DRAFT-Final Report:
Bridge and Culvert Use by Bats in Nebraska

Developed and Used by
The State of Nebraska Department of Roads

3/31/16

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Introduction

BACKGROUND

The Northern Long-Eared Bat (*Myotis septentrionalis*)(NLEB) is a medium-sized bat species, noted by the presence of long-rounded ears. The undersides of NLEB are typically tawny or pale-brown in color with a darker brown pelage on top of the body.

NLEB have been documented to summer roost in colonies or individually within tree snags, hollows, crevices, or underneath bark (Whitacker & Hamilton 1998). Man-made structures such as houses, barns, and bridges have also been recorded as roosts for NLEB during the summer (USFWS 2014a). NLEB glean and forage for insects over water, forest clearings, and under tree canopies in upland and lowland woodlots and tree-lined corridors. Hunting prey such as moths and beetles occurs by echolocation through a low pulse repetition rate and high-frequency call (Faure et. al. 1993). During mid-fall, NLEB migrate to a winter hibernacula within caves and abandoned mine portals. Hibernation lasts until mid-April (Clawson et. al. 1980). Though little information exists regarding NLEB habitat in Nebraska, it is hypothesized that the species would accept comparable habitat in Nebraska (USFWS 2014b).

NLEB survival rates are currently threatened by unsafe winter habitat. White-Nose Syndrome (WNS) is a fungal disease easily transferred between bats and bat colonies. WNS is primarily spread within winter hibernacula. This disease has killed 5.7 to 6.7 million bats since its first North American outbreak during 2006 (USFWS 2012). NLEB are included among bat species most heavily affected. WNS is currently spreading from east to central North America and has recently arrived within the NLEB range of Nebraska. Due to the fall in NLEB populations, the U.S. Fish and Wildlife Service (USFWS) proposed listing NLEB under the Endangered Species Act (ESA); (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.) in October 2013.

In April 2015, the USFWS listed NLEB as federally threatened under the ESA and developed a 4(d) Rule that was incorporated into the NLEB threatened listing. The NLEB 4(d) Rule exempts “take” caused by “maintenance and limited expansion of transportation and utility rights-of-way…” (USFWS 2015). This rule may simplify NDOR construction restrictions. These details are currently under discussion.

PURPOSE AND RESPONSIBILITY

The purpose of the Nebraska Department of Roads (NDOR) Bat Survey Protocol is to meet the requirements of the ESA of 1973, as amended, specifically concerning the proposed listing of NLEB. To fulfill these requests, NDOR will evaluate suitable habitat within NDOR bridge and culvert structures, conduct bat surveys, and write biological conclusions regarding a specific NDOR project region concerning bridge or culvert structure repair and/or replacements and potential impact to NLEB.

OBJECTIVE

The Objective of this study was to identify if bats, including NLEB, are using NDOR bridge and culvert structures, and if they are, what types of structures are being utilized for roosting, in relation to their geographical location and location on the landscape.

Nebraska bat species typically prefer a humid environment with consistent temperatures. Bridges and culvert structures in Nebraska are thought to be inconsistent in thermoregulation due to low and varying temperatures (Keeley & Tuttle 1999). Data collected by researchers from Southern Illinois University revealed 15 of 232 surveyed bridge structures to support roosting bats, and flat slab bridges in particular had zero bat inhabitants (Feldhamer et. al. 2003). Illinois and Nebraska maintained similar average high and low monthly temperatures and comparable bat habitat opportunities. These comparable climatic attributes, coupled with previous data in Illinois, leads to the assumption that Nebraska bridge use by NLEB would be minimal. Further studies need to be done to support this hypothesis.

Two separate research studies concerning bat use of bridges in Arizona and New Mexico, two states with a parallel climate, have data recording bridge use by bats as high as 88% (Geluso & Mink 2009). The bridge survey study in Arizona revealed large populations of day-roosting bats and maternity colonies, which numbered occasionally in the thousands (Davis & Cockrum 1963). Arizona and New Mexico's yearly average high temperatures are 90-100 degrees Fahrenheit, and a yearly average low is 20-30 degrees Fahrenheit. Another team of researchers in New Mexico focused specifically on bridge thermal properties conducive to bat roosting. The study discovered precast concrete to mimic temperatures similar to natural roosting sites (Smith & Stevenson 2013). Precast concrete is hypothesized to be the most successful structure in attracting bats for roosting habitat.

Bridge use by bats is unexplored in Nebraska. Without previous research of NLEB bridge use within the state, the USFWS is concerned that NLEB may be affected by NDOR during future bridge and culvert repair or replacement. In the event NLEB are listed as threatened or endangered, the ESA will require NDOR to avoid "take" or accidental killing of NLEB through special measures such as preconstruction surveys, seasonal restrictions, and "take" preventive guidelines implemented during construction.

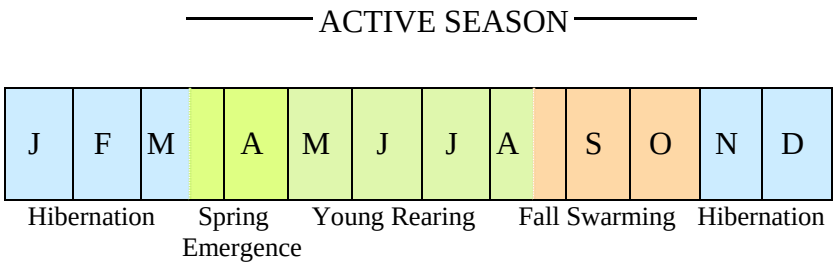
Methods

To meet the objective of this project, the following protocol was developed.

TIME CONSIDERATIONS

Bat surveys were performed between April 1st and September 30th 2014-2015 during daylight hours (Figure 1). Surveyors accessed bridges and culverts in multiple ecoregions throughout Nebraska. Biologists and trained personnel of NDOR conducted bat surveys as needed, according to protocol.

Figure 1. Seasonal time periods of NLEB in Nebraska



SITE SELECTION

Structures inspected were identified and prioritized based on the *Nebraska Surface Transportation Program Book, Fiscal Years 2015-2020* and as substantial through the Local Program. Bridges and culverts over 5 feet tall were inspected and structures lower than the 5 foot minimum were excluded from investigation (Keeley & Tuttle 1999). Common bridge structures and culvert types can be found in Appendix 1.

FIELD METHODS

Surveyors inspected the undersides of bridges and culverts for evidence of day and night roosting. Day roosting is characterized by the visual observance of bats flying or bats located on support beams and pillar ledges, bats squeezed inside small crevices, audible chirping, and the presence of droppings (guano) and/or urine stains below bat roosts. Binoculars, telescopic camera unit, and a spotlight were used to assist visual inspection.

Evidence of night roosting relies primarily on the presence of guano and/or urine staining. Visual inspection was conducted for droppings and urine staining below high points and locations protected from wind. Droppings typically accumulated on the ground and/or support beams and walls below roosting. More recent pellet droppings were brown or black in appearance, while older pellets are grey. See the attached photo references in Appendix 2 for examples of droppings and urine staining. Bat guano may be shiny speckled in appearance due to the consumption of insects and partially undigested wings (Reilly 2015).

Crevices and gaps were examined using a Telescopic Pole mounted camera. Commonly found bat species often chose to roost on bridges in vertical crevices between 0.5 to 1.25 inches wide (Keeley & Tuttle 1999). Roosting was anticipated in riparian areas where bridges are made of concrete that retains heat and provides suitable warmth and moisture for roosting bats. Areas suitable for bats concealed beneath crevices or in appropriate gaps were identified and documented.

DATA CAPTURE AND STORAGE

Existing weather conditions were captured and recorded at each location using a Kestrel 3000. Temperature, average wind speed, and relative humidity were recorded directly under the structure when possible. This information was entered into the Global Position System (GPS) Bat Survey data table during the survey (Table 1).

Before leaving the vehicle at each project site, it was necessary to use the point-and-shoot camera to photograph the project map in order to accurately separate photos after download and for later reference to what project sites had been visited. Visual sign of bats or bat roosts were also recorded by the point-and-shoot camera. This includes evidence of droppings and/or urine staining and crevices in the bridge/culvert structure. At least one photo must detail the inner structure of the bridge/culvert at every project site independent of bat presence. Another photo was taken to document the surrounding habitat. A photo log was kept in the GPS Data Dictionary that includes the image numbers and the direction the photo was captured. Refer to Appendix 4 for a complete list of photos types taken. It was also important not to delete any photos while in the field as this would disorder the photos correlating to a location. Along with photographing bat sign and underneath the structure, surveyors photographed the structure number for records, as well as a photo overview of the structure from above ground. Protocol for how photos were downloaded and stored can be found in Appendix 5.

The GPS Unit was a powerful tool used to store relevant data during a bridge/culvert bat survey inspection. A location point was created next to the bridge/culvert while the surveyor entered the following conditions listed in the GPS Data Dictionary (Figure 3) while being sure to remain in place during the point was logged. Standing out from beneath the bridge provided the best signal. Protocol to transfer and store GPS information can be found in Appendix 5. Definitions and/or standards for GPS data determinations can be found in Appendix 4.

Table 1 - GPS Data Dictionary

Basic Information and Location:	**Conditions:**	**Structure Details:**	**Bat Details:**
GPS User	Temperature	Structure	Bats Present
Date	Relative Humidity	CMP Diameter	Roost type
Control Number	Average Wind Speed (mph)	CBC Height	Number of roosts
Project Type	Amount of Shade		Roost type
Structure Number	Surrounding Habitat		Number of roosts
State	Conditions Beneath Structure		Roost type
County			Ideal Crevices
Highway type			
Ecoregion			
Photo Number/Direction			
Comments			

*This table does not include the GPS Data Dictionary subcatergories due to it’s extensiveness.

EQUIPEMENT

Surveys required specific tools in order to gather and store collected information (Table 2). Certain equipment raised safety levels by adding protection to individuals while working in the field and providing extra opportunities to collect more extensive data (Table 3).

Wildlife Windows from the United Kingdom is where the telescopic camera units were purchased and their camera's partnered device, a ruggedized Android tablet. These two products arrived and were successfully tested in the field. Wildlife Windows recommended a company for a glass-fiber pole that would fit the threading of the camera head unit. A 32' foot pole for the camera has been purchased and was used in the field. For the proceeding units purchased we opted for fiberglass poles. These poles were lighter and easier to usen for prolonged periods of time.

Table 2 - Survey Tools

Equipment	Use
Spotlight/Flashlight	To light up small crevices or illuminate culverts
GPS unit	Accurate positioning and recording of bat surveys at bridges and culverts
Kestrel 3000	To detect average wind speed, temperature, and relative humidity
Safety Vests	To maintain visibility in order to decrease the risk of roadside injury
Spare Batteries	Extra batteries for the portable camera, acoustic recording device, flashlights, and camera pole (camera and monitor)
Point-and-Shoot Camera	Capture photos of the structure, bat signs, surrounding habitat, and bridge identification markers
Telescopic Camera Pole	To view and collect footage of bats at high levels
Muck Boots	To traverse through muddy or low water areas
Binoculars	To observe long-distance activity

Results

A total of 280 bridges were surveyed from all eight districts in Nebraska. Implications of bat roosting, including urine staining, bat gauno, and day-roosting bats, were found on 20.1% of the bridges surveyed. 57 of these bridge structures were found to harbor bat guano. Urine staining was found much less frequently, observed on only 8 bridges. Statistically, urine staining was present at 2.9% of all bridge structures surveyed. 100% of the structures that contained urine staining also contained bat guano. 0.0% of culverts surveyed showed bat sign.

Bat guano was most often observed towards the center of the bridge abutments along ledges, with small amounts also found on the ground. Less often there was guano present along the edges of abutments and near the center of the bridges along supporting piers. Bat guano was also more likely to be found in survey areas located along a raparian wooded; near rivers or small streams.

12 of the bridges that harbored bat guano had imperfections that would make the bridge more suitable for bat roosting. These imperfections include gaps, holes, and crevices in the bridge structure large enough for bats to roost. Bridges with bat signs that also have imperfections make up 21.1% of the total bat sign positive bridges. If the structures did not contain these imperfections, it is possible that the structures may not have been adequate for bats roosting.

Common geographical features were often found near bridges with bat sign. These features included trees, water, and thick vegetation. Trees were the most common feature and their density ranged from areas of scattered trees located near the structure to large-wooded corridors surrounding both sides of the structure. Water was also common, most often in the form of a river or stream, but in some instances stagnant pools were observed. Dense vegetation was also observed near many of the bat sign positive bridges in the form of tall grasses and bushes surrounding the sides of the structure.

Districts one, three, seven, and eight had the most structures surveyed with bat sign. Day-roosting bats were observed on one structure located in district 8. The photosheet for this structure can be viewed in Appendix 6 labeled as “Keya Paha River Bridge East of Mills.” The structure was a concrete slab located over the Keya Paha river. The structure is oriented in the east to west direction. A wooded raparian coordior lies adjacent to the bridge structure, providing suitable habitat for ideal bat roosting. Bat guano was observed on the inner sides of the bridge facing west, and along the ledge where the bats were observed. Little to no bat guano was observed on the east side of the bridge or on the supporting peir in the center of the bridge. No bats were observed in these areas. Bat vocalizations and urine staining were also observed near the west side of the bridge structure. This structure is located near the South Dakota/Nebraska boarder. It is positioned in the far north portion of Nebraska near the middle of the state, east of Mills. The bats observed were found in a gap where the bridge structure connected with the abutment on the northeastern side. We were unable to tell how far back the bat colony was located inside the bridge structure, but estimated that there were at least a few hundred bats located inside the structure. A large pile of guano was also observed on the abutment ledge under the colonies roosting area. We were unable to identify bat species, but it is possible that more than one species was present. Our first survey of the bridge was conducted on 6/30/2015. This was the survey when we observed bats. We conducted a second and more thourough survey on 8/9/2015 and we did not observe any bats at the structure. This survey opportunity was used to compile data of the bridge structure. We used the telescopic camera to view inside the crevice where the bats had been previously observed, along with other holes and imperfections on the bridge structure. Bat guano and urine staining were still present.

Overall, it appears that bats favor Steel Girder bridge structures and are more likely to use structures located in areas populated with trees and a water source. Bridges with imperfections such as holes or crevices also appear to be suitable roosting habitat for bats and may cause them to roost on bridge

structures that otherwise may not be an option if iimperfections were not present. Bat guano was the most often encountered bat sign, followed by urine staining. Day roosting was only observed on one bridge structure. Culverts do not appear to be an adequate roosting habitat for bats. No culverts had gauno, urine staining, or bats present.

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APPENDIX 1

Bridge Structure References

Concrete Box Culvert (CBC)

Photo 1: Broad view of Box Culvert

Photo 2: Close view of boxes of the Box Culvert

Photo 3: Inside Box Culvert

Concrete Flat Slab

Photo 1: Broad view of Concrete Flat Slab Bridge Structure

Photo 2: View of the supports underneath a Flat Slab Bridge

Photo 3: Underside of deck span

Concrete Girder

Photo 1: Broad view of a Concrete Girder Bridge Structure

Photo 2: Underside of deck span

Photo 3: Bridge structure abutment

Prestressed Girder

Photo 1: Broad view of a Prestressed Girder Bridge Structure

Photo 2: Underside of deck span

Photo 3: Elongated view of underside the deck span

Prestressed Tee

Photo 1: Broad view of a Prestressed Tee Bridge Structure

Photo 2: Underside of deck span

Photo 3: Pile bent of the bridge structure

Steel Arch

Photo 1: Broad view of a Steel Arch Bridge Structure

Photo 2: Underside of deck span

Photo 3: Broad view underneath the bridge structure

Steel Box

Photo 1: Broad view of a Steel Box Bridge Structure

Photo 2: Underside of deck span

Photo 3: Bridge structure abutment

Steel Culvert

Photo 1: Entrance of a Steel Culvert

Photo 2: Inside Steel Culvert

Photo 3: A row of Steel Culvert outlets

Steel Girder

Photo 1: Broad view of a Steel Girder Bridge Structure

Photo 2: Underside of deck span

Photo 3: Girders underneath bridge structure

Steel Girder - Floor Beam

Photo 1: Broad view of a Steel Girder-Floor Beam Bridge Structure

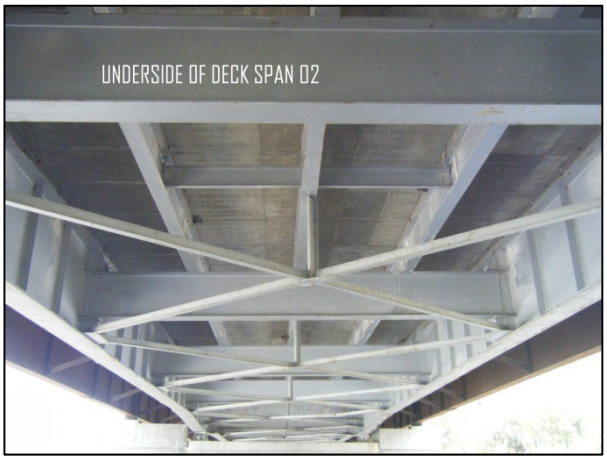


Photo 2: Underside of deck span

Photo 3: Another example of a Girder-Floor Beam Bridge Structure

Steel Truss

Photo 1: Broad view of a Steel Truss Bridge Structure

Photo 2: Underside of deck span

Photo 3: Side of bridge structure

Timber

Photo 1: Broad view of a Timber Bridge Structure

Photo 2: Underside of deck span

Photo 3: Piles underneath the bridge structure

APPENDIX 2

Survey Protocol

ELECTRICAL EQUIPMENT OPERATION AND INFORMATION

Acoustic Monitoring Detector- This set of equipment, and the corresponding sound analysis software, allowed NDOR to locate and identify NLEB among bat populations at bridge sites and culverts. The ultrasound microphone pole was placed toward the bats according to the user manuals prescribed recommended distance (typically more than 5 meters away); the operator tuned the frequency, and then facilitated recording the bat calls. Software at NDOR further interpreted the collected data. Before departing from NDOR the unit was checked for installed batteries, and extra batteries were brought. The memory card was verified to be present and have available recording space.

GPS unit- The GPS unit triangulated and recorded the location of the data collection site. Other local features were recorded manually. Refer to the *Methods* section for more information. The unit was confirmed that it had been fully charged before departing from NDOR.

Point-and-Shoot Camera- This camera functioned as a standard point and shoot camera. Photos were captured as outlined in the *Methods*. The battery was fully charged and the memory card was verified to be present/have available space before departing NDOR.

Telescopic Camera Pole- The camera and monitor were first turned on. The camera head angle was tilted as needed and the pole was adjusted to the crevice inspection height. The recording button was pushed and areas out of reach were inspected. Before departing from NDOR, the unit was checked for installed batteries and extra batteries were brought.

SAFETY CONSIDERATIONS AND PRECAUTIONS

On-site bat surveys were recommended to be completed by teams of two or more as a safety precaution.

Surveyors brought a personal cell phone in case of emergency, a first aid kit, and two sets of motor vehicle keys were kept by two employees in order to ensure access to the NDOR motor vehicle.

Surveys did not take place before dawn or after dusk. Adequate planning and preparation aided in time management, allowing employees to avoid severe time constraints that would otherwise keep surveyors in the field past work-hour guidelines.

Personal judgment was exercised when it comes to extreme weather conditions. It was highly-recommended to avoid standing water and open areas during thunderstorms. If the weather is considered dangerous, seek proper shelter where available. In the case of extreme temperatures, precautions were taken, such as regular breaks and weather appropriate attire.

Caution was taken while working in the presence of bats and their guano. There were not attempts to handle bats. Rabies may or may not be present in the specimen. White-Nose Syndrome (WNS) is known to be transferred by humans to bats. Bats were not handled in order to prevent the spread of WNS fungi. The NDOR Bat Survey Protocol does not prescribe or encourage contact with bats—only observation.

Exposure to guano is known to cause sickness, and in severe cases, fatality. Histoplasmosis is an infection caused by breathing in dust that contains fungi spores from bat guano. These spores are

also known to grow in the soil and areas contaminated with droppings. The ground in these areas were not disturbed. If by accident there was a disturbance, it was recommended to cover the mouth and nose while temporarily withdrawing from the vicinity. Possible symptoms of an infection include fever, cough, fatigue, chills, headache, chest pain, and body aches. Symptoms may appear 3 to 17 after breathing in the fungal spores. Some people never have symptoms. If there were any symptoms as listed above after bat guano exposure, seeking medical attention was highly recommended (CDCP 2014).

Climbing on the ledges of a bridge or other high places is not recommended. The telescopic camera pole and binoculars are provided and will be used for high-level bat roost observations.

APPENDIX 3

Bat Sign References

Photo 1: Bats hanging from cracks along a support beam**

Photo 2: Visible bats within an expansion joint*

Photo 3: Example of open concrete joint used by bats

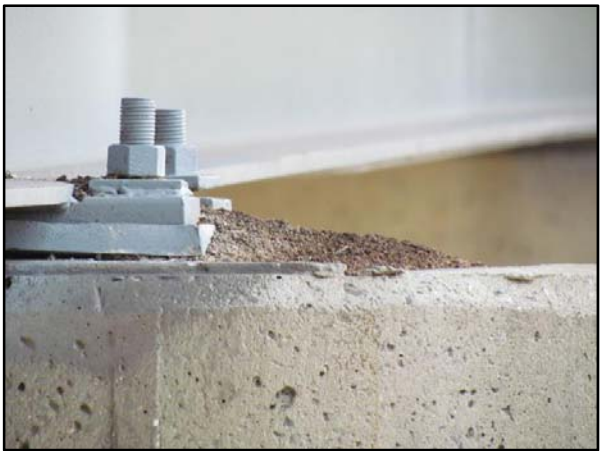


Photo 4: Guano deposits on pier, obscuring structural features

Photo 5: Bat guano on rip-rap

Photo 6: Bats roosting and associated staining**

*Adapted from the Indiana Department of Transportation 2010 Bridge Inspection Manual and the Bernardin, Lochmueller and Associates 2007 document.

** Photoscourtesy of Tom Cervone, Bernardin, Lochmueller and Associates, Jeff Gore, Florida Fish and Wildlife Conservation Commission, and Rick Reynolds, Virginia Department of Game and Inland Fisheries.

APPENDIX 4

GPS Data Dictionary Determination

Data Option	Determination
GPS User	Select your name/title from the options.
Date	Input the survey's date
Control Number	Input the project's control number applicable to the structure being surveyed
Project Type	Select "State" or "Local" according to the project's affiliation corresponding to the surveyed structure
Structure Number	Input "S034 55555" for example. The "S" refers to structure, a "0", and "34" is the Highway in this example. "55555" is the specific structure number found on location, most commonly as a small green sign on a bridge structure. If the structure is too small, it may not have a number. Culverts do not always have a structure number. In this case record the "S034" section and leave the rest blank.
State	Select the abbreviated state where the survey is being taken This will always be Nebraska (NE).
County	Input the County where the survey is taking place
Highway Type	Select the type of road where the structure is located
Ecoregion	Select the region where the structure is located
Amount of Shade	Select the option corresponding to the amount of shade on the structure caused by trees. Do not include shade caused by smaller vegetation such as brush or bushes.
Bats Present	Input the amount of bats present on the structure. If a bat was roosting on the structure and flies away, you will count this.
Day Roost	Select "Yes" or "No" in regards to bat presence during the day at the bridge/culvert structure.

Nursery Roost	Select “Yes” or “No” in regards to the presence of female bats that are lactating and/or raising their young at the bridge/culvert structure.
Night Roost	Select “Yes” or “No” in regards to bat sign presence at the bridge/culvert structure. This indicates possible night roosting.
Roost Comment	Input important/notable information concerning the discovered roosts deemed helpful for later inquiry/record
Structure	Selection options include numerous bridge structures and culverts. Select the corresponding structure being surveyed. Reference the *ROD* if needed. (A shortcut can be found in the *Protocol* folder)
Steel Culvert Diameter	Select the option corresponding to the diameter of the CMP being surveyed.
Concrete Box Culvert (CBC) Height	Input the height in feet corresponding to the surveyed CBC.
Ideal Crevice Present	Select “Yes” or “No” in regards to the crevices/lack of crevices on the structure. An ideal crevice would be 0.5 to 1.25 inches wide and have suitable depth for a bat to easily inhabit the space.
Surrounding Habitat	Select the option that corresponds to the habitat surrounding the structure being surveyed. If the surrounding area has a double combination of habitats select an option such as “Agricultural + Riparian.” Select “Mixed” if the land has three or more surrounding habitats.
Beneath Structure	Select the option that most closely matches the consistency under the structure. “Open Vegetation” refers to sparse areas of vegetation and “Closed Vegetation” refers to the ground being almost/completely covered with vegetation. “Flowing Water” is when there is a body of water with an outlet and inlet present. “Standing Water” is classified

	when there is a body of water without both an outlet and inlet. “Bare Ground” is selected when there are no groupings of plants and vegetation is rare. “Concrete” is selected when there is a floor of concrete under the structure that is predominantly uncovered by dust, vegetation, water, etc.
Temperature	Input the temperature readings taken from underneath the bridge/culvert structure.
Relative Humidity (RH)	Input the relative humidity readings taken from underneath the bridge/culvert structure.
Average Wind Speed (mph)	Input the average wind speed readings taken from underneath the bridge/culvert structure. Collect the average wind speed as you hold up the Kestral facing the direction of wind for 8-10 seconds.
Photo Number	Input the multiple photo numbers and the corresponding direction the photo was taken. I.e. 054w 055s. There should be a minimum of three pictures. Photos to be taken are as follows: the project location map, a photo of the structure from street level in the middle of the road (include the structure number if possible), the structure number (if not already captured in the previous photo), a photo underneath the structure showcasing the walls, a photo facing out from underneath the structure, and multiple photos of bat sign/bats if present.
Comments	Input information deemed important for later review/records

APPENDIX 5

Data and Management Storage

Photo Storage:

- Connect camera or insert the SD memory card
- Navigate to the saving destination as follows:
  - X Drive (environmental)
  - General Info
  - T&E
  - Bat_terns
  - Bat_Survey_Photos
  - Select the folder for the corresponding District
- Make a new folder
  - Label folder to include district and date (District#_1.11.11)
  - Within your new folder, make new folders for each project (CN_00000)
  - If it's a local project (LP_CN_00000)
  - If there are more than one bridge/culvert on a project (CN_00000_1)
- Save photos
- Adjust the individual photo labels:
  - Photo #_direction the photo was taken

Photosheet Storage:

- Navigate to the saving destination as follows:
  - X Drive (environmental)
  - General Info
  - T&E
  - Bat_terns
  - Bat_Survey_Photosheets
  - Select the folder for the corresponding District
- Make a new folder
  - Label file to include district and date (CN_Photo_Pages_1.11.11)
  - If it's a local project (LP_CN_ Photo_Pages_1.11.11)
  - If there are more than one bridge/culvert on a project (CN_Photo_Pages_1.11.11_1)
- Save photosheet

GPS Data Storage:

- Connect the GPS Unit with a USB to the computer tower
- Open GPS Pathfinder
- Select the project name (Bat Surveys)
- If you need to create the project name Bat Survey:
    - Click *New* and navigate to the project folder as follows:
    - X Drive (environmental)
    - General Info
    - T&E
    - Bat_terns
    - GPS Data Storage
    - GPS Pathfinder Files
- Select Data Transfer on the main screen
- Add the data files
- Transfer all
- Open the newly saved files in the GPS Pathfinder Files folder
- Import files into GPS Pathfinder
- Complete Differential Corrections
- Open the Differential Corrections file you just created
  (this will appear next to the original file)
- Export the adjusted file
    - This will auto save into the Export folder in the GPS Pathfinder Files folder
- Open ArcGIS
- Select the file Bat_Surv_MASTER
- If you need to locate it, the location is as follows:
    - X Drive (environmental)
    - General Info
    - T&E
    - Bat_terns
    - GPS Data Storage

- Surveys_ArcGIS

- Right Click, Edit Features, Start Editing
- Select the Bat_Surv file from the date desired
- Right click:
  - Open attributes table
  - Upper left corner, click box, Select All
- Scroll back to map, points should be highlighted
- Put mouse to map, Right click-Paste
- A box pops up to verify you want to paste into Bat_Surv_MASTER
- Okay
- Save Edits under Editor drop down

Acoustic Monitoring Storage:

- Insert the SD memory card into the computer
- Navigate to the saving destination as follows:
  - X Drive (environmental)
  - General Info
  - T&E
  - Bat_terns
  - Acoustic_Monitoring
  - Raw Files
- Make a new folder
  - Label folder to include district and date (District#_1.11.11)
- Save Files
- Adjust files in Anabat/Sonobat
- To save the adjusted files, navigate to the saving destination as follows:
  - X Drive (environmental)
  - General Info
  - T&E
  - Bat-terns
  - Acoustic_Monitoring
  - Edited Files
- Make a new folder
  - Label folder to include district and date (District#_1.11.11)
- Save Files

APPENDIX 6

Photosheet Survey Examples

Photo 1: Above structure **Orientation:** East

Photo 2: Bat guano **Orientation:** South

Photo 3: Bat guano near abutment **Orientation:** South

Photo 4: bat guano by abutment **Orientation:** East

Photo 5: Midsection underneath bridge **Orientation:** West

Photo 6: Abutment ledge where bat guano was found **Orientation:** East

Photo 7: Area surrounding bridge structure **Orientation:** West

Benkelman East and West

Photo 1: View along the side of the roadway. **Orientation:** West

Photo 2: Vegetation surrounding structure. **Orientation:** North

Photo 3: View inside the structure **Orientation:** South

Photo 4: Looking south inside the structure. **Orientation:** South

Photo 1: View over roadway. **Orientation:** East

Photo 2: Vegetation surrounding bridge. **Orientation:** North

Photo 3: Underneath the structure. **Orientation:** West

Photo 4: View of side of the structure. **Orientation:** East

Keya Paha River Bridge East of Mills

Photo 1: View over roadway. **Orientation:** West

Photo 2: Side of structure under the bridge. **Orientation:** East

Photo 3: Side of structure. **Orientation:** West

Photo 4: Bat guano on bridge side. **Orientation:** West

Photo 5: Bats in crevice of bridge. **Orientation:** South

Photo 6: Bats in crevice of bridge. **Orientation:** South

Photo 7: Bats in crevice of bridge. **Orientation:** South

Photo 8: Bats in crevice of bridge. **Orientation:** South

APPENDIX 7

Structures With Bat Guano:
Seperated By District and Structure Type

District	Steel Girder
1	36
2	1
3	9
4	8
5	7
6	7
7	7
8	11
Total:	**86 Structures**

District	Concrete Box Culverts
1	5
2	1
4	8
5	5
6	3
7	10
8	1
Total:	**33 Structures**

Distirct	Concrete Girder
1	3
4	6
Total:	**9 Structures**

District	Concrete I Beam
4	1
Total:	**1 Structure**

District	Concrete T Beam
4	1
Total:	**1 Structure**

District	Concrete Tee
1	2
Total:	**2 Structure**

District	Concrete Slab
1	38
2	1
3	8
4	20
5	10
6	5
7	15
8	8
Total:	**105 Structures**

District	Culvert
4	2
Total:	**2 Structures**

District	Flat Slab
5	1
Total:	**1 Structures**

District	**Prestressed Girder**
1	5
3	5
5	1
6	3
7	6
8	2
Total:	**22 Structures**

District	Presressed T
5	1
Total:	**1 Structures**

District	Prestressed T Beam
4	3
5	1
8	1
Total:	**5 Structures**

District	Prestressed T
3	2
4	1
7	1
Total:	**4 Structures**

District	Steel Girder/Floor Beam
1	1
Total:	**1 Structures**

District	Steel Truss
1	2
Total:	**2 Structures**

Distirct	Timber
1	1
4	1
7	1
8	1
Total:	**4 Structures**

District	Timber Multi Beam
1	1
Total:	**1 Structures**

Bat Guano in Each District

District	Number of Bridges where Bat Guano is Present
1	17
2	1
3	10
4	3
5	3
6	2
7	11
8	10
Total:	**57 Structures**

APPENDIX 8

Statistical Graphs

Figure 1 shows the amount of bat sign for each bridge structure type. Steel Girder structures were the most likely to harbor bat sign, making up 57.9% of the total bridge structures with bat signs present.

Figure 1

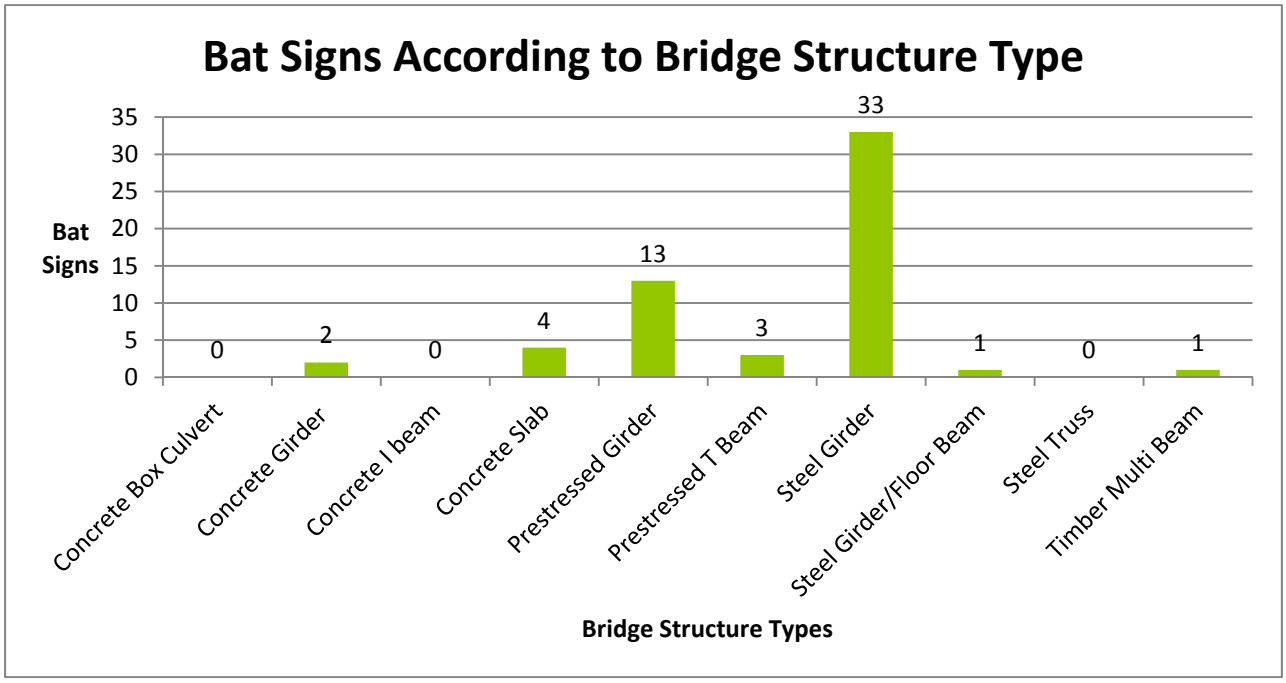
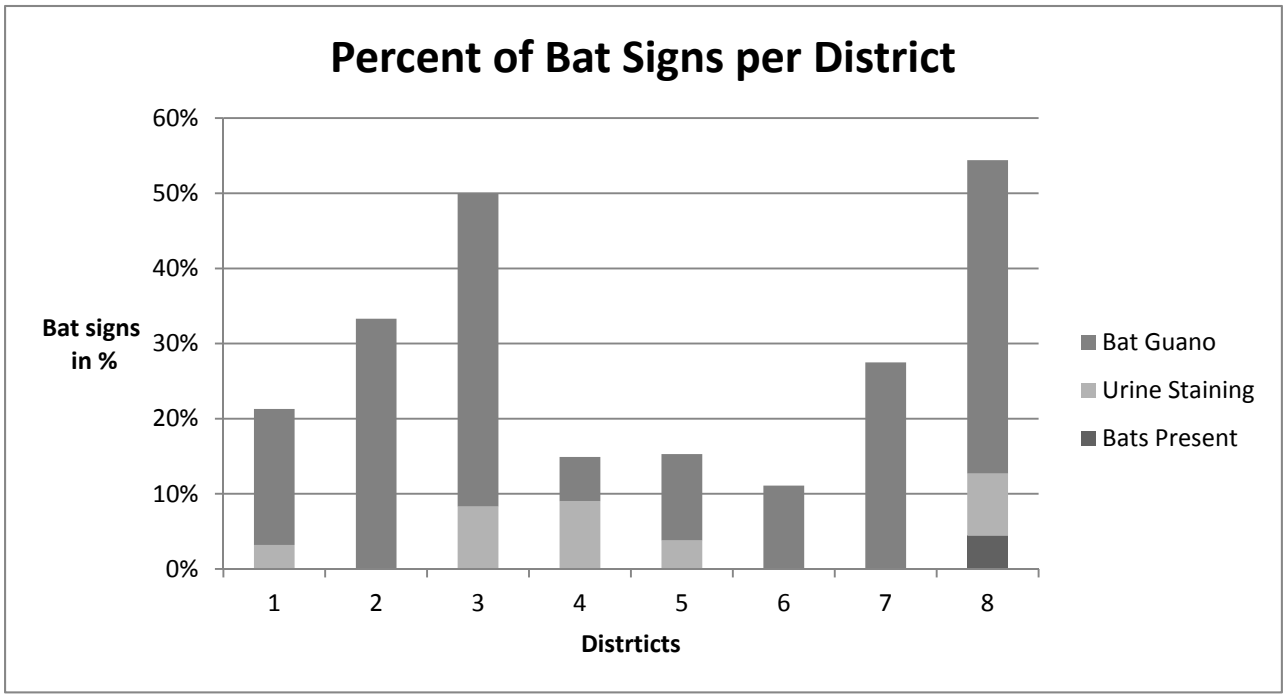


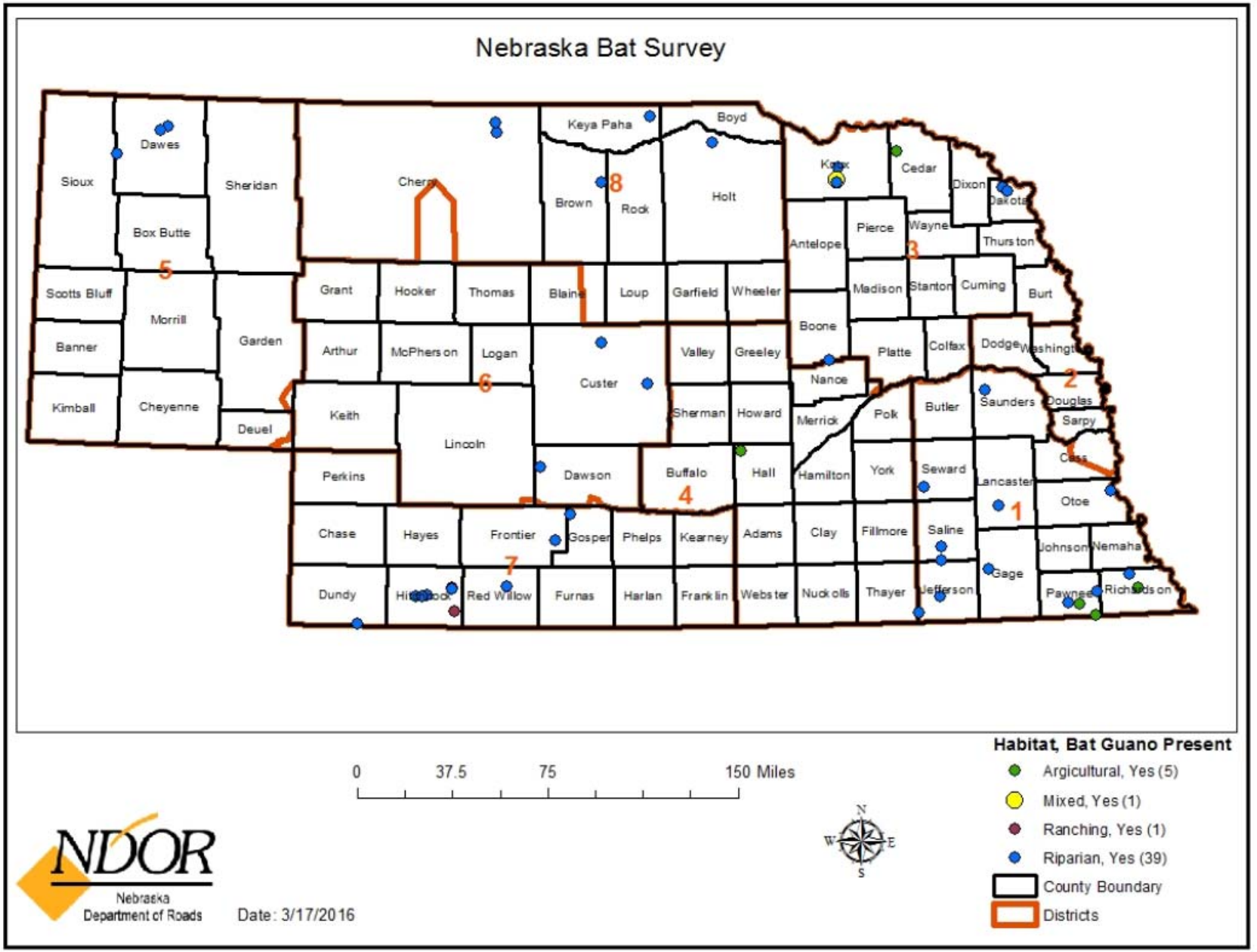
Figure 2 specifies the three types of bat sign and their prominanceon bridge structures in each district of Nebraska. Bat guano was the most likely bat sign to be found, followed by urine staining. Only one bridge was found to have bats present at the time of the survey.

Figure 2



APPENDIX 9

Nebraska Bat Survey Map


Nebraska Bat Survey
Dawes
Sioux
Sheridan
Box Butte
Cherry
Keya Paha
Boyd
Brown
Rock
Holt
Knox
Cedar
Dixon
Dakota
Antelope
Pierce
Wayne
Thurston
Scotts Bluff
Morrill
Garden
Grant
Hooker
Thomas
Blaine
Loup
Garfield
Wheeler
Madison
Stanton
Cuming
Burt
Banner
Arthur
McPherson
Logan
Custer
Valley
Greeley
Boone
Platte
Colfax
Dodge
Washington
Kimball
Cheyenne
Deuel
Keith
Lincoln
Sherman
Howard
Nance
Merrick
Polk
Butler
Saunders
Douglas
Sarpy
Perkins
Dawson
Buffalo
Hall
Hamilton
York
Seward
Lancaster
Otoe
Chase
Hayes
Frontier
Gosper
Phelps
Kearney
Adams
Clay
Fillmore
Saline
Johnson
Nemaha
Dundy
Hitchcock
Red Willow
Furnas
Harlan
Franklin
Webster
Nuckolls
Thayer
Jefferson
Gage
Pawnee
Richardson
1
2
3
4
5
6
7
8
0
37.5
75
150 Miles
N
W
E
S
Habitat, Bat Guano Present
Argicultural, Yes (5)
Mixed, Yes (1)
Ranching, Yes (1)
Riparian, Yes (39)
County Boundary
Districts
NDOR
Nebraska
Department of Roads
Date: 3/17/2016