

***White-Nose Syndrome Surveillance Across Northern Great Plains National
Park Units
2019 Interim Report***

CESU Cooperative Agreement P17AC01135

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Introduction

White-Nose Syndrome (WNS) is the predominant threat to bats in North America. The disease is caused by the fungal pathogen *Pseudogymnoascus destructans* (Pd; formerly *Geomyces destructans*) and affects hibernating bats (Lorch et al. 2011). Since its discovery in New York in 2006, WNS has killed at least several million bats (Froschauer and Coleman 2012). Mortality rates of up to 100% have been documented in some areas (Frick et al. 2010). The disease continues to spread west from the eastern and southeastern US. Following the winter and spring surveillance season of 2018/2019, WNS had been confirmed in 33 states and seven Canadian Provinces and Pd had been documented in five additional states (White-nose Syndrome Response Team 2019). Prior to the initiation of this surveillance effort in 2018, WNS had yet to affect the majority of the region. In 2018, Pd was documented for the first time in South Dakota and Wyoming and WNS was documented for the first time in South Dakota (Abernethy 2018).

It is critical to track the distribution of the disease and its effects to local bat populations. Surveillance for Pd and WNS is a central component of the National WNS Plan (United States Fish and Wildlife Service 2011). Early detection is critical to resource managers tasked with managing wildlife, landscapes, and people in the face of this disease. This is particularly true throughout the central and western United States which support bat species assemblages and habitat features that are currently not affected by WNS. It is likely that these species and habitats are susceptible to the disease but it is unknown if the disease will impact bats in the region in the same manner it has in eastern North America. We continued with a cooperative WNS surveillance effort in 2019 with the primary objective of maintaining surveillance for Pd and WNS across a large region of the north central United States with the ultimate goal of helping land managers and disease ecologists better understand the distribution of Pd and how it may affect bat species not currently impacted by the disease.

Secondary objectives of this project were to fill basic information gaps for National Park Service (NPS) units in the Northern Great Plains Network (NGPN). Prior to the initiation of this project in 2018, bat surveys had been conducted at some NPS Units within the study area but most have been limited in scope or have only included passive acoustic recording of bats. As a result, basic information including species composition and demographic parameters of local populations are uncertain.

This report summarizes WNS surveillance activities conducted in 2019. Ultimately, enhanced understanding of distribution Pd and WNS and the bat species affected will help the NPS in planning current management and mitigation actions leading to preservation of bat communities that occupy NPS units in the region.

Methods

Study Area

The study area included all NPS units in the NGPN (Figure 1). These units included Agate Fossil Beds National Monument, Badlands National Park, Devils Tower National Monument, Fort Laramie National Historic Site, Fort Union Trading Post National Historic Site, Jewel Cave National Monument, Knife River Indian Villages National Historic Site, Missouri National Recreational River, Mount Rushmore National Memorial, Niobrara National Scenic River, Scotts Bluff National Monument, Theodore Roosevelt National Park, and Wind Cave National Park

(Figures 2 – 12). No surveillance activities were conducted at Agate Fossil Beds National Monument, Missouri National Recreational River, or Scotts Bluff National Monument in 2019 due to logistical constraints.

Capture, Handling, and Sampling

Following guidelines developed by the United States Geological Survey's (USGS) National Wildlife Health Center (United States Geological Survey National Wildlife Health Center 2018) and protocols presented in the National WNS Surveillance Plan, we carried out this surveillance between April 16 and June 9, 2019 (Disease Surveillance Working Group 2017). Bats were captured in 38 mm bat-specific mist nets in lengths of 6, 9, 12, and 18 m arranged in single or double-high (2.6 or 5.2 m high, respectively) sets. Mist nets were opened at civil sunset, unless non-target taxa (e.g. birds) are active at the site. Nets were closed approximately five hours after sunset unless weather conditions or low bat activity were encountered. Mist nets were checked for captures continuously and captures were removed immediately. Bats were removed by gloved hand and placed in an unused paper holding bag and processed immediately. At NPS units in South Dakota, permit stipulations required female bats be released immediately and therefore the methods described below did not apply to female bats in South Dakota. We obtained standard morphometric measurements including forearm length and ear length, mass, and evaluation of other morphological and physical characteristics required to identify the bat to species such as the presence or absence of keeled calcar, pelage color, and patagia color. We also determined the sex of each capture and evaluated the reproductive status of each individual by looking for descended testis, swollen abdomen, or signs of current or recent lactation. Time from capture to release was less than 30 minutes.

We collected non-lethal skin swabs to test for the presence of Pd on captured bats following NWHC protocols (United States Geological Survey National Wildlife Health Center 2018). Sterile, individually wrapped polyester-tipped swabs were dipped in a microcentrifuge tube containing nuclease free water and rolled across each forearm and the muzzle three times. Swabs were then placed back into the microcentrifuge tube containing nuclease free water and stored on ice until they could be shipped overnight for lab analyses. In most cases, one swab was collected per bat. However, in some cases we collected two swab samples, one from the left forearm and left side of the muzzle and one from the right forearm and right side of the muzzle. We were prepared to collect two swabs any time any outward sign of potential WNS/Pd infection was observed. This was done to allow independent verification of lab results. Samples were submitted to and analyzed by the Colorado State Veterinary Diagnostic Laboratory (VDL) and the NWHC if needed.

In addition, we used two methods to evaluate the wings of all captured bats for signs of Pd infection or WNS damage. First, using an LED headlamp to backlight the flight membranes, we looked for tissue damage characteristic of bats with WNS (Reichard and Kunz 2009, Reichard 2010). We assigned each captured bat a wing damage index score following Reichard (2010). Second, we scanned the wing membranes of each capture with a UV light which causes portions of the wings infected with Pd to fluoresce a subtle pumpkin-orange color (Turner et al. 2014). If fluorescence was observed, a wing biopsy was collected from a portion of the wing where fluorescence was noted using an individually wrapped 3mm sterile single use tissue biopsy punch. Biopsy samples were placed into a microcentrifuge tube and stored on ice. Biopsy samples were submitted to the NWHC for histological analysis.

As specified by the terms of our state and federal permits, all capture and handling protocols followed the "2019 Range-wide Indiana Bat Survey Guidelines" (United States Fish and Wildlife Service 2019) where applicable and

we strictly adhered to all aspects of the “National White-Nose Syndrome Decontamination Protocol Version 09.13.2018” (United States Fish and Wildlife Service 2018). Survey methods also conformed to other recommended guidelines (e.g., Kunz and Parsons 2009, Sikes et al. 2011). All survey protocols were reviewed and approved by both the University of Wyoming and National Park Service Institutional Animal Care and Use Committees.

Results

In 2019, we captured a total of 144 bats representing 9 species over 40 nights of mist-netting (Figures 2 to 12; Tables 1 and 2). From these captures, we collected wing swabs from a total of 85 individual bats and wing biopsies from 3 bats. These 85 wing swabs resulted in Pd detections in five individual bats (Table 2). These detections came from three NPS units: Knife River Indian Villages National Historic Site, Fort Laramie National Historic Site, and Jewel Cave National Monument. Histological evaluation of one wing biopsy collected near Jewel Cave National Monument revealed evidence WNS. Results for each NPS unit are summarized below. No bats were incidentally or intentionally killed in 2019 and all bats were released at the site of capture in good condition.

Agate Fossil Beds National Monument

No WNS surveillance activities were conducted at Agate Fossil Beds National Monument in 2019 due to time and logistical constraints.

Badlands National Park

At Badlands National Park we captured one big brown bat over four nights of attempted capture activities (Figure 2; Tables 1 and 2). We collected one skin swab and Pd was not detected.

Devils Tower National Monument

We captured seven bats representing three species over four nights of mist netting at Devils Tower National Monument in 2019 (Figure 3; Tables 1 and 2). Seven skin swabs were taken and Pd was not detected. Visual evaluation of the flight membranes did not reveal any evidence of Pd or WNS infection.

Fort Laramie National Historic Site

We captured a total of 30 bats at Fort Laramie National Historic Site over three nights of capture activity in 2019 (Figure 4; Table 2). Of these captures, 15 were little brown myotis captured by mistnet in the vicinity of the bat house. One of these displayed faint orange fluorescence under UV light. Swabs from this individual tested negative for Pd at the VDL but Pd was detected in the swab submitted to the NWHC. A biopsy was collected and submitted to the NWCH for histopathological evaluation but no lesions characteristic of Pd infection were observed. The remaining 15 captures were big brown bats captured in the “Guard House” on the nights of June 5 and June 6 by Dr. Paul Cryan. Swabs from these bats were submitted to the VDL and Pd was not detected.

Fort Union Trading Post National Historic Site

Four nights of bat captures were attempted at Fort Union Trading Post National Historic Site in 2019 (Figure 5; Table 1). No bat captures were made.

Jewel Cave National Monument

In 2019, at Jewel Cave National Monument and adjacent public lands within the Black Hills National Forest we captured a total of 20 bats representing five species over four nights of mist netting (Figure 6; Tables 1 and 2). We collected wing swabs from 17 individuals and one wing biopsy. Pd was detected on five individual bats including one fringed myotis (cover photo), three long-legged myotis, and one long-eared myotis. It should be noted that PCR results from the VDL and the NWHC were inconsistent in some cases. Specifically, the VDL did not detect Pd in the sample collected from the fringed myotis but the NWHC did. Conversely, the VDL detected Pd in a long-eared myotis while the NWHC did not. A wing biopsy was collected from one long-legged myotis and histopathology revealed lesions characteristic of WNS (Table 2). This case represented the second confirmed case of WNS in South Dakota in a long-legged myotis.

Knife River Indian Villages National Historic Site

In 2019, four bats representing three species were captured over seven nights of mistnet captures at Knife River Indian Villages National Historic Site (Figure 7; Tables 1 and 2). Four swabs were collected and Pd was detected on one little brown myotis. Evaluation of the wing membrane of this individual did reveal some wing damage (Figure 13). However, this type of wing damage frequently occurs during typical nightly activity and may not necessarily be the result of Pd infection. As a result, only one swab was collected from this bat. This single swab was first submitted to the VDL where Pd was detected in the sample. The VDL shipped the extracted DNA along with the swab to the NWHC where Pd was detected in the original extracted DNA along with DNA extracted from the swab. It should be noted that this does not represent independent confirmation by the two laboratories as the same swab and extracted DNA were tested at both. However, this provided sufficient evidence to indicate that Pd was present on this bat. This represented the first documentation of Pd in the state of North Dakota.

Missouri National Recreational River

No WNS surveillance activities were conducted at the Missouri National Recreational River in 2019 due to time and logistical constraints.

Mount Rushmore National Memorial

At Mount Rushmore National Memorial and on adjacent public lands within the Black Hills National Forest we conducted three nights of mistnetting and captured 10 bats of 4 different species (Figure 8; Tables 1 and 2). We collected three wing swabs and no Pd detections were made nor did evaluation of the flight membranes did not reveal any damage or signs of Pd or WNS.

Niobrara National Scenic River

We captured five northern long-eared bats in three nights of mist netting within the Fort Niobrara National Wildlife Refuge on the Niobrara National Scenic River in 2019 (Figure 9; Tables 1 and 2). We collected five wing swabs and disease testing did not detect Pd. No evidence of Pd or WNS was noted during evaluation of the flight membranes.

Scotts Bluff National Monument

No WNS surveillance activities were conducted at Scotts Bluff National Monument in 2019 due to time and logistical constraints.

Theodore Roosevelt National Park

We captured two bats of two species over six nights of bat captures at Theodore Roosevelt National Park in 2019 (Figures 10 and 11; Tables 1 and 2). We collected wing swabs from both bats and Pd was not detected. No evidence of Pd or WNS was noted during evaluation of the flight membranes.

Wind Cave National Park

We captured 64 bats representing seven species during three nights of mist netting at Wind Cave National Park in 2019 (Figure 12; Tables 1 and 2). We were only able to collect 16 wing swabs for disease testing because the majority of bats captured at Wind Cave were females and had to be released immediately following stipulations included in our SDGFP permit. No Pd was detected in these samples. However, evaluation of the wing membranes of one MYSE did reveal faint orange fluorescence when exposed to UV light along with faint depigmented areas of the wing membrane. Two swabs were collected from this individual and results from both CSU and NWHC did not reveal any evidence of Pd.

Discussion

We were able to conduct disease surveillance at 10 of 13 NPS units across the NGPN in 2019. Parks across the NGPN occupy a large geographic area, adding to the logistical complexities of this surveillance project. Additionally, WNS has occurred along the Missouri National Recreation River since the winter of 2016 / 2017 and evidence suggests that bat numbers in portions of the area have declined significantly (Jeremy White personal communication 2019). Because of these reasons, it was deemed a lower priority for sampling.

The primary significant finding from surveillance activities in 2019 was the first detection of Pd in North Dakota. As detailed above, Pd was detected in a single little brown myotis at Knife River Indian Villages National Historic Site. Three additional bats were captured and tested but Pd was not detected on these individuals. It should be noted that these three additional samples were collected in early June, beyond the recommended survey period (United States Geological Survey National Wildlife Health Center 2018). We surveyed during this time following the initial Pd detection in an attempt to obtain further evidence of Pd prevalence and species affected in the area. It is still unclear how prevalent Pd is in the area or what bat species might be affected near Knife River. However, the positive result from the single little brown myotis captured and tested could suggest that Pd is pervasive in that species in the area. Alternatively, it is possible that Pd prevalence is limited but by chance we captured a positive individual.

Surveillance in 2019 also allowed us to obtain valuable information following the first detection of Pd in South Dakota and Wyoming and the first documented case of WNS in South Dakota that stemmed from this project in 2018 (Abernethy 2018). More specifically, surveillance in 2019 indicated that both Pd and WNS are still present at Jewel Cave National Monument. Observations of bat mortalities in Jewel Cave and near its entrance over the winter in addition to Pd and WNS detections in spring may suggest that disease prevalence in the area is increasing. It is currently unknown if population level effects of the disease are occurring here yet.

At Fort Laramie National Historic Site Pd was detected on a single little brown myotis in both 2018 and 2019. These bats were captured in the vicinity of the bat house, which supports several thousand little brown myotis in the summer. While no quantitative evaluation of changes in abundance of bats in the bat house has been made following the introduction of Pd into this population, it is clear that this structure still supports a very large and important component of the local bat population and there is no evidence to suggest that abundance has declined to date.

Because bats carry Pd or outward signs of WNS for only about four weeks following emergence, spring landscape surveillance activities must be carried out during April and May (Disease Surveillance Working Group 2017). Few bat survey activities have been conducted across the NGPN during this time of year. Acoustic monitoring at a number of NPS units in the region indicate that bat activity slowly increases in April and May, with higher levels of bat activity observed by mid-to-late-April (Hammesfahr unpublished data; Licht unpublished data). We observed similar patterns with very low bat activity and capture rates in early April followed by steadily increasing activity and capture rates through late April into May. This pattern occurred in both 2018 and 2019 and suggests that this survey window is applicable to this region.

Relatively low capture rates in 2019 made it difficult to obtain sufficient sample sizes at most NPS units. A power analysis conducted by the NWHC indicates that at least 25 bats need to be sampled at a site to have a 95% chance of detecting Pd in a population of bats in which Pd occurs.(United States Geological Survey National Wildlife Health Center 2017). We were only able collect 25 or more samples at Fort Laramie National Historic Site. Because we were unable to obtain sufficient sample sizes in other park units, it is possible that Pd or WNS could have been present at additional units but positive bats were simply not captured. In both 2018 and 2019 most occurrences of Pd or WNS were generally limited to very few individual bats tested. As noted above Pd was detected on only one bat at Fort Laramie National Historic Site and one bat at Knife River Indian Villages National Historic Site. This further highlights the need for large sample sizes at each park, especially in areas where prevalence may be low. At all NPS units in South Dakota we were required by the State of South Dakota to release female bats immediately following extraction from mist nets further reducing our sample size at all park units in the state.

Results from these surveillance activities indicate that the distribution of Pd and WNS continues to increase across the NGPN and into the western United States. It is also now known that a number of western bat species are susceptible to this fungus and disease. However, it is still unknown if the disease will impact bats in the NGPN in the same manner it has in eastern North America. There are a large number of hibernating bat species in this region in which Pd or WNS has not been confirmed. Also, there are a number of behavioral differences in bat species in the region. Many aspects of winter ecology of bats are poorly understood, especially in the western United States (Neubaum et al. 2006, Johnson et al. 2017, Klug-Baerwald et al. 2017, Neubaum 2018). In eastern North America, bats typically hibernate in large numbers within caves and abandoned mines (Perry 2013, Klug-Baerwald et al. 2017). As a result, researchers have traditionally assumed that bats across the continent use similar features for hibernacula. However, these features are not ubiquitous on the landscape, yet bat populations persist. In much of the NGPN and Intermountain west, where caves and abandoned mines exist in areas with suitable geology and topography, surveys for hibernating bats rarely find congregations of bats larger than 50 individuals (Beard 2016). This suggests that bats are likely using some other landscape features for hibernacula. Indeed, recent studies have provided clear evidence that some bat species that occur in western

North America hibernate in a number of different landscape features including rock crevices, talus fields, root wads of large trees, and within karst formations (Neubaum et al. 2006, Klug-Baerwald et al. 2017, Neubaum 2018). This suggests that these features likely play an important role in population persistence for bat species that occur across the region. These differences in hibernation ecology may lead to different outcomes in terms of population level effects of WNS.

The information presented above highlights activities and results from WNS surveillance activities carried out in 2019. These surveys will take place again in 2020. As previously noted, no surveillance activities were conducted on three NPS units in the study area. Park prioritization will be reevaluated prior to conducting work in 2020. Surveys in 2020 may also yield important information regarding changes in distribution of Pd and WNS and if other bat species in the region are susceptible to Pd. In both 2018 and 2019, Pd or WNS was detected in only a very small proportion of bats sampled. Surveillance in 2020 will provide valuable information on how prevalence of Pd and WNS changes through time.

Acknowledgements

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The following individuals assisted in project planning and logistics while conducting surveillance activities on or around their respective NPS Units. Their time and effort was critical to the success of this project.

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Black Hills National Forest: Brad Phillips, David Probasco

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Fort Laramie National Historic Site: James Hill, Maryann Neubert, Eric Valencia, Michael Evans

Fort Niobrara / Valentine National Wildlife Refuge Complex: Steve Hicks and Kathy McPeak

Fort Union Trading Post National Historic Site: Fred MacVaugh, Andy Banta, Travis Lisenbee

Jewel Cave National Monument: Mike Wiles

Knife River Indian Villages National Historic Site: Brenda Todd, Jesse Schiferl

Mount Rushmore National Memorial: Maureen McGee-Ballinger

Niobrara National Scenic River: Gorden Warrick

North Dakota Game and Fish: Patrick Isakson, Charlie Bahnson

Theodore Roosevelt National Park: Blake McCann, J.J. Nelson, Erin Gilham

Wind Cave National Park: Angela Jarding, Hollie Pucket

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Figures

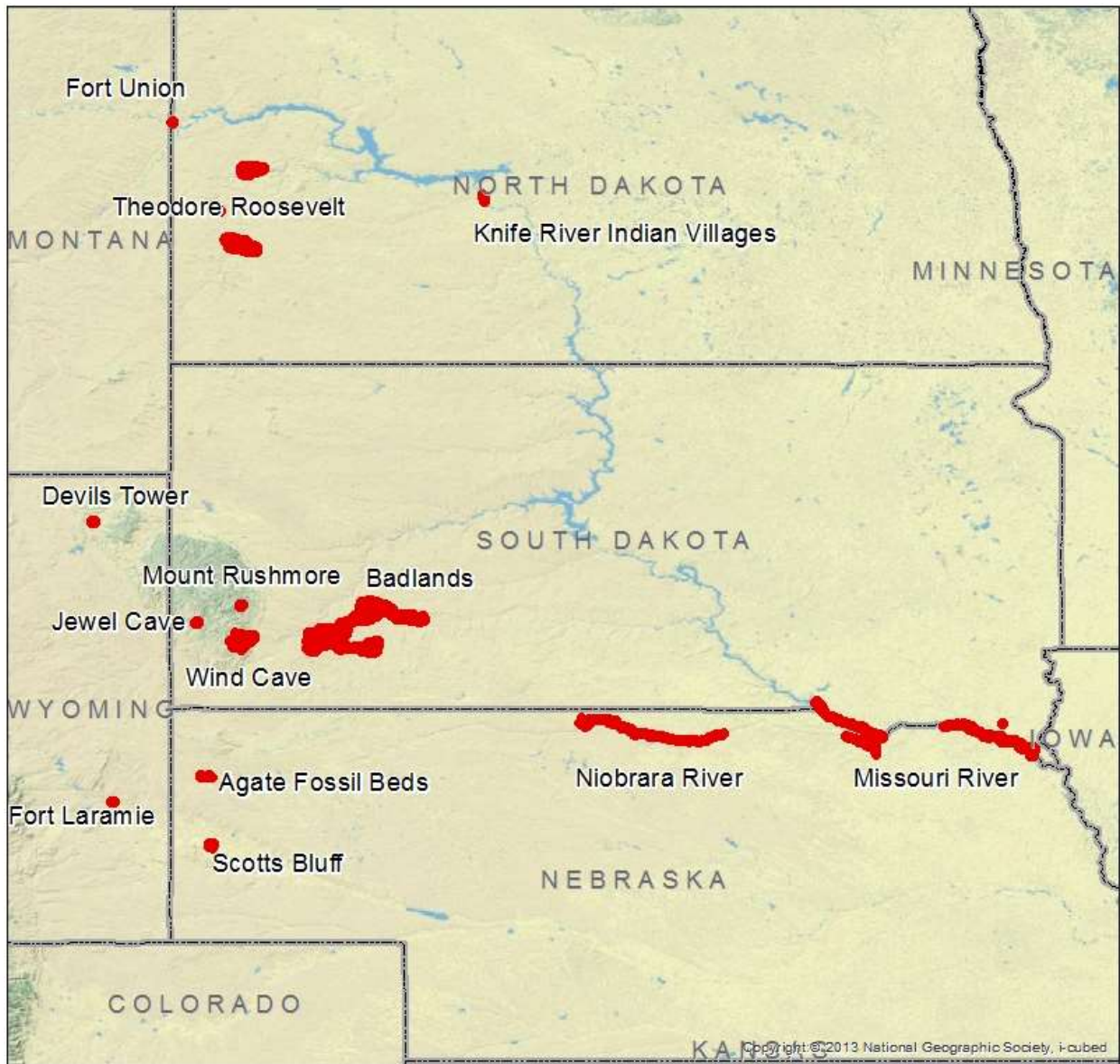
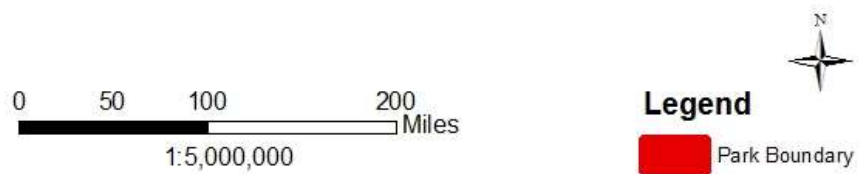


Figure 1. National Park Service units targeted for WNS surveillance in 2019. Note that surveillance did not occur at Agate Fossil Beds National Monument, Missouri National Scenic River, or Scotts Bluff National Monument in 2019.



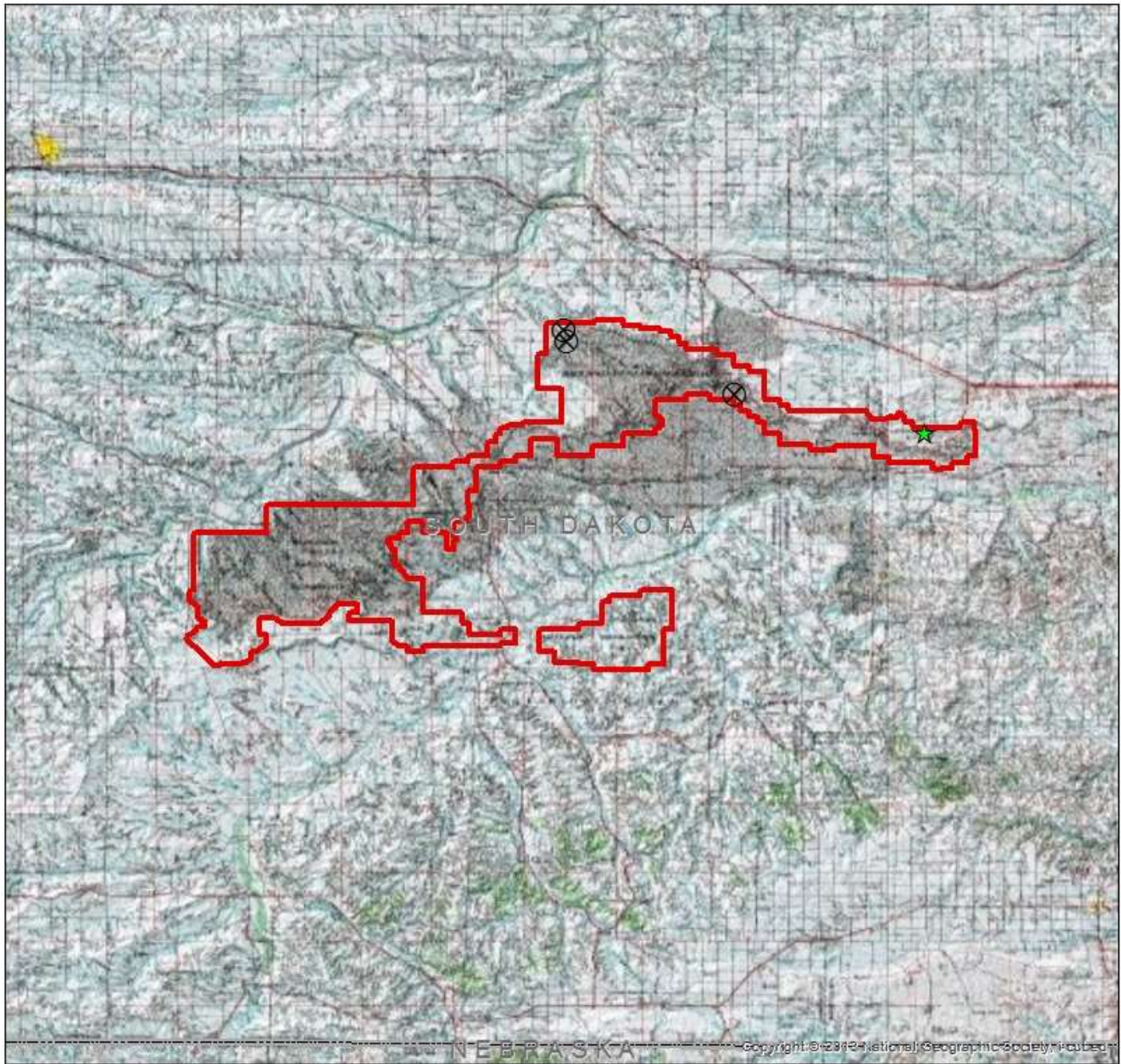
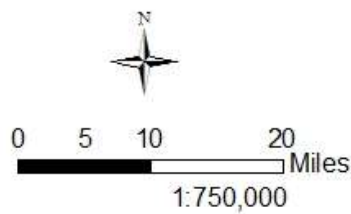
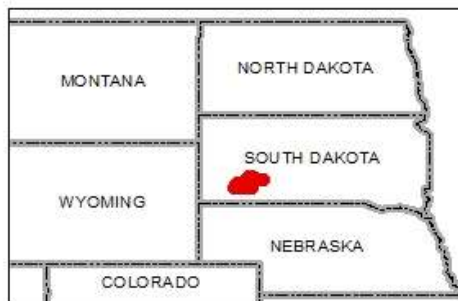


Figure 2. Mistnet survey locations and Pd or WNS status of bats captured at Badlands National Park in 2019.



Legend

Disease Status

- ⊗ No Bats
- ★ Not Detected
- ★ Pd Detected
- ▭ Park Boundary

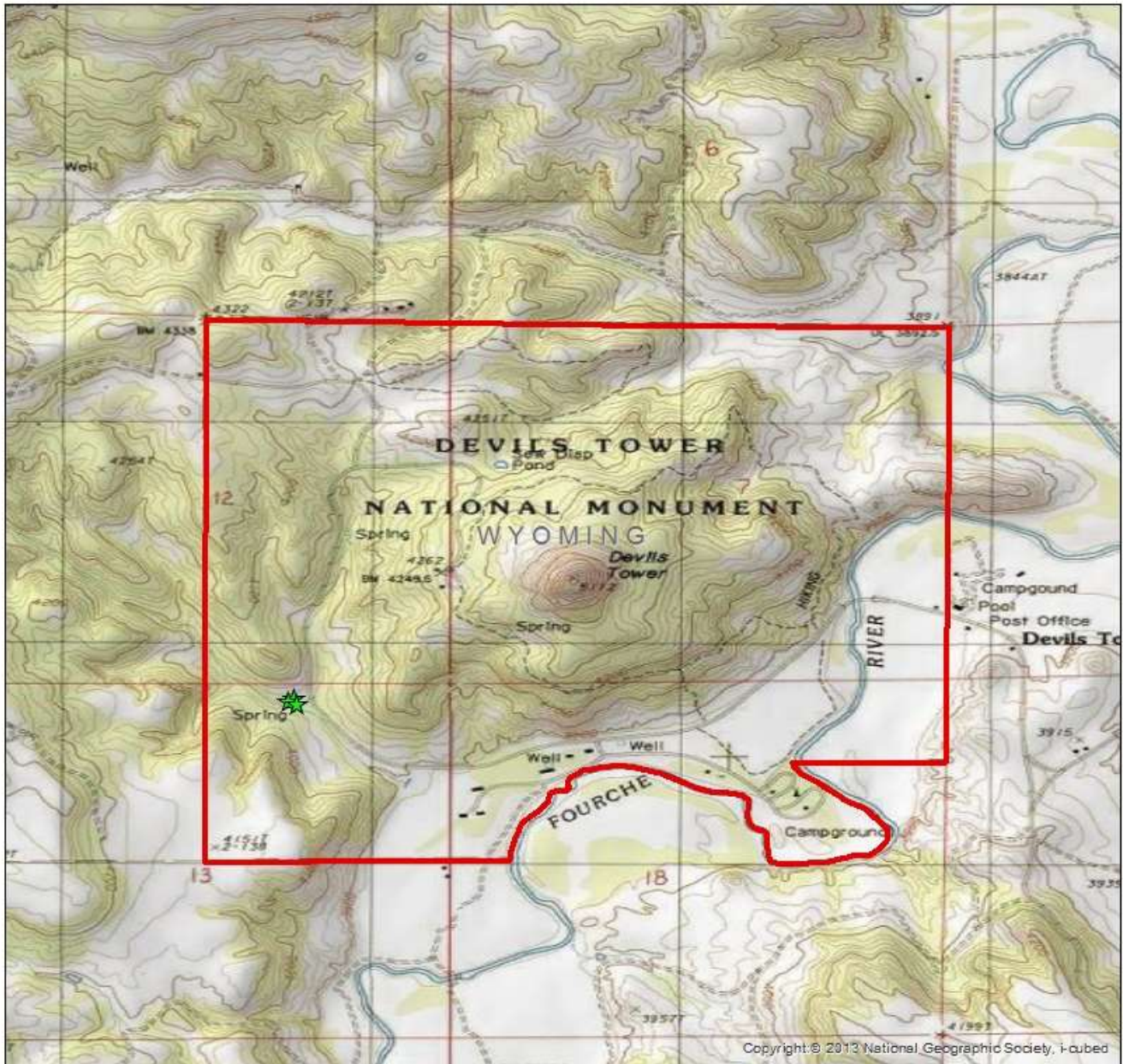
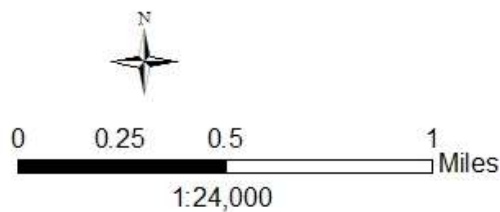


Figure 3. Mistnet survey locations and Pd or WNS status of bats captured at Devils Tower National Monument in 2019.



Legend

Disease Status

- ⊗ No Bats
- ★ Not Detected
- ★ Pd Detected
- ▭ Park Boundary

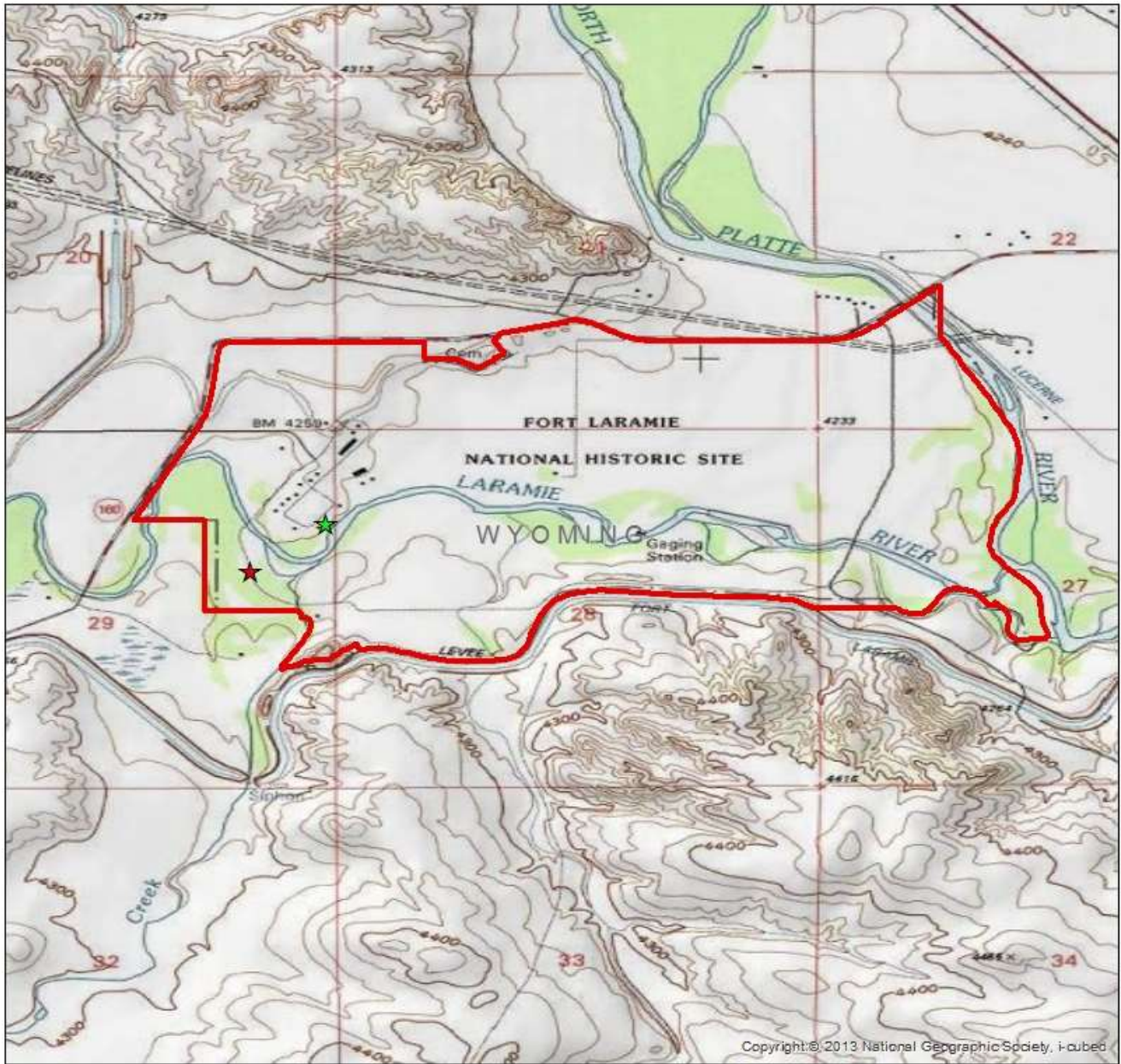
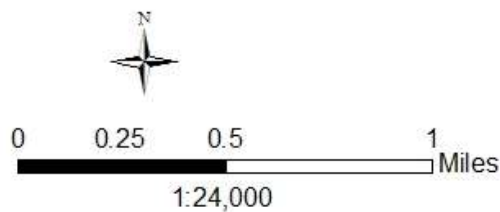


Figure 4. Mistnet survey locations and Pd or WNS status of bats captured at Fort Laramie National Historic Site in 2019.



Legend

Disease Status

- ⊗ No Bats
- ★ Not Detected
- ★ Pd Detected
- ▭ Park Boundary

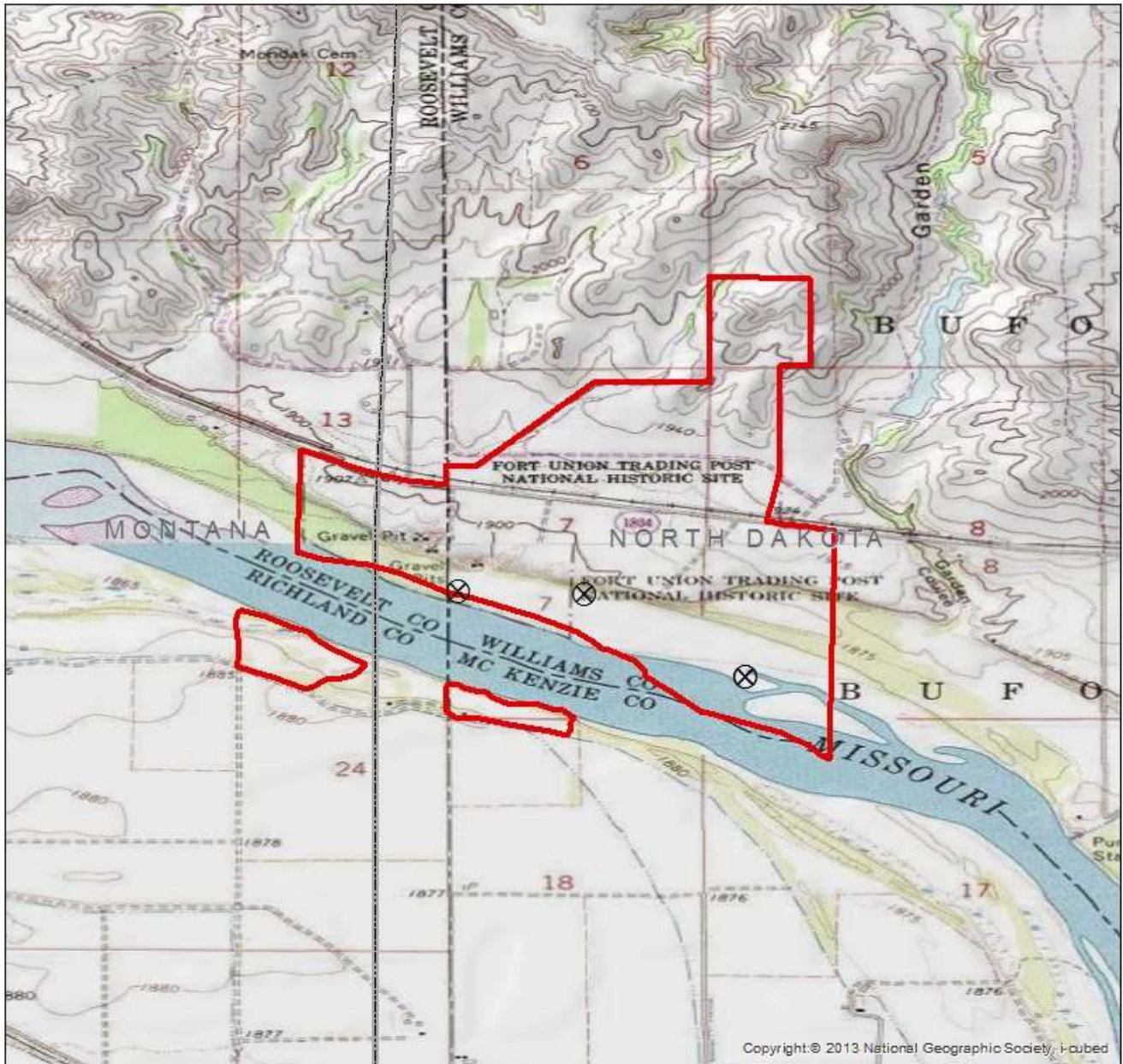
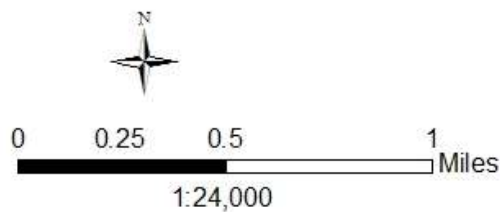


Figure 5. Mistnet survey locations and Pd or WNS status of bats captured at Fort Union Trading Post National Historic Site in 2019.



Legend

Disease Status

- ⊗ No Bats
- ★ Not Detected
- ★ Pd Detected
- ▭ Park Boundary

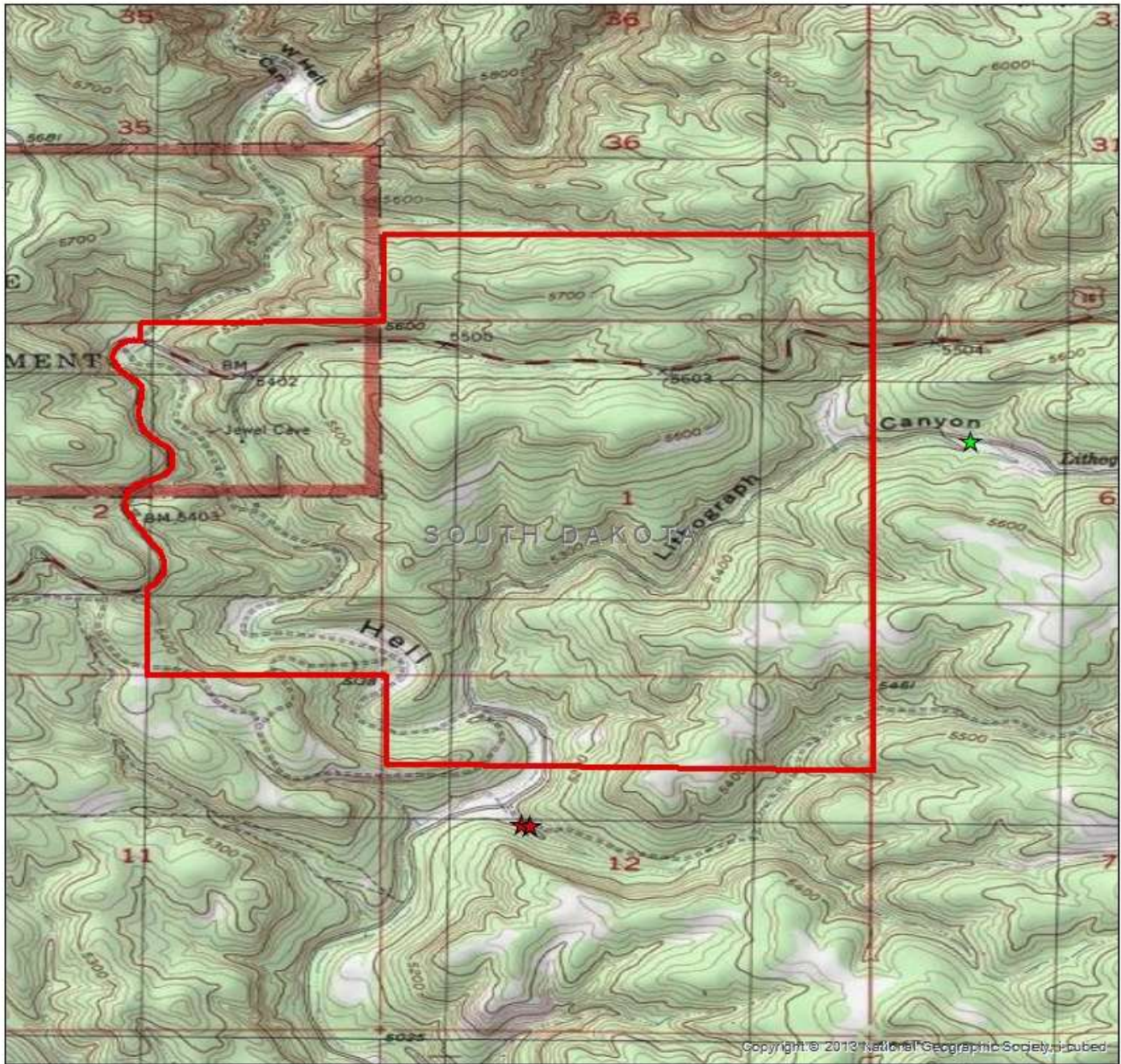
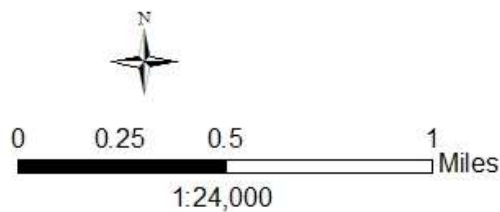


Figure 6. Mistnet survey locations and Pd or WNS status of bats captured at Jewel Cave National Monument in 2019.



Legend

Disease Status

- ⊗ No Bats
- ★ Not Detected
- ★ Pd Detected
- ▭ Park Boundary

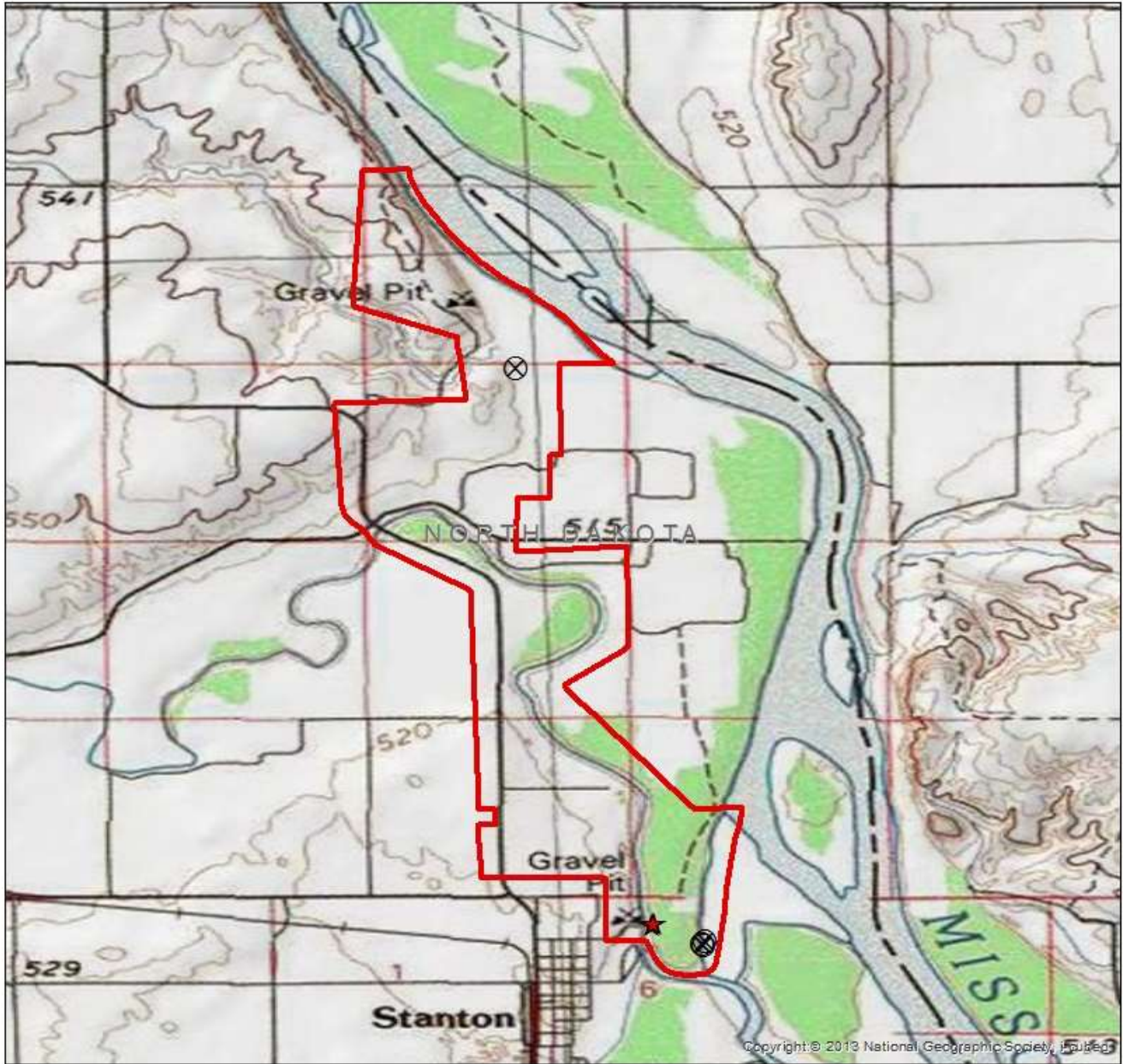
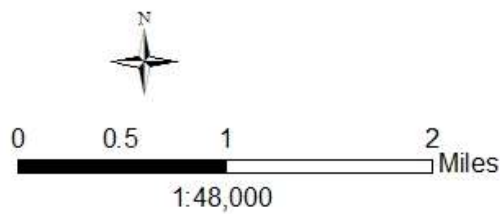
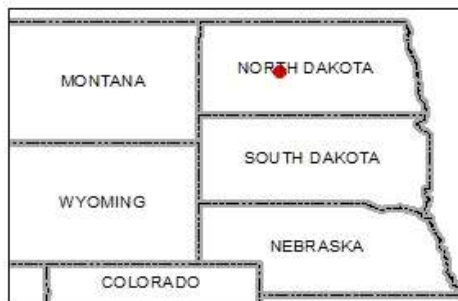


Figure 7. Mistnet survey locations and Pd or WNS status of bats captured at Knife River Indian Villages National Historic Site in 2019.



Legend

Disease Status

- ⊗ No Bats
- ★ Not Detected
- ★ Pd Detected
- ▭ Park Boundary

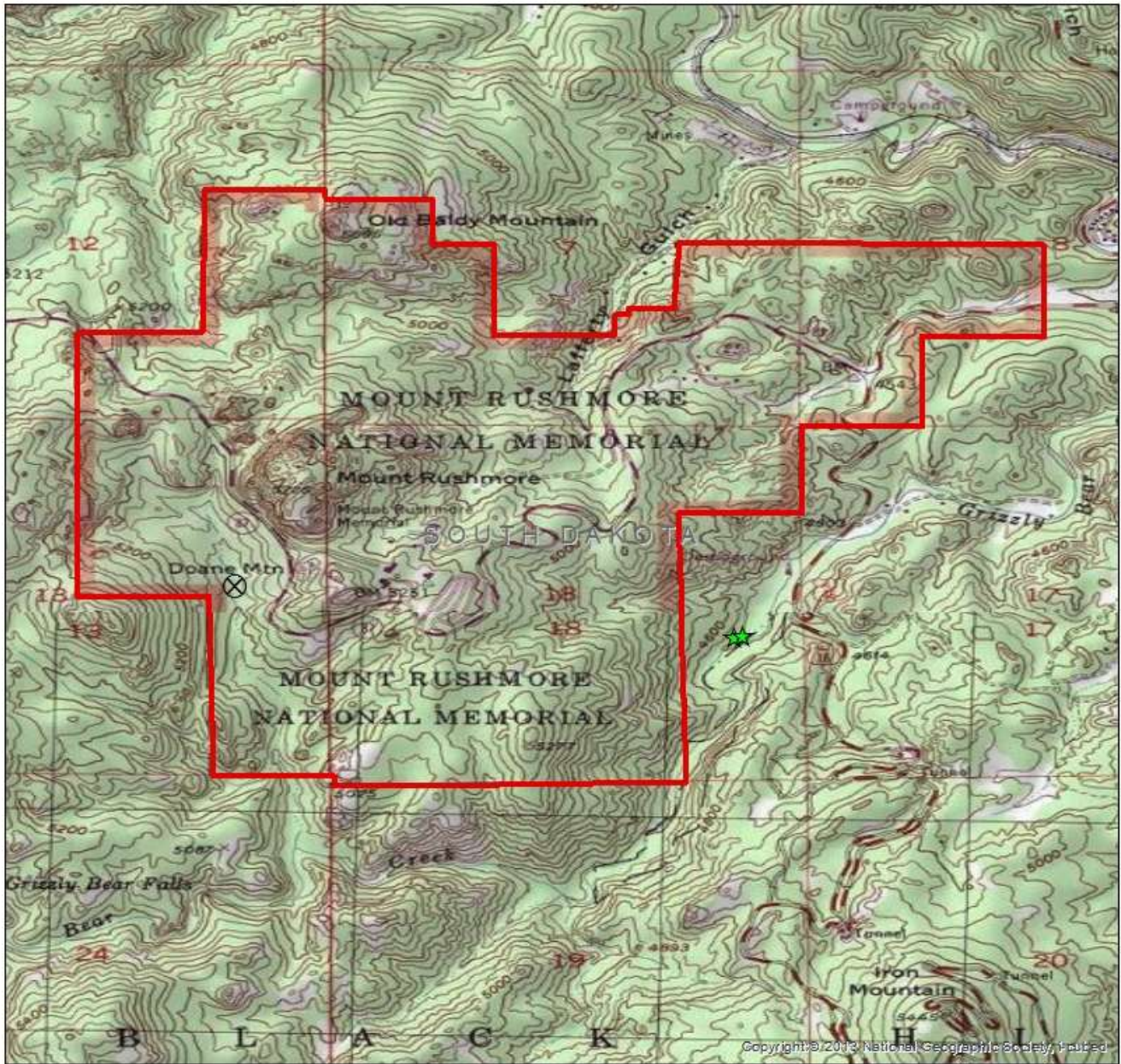
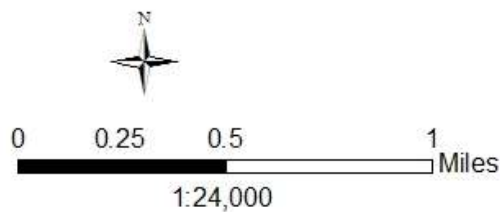
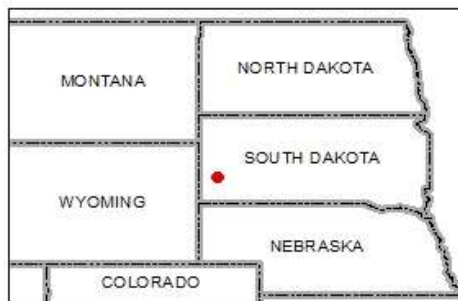


Figure 8. Mistnet survey locations and Pd or WNS status of bats captured at Mount Rushmore National Monument 2019.



Legend

Disease Status

- ⊗ No Bats
- ★ Not Detected
- ★ Pd Detected
- ▭ Park Boundary

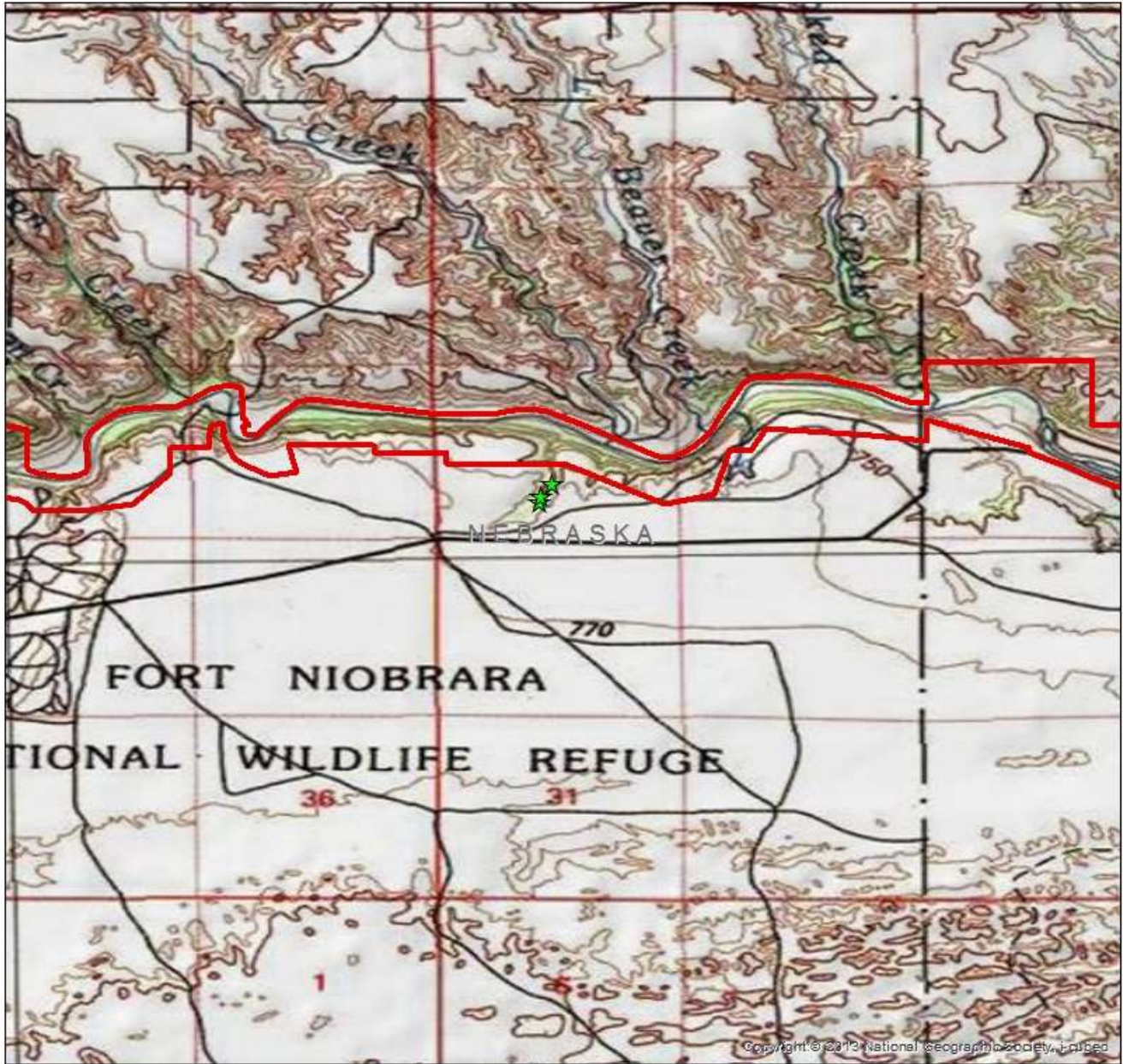
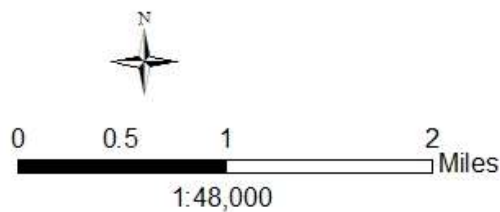


Figure 9. Mistnet survey locations and Pd or WNS status of bats captured at the Niobrara National Scenic River in 2019.



Legend

Disease Status

- ⊗ No Bats
- ★ Not Detected
- ★ Pd Detected
- ▭ Park Boundary

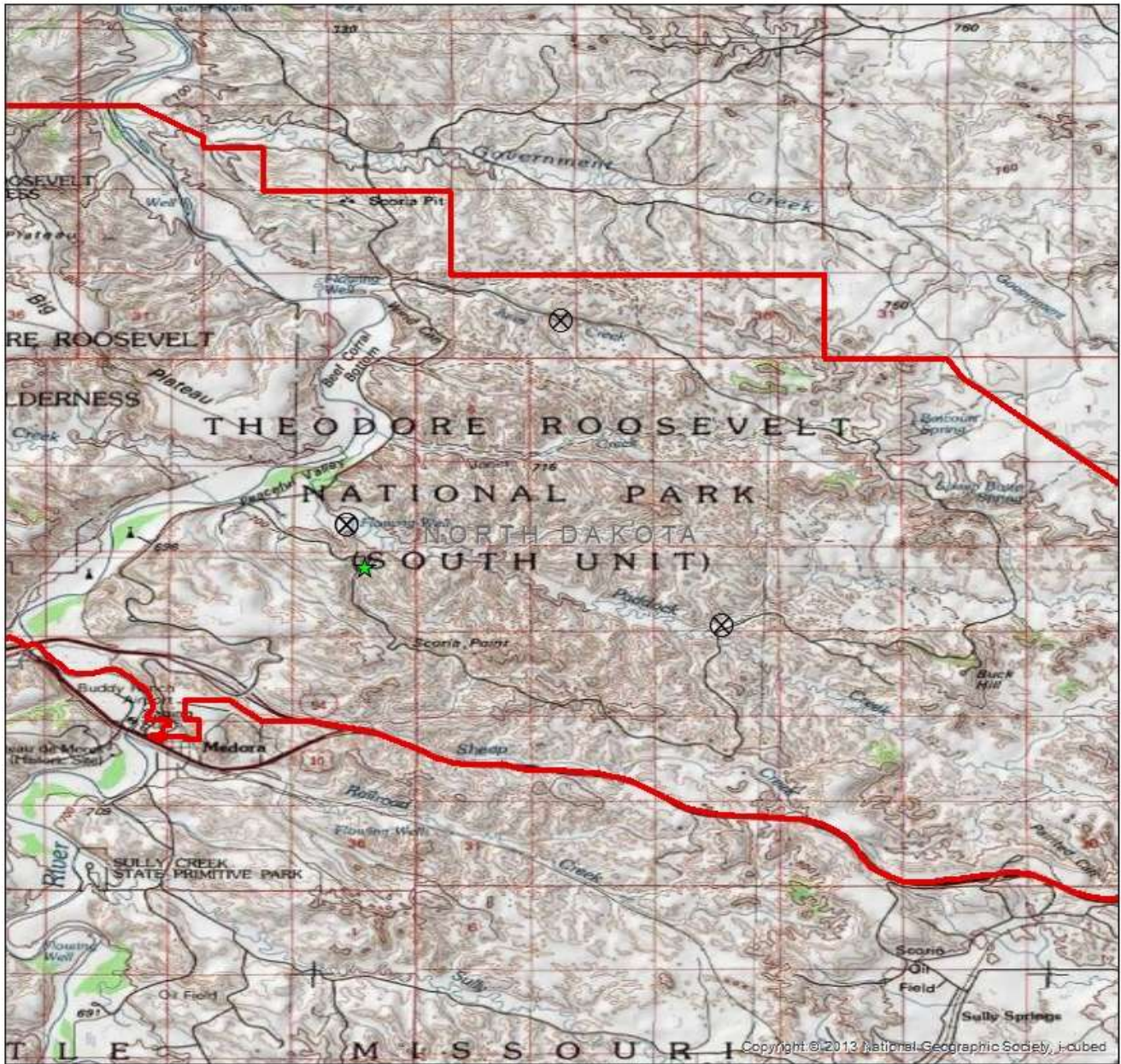
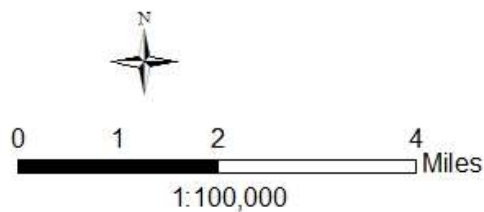
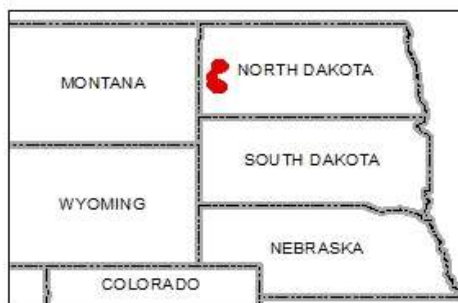


Figure 10. Mistnet survey locations and Pd or WNS status of bats captured at Theodore Roosevelt National Park South Unit in 2019.



Legend

Disease Status

- ⊗ No Bats
- ★ Not Detected
- ★ Pd Detected
- ▭ Park Boundary

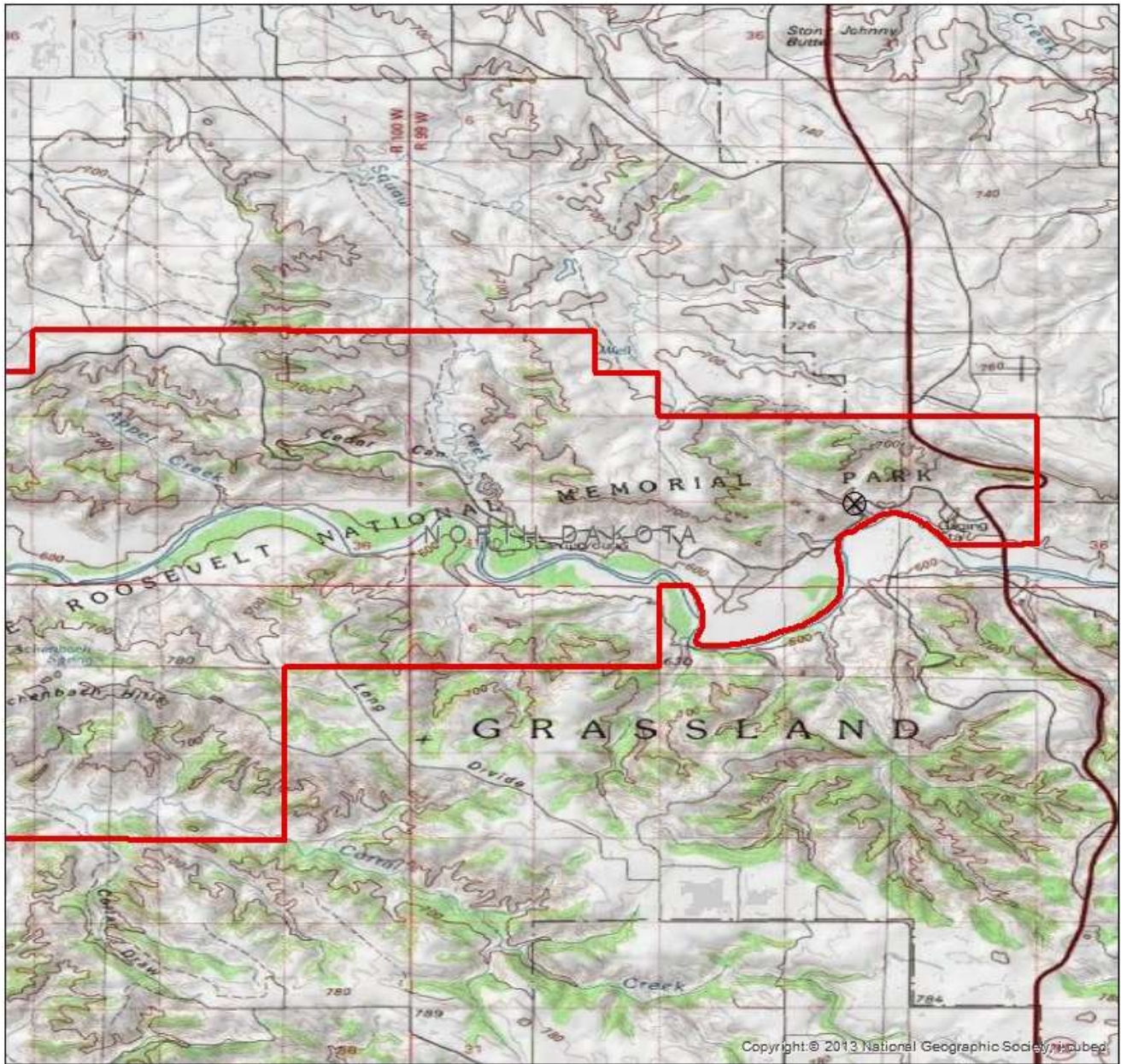
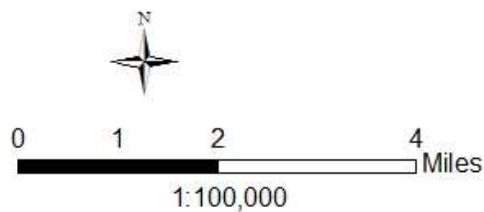
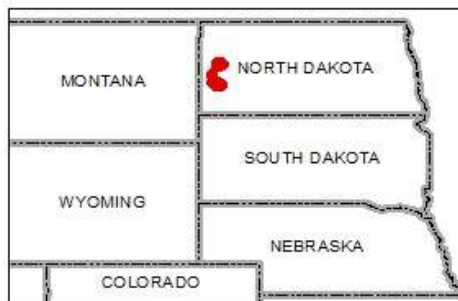


Figure 11. Mistnet survey locations and Pd or WNS status of bats captured at Theodore Roosevelt National Park North Unit in 2019.



Legend

Disease Status

- ⊗ No Bats
- ★ Not Detected
- ★ Pd Detected
- ▭ Park Boundary

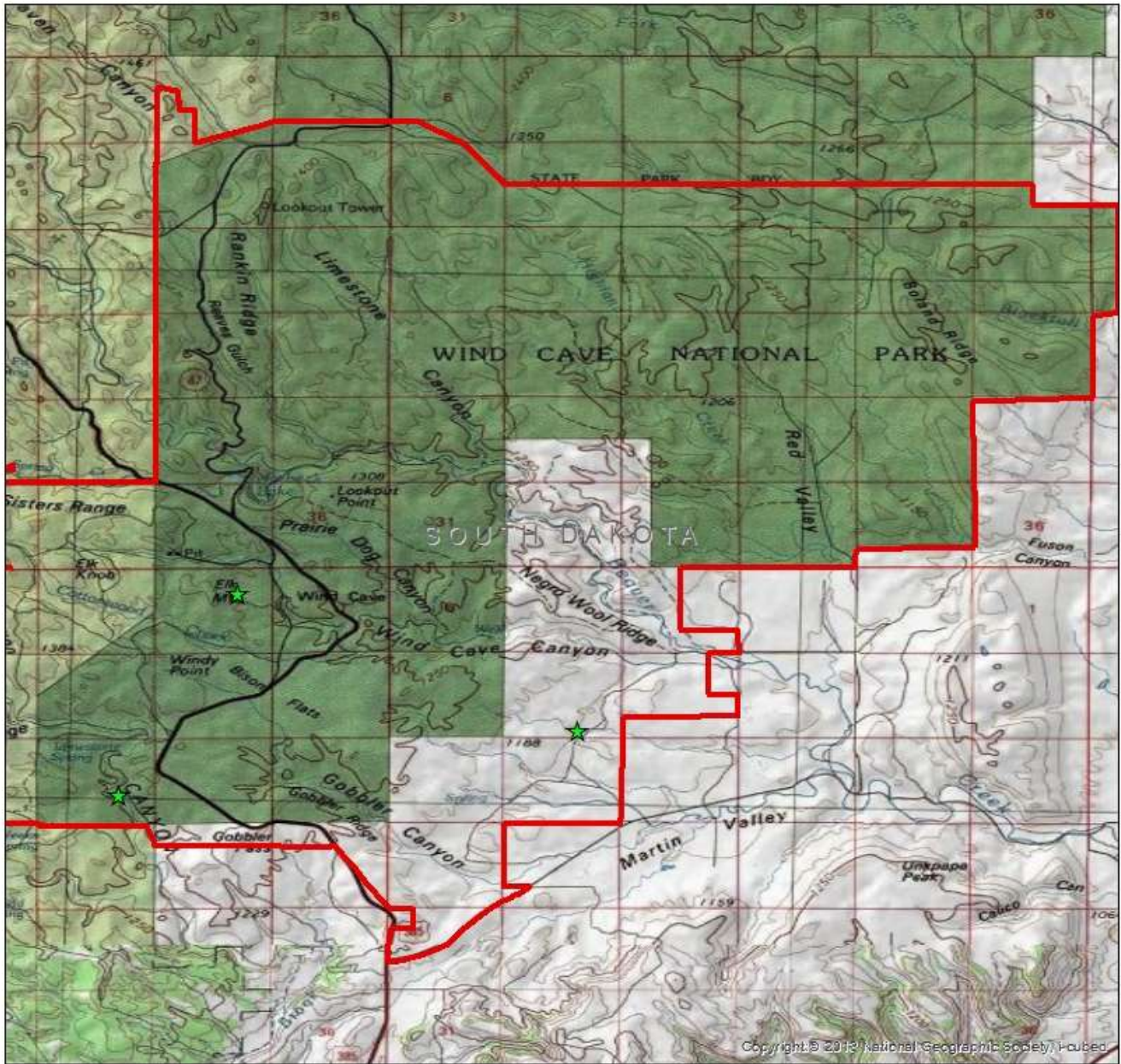
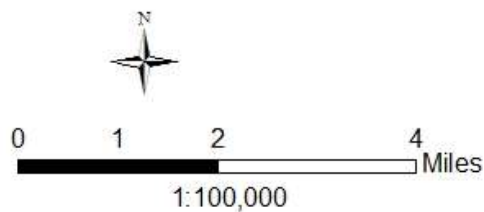


Figure 12. Mistnet survey locations and Pd or WNS status of bats captured at Wind Cave National Park in 2019.



Legend

Disease Status

- ⊗ No Bats
- ★ Not Detected
- ★ Pd Detected
- ▭ Park Boundary

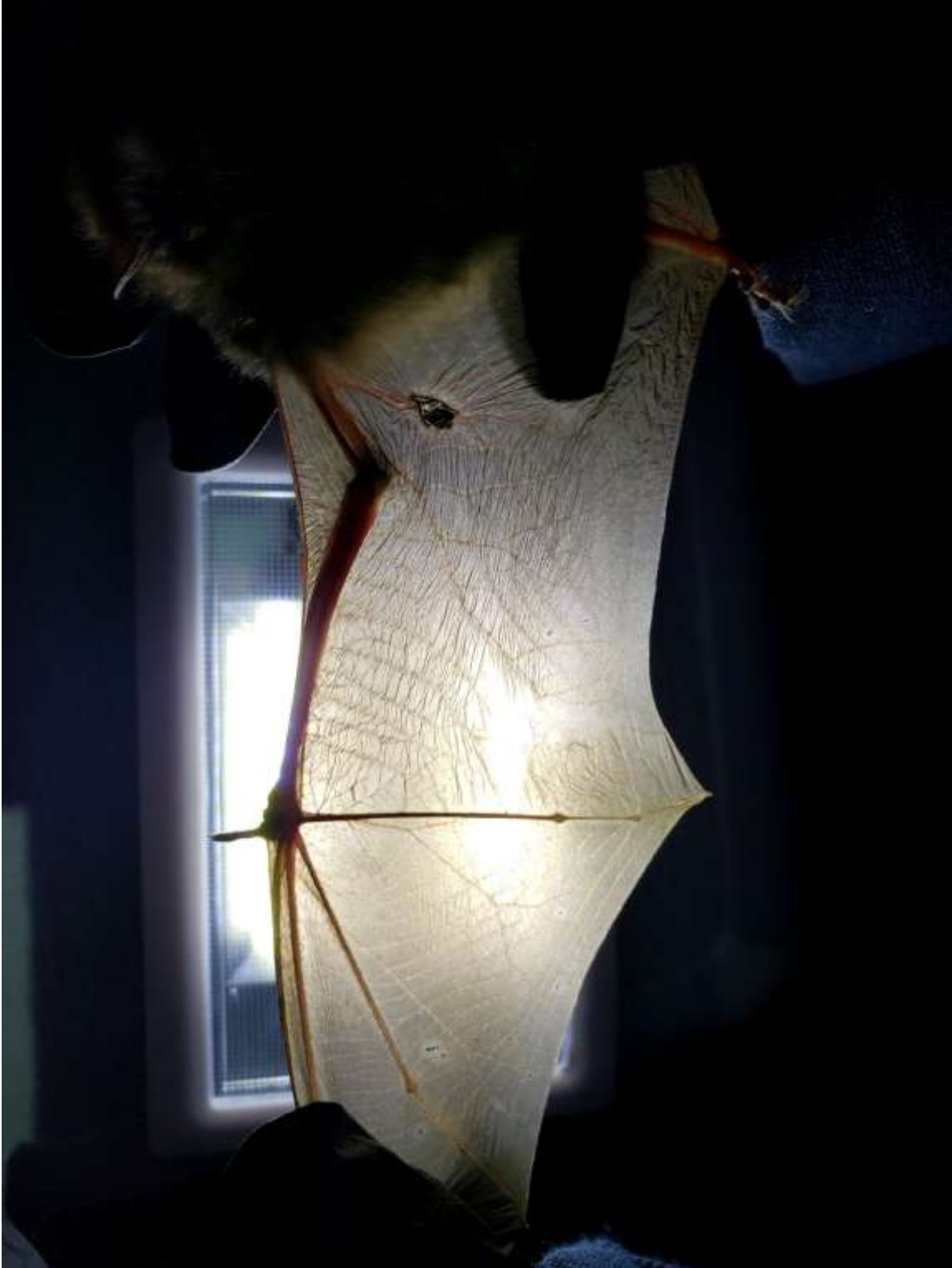


Figure 13. Wing damage on a little brown myotis captured at Knife River Indian Villages National Historic Site in 2019. Pd was detected on this individual.

Tables

Table 1. Mistnet surveys carried out at NPS units across the NGMN in 2019 including topographic locality, survey date, Pd or WNS status, and geographic coordinates.

Park	Locality	Date	Pd/WNS Status	x	y
BADL	Dry Creek	5/23/2019	No Bats	-102.411	43.896
BADL	Conata Basin Stock Pond	5/24/2019	No Bats	-102.197	43.829
BADL	Cedar Pass	5/25/2019	Not Detected	-101.954	43.777
BADL	Sage Creek	5/26/2019	No Bats	-102.414	43.911
DETO	Tarpot Spring	4/16/2019	Not Detected	-104.727	44.585
DETO	Tarpot Spring	4/17/2019	Not Detected	-104.727	44.585
DETO	Tarpot Spring	4/19/2019	Not Detected	-104.727	44.585
FOLA	Bat House	5/16/2019	Pd Detected	-104.560	42.199
FOLA	Guard House	6/5/2019	Not Detected	-104.557	42.202
FOLA	Guard House	6/6/2019	Not Detected	-104.557	42.202
FOUS	Housing Side-channel	5/6/2019	No Bats	-104.032	47.995
FOUS	Trailhead	5/7/2019	No Bats	-104.043	47.998
FOUS	FOUS3	5/8/2019	No Bats	-104.038	47.998
FOUS	Housing Side-channel	5/9/2019	No Bats	-104.032	47.995
JECA	Lower Bat Pond	5/13/2019	Pd Detected	-103.831	43.718
JECA	Lithograph spring	5/14/2019	Not Detected	-103.812	43.733
JECA	Lower Bat Pond	5/15/2019	Pd Detected	-103.83	43.718
JECA	Lower Bat Pond	5/16/2019	Pd Detected	-103.83	43.718
KNRI	Knife River	5/6/2019	Pd Detected	-101.375	47.326
KNRI	Cottonwood Fly	5/7/2019	No Bats	-101.386	47.371
KNRI	Knife River	5/8/2019	Pd Detected	-101.375	47.326
KNRI	Knife River	5/9/2019	Pd Detected	-101.375	47.326
KNRI	Missouri River Carp Pond	6/7/2019	No Bats	-101.371	47.324
KNRI	Missouri River Carp Pond	6/8/2019	No Bats	-101.371	47.324
KNRI	Missouri River Carp Pond	6/9/2019	No Bats	-101.371	47.324
MORU	Lafferty Gulch	4/22/2019	No Bats	-103.462	43.876
MORU	Grizzly Bear Creek	4/23/2019	Not Detected	-103.442	43.874
MORU	Grizzly Creek	4/25/2019	Not Detected	-103.442	43.874
NIOB	Ft. Niobrara Wildlife Refuge Tyler Creek	4/22/2019	Not Detected	-100.427	42.900
NIOB	Fort Niobrara Wildlife Refuge Tyler Creek	4/23/2019	Not Detected	-100.427	42.900
NIOB	Fort Niobrara Wildlife Refuge Tyler Creek	4/25/2019	Not Detected	-100.426	42.902
THRO	Paddock Creek	4/30/2019	No Bats	-103.431	46.935
THRO	Buckhorn Trail/Scenic Drive	5/1/2019	No Bats	-103.279	47.602
THRO	Halliday Well	5/2/2019	No Bats	-103.495	46.952
THRO	Jules Creek	5/2/2019	No Bats	-103.458	46.987
THRO	Paddock Creek	5/3/2019	Not Detected	-103.492	46.944

Park	Locality	Date	Pd/WNS Status	x	y
THRO	Halliday Well	5/3/2019	No Bats	-103.495	46.952
WICA	Elk Mtn. Spring	5/13/2019	Not Detected	-103.487	43.559
WICA	Pipe Spring	5/14/2019	Not Detected	-103.429	43.537
WICA	Herp Hole	5/15/2019	Not Detected	-103.507	43.526

Table 2. Bats captured during WNS surveillance at NPS units across the NGPN in 2019.

Park	Site Name	Date	Species	Sex	Wing Damage	Pd Swab Taken?	Wing Biopsy Taken?	VDL Results	NWHC Results
BADL	Cedar Pass	5/25/2019	EPFU	M	0	Yes	No	Not Detected	--
DETO	Tarpot Spring	4/16/2019	COTO	F	0	Yes	No	Not Detected	--
DETO	Tarpot Spring	4/16/2019	EPFU	M	0	Yes	No	Not Detected	--
DETO	Tarpot Spring	4/17/2019	MYCI	M	0p	Yes	No	Not Detected	--
DETO	Tarpot Spring	4/18/2019	MYEV	M	0p	Yes	No	Not Detected	--
DETO	Tarpot Spring	4/19/2019	EPFU	M	0p	Yes	No	Not Detected	--
DETO	Tarpot Spring	4/19/2019	MYCI	M	0	Yes	No	Not Detected	--
DETO	Tarpot Spring	4/19/2019	MYCI	M	0p	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	1P	Yes	Yes	Not Detected	Pd Detected
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0	Yes	No	Not Detected	--
FOLA	Bat House	5/16/2019	MYLU	F	0p	Yes	No	Not Detected	--
FOLA	Guard House	6/5/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/5/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/5/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/5/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/5/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/5/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/5/2019	EPFU	M	--	Yes	No	Not Detected	--
FOLA	Guard House	6/5/2019	EPFU	F	--	Yes	No	Not Detected	--

Park	Site Name	Date	Species	Sex	Wing Damage	Pd Swab Taken?	Wing Biopsy Taken?	VDL Results	NWHC Results
FOLA	Guard House	6/6/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/6/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/6/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/6/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/6/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/6/2019	EPFU	F	--	Yes	No	Not Detected	--
FOLA	Guard House	6/6/2019	EPFU	F	--	Yes	No	Not Detected	--
JECA	Lower Bat Pond	5/13/2019	MYTH	M	0	Yes	Yes	Not Detected	Pd Detected
JECA	Lower Bat Pond	5/13/2019	MYVO	M	0	Yes	Yes	Pd Detected	Pd Detected
JECA	Lower Bat Pond	5/13/2019	MYEV	M	0	Yes	No	Not Detected	--
JECA	Lower Bat Pond	5/13/2019	EPFU	M	0	Yes	No	Not Detected	--
JECA	Lower Bat Pond	5/13/2019	EPFU	M	0	Yes	No	Not Detected	--
JECA	Lower Bat Pond	5/13/2019	MYVO	M	0p	Yes	No	Not Detected	--
JECA	Lower Bat Pond	5/13/2019	EPFU	M	0p	Yes	No	Not Detected	--
JECA	Lower Bat Pond	5/13/2019	LANO	F	--	No	No	Not Tested	--
JECA	Lower Bat Pond	5/13/2019	EPFU	M	0	Yes	No	Not Detected	--
JECA	Lower Bat Pond	5/13/2019	EPFU	M	0	Yes	No	IC	--
JECA	Lithograph Sprg.	5/14/2019	MYEV	M	0p	Yes	No	Not Detected	--
JECA	Lithograph Sprg.	5/14/2019	LANO	F	--	No	No	Not Tested	--
JECA	Lower Bat Pond	5/15/2019	MYVO	M	0p	Yes	No	Not Detected	--
JECA	Lower Bat Pond	5/15/2019	LANO	F	--	No	No	Not Tested	--
JECA	Lower Bat Pond	5/15/2019	MYVO	M	0	Yes	No	Not Detected	--
JECA	Lower Bat Pond	5/15/2019	MYVO	M	0	Yes	No	Not Detected	--
JECA	Lower Bat Pond	5/15/2019	MYVO	M	0p	Yes	No	Pd Detected	--
JECA	Lower Bat Pond	5/15/2019	MYVO	M	0	Yes	No	Pd Detected	--
JECA	Lower Bat Pond	5/16/2019	MYEV	M	0p	Yes	No	Pd Detected	Not Detected
JECA	Lower Bat Pond	5/16/2019	MYVO	M	0p	Yes	No	Not Detected	--
KNRI	Knife River	5/6/2019	MYLU	F	0p	Yes	No	Pd Detected	Pd Detected
KNRI	Missouri River Carp Pond	6/7/2019	LANO	F	0p	Yes	No	Not Detected	--
KNRI	Missouri River Carp Pond	6/7/2019	EPFU	F		Yes	No	Not Detected	--
KNRI	Missouri River Carp Pond	6/7/2019	MYLU			No	No	--	--
KNRI	Missouri River Carp Pond	6/9/2019	LANO	F	0	Yes	No	Not Detected	--
MORU	Grizzly Creek	4/23/2019	LANO	F	--	No	No	--	--
MORU	Grizzly Creek	4/23/2019	LANO	M	0p	Yes	No	Not Detected	--
MORU	Grizzly Creek	4/23/2019	MYSE	F	--	No	No	--	--
MORU	Grizzly Creek	4/23/2019	LANO	M	0p	Yes	No	Not Detected	
MORU	Grizzly Creek	4/23/2019	LANO	F	--	No	No	--	--

Park	Site Name	Date	Species	Sex	Wing Damage	Pd Swab Taken?	Wing Biopsy Taken?	VDL Results	NWHC Results
MORU	Grizzly Creek	4/23/2019	EPFU	M	0p	Yes	No	Not Detected	--
MORU	Grizzly Creek	4/23/2019	LANO	F	--	No	No	--	--
MORU	Grizzly Creek	4/23/2019	LANO	F	--	No	No	--	--
MORU	Grizzly Creek	4/23/2019	LANO	F	--	No	No	--	--
MORU	Grizzly Creek	4/23/2019	MYCI	F	--	No	No	--	--
NIOB	Fort Niobrara Wildlife Refuge Tyler Creek	4/23/2019	MYSE	F	0	Yes	No	Not Detected	--
NIOB	Fort Niobrara Wildlife Refuge Tyler Creek	4/23/2019	MYSE	F	0	Yes	No	Not Detected	--
NIOB	Fort Niobrara Wildlife Refuge Tyler Creek	4/23/2019	MYSE	F	0p	Yes	No	Not Detected	--
NIOB	Fort Niobrara Wildlife Refuge Tyler Creek	4/23/2019	MYSE	F	0p	Yes	No	Not Detected	--
NIOB	Fort Niobrara Wildlife Refuge Tyler Creek	4/25/2019	MYSE	M	1	Yes	No	Not Detected	--
THRO	Paddock Creek	5/3/2019	MYEV	F	0	Yes	No	Not Detected	--
THRO	Paddock Creek	5/3/2019	MYLU	M	0	Yes	No	Not Detected	--
WICA	Elk Mtn. Spring	5/13/2019	EPFU	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	EPFU	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	MYCI	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	MYCI	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	MYCI	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	MYSE	M	0p	Yes	No	Not Detected	--
WICA	Elk Mtn. Spring	5/13/2019	MYSE	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	EPFU	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	MYLU	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	myth	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	EPFU	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	EPFU	M	0p	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	EPFU	UKN	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	MYSE	M	0p	Yes	No	Not Detected	--
WICA	Elk Mtn. Spring	5/13/2019	MYSE	M	0p	Yes	No	Not Detected	--
WICA	Elk Mtn. Spring	5/13/2019	MYCI	M	0	Yes	No	Not Detected	--
WICA	Elk Mtn. Spring	5/13/2019	MYSE	M	0p	Yes	No	Not Detected	--
WICA	Elk Mtn. Spring	5/13/2019	MYSP	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	MYCI	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	MYSE	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	EPFU	F	--	No	No	--	--

Park	Site Name	Date	Species	Sex	Wing Damage	Pd Swab Taken?	Wing Biopsy Taken?	VDL Results	NWHC Results
WICA	Elk Mtn. Spring	5/13/2019	MYSE	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	MYSE	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	MYSE	M	Op	Yes	No	Not Detected	Not Detected
WICA	Elk Mtn. Spring	5/13/2019	EPFU	M	0	Yes	No	Not Detected	--
WICA	Elk Mtn. Spring	5/13/2019	MYSE	F	--	No	No	--	--
WICA	Elk Mtn. Spring	5/13/2019	MYTH	M	Op	Yes	No	Not Detected	--
WICA	Elk Mtn. Spring	5/13/2019	MYSE	F	--	No	No	--	--
WICA	Pipe Spring	5/14/2019	MYCI	F	--	No	No	--	--
WICA	Pipe Spring	5/14/2019	MYTH	F	--	No	No	--	--
WICA	Pipe spring	5/14/2019	EPFU	M	Op	Yes	No	Not Detected	--
WICA	Pipe spring	5/14/2019	EPFU	M	Op	Yes	No	Not Detected	--
WICA	Herp Hole Pond	5/15/2019	MYCI	M	Op	Yes	No	Not Detected	--
WICA	Herp Hole Pond	5/15/2019	LANO	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	LANO	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	LANO	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	LANO	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	LANO	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	LANO	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	LANO	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	LANO	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	LANO	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	MYVO	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	M	Op	Yes	No	Not Detected	--
WICA	Herp Hole Pond	5/15/2019	MYCI	M	Op	Yes	No	Not Detected	--
WICA	Herp Hole Pond	5/15/2019	LANO	F	--	No	No	--	--

Park	Site Name	Date	Species	Sex	Wing Damage	Pd Swab Taken?	Wing Biopsy Taken?	VDL Results	NWHC Results
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--
WICA	Herp Hole Pond	5/15/2019	EPFU	M	Op	Yes	No	Not Detected	--
WICA	Herp Hole Pond	5/15/2019	EPFU	F	--	No	No	--	--