Preliminary Assessment of Hiawatha National Forest Karst Features As Potential Northern Long-eared Bat Hibernacula

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Introduction

The Northern long-eared bat (NLE) (*Myotis septentrionalis*) is a widely-distributed species, with a range that extends over much of Eastern North America (USFWSa 2014). In the summer, NLE females form maternity colonies. While some have been reported roosting in man-made structures, numerous researchers report a strong preference toward trees as maternity roosting sites. From a Michigan study, Foster and Kurta (1999) report that NLE roost in crevices, hollows or under the bark of living or dead, larger-diameter, deciduous tree species.

NLE spend winters hibernating in caves and mines. They typically use large caves or mines with: large passages and entrances; constant temperatures; and high humidity with no air currents. Specific areas where they hibernate have very high humidity, so much so that droplets of water are often seen on their fur. Within hibernacula, surveyors find them in small crevices or cracks, often with only the nose and ears visible (USFWSb 2014). Whitaker and Rissler (1992) report that NLE hibernated far back in crevices, and NLE was the most active bat species in hibernacula with mixed species. Caceres and Barclay (2002) report that hibernation is preceded by swarming, or flights through the hibernacula which occur in August and September.

Because of population declines due to White-nose Syndrome, the US Fish and Wildlife Service (USFWS) is proposing to list the NLE as a Threatened or Endangered Species under the Endangered Species Act (USFWSc 2014). Because of this association with woodlands and the impending listing, NLE are a concern with respect to forestry operations. The Hiawatha National Forest contains a number of karst features including caves and cliffs with fissures within forested areas that could be potential NLE hibernacula. The purpose of this study is to determine if karst features on the Hiawatha National Forest may serve as potential hibernacula for NLE. Of particular interest are those karst features that may contain cracks or fissures deep enough to provide appropriate conditions for NLE hibernation.

Methodology

The Michigan Natural Features Inventory (MNFI) a program of Michigan State University Extension, installed Wildlife Acoustics SM2Bat+ ultrasonic monitors in conjunction with SMX – US ultrasonic microphones at five locations on the Hiawatha National Forest (Figure 1 Map). The locations were determined utilizing a Geographic Information System layer of karst features provide by the Hiawatha National Forest. Four of the locations were set within surveyed stands containing karst features. A control site was established in a stand that was surveyed for karst features but where none were found. Table 1 provides the coordinates of the monitor locations. Table 2 provides the straight line distance between the monitors.

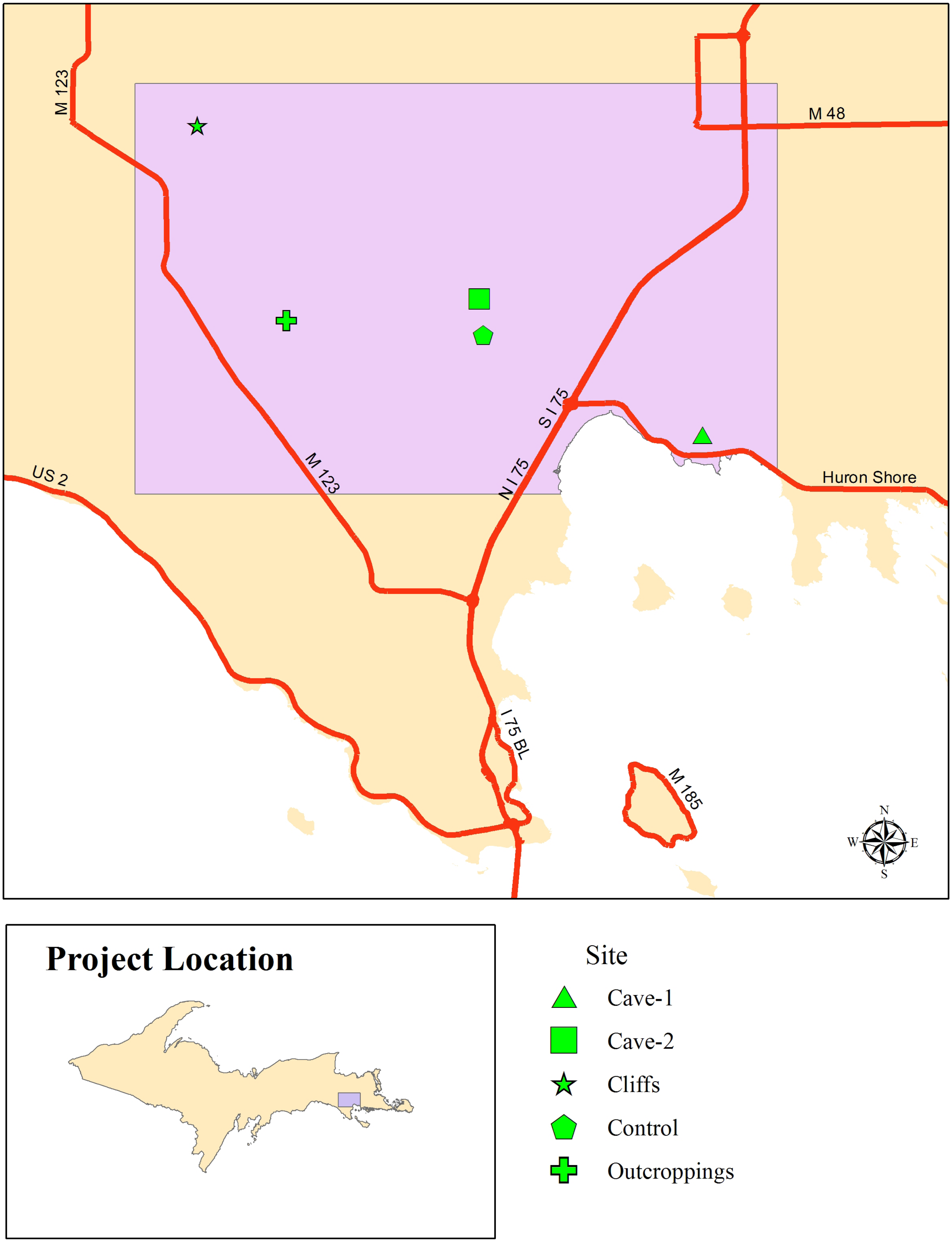
Table 1. Table of site location coordinates in Decimal Degrees and Michigan Georef (MGR) coordinates.

Site	Latitude	Longitude	MGR_X	MGR_Y
Cliffs	46.192	-84.935	581996	627217
Outcroppings	46.099	-84.876	586695	616935
Cave-1	46.041	-84.593	608676	610888
Cave-2	46.108	-84.744	596893	618067
Control	46.091	-84.742	597105	616179

Table 2. Distance between monitor sites in miles.

	Cliffs	Outcroppings	Cave-1	Cave-2	Control
Cliffs	0.0	7.0	19.4	10.9	11.6
Outcroppings	7.0	0.0	14.2	6.4	6.5
Cave-1	19.4	14.2	0.0	8.6	7.9
Cave-2	10.9	6.4	8.6	0.0	1.2
Control	11.6	6.5	7.9	1.2	0.0

Figure 1. Site locations.



Site descriptions

Control (non-karst).

To help evaluate whether the local karst features in the Hiawatha National Forest serve as an "attractor" for NLE, a control site was selected in an area that had been surveyed for karst features, but in which none have been found. The control was located 1.9 miles from the nearest karst feature that was being monitored (Cave 2). The vegetation surrounding the Control site consisted of a mixture of balsam fir (*Abies balsamea*) and maples (*Acer* spp.) (Figure 2).

"Clutter" is a term applied to the amount of physical structures (usually vegetation) located in bat foraging areas that may interfere with their foraging, or at the least, need to be negotiated through while flying. Thus, the upper canopy of a forest has a high amount of clutter, as does an area with many shrubs and small saplings. An open area, such as an old field, has low amounts of clutter. Clutter in the immediate area around the Control site was considered to be medium, with a fair number of small fir trees, but substantial open area.

Cliffs.

The Cliffs site was located along a ridge of limestone that provides a substantial amount of relief; some features represented vertical drops of approximately 20 feet. The face of the ridge faced north and the topography then sloped down into the surrounding forest, which consisted of a mixture primarily of maples of relatively mature stage (Figures 3 & 4). Canopy cover was essentially 100%. The understory had minimal "clutter" and with downward sloping topography into the adjacent forest, provided ideal areas for foraging.

Figure 2. Monitoring station at control site.

Figure 3. Cliff Site.

Figure 4. Forest below cliff site.

Outcroppings.

The Outcroppings site was characterized by limestone features at the surface of the ground. Unlike the cliffs, the outcroppings provided little topographic relief with most features being easily stepped over. The surrounding area was heavily forested primarily with young balsam fir (Figure 5). There was only a medium amount of clutter in the immediate vicinity of the outcroppings where the monitor was deployed, but much of the surrounding area had heavy amounts of clutter in the understory.

Cave-1.

Cave-1 consisted of a small opening, approximately 4 feet across, and oriented vertically. It was located in an area in which the understory had been recently cleared (Figure 6). Thus, there was virtually no clutter until reaching the canopy, providing extensive unobstructed foraging space.

Cave 2.

Like Cave 1, Cave 2 consisted of a small opening, approximately 2 feet across, and having a vertical orientation to the entrance. It was surrounded by a mixture of firs and maples and there was active forestry management in the nearby area (within a few hundred feet), though the area immediately around the cave was undisturbed. Cave 2 was situated in a slight clearing about 30 feet in diameter which had little clutter; however, clutter immediately around the area was heavy (Figure 7).

Figure 5. Outcropping site.

Figure 6. Cave-1 site.

Figure 7. Cave-2 site.

Monitors were set in place on July 10 and July 11, 2014 and retrieved on September 24, 2014. Monitor batteries were changed and microphones tested on July 31, August 18, and September 5. The monitors were active a half-hour before sunset until a half hour after sunrise and used a standard 15 minute on, 15 minute off, duty cycle. MNFI analyzed the acoustic files with two acoustic analysis programs, Sonobat and Kaleidoscope. Both are USFWS approved bat call identification programs (USFWSd 2014). We utilized the Kaleidoscope software package to differentiate bat signals from noise and to classify calls to the species level. All calls identified to the species level were visually examined with the viewers in Sonobat and Kaleidoscope, and those determined to be noise were rejected.

Results and Discussion

Among Site Comparisons

NLE were detected at all sites. The frequency of recorded calls were not evenly distributed across sites; the differences were significant ($\chi2 = 11,119$, $P << 0.001$). Two sites, Cliffs and Cave-1 had significantly more activity of all bat species, than the other karst based sites, or the control site (Table 3). These site differences were also highly significant when considering recorded passes for NLE alone ($\chi2 = 6,136$, $P << 0.001$) (Table 4).

Table 3. Total numbers of all recorded bat passes at monitoring sites.

Site	Number of Calls
Control (non-karst)	186
Cliffs	4455
Outcroppings	122
Cave 1	3819
Cave 2	120
Total	8702

Table 4. Number of recorded NLE passes at monitoring sites.

Site	Number of Calls
Control (non-karst)	39
Cliffs	391
Outcroppings	3
Cave 1	341
Cave 2	5
Total	779

Individual Site Temporal Pattens.

In addition to the overall difference in NLE and general bat activity among the sites, there were also very distinct patterns noted for NLE and general bat activity at the individual sites over the course of the monitoring period.

Cliffs (Figure 7).

The Cliff site showed a large peak in all bat activity from August 4 through August 10, with the highest daily activity being August 9. On August 9, 410 total bat passes were recorded, of which 66 (16%) were identified as NLE. A second peak occurred on September 19 with 276 total passes detected, of which 80 (29%) were NLE. During the sampling period 4,455 bat passes were recorded with 391 (8.8%) detected as NLE. Other detected bat species were little brown bat (*Myotis lucifugus*) and eastern red bat (*Lasiurus borealis*).

Outcroppings (Figure 8).

The daily activity at the Outcropping site was ten or fewer total bat passes except for September 4 and September 5, with counts of 85 and 42 respectively. Three NLE passes were detected at the site, one each on July 13, August 19, and September 4. During the sampling period a total of 122 bat passes were recorded with three (11.0%) detected as NLE. Other detected bat species were little brown bat, silver-haired bat (*Lasionycteris noctivagans*) and eastern red bat.

Cave-1 (Figure 9).

The most notable results at Cave 1 were spikes in activity on August 12 and September 19. August 12 had 455 total bat passes of which 35 (8% were identified as NLE. September 19 had 598 total bat passes with 27 (5%) identified as NLE. During the sampling period, 3,819 bat passes were recorded with 341 (8.9%) detected as NLE. Other detected bat species were little brown bat, silver-haired bat, eastern red bat and tri-colored bat (*Perimyotis subflavus*).

Cave-2 (Figure 10)

Cave -2 had little bat activity detected, with counts for every night in the single digits except for a spike if 14 bat passes on August 15. There were only five detected NLE passes throughout the whole sampling effort. These occurred on July 16, July 25, August 7, August 24, and August 28. During the sampling period, 120 bat passes were recorded with five (4.2%) detected as NLE. Other detected bat species were little brown bat and eastern red bat.

Control (Figure 11)

The control site had daily counts of ten or fewer bat passes except for August 18 with a spike of 14 bat passes. Of the 14 total passes, four (29%) were detected as NLE. During the sampling period 186 bat passes were recorded with 39 (21.0%) detected as NLE. Other detected bat species were little brown bat and eastern red bat.

Figure7. Cliff site daily bat passes.

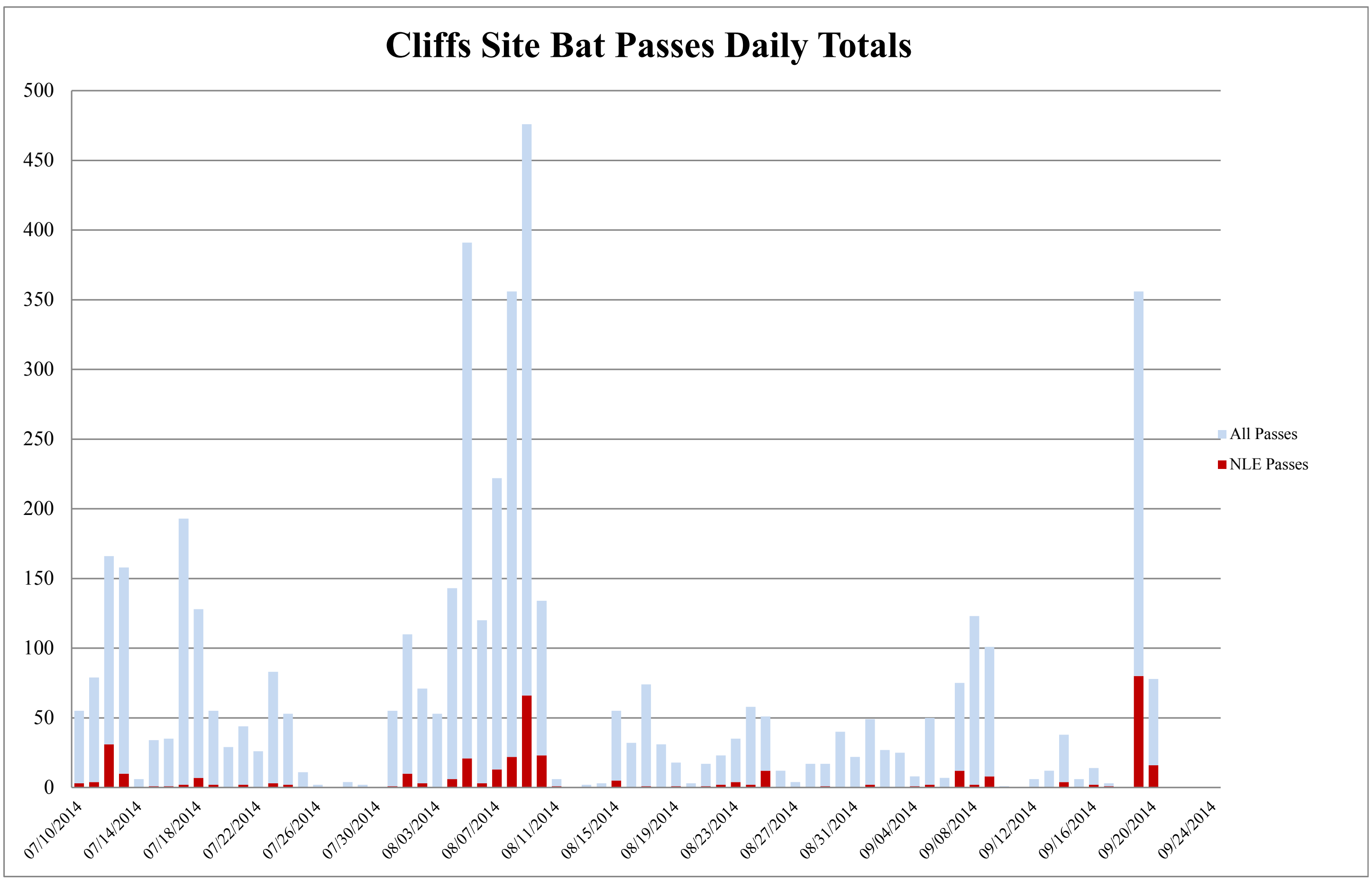


Figure 8. Outcroppings site daily bat passes.

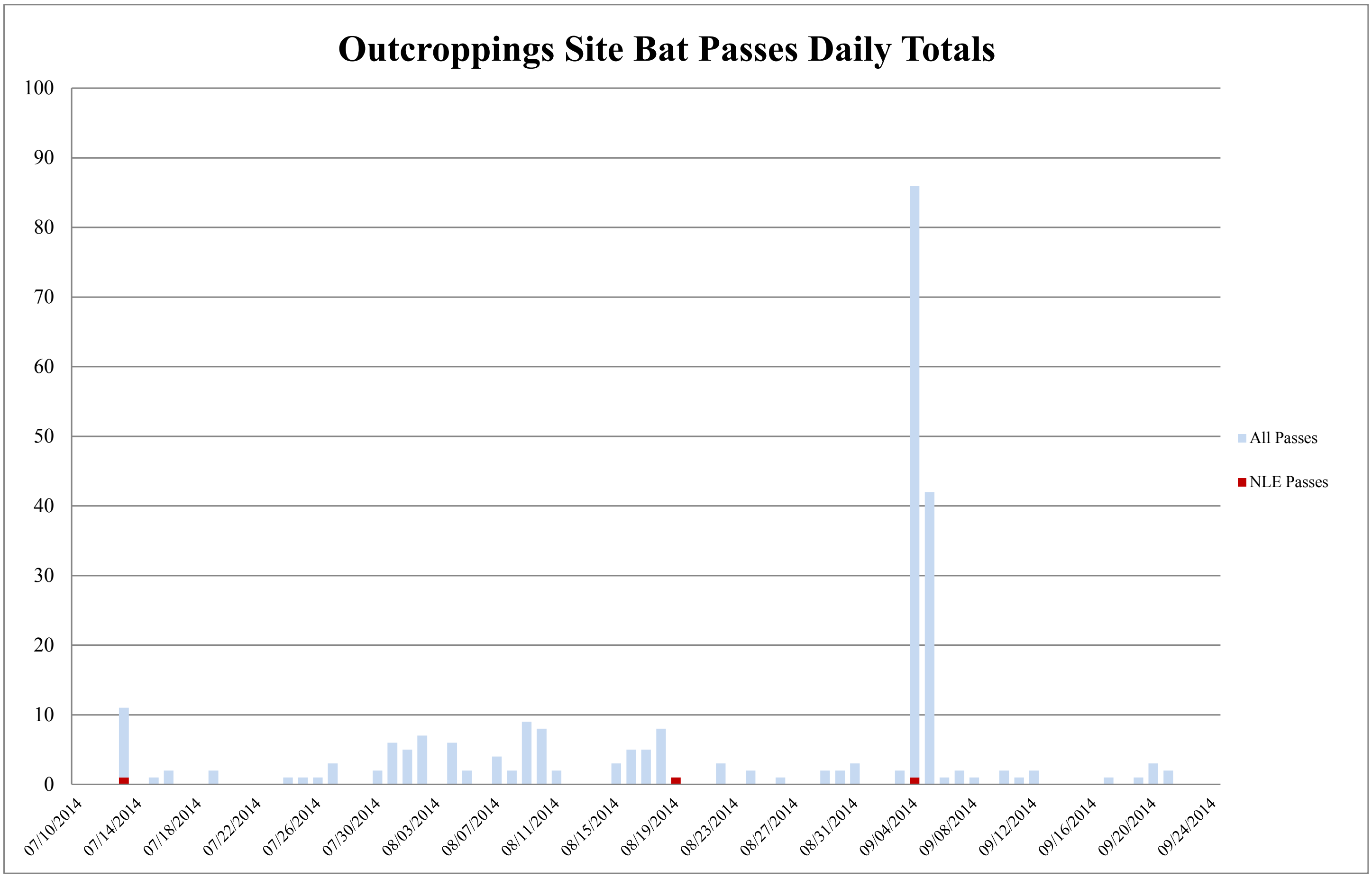


Figure 9. Cave-1 site daily bat passes.

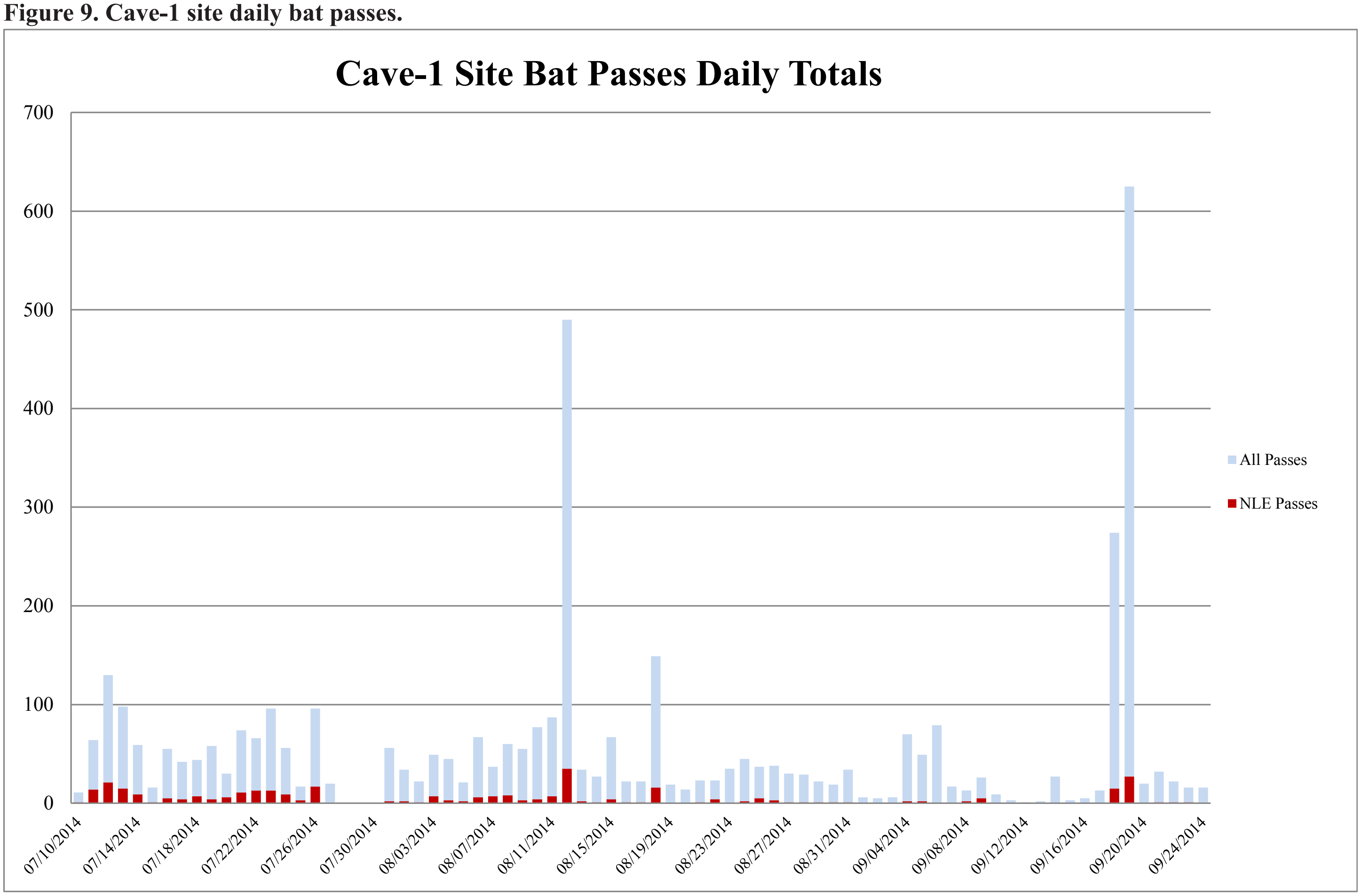


Figure 10. Cave-2 site daily bat passes.

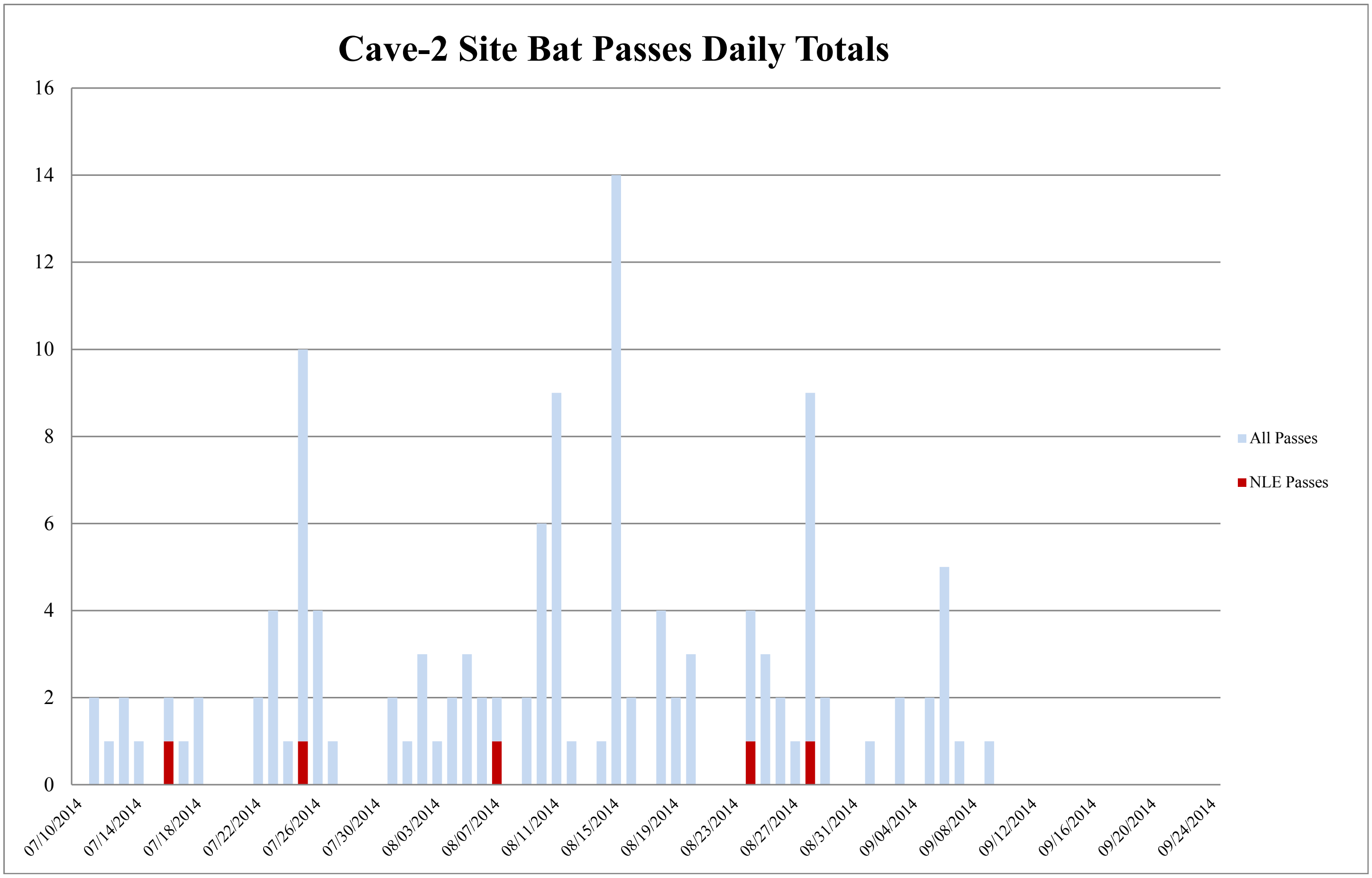
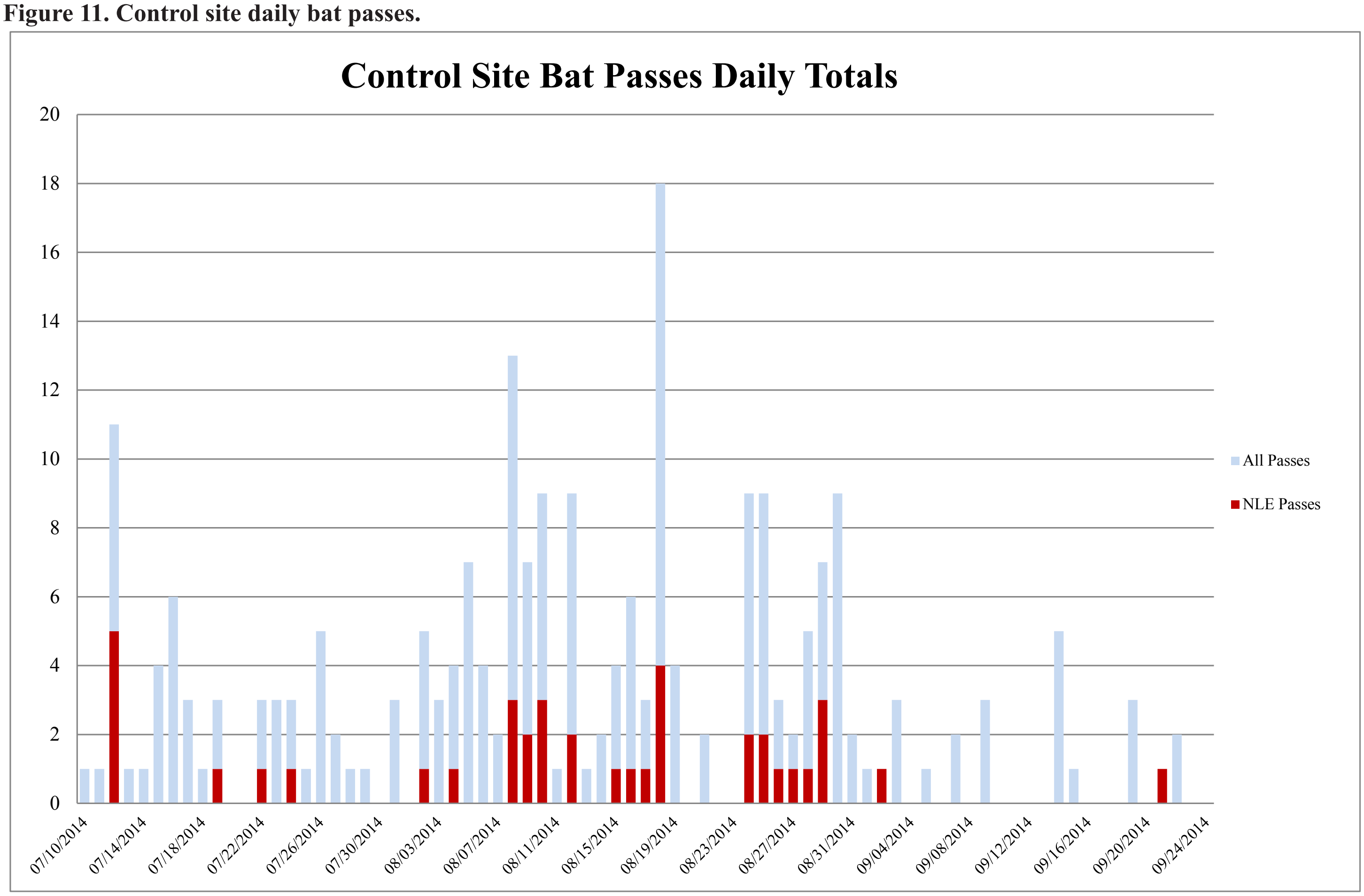


Figure 11. Control site daily bat passes.



Inter-site Temporal Patterns

Monitors were in place before and into the reported starting time for NLE hibernation. Changes in daily counts, either spikes in activity or reduced daily activity, could be indicative of hibernation activity.

Three sites, Cliffs, Cave-1, and Outcroppings, show spikes in activity above background counts that could be indicative of swarming behavior before hibernation (Figures 12 and 13). Two sites, Cliffs and Cave-1 have the greatest likelihood of being hibernacula. Both show consistently higher daily activity than the other sites and both show temporally coupled bimodal peaks of high bat activity. After the peaks, daily activity at both sites appears to drop to a lower level than prior to the peak, indicative of bats entering hibernation.

The three sites are separated from each other by distances large enough to consider the sites independent of each other. The spikes in activity for the three sites occur temporally close to each other, suggesting an environmental trigger affecting the higher level of activity. Cliffs has a cluster of increased activity from August 8 through August 10, with a peak day on August 9. Cave-1 has an abrupt spike in activity on August 12. Both have a second peak in activity on September 19.

The Outcroppings site shows a small activity spike on September 4 and September 5. While this peak is high relative to the daily activity at the site, it is not the magnitude of the activity peaks at the Cliffs or Cave-1 sites. Compared to the other two sites, the daily activity at the Outcroppings site does not suggest consistent bat use or the presence of an attractor. The Outcroppings activity peak does correspond to small activity spikes at both the Cliffs and the Cave-1 site, suggesting an environmental factor such as weather causing the peak.

The activity at Cave-1 indicates that NLE are attracted to the cave area and the site may be a hibernaculum. The lack of NLE affinity to the Cave-2 site could indicate that the cave does not have the hibernation requirements, such as constant humidity, reportedly required for NLE hibernacula.

The significant activity at the Cliffs site indicates there is an NLE attractor in the vicinity. Two daytime visual examinations of the cliff feature in close proximity to the monitor did not show any sign of bat use. No bats of any species were observed within cliff fissures and there was no sign of bat guano. Given the reported NLE specificity of selected hibernation spots, the cliffs at the monitoring site do not appear to be likely candidates for hibernacula. However, the overall activity and the spikes of activity in early August and in September are consistent with the reported swarming of Northern long-eared bats before entering hibernation. While cliffs at the monitoring site do not appear as suitable hibernacula, the data suggest the possibility of nearby hibernaculum.

Conclusions

This was a limited assessment, relying exclusively on acoustic monitoring. These results are interesting enough to warrant further assessment of Hiawatha National Forest karst features. Both the features studied here and other Hiawatha features should be examined more thoroughly. Because this study was limited in scope, there was no pre-deployment survey of the karst features to optimize sensor placement (e.g. a thorough search of the cliff site for caves). A more thorough examination of Hiawatha karst features as potential hibernacula sites should include pre-deployment surveys to optimize sensor placement.

Caves are well documented as NLE hibernacula. Our results indicate that NLE utilize one cave but not the other. Visual assessments at Cave-1 and Cave-2 could confirm the acoustic monitoring results. The openings to both these caves are small so visual confirmation could be in the form of observation at the cave mouth or use of video equipment internally. Additionally, this was a one season study. NLE are known to return to prior used hibernacula, but not always in successive years (Caceres. and Barclay 2000). Both caves should be assessed in multiple years to confirm their use or non-use as hibernacula sites.

Our results indicate that there is a NLE attractor at the Cliffs site. From this study, we cannot determine if the cliffs are the attractor, or some other nearby feature such as an unknown cave is the attractor. Based on the strength of our results, further efforts should be implemented to determine the NLE attractor at this site. Further efforts should include visual surveys for unknown caves, assessment of other karst features in the vicinity, and further acoustic monitoring.

Figure 12. Daily Bat Passes for the Cliffs, Cave-1, And Control Sites.

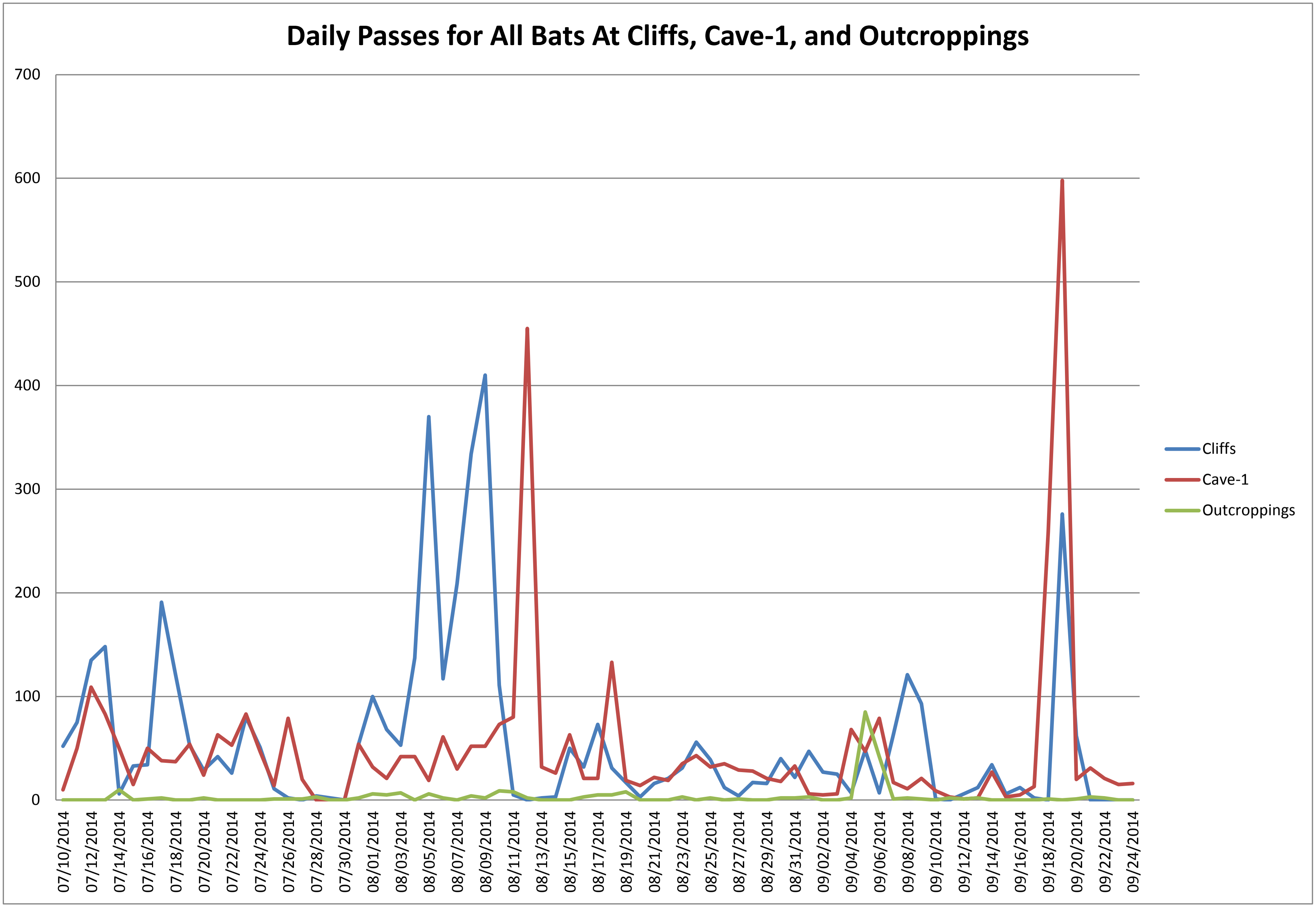
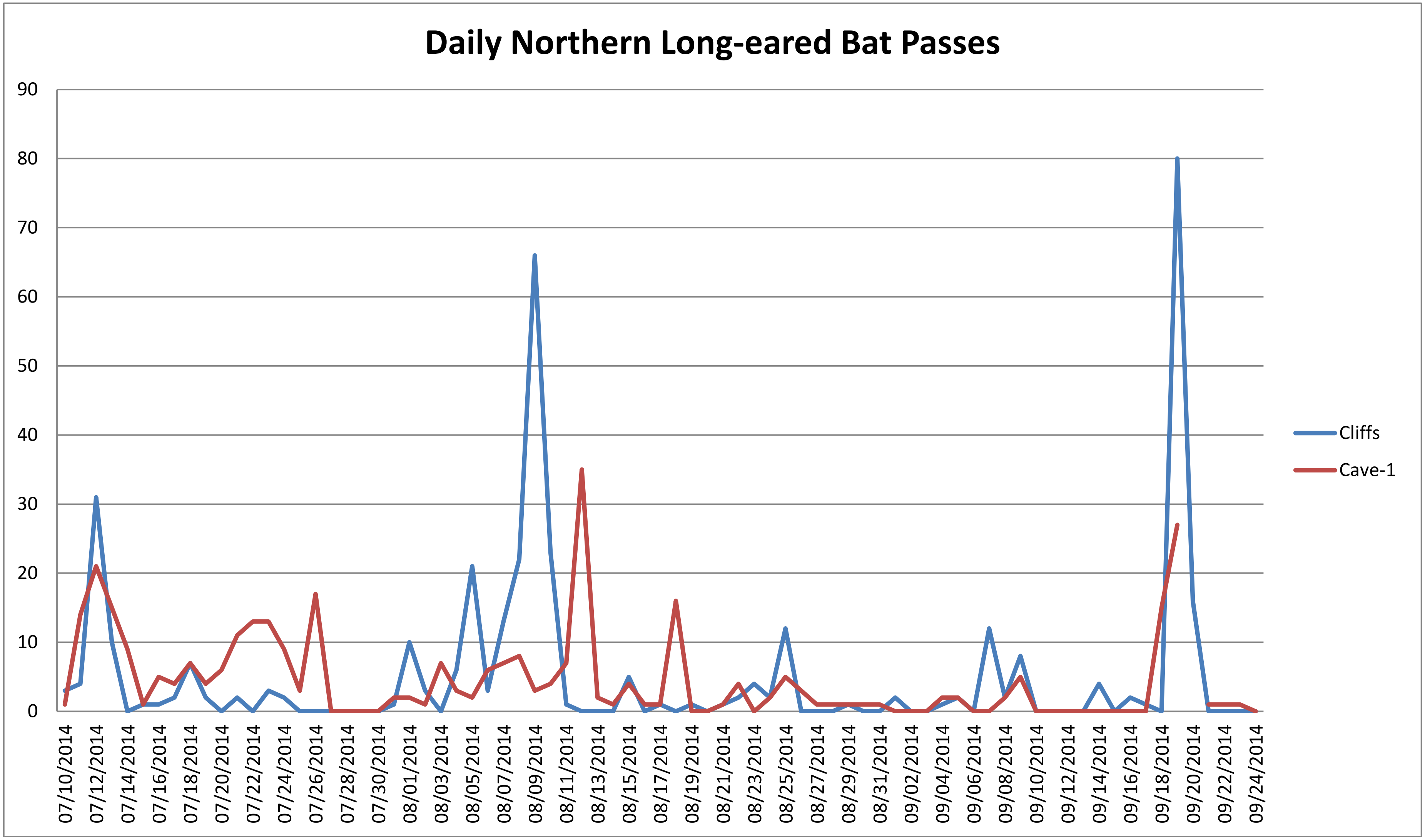


Figure 13. Daily Northern-Long-eared Bat Passes for the Cliffs and Cave-1 Sites.



Citations

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