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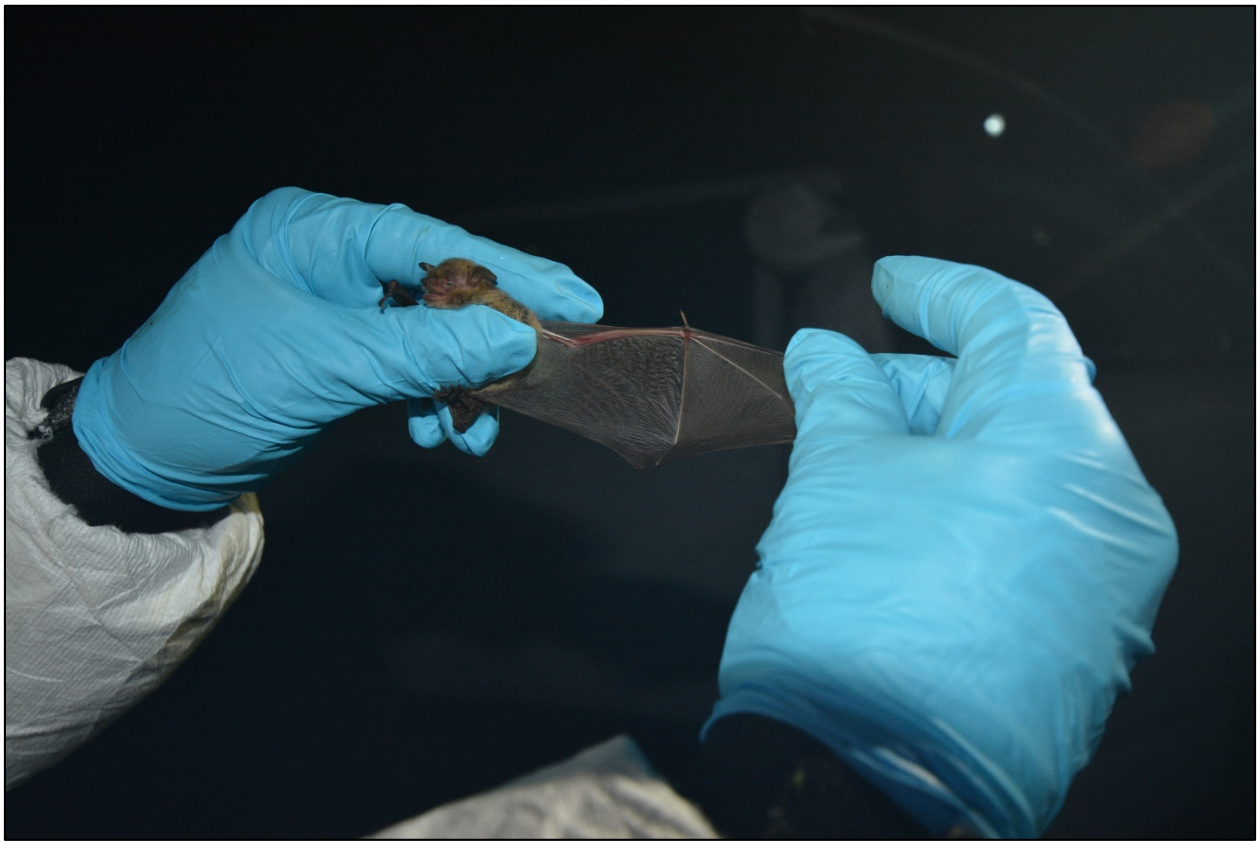
2018 Bat Maternity Roosts at the 183-F and 183-D Clearwells



Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

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P.O. Box 650
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1.0 INTRODUCTION

The 183-F and 183-D Water Treatment Plants served three of the historic reactors at the Hanford Site for a combined 45 years, assisting in the production of weapons grade plutonium. These once massive facilities have been remediated to near unrecognizable landscape with limited infrastructure remaining. Although small in proportion to the pre-demolished facilities, the associated 183-F and 183-D Clearwells played a critical role during the operating years of the site and continue to serve as an unintended high-priority habitat for breeding bat populations.

1.1 PURPOSE

The purpose of this report is to provide an overview on the historical and current status of the bat species Yuma myotis (*Myotis yumanensis*) that use the 183-F and 183-D Clearwells as maternity roosts on the Hanford Site. This report reviews the history of the facilities, mitigation actions taken in support of bat maternity colonies at these locations, and the results of recent monitoring of those populations.

1.2 SCOPE

The following topics are discussed in this report:

- The reasoning behind the mitigation of the 183-F and 183-D Clearwells
- A description of the bat species Yuma myotis and its life cycle on the Hanford Site
- The construction and renovations to the 183-F and 183-D Water Treatment Plants beginning in 1944 through decommissioning in 1965 and 1994 (respectively)
- All bat mitigation monitoring efforts conducted through 2018 at the 183-F and 183-D Clearwells.

1.3 MITIGATION DRIVERS

In order to protect sensitive biological resources during remediation activities on the Hanford Site, potential impacts to resources are reviewed. When findings conclude that a potential impact exists, DOE/RL-96-32, *Hanford Site Biological Resource Management Plan,* (BRMP) provides mitigation guidance. BRMP determines the level of mitigation action required to protect vulnerable habitat and species of concern. Under BRMP, bat roosts are classified as a Level 3 resource, which includes species recognized by Washington State as having conservation concern, including state sensitive and review plant species, state sensitive and candidate animal species, Washington Department of Fish and Wildlife (WDFW) priority species

and habitats, and those listed by the United States Department of Fish and Wildlife (USFWS) as federal species of concern in the Columbia Basin Ecoregion (DOE/RL-96-32). The management goal for Level 3 resources is conservation, with a compensatory mitigation action of habitat replacement at a 3:1 ratio when disturbance to the resource is unavoidable.

Bat surveys were conducted at both the 183-F Clearwell and 183-D Water Treatment Plant prior to their planned demolition (Figure 1). Findings indicated that Yuma myotis were utilizing both structures for roosting. This finding initiated the planning process for possible mitigation under the *National Environmental Policy Act of 1969* while conducting remediation projects under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA).

WDFW maintains the status of statewide plant and wildlife species noted in their Species of Concern (SOC) list and Priority Habitats and Species list. Those protected by WDFW include State Endangered, Threatened, Sensitive, and Candidate species, along with animal aggregations considered a conservation priority. Additionally, WDFW manages and protects vulnerable species of recreational, commercial, or Tribal importance. BRMP has incorporated the WDFW guidelines to aid in actions taken on the Hanford Site and a final decision was made for the clearwells to be kept in place because they qualified as WDFW priority habitat for roosting bat colonies.

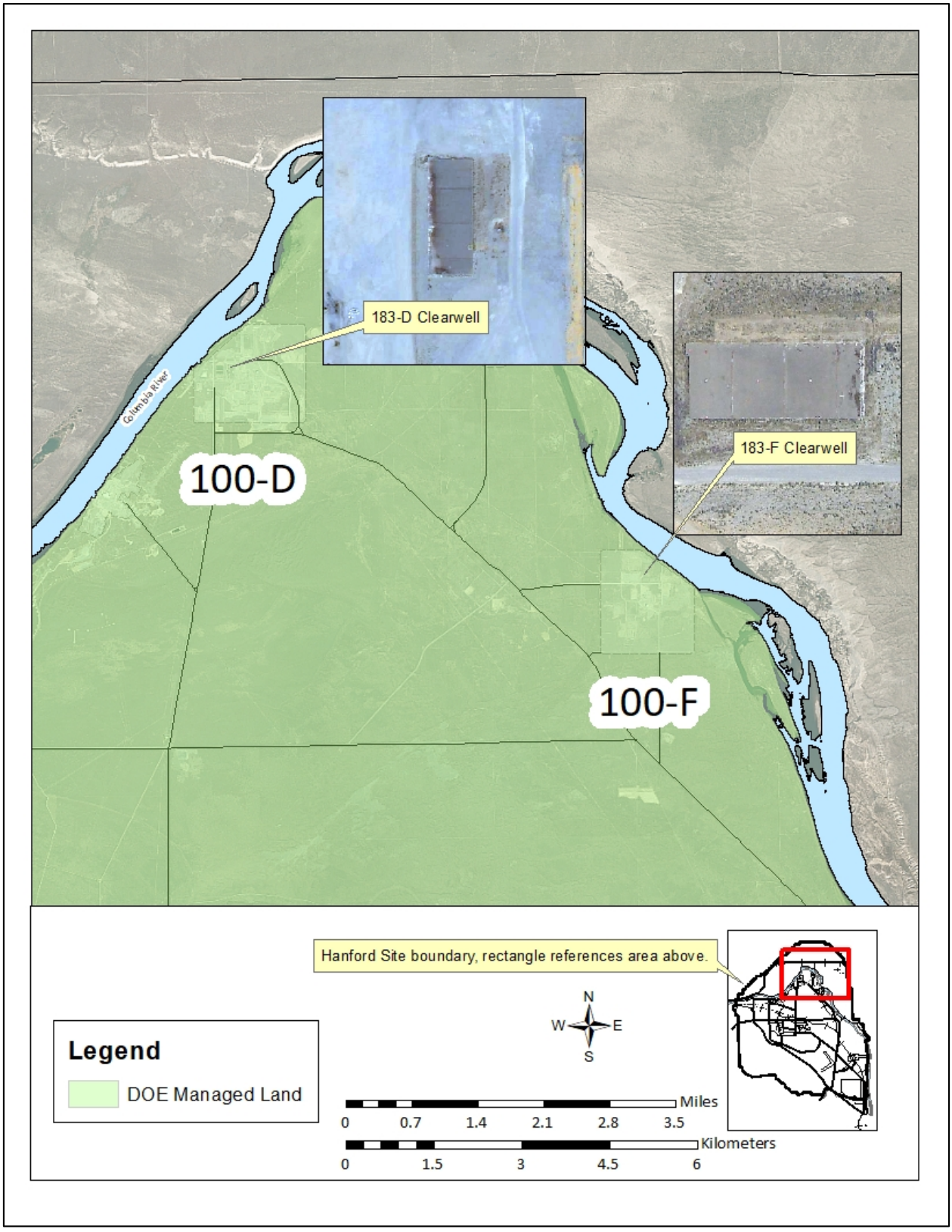

Figure 1. Locations of the 183-F and 183-D Water Treatment Plant Clearwells

2.0 YUMA MYOTIS

2.1 SPECIES OVERVIEW

Yuma myotis is a species of small brown bat that has been identified in nearly every county of Washington State. The species has a North American distribution from western Montana and southeast Alaska down to west Texas and Central Mexico (Hayes and Wiles 2013). Although the species is widespread, little is known about how many populations exist throughout its geographic range, which makes identifying and protecting maternity roosts important. The bat species resides in various lower elevation landscapes with a strong association to rivers where food sources thrive. Yuma myotis forage on various insect species and have been reported flying up to 13 km (8.08 mi) from roosts to feeding sites (Falxa 2008). Mating typically occurs in autumn prior to hibernation. Ovulation is delayed throughout the hibernation season and the egg becomes fertilized in spring. Typically, pups are born in June and start fledging in early to mid-July (Dalquest 1947, Betts 1997). In eastern Washington, hibernation has been observed to last from early November until March (Lucas 2011). Prior to parturition, the species departs their winter roost and females associate with a maternity colony to deliver and raise young. Males are seldom observed roosting out of hibernation with females (Adams 2003).

2.2 MATERNITY ROOSTS

While male Yuma myotis typically roost individually or in small numbers throughout the feeding season, mature females congregate in groups, sometimes consisting of many thousand individuals forming maternity colonies. In these maternity roosts, female bats will give birth to and raise their young until they can fend for themselves, a process that typically takes 2 to 3 months. Roost locations are occupied annually to complete the reproduction process. Yuma myotis select maternity roost locations based on a number of requirements. The habitat must maintain a balance of lighting, temperature, and humidity with food and water resources available in the approximate area (HNF-56359). Alternations to these habitat requirements can cause significant mortality to an entire generation, specifically when developing young are not volant; therefore, it is vital for the habitats to be identified and safeguarded in order for pregnant and lactating bats to birth and rear young successfully. Human disturbance is especially stressful to maternity roosts, females have been known to abandon the roost site all together following human disturbance, jeopardizing the survival of young (O'Shea and Vaughan 1999). Anthropogenic noise, vibrations from human activity, such as construction and mining, and recreational activities, such as caving and rock climbing, have all shown to disrupt roosting behavior (Hayes et al. 2013).

2.3 CONSERVATION

The three key factors that have nationally negatively affected bat populations are habitat loss; human disturbance; and *Pseudogymnoascus destructans*, which is a fungus that causes a fatal disease commonly known as white-nose syndrome (WNS). The fungal disease agitates bats during times of hibernation, depleting crucial fat reserves resulting in starvation and death (WDFW 2018, Hayes et al. 2013). WNS is an emergent disease of hibernating bats that has spread from the continental northeast

of the United States killing an estimated 5.7 to 6.7 million bats in 30 states and 5 Canadian provinces since 2006 (Hayes et al. 2013). The disease was recently identified in western Washington in 2016 with additional confirmed cases in 2017 and 2018 (WDFW 2018); monitoring for WNS at known roosting locations has become a major component of the WDFW bat conservation plan (Hayes et al. 2013). In order to track population health, it is necessary to create a baseline by identifying and protecting roosts, as well as continued monitoring.

3.0 183-F AND 183-D WATER TREATMENT PLANTS

3.1 FACILITY BACKGROUND INFORMATION

The 183-F (Figure 2) and 183-D (Figure 3) Water Treatment Plants were constructed in 1944 and each included a head house, flocculation basins (12 at 183-F, 13 at 183-D), sedimentation basins (12 at 183-F, 13 at 183-D), filters (12 at 183-F, 13 at 183-D), a filter pump house, and two clearwells (HW-74094). Three additional filtration systems each consisting of one flocculation basin, one sedimentation basin, and one filter system were installed in 1950 at the 183-D Water Treatment Plant (HW-24800-34). The plants served as a treatment system for water that was pumped from the Columbia River and purified for the use of sanitary water, fire protection water, and cooling water for the process tubes at the 105-F and 105-D Reactors (HW-74094). In order for the water to be deemed suitable, chemicals were added as coagulant agents and pH control; followed by a settling period; and, lastly, filtered and stored.

Figure 2. The 183-F Water Treatment Plant in 1966

Figure 3. The 183-D Water Treatment Plant in 1945

The filtered water passed into large clearwells where its distribution was regulated by the 183-F and 183-D Filter Pump Houses, supplying both the 190-F and 190-D process water storage and pump house with purified river water. Each clearwell was constructed out of reinforced concrete with a cement slab roof 15.2 cm (6 in.) thick. The ceilings were located at near ground level with an underground holding capacity of 17,034,353 L (4,500,000 gal) of clean water at 183-F, and 18,927,058.9 L (5,000,000 gal) at 183-D. Each clearwell at 183-F measured 41 m (134 ft) wide by 114 m (375 ft) long by 5 m (16 ft) deep, with 98 concrete pillars supporting the heavy ceiling (WCH-312) (Figure 4). The clearwells at 183-D had similar dimensions. The 105-F Reactor was decommissioned in 1965 and the 105-D Reactor in 1968; however, the 183-D Water Treatment Plant continued to operate until 1994, providing water services for the 100-D, 100-F, and 100-H Areas (HW-82188).

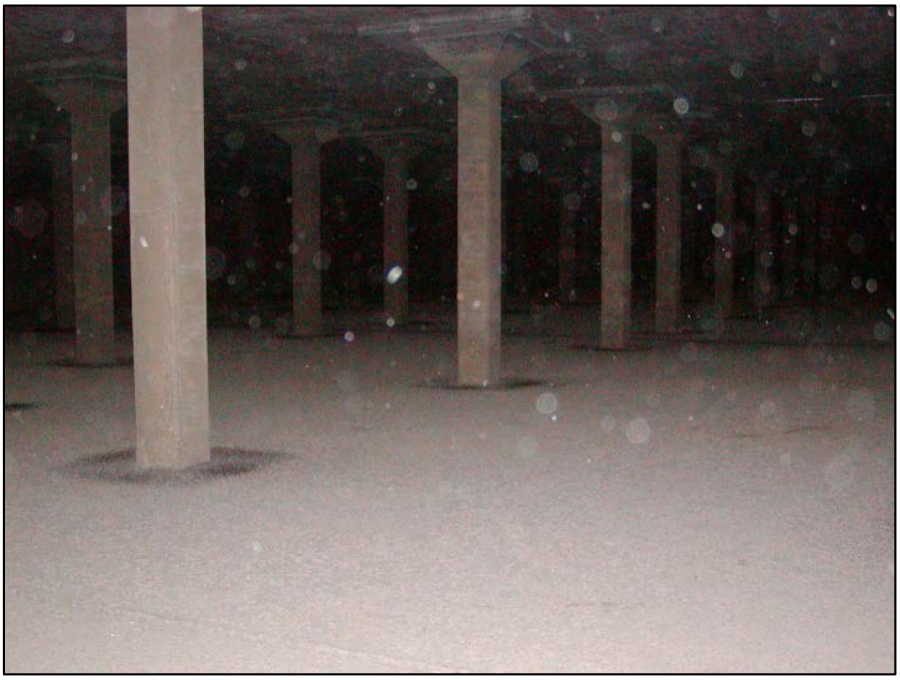

Figure 4. The Support Columns in the Interior of the 183-F Clearwell

3.2 183-F CLEARWELL MITIGATION

Following the 1965 decommissioning of the 105-F Reactor, the entire water treatment plants infrastructure, with the exception of the west clearwell, was demolished starting in 1977. Throughout the late 1970s and early 1980s, the east clearwell was used as a storage facility for debris from various structures that were demolished in the vicinity. After approximately 28,986 metric tons (31,952 tons) of stored debris was cleaned out in 2005, the east clearwell was backfilled with clean soil and revegetated between December 2007 and February 2008 (HW-74094).

In 2006, a colony of bats was discovered residing in the one remaining intact clearwell. Using an infrared digital video recorder more than 2,000 bats were observed exiting one of the structure's ceiling hatches, sparking great interest by a number of organizations to further research the location. These

organizations included the Oregon State Department of Energy, Washington State Department of Ecology, WDFW, Washington State Department of Natural Resources, Confederated Tribes of the Umatilla Indian Reservation, Western Bat Working Group, USFWS, Oregon Chapter of The Wildlife Society, and Cascadia Research Collective (WCH-312). A study was planned and initiated in 2007 using methods similar to previous bat monitoring efforts conducted on the Hanford Site, investigating potential roosting habitats that could be lost because of Interim Safe Storage projects. These Interim Safe Storage projects are responsible for the safeguarding of contaminated reactor buildings and the removal of their ancillary structures.

The bat study at the 183-F Clearwell began in 2007 and consisted of mist netting, evaluation from within the structure, DNA testing, and acoustic monitoring. Mist netting was conducted between August 2007 and September 2008. Data collected during mist netting included estimating age, forearm length, sex, reproductive status, species, and weight. In total, 135 Yuma myotis bats were captured and released at the 183-F Clearwell. Of the 135 bats captured 131 were female, with the majority showing signs of reproductive activity. This information provided the necessary data to classify the site as a maternal roost. During this time bats were also mist netted at the 190-DR water process tunnels to enable a DNA comparison between the 100-F and 100-D locations. Between the two locations there were 10 specific maternal lines identified in the mitochondrial DNA analysis, 6 of which were shared between the 2 locations (WCH-312). While this does not prove that bats integrate between locations, it does indicate that the two maternal colonies belong to the same breeding population.

An inspection of the structural integrity of the 183-F Clearwell and associated filter backwash flume was conducted on October 3, 2007, by a structural engineer, environmental staff, and industrial hygienist. Less than 20 bats were observed in the clearwell and 200 to 300 were observed roosting along the flume walls (WCH-312) (Figure 5). The structural configuration of the flume allows it to absorb solar radiation at greater levels than the clearwell, resulting in a warmer roosting location in the cooler months (Lucas 2011). This is the probable factor for a comparative difference of bat observations between the clearwell and flume.

The clearwell and associated backwash flume were entered again on February 7, 2008, to investigate if bats use the locations to winter roost. No bats were observed during this time and the engineer again declared the building to be structurally sound (WCH-312). The associated suction well, which is located on the east end of the clearwell, was noted as a possible roosting site and inspected on March 13, 2008. After a thorough visual inspection, no signs of bats or guano were observed; the suction well did not appear to be utilized as a roosting site in either summer or winter (WCH-312).

A fourth entry was made into both the clearwell and filter backwash flume on June 6, 2008, in order to film the maternity colony. The majority of roosting activities were observed on the ends of the support pillars on the west end of the clearwell. After analyzing the field recording, an estimated 1,800 to 2,000 bats were observed. No bats were observed in the backwash flume (WCH-312). Data loggers that were deployed to collect temperature recordings were retrieved from the clearwell on September 22, 2008, and from the flume on September 30, 2008. There were 300 to 500 bats observed roosting on the steel ceiling hatches of the clearwell and approximately 200 in the flume (WCH-312).

Figure 5. The Interior of the 183-F Filter Backwash Flume

Beginning on October 9, 2007, acoustic monitoring equipment was deployed in the entrance of the filter backwash flume and then moved to the exterior of an open ceiling hatch on the clearwell in mid-February 2008. The purpose of these recordings was to track seasonal trends of roosting bats. Recordings provided evidence that the structures are heavily used between mid-March and dwindle down by mid-October (WCH-312). Surprisingly, acoustic monitoring showed that a few bats (species unidentified in Lucas 2011 report) were active at the location on January 23 to 24, 2008 when the average minimum ambient nighttime temperature was 13.8 °C (7.1 °F) (Lucas 2011).

This initial bat study of the 183-F clearwell and associated filter backwash flume demonstrated the classification of this site as a priority habitat. Proving to be one of the largest maternity roosts of Yuma myotis in Washington State, it potentially supports other regional bat populations (Lucas 2011). Sampling of the clearwells were determined to be free of residual contamination; therefore, demolition of the 183-F (west) clearwell and flumes was not required under CERCLA. The structures were left intact as priority habitats. The location was fenced off and posted as a sensitive habitat area (WCH-312).

3.1 183-D CLEARWELL MITIGATION

Prior to the demolition of the 183-D Water Treatment Plant that began in 2013 and completed the following year, an ecological review was conducted to evaluate the potential impact of demolition activities on ecological resources. This review included a bat study to assess if any of the structures were being utilized as roosting sites (WCH-438). The study consisted of mist netting, acoustic monitoring, visual surveys, and entry into accessible facility structures. The mist netting efforts on May 20, 2009, resulted in the capture of 29 Yuma myotis. Acoustic monitoring conducted during the mist netting

showed that pallid (*Antrozous pallidus*) and canyon bats (*Parastrellus hesperus*) were making passes in the area. During an entry into the two 183-D Clearwells and connecting flumes on October 25, 2010, guano was discovered in both structures but no bats were observed (WCH-438). It was discovered that pallid bats were using the head house as a maternity roost, as well as Yuma myotis night roosting in the structure. It was suspected that Yuma myotis also had a maternity roost somewhere in the facility that was inaccessible to monitoring staff. A bat survey was conducted on July 24, 2013, near an open ceiling hatch at the north clearwell using both acoustic recording equipment and infrared digital video recording equipment. An estimated 11 bats were observed exiting the clearwell along with others flying above. The acoustic recordings confirmed that they were Yuma myotis (WCH-577). The head house, flocculation basins, filter building, and south clearwell were demolished and removed. In order to mitigate the loss of habitat due to structure demolition, the north clearwell and its associated filter backwash flume were preserved for roosting habitat (Figure 6). These locations were fenced off and posted as a sensitive habitat area.

Figure 6. The demolished 183-D South Clearwell and intact 183-D North Clearwell

4.0 183-F MONITORING RESULTS

4.1 2009-2012 MONITORING RESULTS

Mitigation monitoring of bat activity at the 183-F Clearwell continued annually through 2012, using methods such as mist netting and emergence counts. In 2009, biologists set up two mist nets by the ceiling hatch in order to determine bat species present. This effort resulted in trapping eight Yuma myotis and one western small-footed bat (*Myotis ciliolabrum*). Using infrared digital video equipment, emergence counts were conducted at both the ceiling hatch and filter backwash entrance with an

estimated 2,640 and 120 bats observed, respectively (WCH-362). Two emergence counts were conducted using the same method at the ceiling hatch the following year. On June 16, 2010, there were 3,539 bats observed exiting and 3,637 bats observed exiting on August 17, 2010 (WCH-428). The colony showed to have continued growth. On June 22, 2011, and August 23, 2011, 4,114 and 3,777 bats were observed, respectively (WCH-512). Mist netting took place during the August 23, 2011, emergence count, capturing 30 Yuma myotis bats including 27 females (12 adults and 15 juveniles), and three males (one adult and two juveniles) (WCH-512). The final count conducted between 2008 and 2012 was on July 24, 2012. This survey observed the highest count to date with 6,627 bats emerging from the ceiling hatch (Table 1). During all of the mist netting sessions conducted between these years, all captured bats appeared to be in good health, with the majority being female Yuma myotis (WCH-554).

Table 1. Estimated Bat Emergence Count Totals at the 183-F Clearwell between 2008 and 2012.

Date	Estimated Total
6/6/2008	1,900
8/2009	2,640
6/16/2010	3,539
8/17/2010	3,637
6/22/2011	4,114
8/23/2011	3,777
7/24/2012	6,627

4.2 2016-2017 MONITORING RESULTS

Mitigation monitoring was conducted at the 183-F Clearwell on June 29, 2016. Using Infrared digital video equipment and manual counting by two staff members, an estimated 3,500 bats were observed exiting the clearwell. The camera was placed roughly 3.04 m (10 ft) from the ceiling hatch opening and pointed away from the sun. The survey began a half hour before sunset and concluded when visibility became too poor to observe bats. The camera ran out of battery power before the survey was complete and bats were counted for an additional 15 to 20 minutes. The total survey lasted around 1.5 hours, similar to the length of 2008 to 2012 surveys.

Hanford staff and WDFW staff conducted mist netting at the 183-F Clearwell on April 26, 2017, as part of a statewide program monitoring maternity colonies in early spring for WNS. Two mist nets were located immediately south of the 183-F Clearwell entrance and another mist net was located to the east end of the clearwell (HNF-63012). During this netting effort, 37 Yuma myotis were captured. The bats were surveyed for radiological contamination, seven bats were released, and the remaining 30 bats were surveyed with ultraviolet light to detect surface WNS fungus, measured, and sexed. Of the 30 bats, muzzle and wing swabs for the WNS fungus were taken from 25 bats. These samples were sent to the United States Geologic Survey National Wildlife Health Center for analysis for the WNS fungus. No physical signs of WNS were observed and all lab results came back negative (HNF-63012). All 37 bats

captured were adult female Yuma myotis, all appeared to be in good health with only two bats having minor wing damage consisting of a few pin-sized holes.

5.0 183-D MONITORING RESULTS

5.1 2014-2016 MONITORING RESULTS

The first post-demolition bat mitigation monitoring was conducted on July 30, 2014, at the open ceiling hatch door located on the east side of the north 183-D clearwell. This monitoring included mist netting and infrared digital video recording efforts. During this survey, mist netting was unsuccessful and an estimated 387 bats were observed exiting the location (WCH-593), a 3,518.2% increase from the observations recorded at the same location during the pre-demolition survey conducted in 2013. On July 29, 2015, the monitoring was completed using infrared digital video equipment to record emergence; an estimated 365 bats were observed (WCH-631). On June 21, 2016, monitoring was conducted at the north 183-D Clearwell and a 301.6% increase of bats was observed from the previous year utilizing the location (Table 2). An estimated 1,466 were recorded exiting the hatch (WCH-634).

Table 2. Estimated Bat Emergence Count Totals at the 183-D Clearwell between 2013 and 2016.

Date	Estimated Total
7/24/2013	11
7/30/2014	387
7/29/2015	365
6/21/2016	1,466

6.0 2018 MONITORING OF THE 183-F AND 183-D CLEARWELLS

6.1 2018 SURVEY METHOD

The 2018 bat surveys at the 183-F Clearwell were conducted simultaneously at the 183-D Clearwell by teams of two staff members at each location using the same survey method. The counting method and restrictions followed emergence count protocol used by WDFW (Washington Department of Fish and Wildlife Bat Colony Emergence Count Protocol). The initial two surveys were scheduled within 3 to 7 days of each other to minimize the possibility of short-term weather events or other environmental conditions influencing emergence counts. If environmental conditions were anticipated to affect the emergence, the survey was to be halted or canceled. These conditions included a temperature below 32 ^{o}F, heavy precipitation or fog, or steady winds above Beaufort scale 3 (13+ mph). Surveys began a

half hour before sunset and ended when either it became too dark to observe bats, emergence slowed to a period of no bats observed exiting for 5 minutes, or when more bats were entering than exiting. Staff positioned themselves roughly 3 to 8 m (10 to 25 ft) from the ceiling hatch and counted bats exiting and entering the clearwell through the opening. In order to tally the two sets of counts, a manual hand counter was operated in each hand (one hand for exiting, the other hand for entering). Emergence totals were calculated by using the formula:

$$\frac{(\textbf{Surveyor 1}\ \text{Exiting Total} - \text{Entering Total}) + (\textbf{Surveyor 2}\ \text{Exiting Total} - \text{Entering Total})}{2} = \textbf{Estimated Colony Emergence Total}$$

During the survey, the two observers did not share their observations with each other in order to keep the survey unbiased. A *T*-Test was conducted to evaluate the grand totals of both surveyors (surveyor 1 vs. surveyor 2) for all surveys in order to determine significance at 95%.

A digital video recording was taken during both of 183-F emergence surveys. The camera with night vision capabilities was placed roughly 2 m (6 ft.) from the hatch opening and left to record the entire emergence.

6.2 183-F RESULTS

Hanford staff conducted three emergence counts at the 183-F clearwell hatch opening on June 20, 2018, June 26, 2018, and July 26, 2018. Weather was clear and calm with the occasional light breeze and temperatures ranged between 70 and 85 °F. Emergence totals were 1,682, 2,849, and 3,397, respectively (Table 3). The first survey on June 20, 2018, was conducted when the moon phase was waxing at half size, which limited the visibility making the emergence count difficult once dusk had ended. This survey holds the greatest difference between surveyor totals, as one of the staff members continued to survey longer than the other due to visibility discretions. The second survey on June 26, 2018, was conducted close to a full moon, with an increase of post-dusk visibility. A 69.4% increase in exiting bats was observed between the first two surveys from 1,682 to 2,849 bats. The third survey was conducted in late July during a full moon phase; this survey was within the timeframe when fledging of pups was probable. The 19.2% increase during the July 26 survey likely includes adults and volant pups. All three surveys lasted for about 1.5 hours, which is similar in length to previous surveys performed at the 183-F Clearwell. A *T*-Test was performed to check the significance between the surveyors (surveyor grand totals 1 vs. surveyor 2 grand totals) in all three surveys at 95% with a result of not significant (*t*-value=0.25993, *p*-value= 0.807752. The result is *not* significant at *p* less than 0.05).

Table 3. Estimated Bat Emergence Count Totals at the 183-F Clearwell in 2018. (2 Pages)

Date	Surveyor	Total Bats Exiting	Total Bats Entering	Grand Total	Estimated Total
6/20/2018	1	2,000	104	1,896	**1,682**
	2	1,570	103	1,467	

Table 3. Estimated Bat Emergence Count Totals at the 183-F Clearwell in 2018. (2 Pages)

Date	Surveyor	Total Bats Exiting	Total Bats Entering	Grand Total	Estimated Total
6/26/2018	1	3,069	163	2,906	**2,849**
	2	2,945	154	2,791	
7/26/2018	1	3,438	32	3,406	**3,397**
	2	3,425	37	3,388	

6.3 183-D RESULTS

Staff conducted three emergence counts in 2018 at the 183-D Clearwell on June 20, 2018, June 26, 2018, and July 26, 2018. A total of 1,105, 1,657, and 2,325 bats were estimated exiting the clearwell ceiling hatch, respectively (Table 4). Possibly due to the increased post-dusk visibility, there was a 50% increase in exiting bats observed between the first two surveys. The third survey was conducted the day prior to the full moon and during the timeframe when counting volant pups is probable. The 40.3% increase from June 26, 2018, may include adults and fledglings. There was a 110.4% increase of bat emergence from June 20 and July 26. A *T*-Test was performed to check the significance between the surveyors (surveyor grand totals 1 vs. surveyor 2 grand totals) in all three surveys at 95% with a result of not significant (*t*-value= -0.07569, *p*-value= 0.943299. The result is *not* significant at *p* less than 0.05). The maternity colony of Yuma myotis in the 183-D Clearwell appears to be increasing in size, showing positive results from the priority habitat mitigation at this location (Figure 8).

Table 4. Estimated Bat Emergence Count Totals at the 183-D Clearwell in 2018.

Date	Surveyor	Total Bats Exiting	Total Bats Entering	Grand Total	Estimated Total
6/20/2018	1	1,230	72	1,158	**1,105**
	2	1,169	118	1,051	
6/26/2018	1	1,947	370	1,577	**1,657**
	2	2,226	490	1,736	
7/26/2018	1	2,525	231	2,294	**2,325**
	2	2,440	84	2,356	

7.0 DISCUSSION OF RESULTS

7.1 183-F CLEARWELL

The highest count was July 24, 2012, with 6,627 Yuma myotis counted (Figure 7). The increase compared to previous late season counts could be a result of a growing colony and of most young being volant. Because this emergence count was conducted during the period when peak fledging is probable, the

high number of bats can be explained by adults and fledglings combined. If this were the case, this emergence count would be estimated to be approximately double the pre-fledging adult population, as each adult female typically has a single pup (Betts 1997), making the birthing adult population in 2012 roughly 3,300 bats. There were no pre-fledging emergence counts conducted in 2012 for comparison, therefore, the number of birthing adults cannot be accurately estimated. Fledglings and adults are nearly the same size, making it impossible to differentiate in flight. Bats recorded on the video camera move at a high rate of speed; due to the low level of light, the image is often blurry. Capturing and handling the bats is the best method for an accurate age analysis. Methods from the 2012 survey work did not define weather bats returning through the hatch were subtracted from the total count. If they were not, the emergence count would have been higher than the actual number. The only other survey conducted in late July was in 2018, and the total was 3,397. Between the years of these two July surveys, the 183-D Clearwell increased from 365 in 2015 to 1,466 in 2016. This increase may be partially explained by a portion of the 183-F population immigrating to the 183-D Clearwell, as the 183-F population has not been observed to surpass 3,500 bats (Figure 7).

It is important to recognize that bat population sizes fluctuate. Fluctuations can be caused by successful reproduction rates due to the age and health of the female, seasonal activities, food availability, and environmental constraints (Barclay 2012). Colony fledging is staggered and can fluctuate when it occurs year to year (Barclay 2012), which highlights the importance of pre-fledging month surveys to calculate adults utilizing a maternity roost. Surveys conducted in mid-to late June can include fledglings.

When evaluating the 2018 count totals, there was a significant increase of 69.4% between the June 20 and June 26 surveys. Both of the June 2018 surveys were conducted during similar weather conditions with a significant mosquito presence. There is a good possibility that a surge in fledging occurred between those dates. When comparing the July 26 to the June 20 count, the estimated total increased by 102.0%. If the June 20 count only contained adults, the July count would reflect a nearly perfect 1:1 ratio of adults to fledged pups.

It should be highlighted that the 2018 183-F Clearwell surveys were focused on manual counting with the addition of infrared video recording, while all previous surveys were based solely on infrared video recordings. Due to the combination of low visibility and high rate of speed that bats exit and enter, the 2018 video recordings could not be accurately analyzed due to images showing up as undistinguished blurs. An updated camera with higher night vision resolution, longer lasting battery, and better camera placement may aid in this dilemma. To avoid any discrepancies in the future, surveys should be conducted using a consistent monitoring method. The manual counting appears to work well, and the addition of proven infrared recording equipment would be a method to validate manual counts.

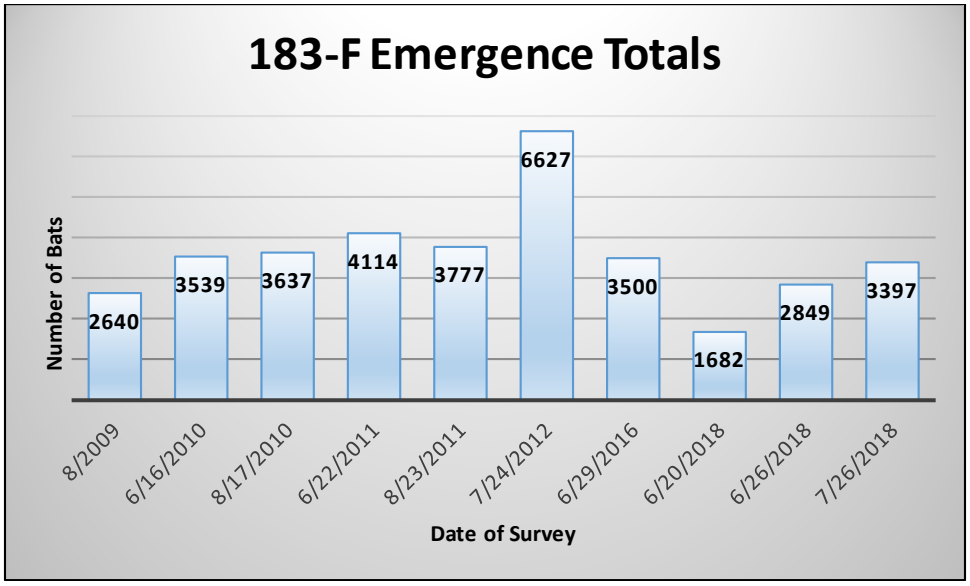

Figure 7. Estimated Bat Emergence Count Totals at the 183-F Clearwell

7.2 183-D CLEARWELL

Bat post-mitigation monitoring of the 183-D Clearwell was initiated in 2014 and the survey count totals are provided in Figure 8. During the 4 years that bat emergence monitoring has been conducted, count totals have increased 500.8%, from 387 (July 30, 2014) to 2,325 (July 26, 2018) (Figure 8). The 183-F Clearwell had a substantial maternity roost colony of more than 2,000 observations prior to the decision to keep the clearwell intact, while the 183-D Clearwell was not suspected to be a maternity roost due to no major guano accumulations or urine staining observed during the October 25, 2010, inspection (WCH-438). Similarities between the two sites may show similar population fluctuations in the future. Both structures are nearly identical in design; the proximity to the Columbia River that provides food and water resources is similar and, due to their close proximity of each other, weather patterns will show little difference. These factors may set similar carrying capacities for the two maternity roosts. In theory, these two locations should be able to support populations of the same size. If this proves to be true in the future, any major fluctuations identified at both clearwells during the same year could indicate fluctuations in the regional populations as a whole. Previous DNA analysis shows that the two roost sites are part of the same breeding population; therefore, it can be perceived that reproduction and fledging activities will occur in a similar fashion. An example of the behavior similarities between the two sites is reflected in the 2018 surveys where each site was surveyed for emergence simultaneously on three separate nights. There was an increase in emergence numbers at both locations during each survey and an overall increase of observations between June 20, 2018, and July 26, 2018, of 102% (183-F) and 110.4 % (183-D). These percent increases may be explained by the first survey having been conducted very close to pre-fledging while the second includes the near 1:1 ratio of female to fledged pup. Emergent count trends between the two populations appear to correlate with each other.

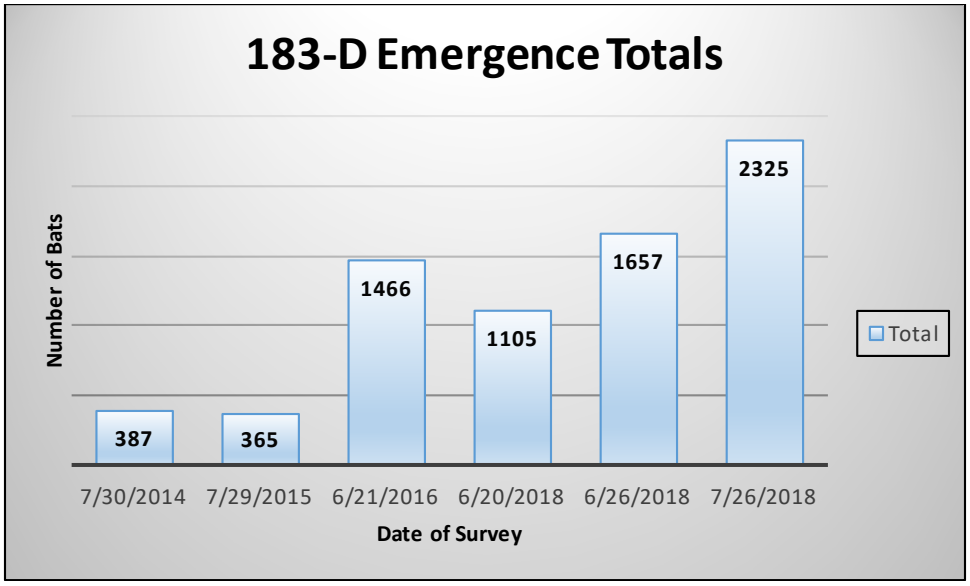

Figure 8. Estimated Bat Emergence Count Totals at the 183-D Clearwell

7.3 CONCLUDING STATEMENTS

Both of these mitigation sites show a continued use for maternity roosting by Yuma myotis. Currently, the 183-F Clearwell is recognized by WDFW as the largest maternal colony in Washington State (Hayes et al. 2013), and the 183-D Clearwell population is increasing in size. The high counts at the 183-F Clearwell peaked at 6,627 on July 24, 2012, and has not been observed greater than 3,500 since. This peak occurred the year before the 183-D Clearwell was first monitored during a pre-mitigation survey on July 24, 2013, when 11 bats were observed emerging from the clearwell. Data shows that the 183-D Clearwell population is growing, while the 183-F population has decreased. The growth of the 183-D population may be due to a portion of the 183-F population immigrating to the 183-D Clearwell. There are known maternity colonies of Yuma myotis in the vicinity, located in the 190-D/DR water process tunnels (WCH-634), which may also be influencing the growth of the 183-D Clearwell population through immigration. As of 2018, the high count difference between the two clearwell populations is 1,072 bats (Figure 9).

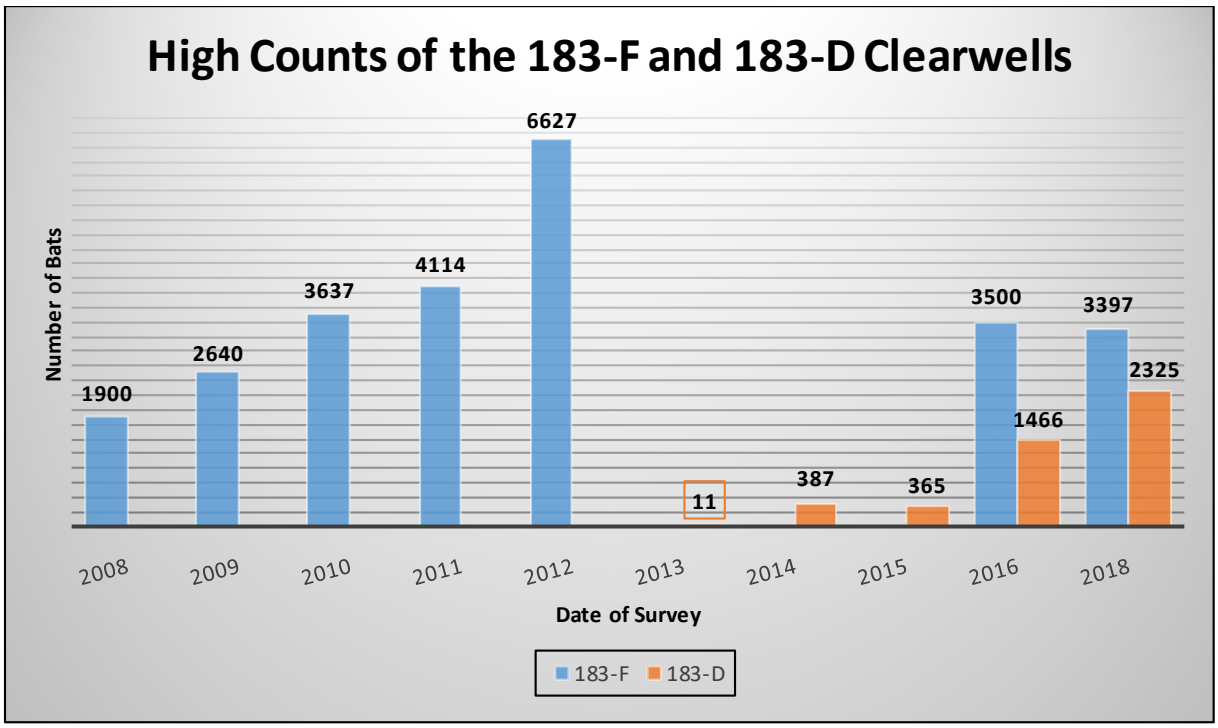

Figure 9. Comparison of the Yearly 183-F and 183-D High Counts

Continued annual monitoring will develop a valuable long-term timeline of bat numbers utilizing the two clearwells, better illustrating the carrying capacity of the locations. It is important to note that a number of factors can fluctuate the emergence observations including weather, phase of the moon, overall colony activity, and survey methods. Surveys conducted prior to 2018 relied on digital video recording while the 2018 surveys were based on real-time manual counting. Digital video recording was attempted during the manual counts but proved uninformative. Future surveys would benefit by using both survey methods and upgraded infrared recording equipment. These surveys should be conducted during both the pre- and post-fledging seasons in order to more accurately assess the colonies reproductive success.

The overall annual high counts at the 183-F Clearwell and the growing population of Yuma myotis at the 183-D Clearwell demonstrate that the collaborative input and final decisions made during the demolition process to keep these structures intact have proved to benefit this bat species. Annual emergence surveys should continue in order to track the population's health while keeping the sites protected will provide critical habitat for years to come. With the threat of WNS spreading in Washington State, mist netting should continue to test for the disease under the guidance of WDFW. Due to the size of these colonies, and the DNA matches relating the two, it is possible that they may share the same hibernation locations, increasing the possibility of the disease spreading to both the 183-F and 183-D maternity colonies. Future mist netting efforts should be conducted at both locations, providing a larger scope of the epidemic on the mating population as a whole.

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