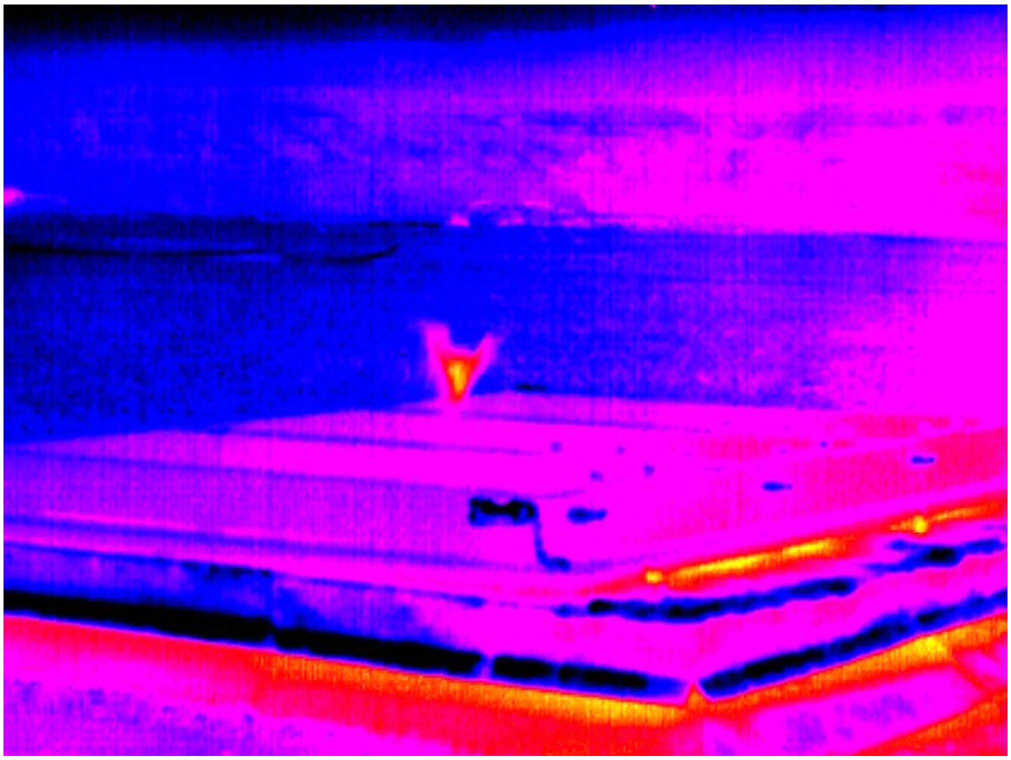
HNF-68253
Revision 0

Summer Bat Monitoring Report for Calendar Year 2021



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Summer Bat Monitoring Report for Calendar Year 2021

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1.0 INTRODUCTION

Bats belong to the order *Chiroptera*, which means “hand-wing.” They use a thin membrane of skin stretched between their fingers to fly. All bat species known in the state of Washington are insectivorous, and each bat can consume 600-1000 insects per hour while feeding. Unlike rodents, who give birth to multiple litters of several young each year, bats typically give birth once per year to only one pup, making bat populations more vulnerable to impacts and slower to recover. Several species of bats have been documented on the Hanford Site, with nine species identified during The Nature Conservancy surveys in 1997 and 1998, and an additional seven species listed as potentially present (Soll et al. 1999). Previous U.S. Department of Energy, Richland Operations Office (DOE-RL) acoustic surveys conducted in 2012 also confirmed the presence of the same nine species documented by Soll et al. (HNF-53759). In 2021, an additional species, the spotted bat, was observed roosting on the exterior of a facility by Hanford Site personnel; the species was confirmed via photograph by site biologists (Table 1).

Table 1. Bat Species Documented on the Hanford Site

Common Name	Scientific Name	TNC 1999 (Acoustic)	TNC 1999 (Captured)	HNF-53759 (Acoustic)
Pallid bat	*Antrozous pallidus*	X	X	X
Big brown bat	*Eptesicus fuscus*	X		X
Silver-haired bat	*Lasionycteris noctivagans*	X	X	X
Hoary bat	*Lasiurus cinereus*	X		X
California myotis	*Myotis californicus*	X	X	X
Western small-footed myotis	*Myotis ciliolabrum*	X	X	X
Little brown myotis	*Myotis lucifigus*	X	X	X
Yuma myotis	*Myotis yumanensis*	X	X	X
Canyon bat	*Parastrellus hesperus*	X		X
Spotted bat [a]	*Euderma maculatum*			

[a] Single individual observed roosting on the exterior of a Hanford Site facility in 2021.

Of the species confirmed on the Hanford Site, communal roosts (e.g., maternity roosts, winter roosts, and night roosts) of big brown bats, *Myotis* bats, and pallid bats are listed as Priority Habitats by the Washington State Department of Fish and Wildlife (WDFW). Males typically day roost alone or in small groups and do not have the same strict roosting habitat requirements as maternity colonies. Maternity colonies are specialized locations where groups of female bats roost together to give birth and raise their young. Individuals show strong fidelity to these roosting locations, and the same roosts are used year-after-year. These locations are selected for proximity to food and water resources, as well as appropriate temperature, humidity, and light conditions. The bats congregate to share body heat to conserve energy. These maternity locations are vital to successful reproduction. Night roosts are located close to feeding areas and are used by bats for resting and digestion between feeding bouts. Bats are known to habitually use night roosts from night-to-night and from year-to-year (Ormsbee et al. 2007). Although some species are migratory (e.g., silver-haired bat, hoary bat), most of the bat species occupying the Hanford Site are thought to remain in the region during the winter, roosting alone or in small groups. Due to cold temperatures and lack of available food (insects), bats must use winter roosts to survive. Winter roosts are selected for cold and constant temperatures so bats can down-regulate their body temperature, slowing their metabolism and conserving energy to survive through the winter. Bats select all communal roost types based on very specific conditions, which may not be otherwise available in the same area.

Identification and protection of roosting locations is becoming increasingly important with the outbreak of the fungal infection referred to as White Nose Syndrome (WNS). White nose syndrome was first recorded in bat colonies in the eastern United States and is rapidly expanding westward, including documentation of bats infected in Washington State according to the WDFW (WDFW 2021). Bats save energy during the winter by reducing their body temperature and entering a state of hibernation called torpor. They break these torpor bouts by warming their body temperature back up at regular intervals through the winter; these events are termed "arousals." Bats are thought to use these arousals for depuration, defecation, grooming, breeding, and possibly drinking. Although these arousals represent a relatively small portion of the time the bats spend winter roosting, a large amount (up to 80%) of their energy stores for the season are burned during arousals (Thomas et al. 1990). Bats are thought to increase the number of arousals due to WNS, likely for additional grooming. This causes the bats to exhaust their energy stores prior to the end of the winter, resulting in starvation. This disease spreads quickly through roosting colonies and causes fatality rates up to 100% at infected winter roosts (WNS 2020). Because of the collapse of these bat colonies and the potential expansion of this disease westward, it is extremely important to identify and characterize roosts to provide a baseline in case the disease reaches this area. Bat researchers must follow strict WNS Protocols established by the U.S. Fish and Wildlife Service and other agencies when working with bats (WNS 2020).

Bats are sensitive to disturbance, especially while pregnant and lactating. Early identification of roost areas can help avoid impacts to these sensitive species. The DOE-RL has shown a commitment to protecting bats on the Hanford Site, providing protection for known roost sites and mitigating for unavoidable impacts to other roosting locations. DOE-RL biologists and contractors have identified maternity colonies of Yuma myotis and pallid bats in the 100-F, 100-K, and 100-D Areas of the Hanford Site, along with some 600 Area sites (West et al. 2011; Table 2).

Table 2. Known Bat Roost Locations Across the Hanford Site as of 2021 (2 Pages)

Description	Primary Roost Type	Primary Species Present
105-F Reactor Bat Boxes	Maternity	Pallid Bats
105-H Reactor Bat Boxes	Unknown	Unknown
183-D Clearwell	Maternity	Yuma myotis
183-F Clearwell	Maternity	Yuma myotis
190-D Pipe Tunnel	Maternity	Yuma myotis
190-DR Pipe Tunnel	Maternity	Yuma myotis
Cornelius Pump House	Night Roost	Pallid Bats

Table 2. Known Bat Roost Locations Across the Hanford Site as of 2021 (2 Pages)

Description	Primary Roost Type	Primary Species Present
Hanford Townsite School	Unknown	Unknown
165-KW Facility	Maternity	Yuma myotis
114-D Bat Tower	Not occupied	

Bat roost monitoring is conducted at selected sites to document the status of the bat colonies present. Emergence counts can help to determine the size and population trends of the colonies to track mitigation success and can also help to monitor for possible WNS infection, which could result in drastic population reductions. Roost conditions were characterized to determine site suitability for bat roosting at one mitigation roost location (114-D).

2.0 METHODS

Emergence counts were conducted at previously identified bat roost locations to evaluate the number of bats present and to compare those numbers to previous counts to determine if populations are stable, declining, or increasing. The clearwell roost sites have a single emergence location, originally designed for human entry into the building, thus all bats emerging from the facilities must use the same entrance allowing observations to focus only on one location. Surveys were conducted by manually counting emerging bats, recording emergence with thermal cameras, and with automated infrared counters. Manual counts were conducted by two staff members, each with a clicker counter, that clicked once for each bat leaving the roost entrances. Bats returning to the roosts were counted on a separate clicker by one staff member. Minimum population estimates are calculated from manual counts by averaging the number of exiting bats counted by the two observers and subtracting the number bats that returned into the roost during the observation period. Bats can only be counted manually while ambient light is sufficient for observers to see bats flying. Observers orient to maximize use of available light on the horizon to increase the time when observations can be made. Thermal camera recordings were conducted concurrently with manual counts. Recordings were started when the first bat was observed and continued until the camera batteries died. Thermal videos were analyzed by counting the number of bats exiting and entering the roosts, by minute, for the duration of the recording. This allowed a running total to determine if the peak difference (exiting minus entering) occurs prior to the end of the recording period, which is the value used to estimate the minimum population size. An infrared counter was installed at the 183-F Clearwell for several nights prior to monitoring to allow bats to habituate to the novel structure at the roost entrance. The infrared counter records a bat each time one passes through the sensor, breaking the infrared beams. The counter is directional, recording bats leaving (out) or returning to (in) the roost. The three techniques of emergence counting were conducted concurrently so that the results could be compared for effectiveness and efficiency. Counts were conducted prior to juvenile emergence to attempt to document the number of mature females occupying the maternity roosts. Juvenile bat emergence on the Hanford Site is typically observed in mid-July. Sites selected for monitoring in 2021 were the 183-F Clearwell and the 183-D Clearwell.

In addition, roost site environmental conditions were monitored at the 114-D Bat Tower during 2021. The tower was installed as a mitigation for the maternity colony of pallid bats that occupied the 183-D Head House prior to demolition. The tower has not been occupied by pallid bats since it was constructed. Yuma myotis bats occupied the site temporarily (2014/2015) but appeared to abandon the building, apparently due to excessive high temperatures that caused some bat mortalities inside the structure in 2015. Remote temperature loggers (HOBO RX2100 Station and HOBOnet wireless sensors) were installed on the interior (one at the ceiling [high] and one 4 ft below the ceiling [mid]) and exterior (one on the north side of the tower in the shade) of the tower to compare internal temperatures to ambient temperatures and to evaluate maximum and minimum temperatures compared to suitable roosting temperatures for bats. The data from the sensors was downloaded over a cellular data network allowing for real time data analysis. Temperature data was collected every 5 minutes throughout the monitoring period. Plans were to monitor temperatures and then institute temperature mitigation strategies to modify internal temperatures if they were determined unsuitable for bats.

3.0 RESULTS

Emergence counts were conducted at the 183-F and 183-D facilities on June 21 and 22, 2021. Environmental conditions were ideal for emergence monitoring, with low wind (0 to 10 mph), warm temperatures (80 to 90 ºF at the start of the surveys), and no precipitation. Data for the manual counts are provided in Table 3. From the manual counts, the population of adults at the 183-D is estimated to be at least 1,841, while the population at the 183ºF is estimated to be at least 1,011.

Table 3. Manual Emergence Count Data for 183-D and 183-F Roosts.

Date	Site	Count (Obs. 1)	Count (Obs. 2)	Exit Count (Average)	Entrance Count (Average)	Population Estimate (Exit - Entrance)
6/21/2021	183-D	2,172	2,322	2,247	406	1,841
6/21/2021	183-F	1,005	1,082	1,044	104	940
6/22/2021	183-D	2,307	2,606	2,457	696	1,761
6/22/2021	183-F	1,043	1,050	1,047	36	1,011

Only one thermal camera was available for monitoring and it was utilized at the 183-F roost site concurrently with manual counts on June 21 and 22, 2021. The recording on June 21 was the same duration as the manual counting (66 minutes) but the recording on June 22 continued 11 minutes longer than the manual counting (76 minutes). The peak number of bats counted emerging during a single minute was 33, while the peak number returning to the roost was 8 in 1 minute. A running total for the minimum population estimate (bats exiting minus bats returned) was used, and the greatest population estimate was during the final minute during both recording sessions. On June 21, 1,059 bats were observed exiting and 83 returned, for a total population estimate of 976. On June 22 a total of 1,171 bats exited the roost and 83 returned, for a total estimated population of 1,088. Emergence data shown as bats-per-minute are provided in Figure 1.

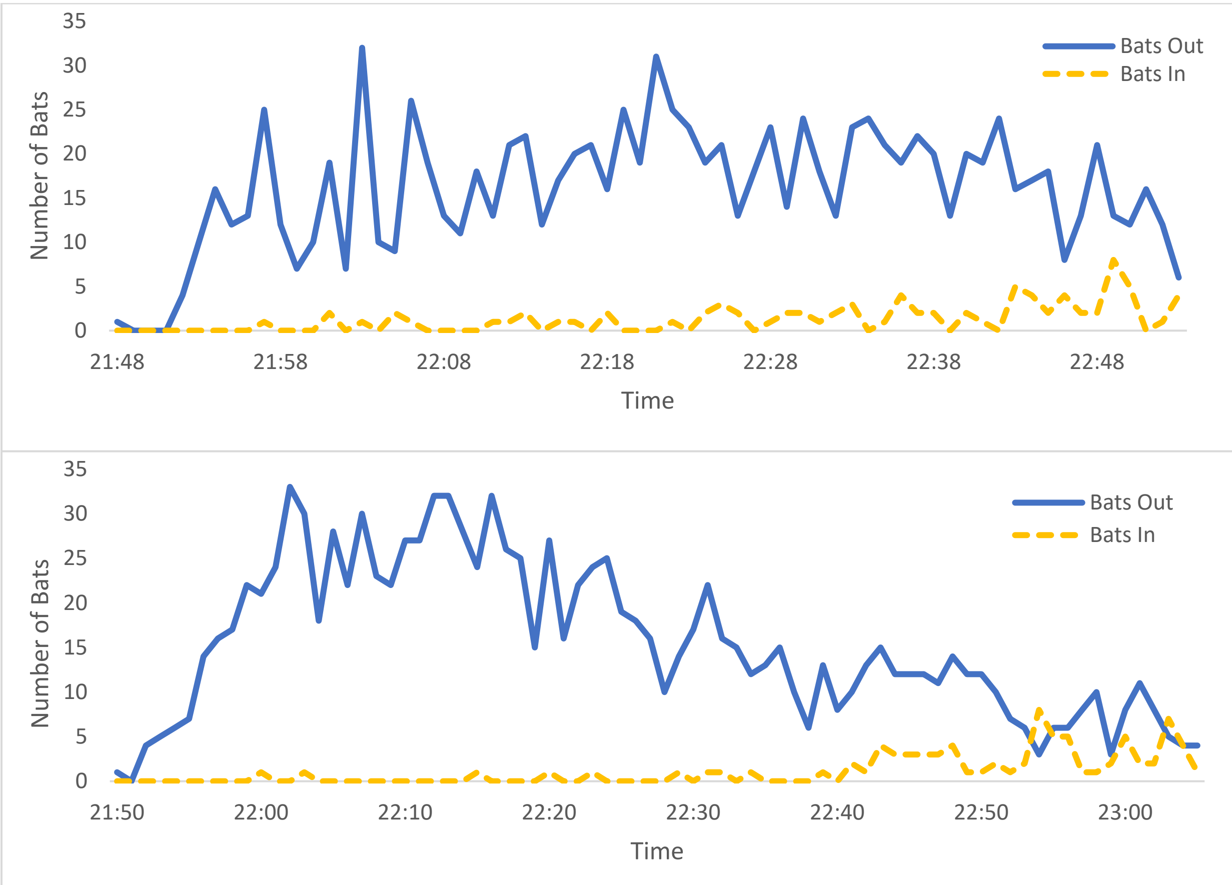

Figure 1. Bat emergence counts by-minute from thermal videos at 183-F on 6/21/2021 (top) and 6/22/2021 (bottom)

Although the infrared counter was deployed at the 183-F on June 21 and June 22, the recorder only functioned properly for the first night, with the batteries failing in two of the arrays during the second night. The infrared counter recorded 1,086 bats exiting and 65 bats entering during the monitoring period observed manually and by the thermal camera at 183-F on June 21. Thus, the infrared counter data was within 4% of the average manual count for exiting bats and within 38% of the manual count for returning bats. The infrared counter was within 2.5% of the exit count from the thermal camera and within 21% for the returning bat count. The total number of bats counted exiting with the infrared counter from 30 minutes after sunset until 30 minutes before sunrise on June 21 was 3,277 bats exiting and 2,543 bats returning. The maximum difference between bats exiting and bats entering during the monitoring night occurred at 0257 hrs, with 1,147 bats out. However, at the conclusion of the monitoring period an additional 729 bats were unaccounted for (out but not in).

Bat emergence counts were also compared to emergence counts conducted at the 183-F and 183-D facilities during prior years (Figure 2).

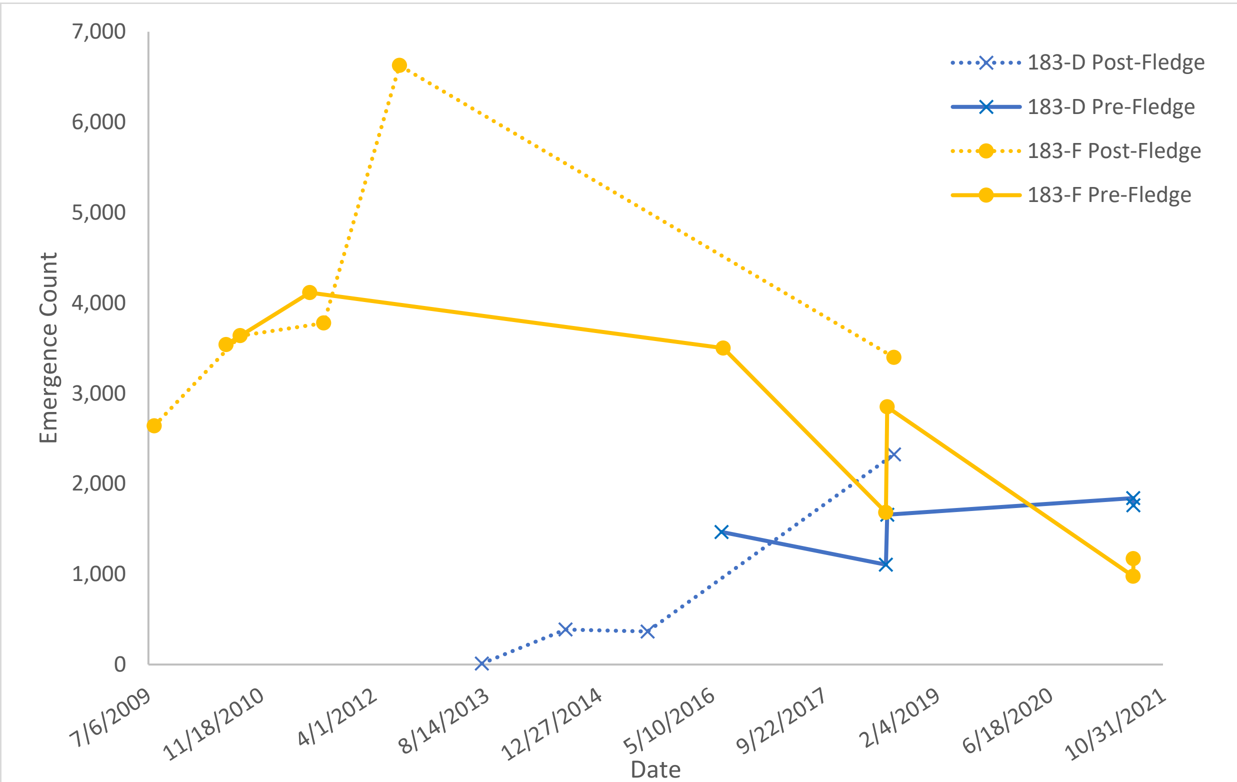

Figure 2. Pre- and Post-Fledging Emergence Counts at the 183-F and 183-D Clearwell Roost Locations Over Time

Environmental monitoring was conducted at the 114-D from March 16 through August 27, 2021. The temperature probes recorded temperatures every 5 minutes for the duration of the season and the data was downloaded remotely. The summer of 2021 was exceptionally hot. According to the Hanford Meteorological Station, June was 8.3°F above normal, with six dates recording all time high temperatures including a station recording an all-time state record of 120°F. Extreme temperatures continued in July (5°F above normal) and August (1°F above normal) with a total for the summer of 2021 of 68 days above 100°F compared to a normal of 53 days. These extreme temperatures provided a worst-case-scenario for high temperatures in the 114-D, where a maximum temperature of over 121.4°F was recorded at the high interior location and 118.3°F at the mid-interior location. Temperatures were recorded to exceed 104°F during 1,114 5-minute data points in 2021 on the exterior of the 114-D, 2,272 times at the high-interior monitoring location, and 1,266 times at the mid-interior monitoring location. This indicates that the lower roosting levels available in the building do provide some thermal refuge for bats but still exceed temperatures that may be suitable for bat roosting.

The 114-D was observed to moderate temperatures with warmer temperatures on the interior during the night and cooler temperatures on the interior during the day, compared with the exterior in the spring (Figure 3). However, as temperatures increased during the summer, the building became too warm on the interior, sometimes exceeding maximum daily exterior temperatures (Figure 4). There is a lag between the maximum daily exterior and interior temperatures, with the building continuing to heat up on the interior throughout most of the night.

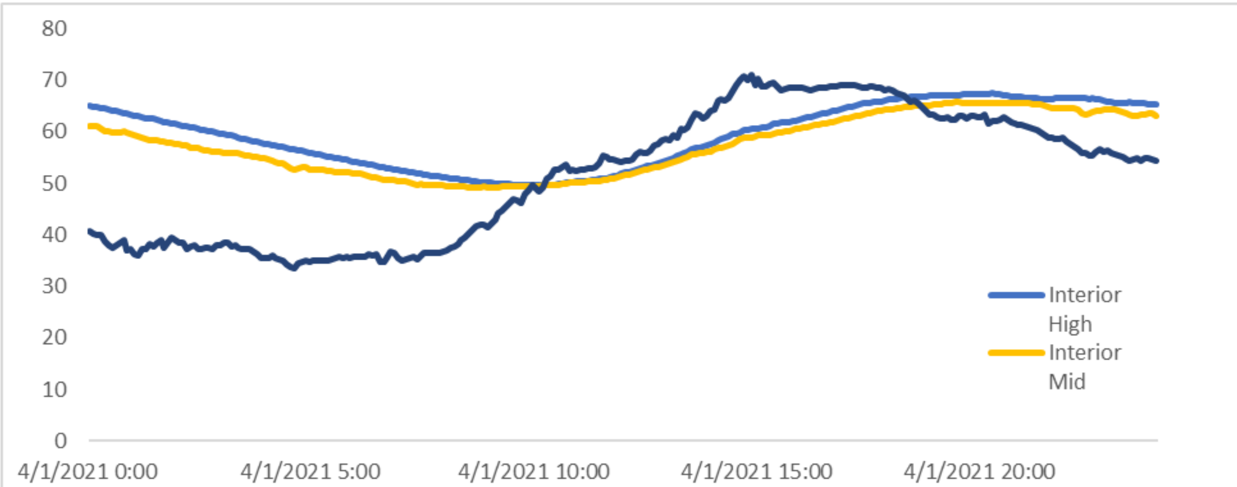

Figure 3. Temperature Changes on the Interior and Exterior During a 24-Hour Period During Spring of 2021 at the 114-D

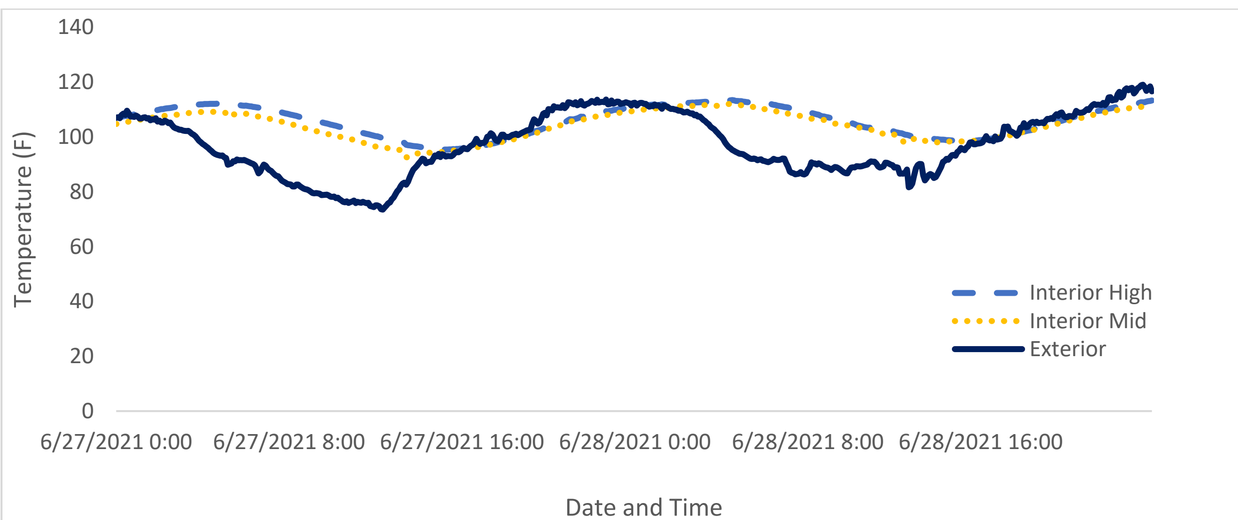

Figure 4. Temperature Changes on the Interior and Exterior During a 48-Hour Period During Summer of 2021 at the 114-D

Due to the observed delay between exterior and interior temperatures, the exterior temperatures were shifted back in time until they correlated most strongly with the interior temperature, which was at a shift of 5 hours and 20 minutes (5:20) later for the exterior temperatures (Figure 5). While accounting for the 5:20 time shift, when exterior temperatures were above 90ºF interior high temperatures were on average 4.2ºF greater than exterior temperatures, with a standard deviation of 3.5 ºF and a maximum differential of 19.0 ºF. The resulting correlation (R^2=0.9069) is provided in Figure 6.

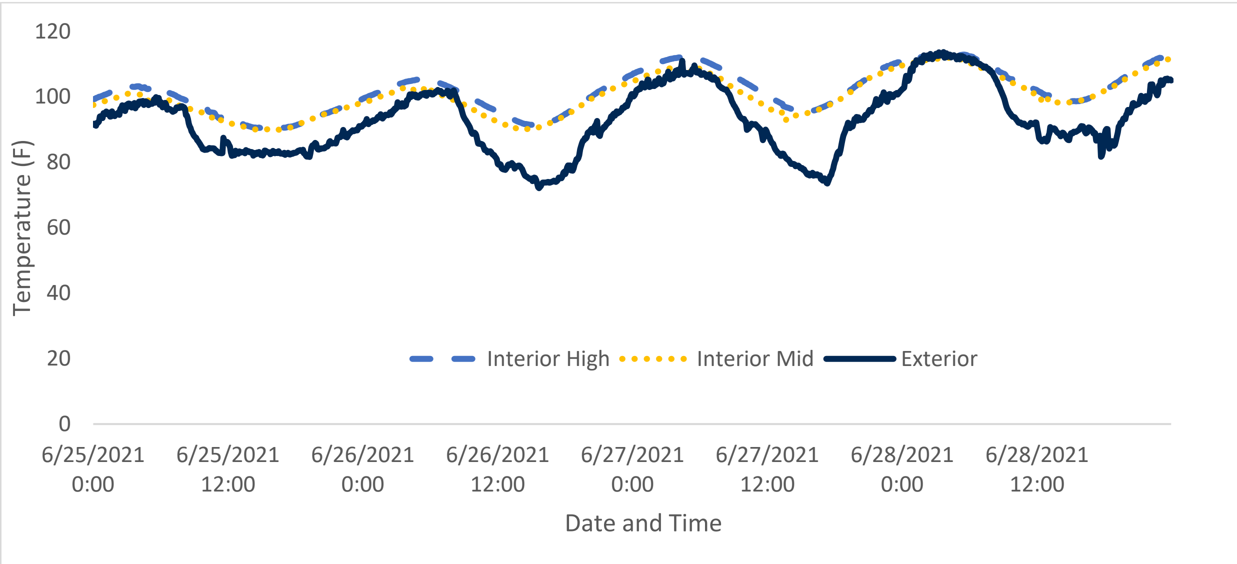

Figure 5. Interior and Exterior Temperature Changes Aligned Utilizing 5:20 Time Shift

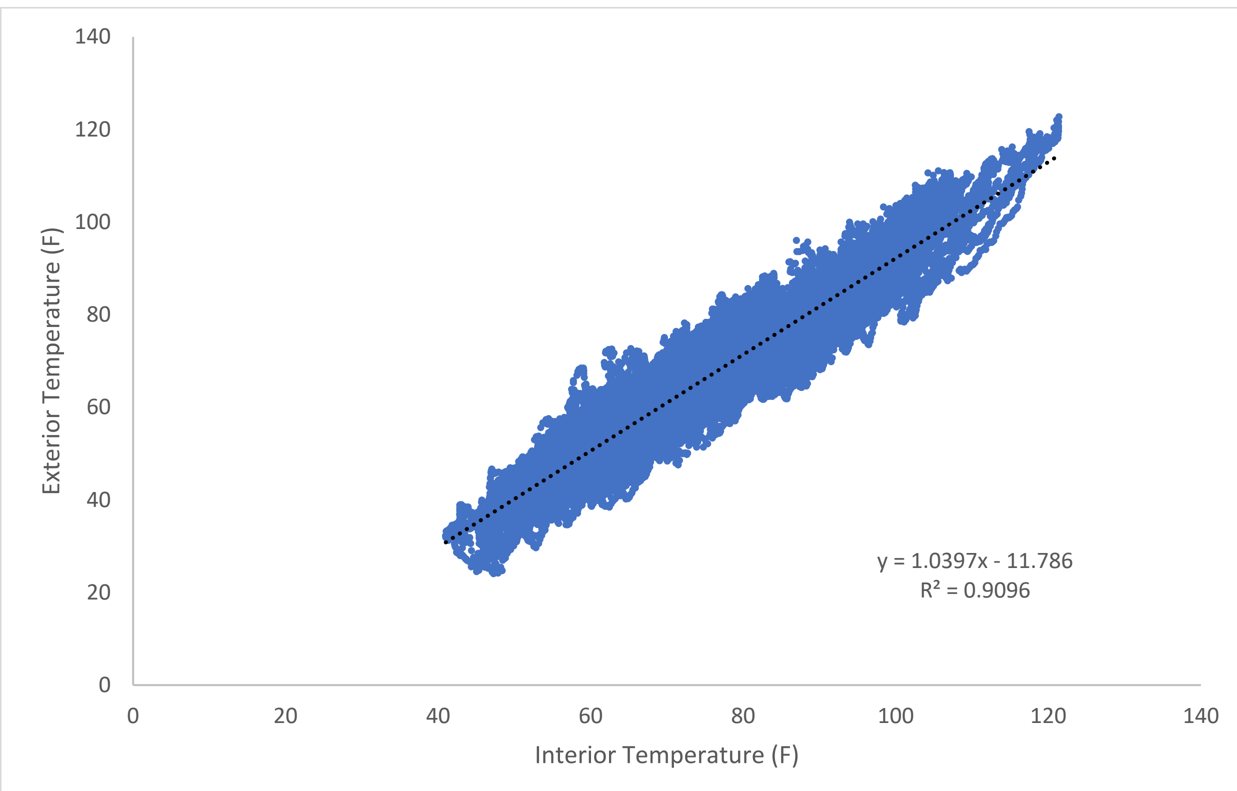

Figure 6. Correlation Between Interior and Exterior Temperatures at 114-D with 5:20 Tie Shift

4.0 DISCUSSION

One additional bat species was documented incidentally during 2021, the spotted bat. Spotted bats are known to occupy habitats like those present on the Hanford Site, although previous acoustic and mist netting efforts have failed to detect them. Additional research would be necessary to understand how often and to what extent spotted bats utilize the Hanford Site.

Emergence counts have not been conducted on a routine basis, and methods and timing have varied somewhat over time, therefore, the utility of these data in documenting trends in population numbers are not ideal. Since becoming established in 2013, the population at 183-D expanded quickly through 2016 and then appears to have stabilized. The population at 183-F appears to have reduced since the peak during 2011/2012. Whether bats have moved between roosts or whether other factors have reduced populations are unknown. However, if ongoing monitoring continues to show reductions, additional WNS screening at the facility may be warranted. More consistent and standardized emergence counts would help to establish more reliable trends in population levels at these facilities. Specifically, counts conducted prior to juveniles fledging that capture the entire emergence, including the peak difference between bats entering and exiting the facility, are most useful and comparable between years. Due to the internight variability in bat activity, multiple counts are likely necessary per year to best characterize population size.

During emergence counts, bats continue to emerge after observers are no longer able to see and count them manually. Thermal cameras can continue to record after visible light fades but require additional time for post-processing. Larger thermal camera battery/file storage capacity will be necessary to capture the entire emergence period and to more closely approximate the populations at these roosts. The infrared counter likely provides the most consistent and detailed evaluation with the lowest level of effort. Multiple nights can be monitored in a row without personnel remaining out in the field to manually count or to start and stop thermal cameras. However, technical difficulties related to bad batteries caused the sensors to fail to record the entire survey periods for each of the three arrays. Subsequent deployments of the infrared counting unit will help to confirm the effectiveness and efficiency of this device in monitoring emergences at these facilities. In addition, there is an unexplained difference between the total number of bats counted leaving the facility and the total number returning, which would be expected to be close to 1:1. Follow-up surveys could help to determine if this is due to sensor malfunction, or if some other factor is involved related to bat behavior.

Because bats return to the roost locations shortly after emergence, it is likely the locations are being utilized for night roosting in addition to day roosting. Alternative night roost sites are sometimes used due to their proximity to food and water resources, but the 183 Clearwell facilities are located within 1600 ft of the Columbia River, an excellent source of water and aquatic emergent insects, so alternative night roosts may not be necessary. Although bats did begin returning to the roost during emergence, complicating population estimates, bats were continuing to emerge at a greater rate than they were returning to the roost by the conclusion of the thermal video counts, indicating that the maximum population estimate was not obtained, and that extending the thermal camera recording time would likely increase the estimated minimum population number (bats exiting minus bats returning).

It is desirable to provide bats with a wide range of roosting conditions at mitigation roost sites, so that they are able to utilize areas that are suitable under a variety of environmental conditions. For example, bats in the 183 Clearwell have been observed roosting in different parts of the structures, depending on ambient temperatures. In 2021, temperature monitoring at the 114-D bat roost revealed unsuitable conditions for roosting. Monitoring of the ceiling and 4 ft below the ceiling of the structure provided a better understanding of the range of temperatures available for bats to utilize in the structure, as it is unlikely for bats to roost below the roost entrance (~6 ft below ceiling). As expected, the structure moderated temperatures, providing warm refugia during the night and cooler roosting conditions during the day in the spring, compared to unsheltered exterior locations. This is the desired function of the roosting structure. However, as temperatures increased later in the summer, interior temperatures often exceeded daytime high exterior temperatures. The observation that the 114-D Building continued to heat up through the night is concerning for pre-fledge juvenile bats, which are left in the roost for periods of time during the night, while females emerge to forage. High temperatures during these vulnerable times for juvenile bats likely make the roost unsuitable for a maternity colony with the current temperature regime. Plans have been instituted to change the exterior color of the building from dark brown to light grey utilizing an insulative paint, with the goal of decreasing maximum interior temperatures. The painting was not completed prior to the end of the monitoring season. Continued temperature monitoring will help to determine whether additional mitigative steps are necessary in the 114-D Building, such as adding passive or mechanical ventilation. Specifically, reanalyzing the difference between exterior and interior temperatures when exterior temperatures exceed 90°F will help to determine the effectiveness of the temperature mitigation actions.

Continuing bat work on the Hanford Site may include monitoring at additional known roost sites, ongoing mitigation projects to protect or replace roosting habitat, and acoustic monitoring to evaluate for other bat resources in areas that may be impacted by project activities in the future. Detailed emergence counts prior to and after expected juvenile fledging timing could also help to determine the levels of recruitment occurring at the facilities. Maintaining a detailed understanding of the number of bats utilizing these facilities may help to monitor for possible WNS infection, which would need to be confirmed with subsequent testing.

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