (20 June). Neither the sunset or early morning surveys yielded any WPW detections. Unlike the first survey, there was not excessive noise on the second survey. In addition, four ad hoc points were surveyed (11 June, 17 June) as time allowed without WPW detections.

The Berkshire route is primarily in a rural area in northern Vermont, with several large-scale dairy farms, large hay fields and many corn fields. The route begins just south of the Canadian border, heading south along dirt roads with several small sand pits and a large forested area on the east of the route. Six of ten points have forests consisting primarily of pine forests. The southern portion of the route travels for two points along a busy highway along the Missisquoi River, where there is an approximately 50 meter power line cut that parallels the river. A large sand pit extends from the highway, stretching nearly a mile to the north. With Berkshire's pine forests and open habitat consisting of fields, sand pits, and power lines, there is good potential habitat for WPWs. Limiting factors of its use could be due to the current overall low population of WPWs and the proximity to high elevation forests to the east.

Highgate:

The Highgate route (Figure 4) was first attempted after sunset (13 June) but was cancelled due to rain. Point one yielded a calling WPW in the first two minutes before the rain started. Cluster sampling was not completed due to unfavorable weather conditions. The weather improved later in the night, when points eight, nine, and two ad hoc points were surveyed (14 June) before sunrise with no WPW detections. The second survey (16/17 June) was completed in good weather conditions starting after sunset, with cluster sampling and a total of 17 points surveyed. WPWs were detected at three primary points and two supplemental points (Figure 5). Based on distance and bearings, there were five calling males detected along the route. Each number noted along the red detection line on the map indicates a calling male, located somewhere along the red line. The third survey (23/24 June) began after sunset, with one primary point and two supplemental points. We waited for the moon to rise above the trees, then resumed the survey after 2 a.m., completing 15 points before sunrise. We detected WPWs at three primary points and one supplemental point (Figure 6). Based on distance and bearings, there were four calling males detected along the route.

The Highgate route is the only route in the counties we surveyed with historical records of WPW. Missisquoi National Refuge and Lake Champlain lies to the west, the Missisquoi River is south, and the Canadian border is north of the route. The route begins at the Franklin county airfield, which is a small airport surrounded by hay fields, sand pits, forests, early successional habitat, marshy areas, and has sandy roads intersecting the fields. It is a developed area, with many houses, a fairly busy town, and paved roads. The sand pits are well traveled by ATVs and the sand pits are used as a shooting range. The route travels around the sand pits and airfield, travels northeast, then ends at several farms with dirt roads and wide fields. The route is primarily on a busy paved road, with the interstate very close along several points. The route consists of at least six points with suitable pine forests. Due to its proximity to many sand pits, matrix of pine forests and open areas, and a small airport, finding a volunteer to survey this route on a regular basis could provide valuable data.

Fairfax:

The Fairfax route was surveyed twice, conducted in a different lunar cycles (Figure 7). The first survey (18/19 June) was completed on a windless, clear night after sunset, paused briefly while the moon rose above the trees, then resumed until completion. An additional two ad hoc points were surveyed under increasing cloud cover and winds. Due to weather conditions, no additional points were surveyed. No WPWs were detected on the route or at ad hoc points. ARUs were set to record (22/23 June) near all points along the route. No WPWs were detected in the analysis of two hours of recordings at each point, from 21:00 to 22:00 (near sunset) and 3:00 to 4:00 (after the moon was over the trees). The replicate survey (9 July) was completed by two observers during the sequential lunar cycle with no wind under clear skies. We began the survey after sunset at supplemental point 1C due to highway and amphibian noise at point one, then continued the survey from points one to ten. In addition, two ad hoc points were surveyed. Once again, there were no WPW detections at any of these points.

The Fairfax route begins at the southern end of Fairfield swamp, with large, relatively high elevation forested mountains to the east, a matrix of forest and fields to the west, and the Lamoille River to the south. The route follows small valleys with brooks and most points consists of pine forests. There are several sand pits along the southern end of the route that indicated sandy soil during mapping. In addition, there are large power line cuts that intersect the southern portion of the route. Though there were no detections of WPW, there is good WPW habitat available, making future surveys worthwhile.

Georgia:

The first survey (22 June) of the Georgia Route (Figure 8) began early morning in the waning moon, after unexpected clouds cleared and the moon became visible. At point seven, one observer heard a distant WPW calling. Cluster sampling was employed, but only one supplemental point was surveyed due to impending sunrise and no WPW detections at the supplemental point. All points were completed under clear skies with no wind. However, points eight through ten were moderately noisy due to dawn chorus. As a result, we repeated points eight through ten after sunset on the same day (22 June), along with one supplemental point. No WPWs were detected on the second survey. The third survey (24/25 June) started after sunset and points one through four were completed without any WPW detections. The survey then resumed after the moon rose above the trees and the survey was conducted under mostly clear skies and no wind. Immediately after the route was completed, supplemental point 5A was surveyed and a WPW was detected. Cluster sampling protocol was employed with a calling WPW in close proximity at point five, but no detections at supplemental point 5D. No additional points were surveyed due sunrise.

Prior to this survey, ARUs were set up near all points along the route. WPWs were detected (Table 2) by the analysis of ARU recordings taken one hour near sunset (21:00 to 22:00) and one hour when the moon was over the trees (3:00 to 4:00). A WPW was detected near sunset (24 June) at point six calling intermittently from approximately 21:07 to 21:34. A majority of the WPW calls in this time frame were barely visible on the spectrogram, with a frequency of approximately 1.4 to 1.5k, likely due to distance of the WPW from the recorder and background noises of other birds and frogs vocalizing (Image 2). The next detection was when the moon was up over the trees (25 June) also at point six: a WPW clucks for a few seconds, then bursts into song for approximately six seconds (Image 3). This occurred twice, singing for only 15 seconds total in an entire hour (Image 4). There was a simultaneous detection of a calling WPW at point five with a clear spectrogram, indicating the WPW was close, therefore providing evidence of a different calling male at each point. The WPW at point five called nearly continuously to the end of the recording at 4:00.

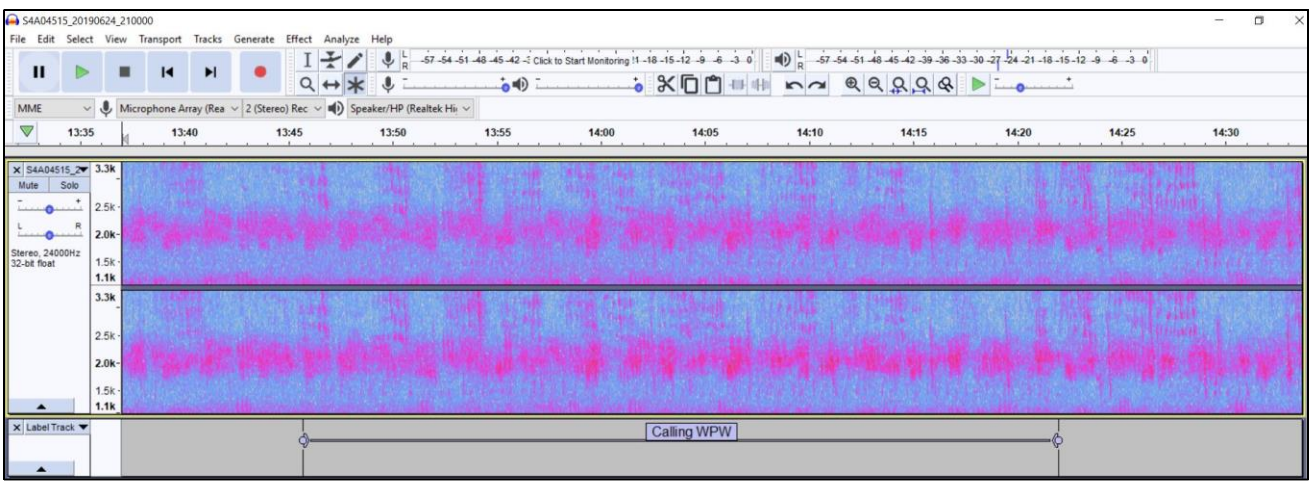


Image 2. WPW detection Georgia Route zoomed to one second intervals

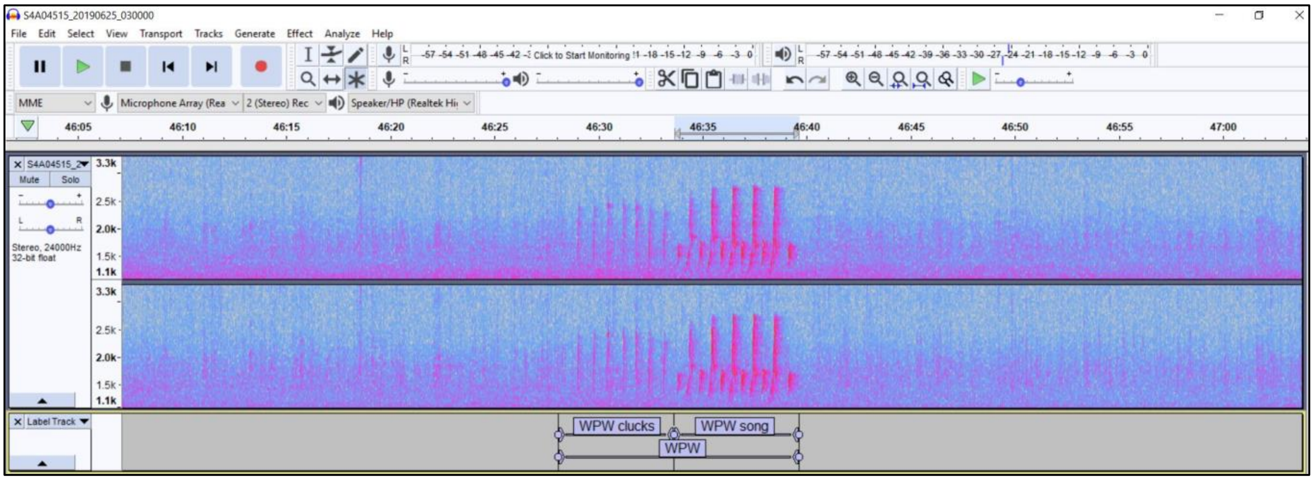


Image 3. WPW detection Georgia Route zoomed to one second intervals

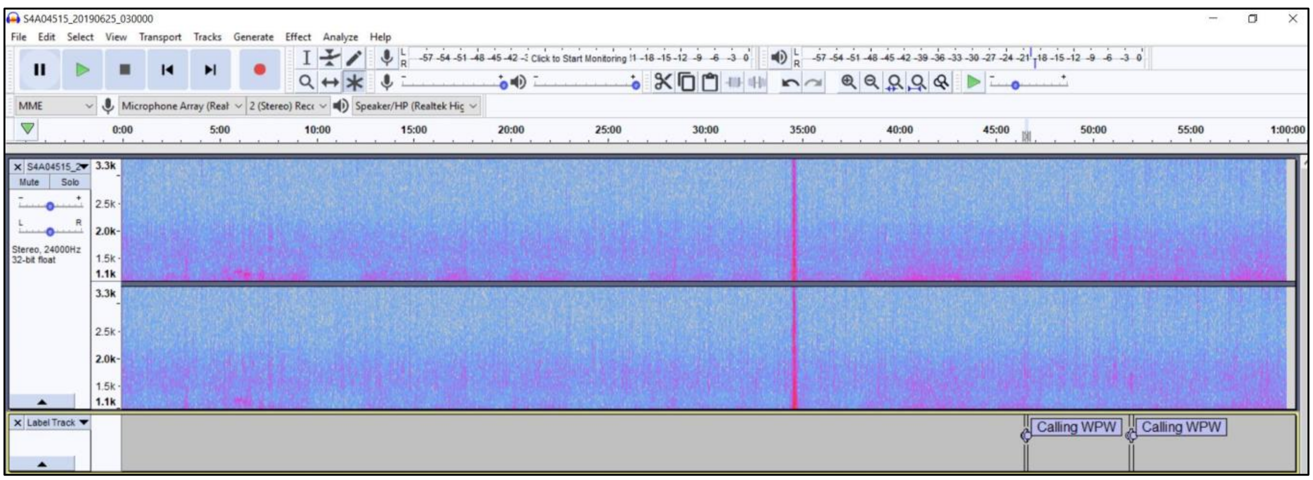


Image 4. WPW detection Georgia Route one hour recording

The Georgia route lies between Lake Champlain to the west and bustling Route 7 to the east, with large forested areas on either side of valley where the route lies. An approximately 50 meter power line cut parallels over half of the route, then ends at a small airfield. The Lamoille River borders the southern end of the route. The entire route has abundant early successional habitat due to power line cuts, swampy areas, and many overgrown field edges. There are sand pits and quarries near the southern end of the route, which indicates sandy soil. Pine forests consist of the majority of forest types along the route. This route has ideal WPW habitat and should be surveyed by volunteers in the future.

Lake Champlain Islands:

Upon evaluation of the Lake Champlain Islands, we determined that there is only a small amount of suitable habitat for breeding WPWs. Instead of creating routes to survey this area, we completed ad hoc surveys (Figure 9, Figure 10) in areas of suitable habitat. Each ad hoc point was surveyed once. The first night (23 June) began once the moon rose above the trees, near 2 a.m. under clear skies. At times, there were moderate winds depending on the island location, but it was not windy enough to cancel the surveys according to the Northeast Nightjar protocol. Ten points were surveyed before sunrise, from South Hero northward to Grande Isle, North Hero, ending at Alburg Dunes. Six ad hoc points were completed on the second night (25/26 June) from Isle La Motte northward to Alburg. We started after sunset surveyed four points, then waited for the moon to rise above the trees. Two additional points were surveyed before sunrise, then clouds moved in, preventing any more points from being completed. No WPWs were detected at any of the ad hoc points.

The Lake Champlain Islands are fairly developed, with houses along most shorelines and a majority of roads are paved. Sandy soils are evident in many of the islands on Google Earth and there are open fields available for foraging. However, there are few pine trees on any of the islands. The possibility exists that some of the dense cedar forests could be used for nesting WPWs. The Lake Champlain Islands could provide habitat to migrating WPWs. If further investigation of WPW populations is deemed necessary in the future, time would need to be devoted to setting up ARUs and analyzing data to improve detection rates.

Volunteer Surveys:

The 2019 breeding season surveys completed by volunteers provided a significant amount of data for the project, with 195 individual points surveyed (Figure 11). Many of the routes have been consistently surveyed over the past 12 years. Several of the volunteers noted a decrease in WPW detections on their survey completed within the survey protocols, compared to the previous year: Fair Haven, Rutland, Salisbury, Snake Mountain, Wells and West Haven. The South Tunbridge route showed an increase in 2019. Of 195 points surveyed, 19 WPWs were detected within the survey protocol at primary points (Table 3). Of these detections, there were 17 individuals based on mapping.
In June 2019, a WPW was found injured on the road (at a point on the Snake Mountain route) with a broken wing. It was transported to a wildlife rehabilitator,

who evaluated the bird and euthanized it due to the severity of its injuries. There is little documentation for collisions with vehicles for WPWs, and this appears to be the first documentation of this kind in Vermont.

Conclusion

The 2019 breeding season surveys completed by VCE yielded 18 WPW detections (Table 4). Based on compass bearings and subsequent mapping, there were an estimated eight individual WPWs. No historic WPW records exist for areas in which the new routes were created in 2019, except for Highgate. The only eBird records in Highgate are fairly recent, with 2011 being the oldest records. Though there were only two new areas with detections this season, 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 five new routes possesses potential WPW habitat. Grand Isle may provide stopover habitat for migrating birds. If possible, Berkshire, Highgate, and Georgia should be surveyed by volunteers. Since these routes lie in rural areas, finding volunteers for these routes may present 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. WPWs have been successfully detected by ARUs even on nights outside of the Northeast Nightjar Protocol, when the moon is less than 50% illuminated (Clark and Fristrup 2009), which could allow more points to be surveyed in the short breeding season. 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 2019, ARUs were found to be useful in detecting WPWs in low population areas, allowing more data to be collected and provided larger presence/absence data sets along routes. 60 hours of recordings were analyzed in total. ARUs were set to record when only one observer was available to survey a route, once again providing larger data sets. In addition, points with a lot of traffic (when a WPW would be difficult to detect) were evaluated over a longer time period. This allowed analysis of recordings at times of reduced traffic or background noise, with a clear spectrogram. ARUs recorded WPWs simultaneously calling at two points, revealing more than one calling male along a route. 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 2019 survey season discovered only six WPWs along routes using the standardized 10 point 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. Modeling to identify potential WPW habitat could prove to be a valuable tool to increase detections across Vermont. Volunteers or VCE staff could follow up with point count surveys, thereby strengthening the model over time.

Anecdotal evidence of WPW declines have been widely recognized. Obtaining historical records and converting them to electronic records (notably eBird) may assist in providing insight into WPW declines. VCE is currently in the process of digitizing historical records, which contains WPW documentation. Outreach to landowners could reveal areas of historical records, or even discover new locations from farmers or other landowners who are not familiar with the call of a WPW. In 2019, we spoke with many landowners along routes and found that many people (mostly under 50 – 60 years old) are unaware of the WPW or its call. Documenting areas where landowners (over 50 – 60 years old) routinely heard WPWs calling in the past could be helpful as well. Outreach could also include informing landowners about ideal WPW habitat and possible reasons for declines.

With more aerial insectivores experiencing rapidly declining populations, widespread declines in insect populations are on the forefront of leading explanations for aerial insectivore declines, such as WPW. Habitat loss, predation and collisions with vehicles may also contribute to their decline. WPW populations in Vermont should be continued to be monitored with surveys and automated recording devices over time to help determine if a conservation plan is needed in the future.

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.*

Table 2. Date, time of WPW detections, duration of calling WPW and location of Automated Recording Units (ARUs) at Georgia route in chronological order

Date	Time	Duration (s)	Route and Point	XCOORD	YCOORD
24-June-19	21:07:16 - 22:07:20	4	Georgia 6	-73.162678	44.676201
24-June-19	21:12:37 - 21:13:30	53	Georgia 6	-73.162678	44.676201
24-June-19	21:13:46 - 21:14:22	36	Georgia 6	-73.162678	44.676201
24-June-19	21:14:28 - 21:14:45	9	Georgia 6	-73.162678	44.676201
24-June-19	21:15:35 - 21:16:10	35	Georgia 6	-73.162678	44.676201
24-June-19	21:17:50 - 21:17:57	7	Georgia 6	-73.162678	44.676201
24-June-19	21:20:47 - 21:21:05	18	Georgia 6	-73.162678	44.676201
24-June-19	21:30:08 - 21:30:22	14	Georgia 6	-73.162678	44.676201
24-June-19	21:31:30 - 21:31:37	7	Georgia 6	-73.162678	44.676201
24-June-19	21:31:41 - 21:32:24	43	Georgia 6	-73.162678	44.676201
24-June-19	21:32:32 - 21:32:58	26	Georgia 6	-73.162678	44.676201
24-June-19	21:33:06 - 21:33:17	11	Georgia 6	-73.162678	44.676201
24-June-19	21:33:26 - 21:33:55	29	Georgia 6	-73.162678	44.676201
24-June-19	21:34:10 - 21:34:28	18	Georgia 6	-73.162678	44.676201
25-June-19	3:46:28 - 3:46:39	11	Georgia 6	-73.162678	44.676201
25-June-19	3:51:48 - 3:54:35	167	Georgia 5	-73.163053	44.687578
25-June-19	3:51:51 - 3:52:05	14	Georgia 6	-73.162678	44.676201
25-June-19	3:54:58 - 4:00:00	298	Georgia 5	-73.163053	44.687578

Table 3. Date, route, point number, approximate location of volunteer observer at time of WPW detection, and indication of a possible repeat detection based on mapping. Does not include surveys completed outside of the Northeast Nightjar Protocol or points other than primary points.

Date	Route and Point	XCOORD	YCOORD	Repeat?
22-May-19	Fair Haven 1	-73.243016	43.59285	N
22-May-19	Fair Haven 1	-73.243016	43.59285	N
22-May-19	Fair Haven 2	-73.2427	43.5786	N
22-May-19	Fair Haven 2	-73.2427	43.5786	Y
22-May-19	Fair Haven 3	-73.2368	43.56586	N
22-May-19	Fair Haven 3	-73.2368	43.56586	N
22-May-19	Fair Haven 3	-73.2368	43.56586	Y
17-June-19	S. Tunbridge 4	-72.4669	43.84281	N
17-June-19	S. Tunbridge 10	-72.5263	43.89304	N
17-June-19	S. Tunbridge 10	-72.5263	43.89304	N
17-June-19	Concord 8	-71.7955	44.4246	N
17-June-19	Concord 8	-71.7955	44.4246	N
17-June-19	Concord 8	-71.7955	44.4246	N
17-June-19	Concord 9	-71.7752	44.42583	N
17-June-19	Concord 9	-71.7752	44.42583	N
18-June-19	Wells 1	-73.2414	43.45568	N
23-June-19	West Haven 9	-73.4038	43.57286	N
24-June-19	West Haven 2	-73.3905	43.63704	N
24-June-19	West Haven 3	-73.3763	43.62756	N

Table 4. Date, survey start time, route, point number, point type, location of observer at time of WPW detection, and indication of a possible repeat detection based on mapping.

Date	Time	Route and Point	Point type	XCOORD	YCOORD	Repeat?
12-June-19	4:16	Franklin	Ad Hoc	-72.859016	44.911348	N
12-June-19	4:30	Franklin	Ad Hoc	-72.853886	44.929178	Y
13-June-19	21:08	Highgate 1	Primary	-73.093884	44.935682	N
16-June-19	21:15	Highgate 1	Primary	-73.093884	44.935682	N
16-June-19	21:15	Highgate 1	Primary	-73.093884	44.935682	N
16-June-19	21:30	Highgate 1B	Supplemental	-73.093076	44.928602	Y
16-June-19	22:10	Highgate 4	Primary	-73.112707	44.946388	N
16-June-19	23:03	Highgate 6	Primary	-73.092377	44.955239	N
16-June-19	23:03	Highgate 6	Primary	-73.092377	44.955239	N
16-June-19	23:37	Highgate 6B	Supplemental	-73.089923	44.949549	Y
16-June-19	23:37	Highgate 6B	Supplemental	-73.089923	44.949549	Y
23-June-19	21:02	Highgate 1	Primary	-73.093884	44.935682	N
23-June-19	21:21	Highgate 1B	Supplemental	-73.093076	44.928602	Y
24-June-19	2:22	Highgate 3	Primary	-73.110711	44.931014	N
24-June-19	3:00	Highgate 4	Primary	-73.112707	44.946388	Y
24-June-19	3:00	Highgate 4	Primary	-73.112707	44.946388	N
25-June-19	3:41	Georgia 5A	Supplemental	-73.161899	44.697318	N
25-June-19	3:53	Georgia 5	Primary	-73.162038	44.690366	Y

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 Franklin route

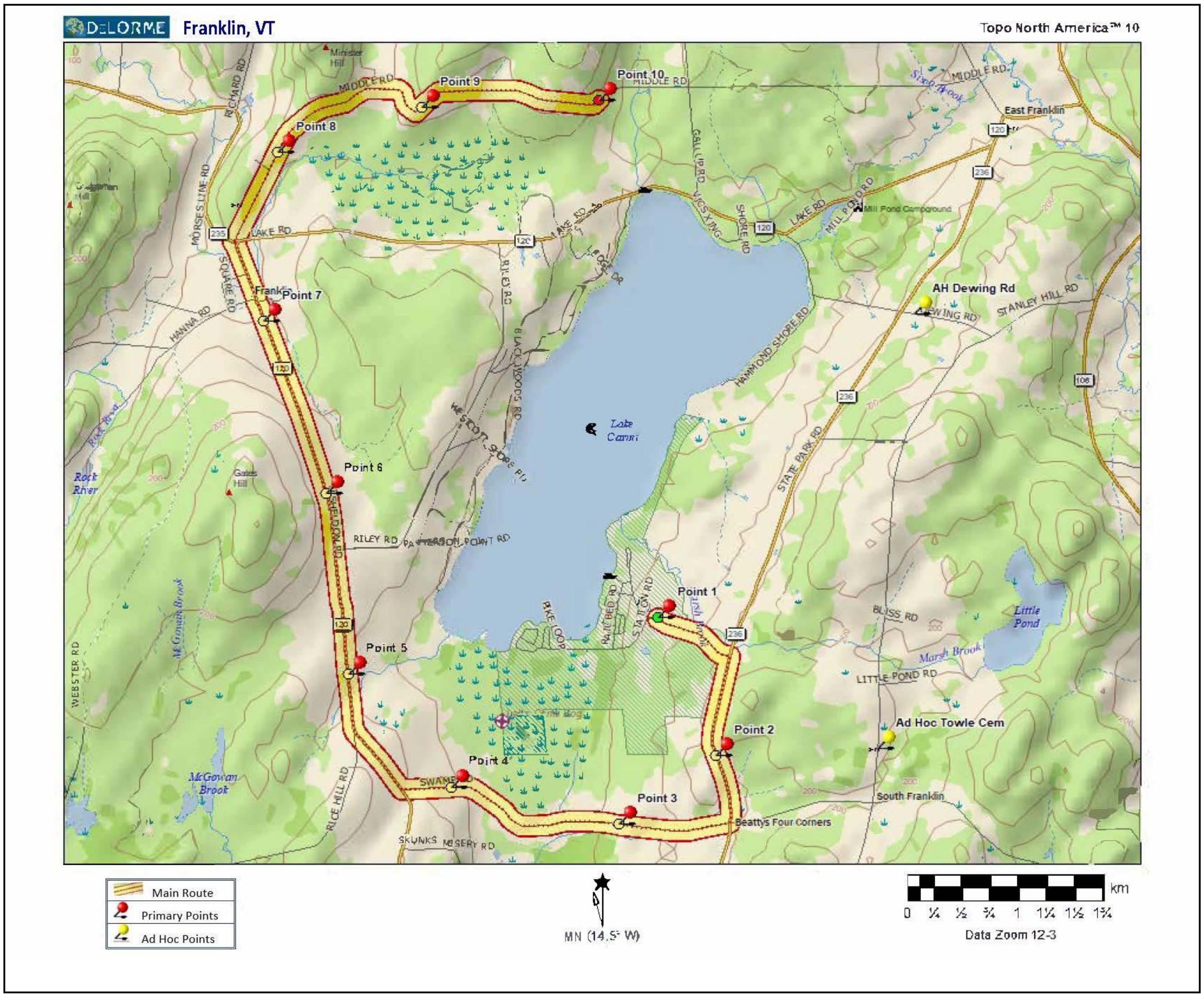


Figure 2. Points surveyed and WPW detected Franklin ad hoc points

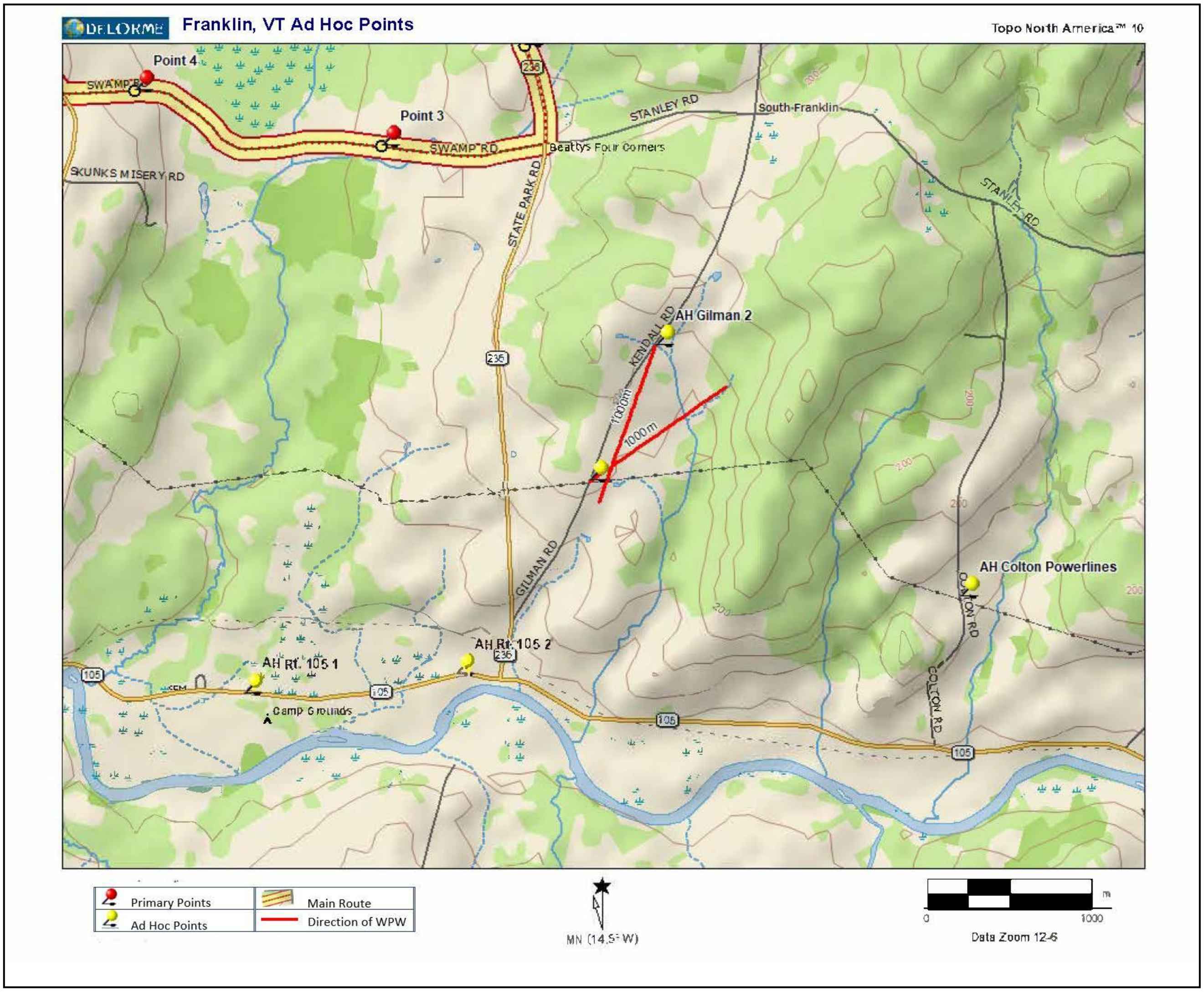


Figure 3. Points surveyed Berkshire route

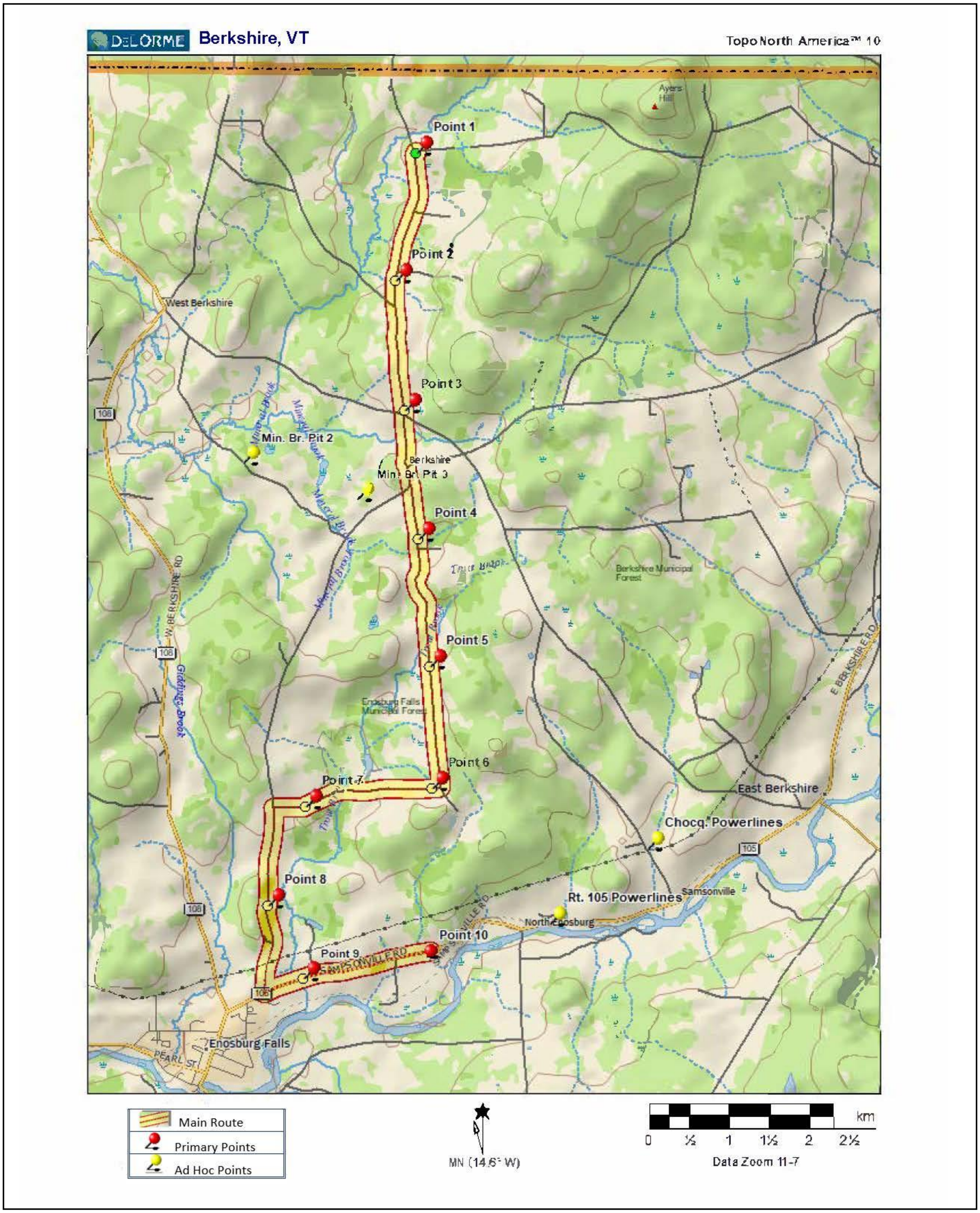


Figure 4. Points surveyed Highgate route

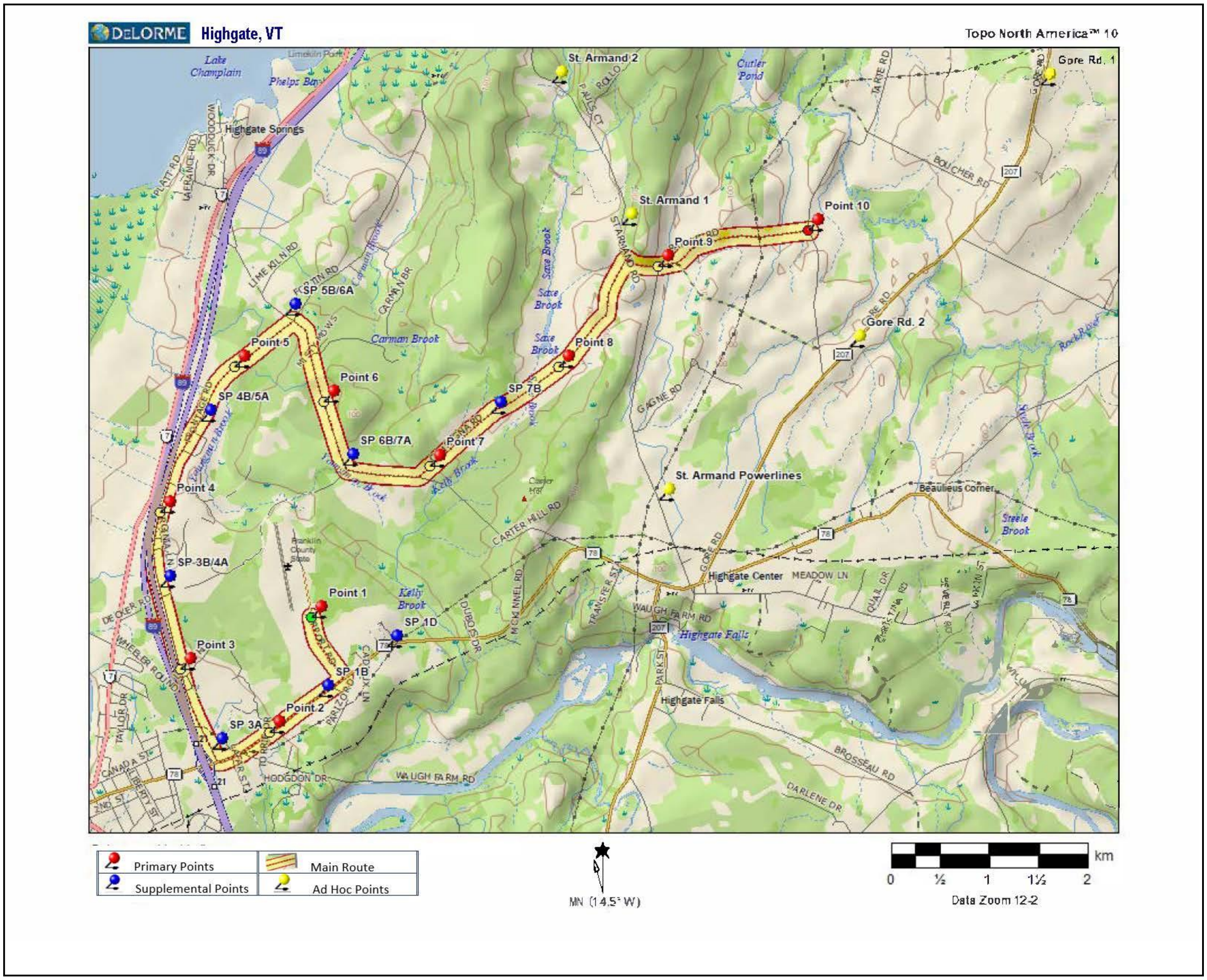


Figure 5. Highgate route WPW detected visit #2

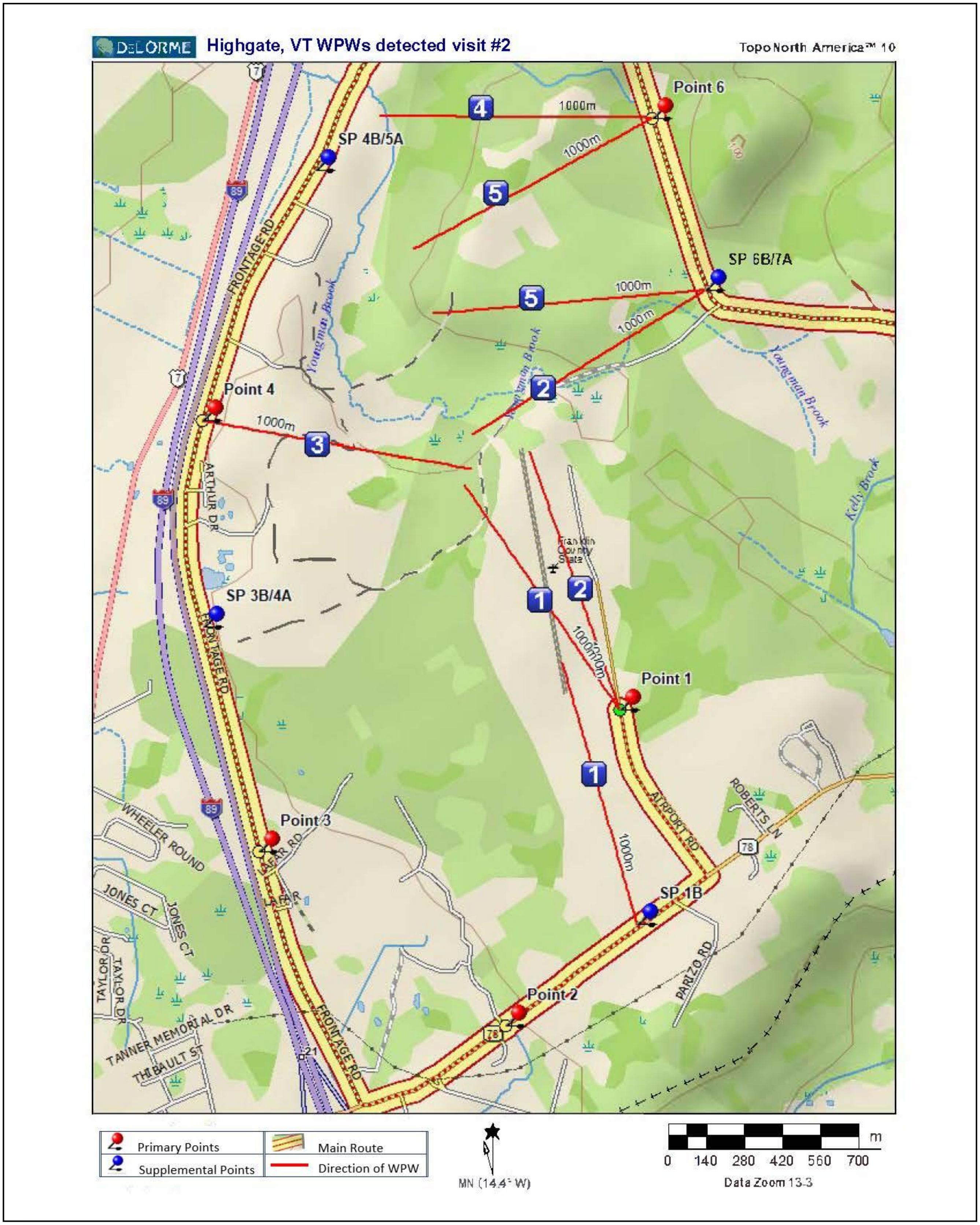


Figure 6. Highgate route WPW detected visit #3

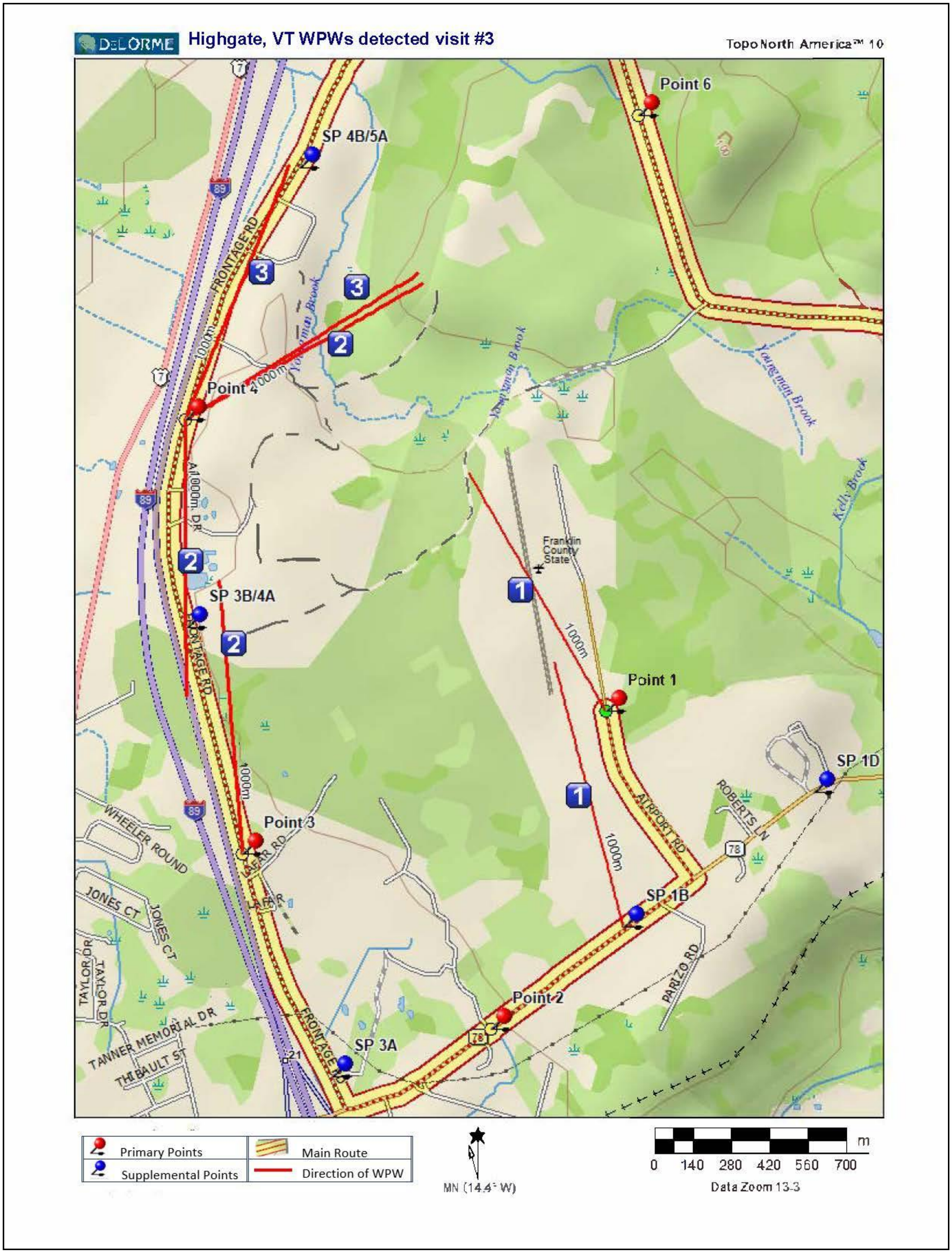


Figure 7. Points surveyed Fairfax route

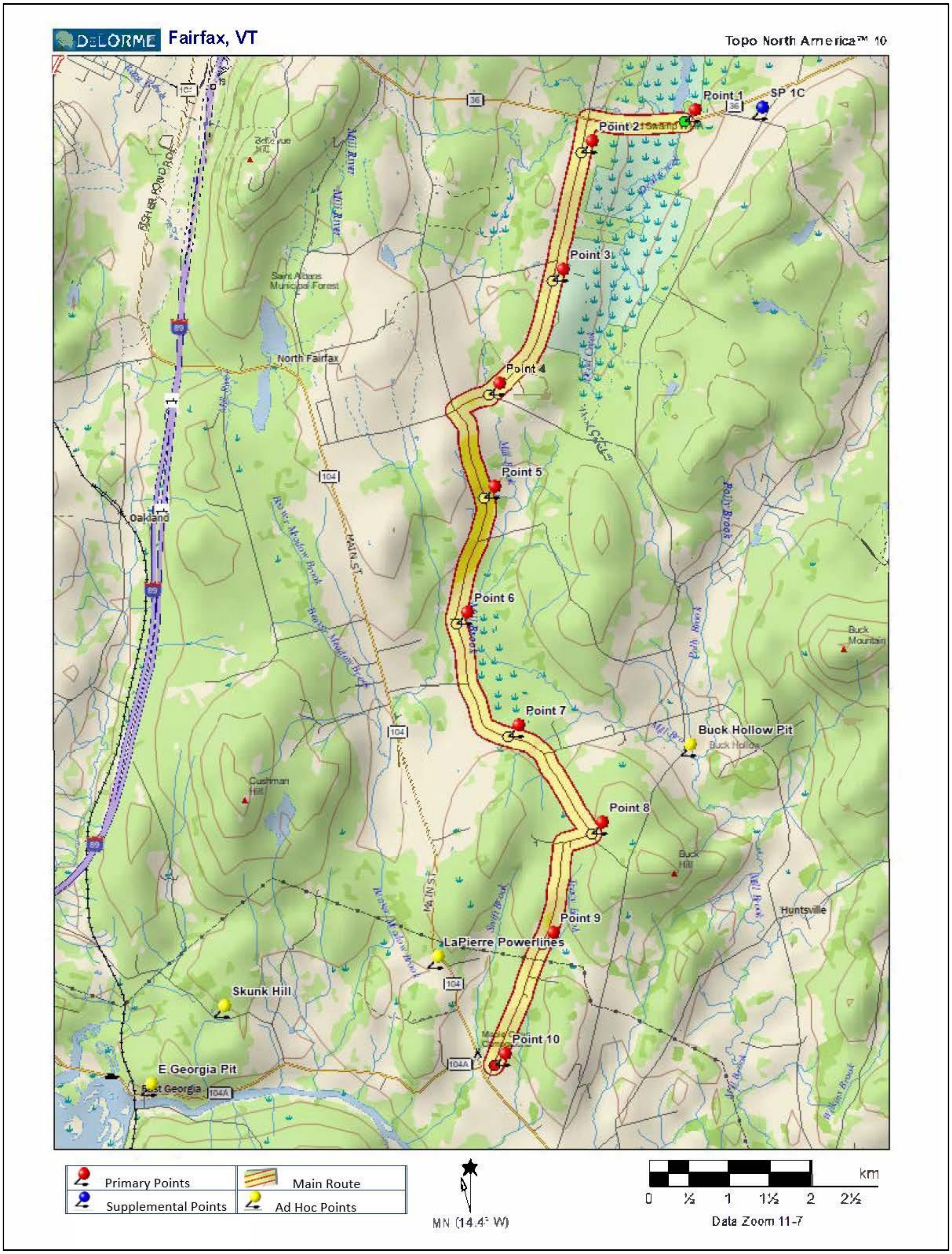


Figure 8. Points surveyed and WPW detected Georgia route

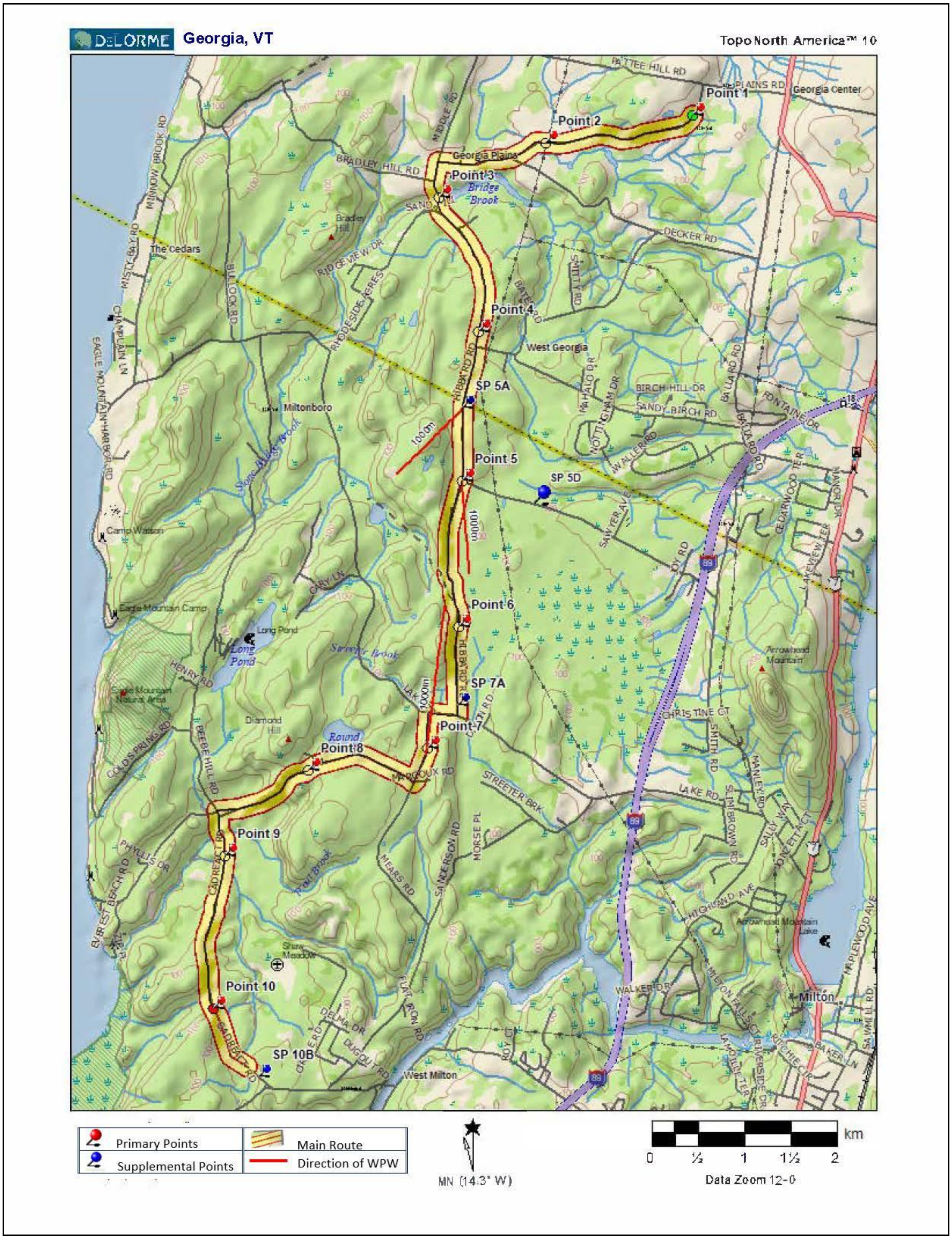


Figure 9. Points surveyed Alburg, Isle La Mott and North Hero

Figure 10. Points surveyed Grande Isle and South Hero

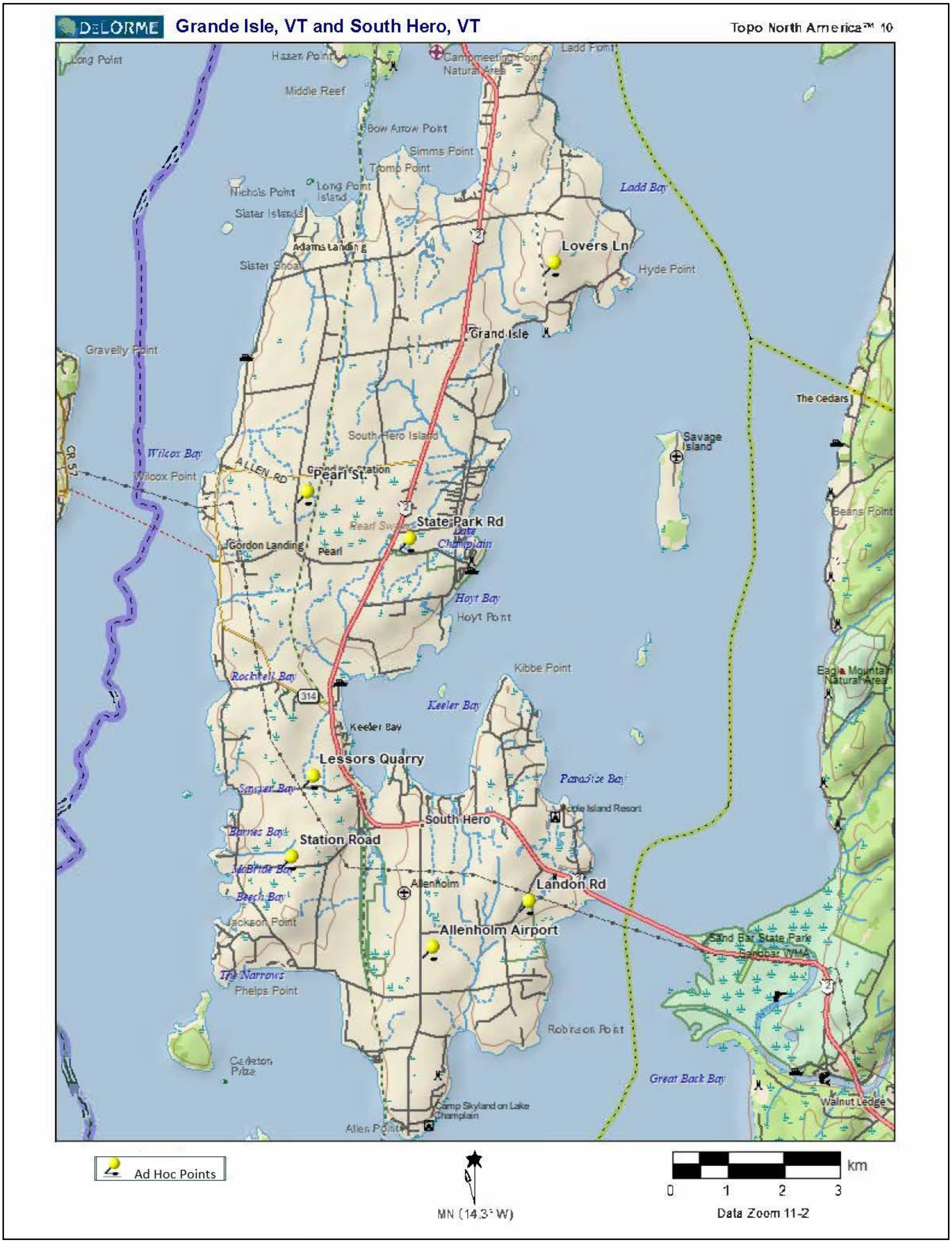
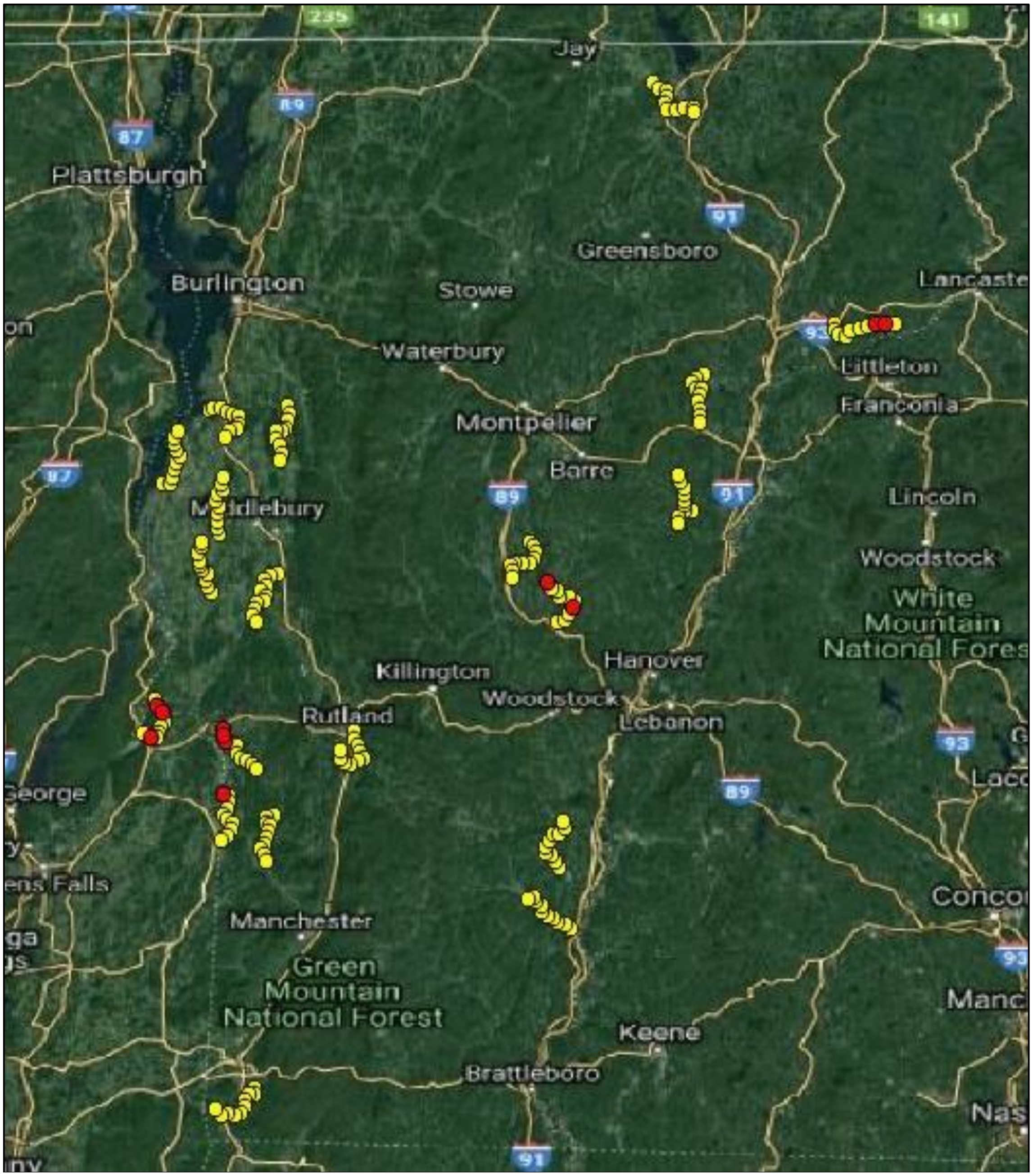


Figure 11. Points surveyed by volunteers. Red pins indicate points with WPW detection(s).



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