Standing Analysis and Implementation Plan – Northern Long-Eared Bat Assisted Determination Key

Version 1.1 April 2023
Midwest Region
U.S. Fish and Wildlife Service
Bloomington, MN

LORI NORDSTROM Digitally signed by LORI NORDSTROM
Date: 2023.04.04
10:15:34 -05'00'

Lori H. Nordstrom
Assistant Regional Director, Ecological Services, Region 3
U.S. Fish and Wildlife Service

Table of Contents

1 INTRODUCTION

1.1 PURPOSE OF ANALYSIS

This standing analysis supports the Northern long-eared bat (*Myotis septentrionalis;* NLEB) Rangewide Determination Key (DKey), which will be delivered through the U.S. Fish and Wildlife (USFWS) Information for Planning and Consultation (IPaC) project planning tool. USFWS developed the DKey to streamline the process of reviewing actions for which "no effect" or "may affect, not likely to adversely affect" determinations for the NLEB are appropriate. This analysis is based on the best available scientific information and contains the analytical basis for those predetermined consultation outcomes. It also explains the basis for actions that do not warrant predetermined outcomes via the DKey and that should undergo additional review or consultation.

1.2 BENEFITS AND JUSTIFICATION FOR DETERMINATION KEY

The routine nature of the review of many actions (projects) provides an opportunity to programmatically evaluate their effects on this species. The streamlined process facilitated by the NLEB DKey will reduce the amount of staff time necessary to review these actions and provides federal agencies, consultants, and other project proponents a prompt response for qualified actions upon completion of the DKey in IPaC.

1.3 ELIGIBILITY FOR PREDETERMINED CONSULTATION OUTCOMES VIA THE DETERMINATION KEY

The DKey "kicks out" actions that are ineligible for predetermined 'no effect' (NE) or 'not likely to adversely affect' (NLAA) consultation outcomes. When a project is kicked out of the key, the DKey user is directed to coordinate with the local USFWS Ecological Services Field Office (ESFO) and/or to follow a supplemental consultation process. The precautions that are built into the key to are described below under **Conservation Measures**.

1.4 DETERMINATION KEY APPLICABILITY AND OUTCOMES

The DKey is intended to be used for both section 7 consultation for federal agency actions and for proponents of actions that lack a federal nexus.

1.4.1 Federal Agency Actions

Federal agencies must consult with USFWS under section 7(a)(2) of the Endangered Species Act (ESA) on any action that may affect an endangered or threatened species. This requirement applies to actions that a federal agency funds, authorizes, or carries out, in whole or in part.

For some actions, federal agencies will be able to complete Endangered Species Act (ESA) section 7 consultation for the NLEB via the DKey in IPaC. After completing the DKey, agencies have met their consultation requirement for the NLEB when they receive a verification letter that verifies a determination of 'may affect, not likely to adversely affect northern long-eared bat.' Two other outcomes are possible. If the project is consistent with a finding that the action will not affect the NLEB, the DKey will produce a "no effect consistency letter." If the action may affect the NLEB but does not qualify for either of those pre-determined outcomes, the agency would receive a "may affect consistency letter." That letter will provide further instructions for completing consultation.

1.4.2 Use of DKey by Non-Federal Representatives of Federal Agencies

Another entity may conduct informal consultation if the federal agency has designated them in writing to USFWS as their non-federal representatives (see 50 CFR § 402.08). These designated non-federal representatives may also conclude consultation for federal actions that may affect the NLEB if they receive a verification letter for a finding of 'may affect, not likely to adversely affect' for the species via the DKey.

1.4.3 Non-Federal Projects

Projects with *no federal nexus* are not subject to the section 7(a)(2) consultation requirements but are subject to its take prohibitions. Therefore, if non-federal actions are reasonably certain to cause incidental take of the northern long-eared bat, application for an incidental take permit (ITP) may be warranted. To help proponents of non-federal actions determine whether to apply for an ITP, actions eligible for NE or NLAA predetermined outcomes in the DKey would receive either a NE or NLAA consistency letter that would clarify that the action is not reasonably certain to cause incidental take of the NLEB.

1.5 Ensuring Accurate Determinations Through the Determination Key

Appropriate conclusions reached through the DKey rely on truthful and accurate responses to the questions. In the letters delivered to project proponents, USFWS states that "All information submitted by the Project proponent into the IPaC must accurately represent the full scope and details of the Project. Failure to accurately represent or implement the Project as detailed in IPaC or the Northern Long-eared Bat Rangewide Determination Key (Dkey), invalidates this letter."

1.6 Updating the Analysis

The USFWS DKey sponsor will ensure that this analysis is updated whenever changes to the DKey are proposed and whenever new information warrants updates. Public access to the most recent version of the standing analysis will be via the Internet - https://www.fws.gov/media/standing-analysis-nleb-determination-key. Current and previous versions of the standing analysis will also be maintained in the electronic files of the USFWS's Midwest Region 3 in the Standing Analysis folder at this SharePoint site - https://doimspp.sharepoint.com/:f:/r/sites/fws-NLEB/Shared%20Documents/Section%207/DKey?csf=1&web=1&e=3ZzSis.

2 PROPOSED ACTIONS

The Proposed Action includes a wide variety of different activities that could cause effects to the NLEB and to which agencies and others may apply the DKey. The structure of the DKey, including conservation measures (see below), will determine which specific actions in these broad groupings will be eligible for predetermined NE or NLAA outcomes. Listing of activities here does not imply that they will always result in effects to the NLEB.

- Vegetation management – for example, forestry activities, including timber harvest, and prescribed burning
- Construction, maintenance, operation, and/or removal of:
    - Roads and trails
    - Communication towers
    - Transmission and utility lines
    - Bridges and culverts
    - Oil and gas pipelines
    - Solar power facilities
    - Hydroelectric facilities/dams
    - Canals, levees, or dikes
- Commercial, residential, and recreational developments
- Agricultural activities
- Habitat restoration and enhancement
- Dredging and filling of wetlands or waterbodies

2.1 EXCLUSIONS

Actions that include certain activities, occur in certain geographic areas, or that meet one or more context-dependent conditions will not be eligible for pre-determined NE or NLAA consultation outcomes. Instead, the DKey will request that proponents of these actions contact the appropriate ESFO directly.

2.1.1 Generally Excluded Activities

To base section 7 consultation for a project on this standing analysis and to receive concurrence or verification with a 'no effect' or 'not likely to adversely affect' determination in IPaC through the DKey, actions and activities may NOT include the following:

1. Purposeful take of a NLEB (e.g., capture and handling for surveys or research).
2. Actions that may include construction or operation of wind turbines.

2.1.2 Exclusions Based on Geographic Locations

The DKey will apply broadly where the NLEB may be present, except in Michigan, where a state specific DKey will be used.

Actions that include blasting will also be excluded when they occur in certain geographic areas (e.g., karst landscapes), as will actions that affect areas near a documented hibernaculum. These and other conditional exclusions are addressed below under Conservation Measures.

2.2 STATE- AND REGIONALLY SPECIFIC FOCUS AREAS

Except in the areas excluded from the DKey, it will generally apply across the range of the NLEB. For a few states, however, the DKey includes a "hidden semantic" question that further defines the area in which we think the NLEB may be present. Actions that affect only areas outside of these state-specific "focus areas" would not affect the NLEB. The basis for each of these focus areas is summarized below.

2.2.1 New York

New York's focus area is based on analysis of acoustic sampling data collected during 2006-2017, primarily on National Wildlife Refuges in the northeastern United States, and capture data collected during 2015-2018 (De La Cruz et al. 2019, entire). Their analysis suggests that populations of the NLEB in the northeastern U.S. are now localized and that the species is no longer widespread across the region (De La Cruz et al. 2019, p. 18).

2.2.2 Western North Carolina – Asheville, North Carolina Ecological Services Field Office Area

The Asheville, North Carolina ESFO reviewed existing NLEB data (positive and negative), NLEB life history and home-range in western North Carolina to refine and create a NLEB focus area for western North Carolina. ESFO biologists concluded that the NLEB is only likely to be present in North Carolina in the Level III Blue Ridge Ecoregion (Wilken et al. 2011, p. 70). To create the polygons used by the DKey, they buffered the Blue Ridge Ecoregion polygons by five miles and applied a Concave Hull (XTools Pro) with a level of detail set at 40 on the buffered Blue Ridge Ecoregion. The latter step was done to connect separate Blue Ridge Ecoregion polygons and create a single contiguous polygon in North Carolina.

2.2.3 Georgia

The focus area for Georgia is based on results of a multi-agency and university study that included modeling based on habitat and geographic features, historic NLEB records, and records of NLEBs activity collected by mist netting, acoustic sampling, and radio telemetry tracking (Grider 2020). Grider's (2020) model estimated occupancy prior to WNS in Georgia (2007-2011) and, using records collected 2012-2017, the species' post-WNS distribution. He found that post-WNS, NLEB "occupancy was associated with large patches of deciduous forest and areas of higher elevation" and "the extirpation of peripheral populations." The Georgia Department of Natural Resources (GDNR) continues to monitor the species' status at a subset of the sites used for Grider's study but has not detected the species anywhere in the state since 2017. GDNR is also sampling coastal areas in habitats like those where the NLEB has been found on the coastal plains of North Carolina and South Carolina but has not detected the species there either.

2.2.4 New England States (CT, RI, MA, NH, and VT) and Maine

The USFWS New England and Maine ESFOs developed a focus area for the states of Connecticut, Rhode Island, Massachusetts, Maine, New Hampshire, and Vermont based on occupancy modeling (De La Cruz 2022) and supplemented with recorded locations of NLEB hibernacula, acoustic detections, and roosts. The occupancy modeling relied on acoustic data collected from 2013-2021 and habitat data. The habitat data included habitat diversity, evenness, and richness, land use/land cover, tree canopy height, forest fragmentation, distant to and from forest edge, average annual temperature, elevation, aspect, and slope (De La Cruz 2022, p. 1). The model produced an occupancy probability map for the five states and Maine. The final focus area map included the areas where the occupancy probability was 30% or greater plus additional areas within 5.0 of NLEB hibernacula, within 3.0 miles of NLEB captures and acoustic detections, and within 1.5 miles of known roosts.

2.2.5 Chesapeake Bay States (DE, MD, and DC)

The rationale that the Chesapeake Bay ESFO used to determine the focus area for Delaware, Maryland, and the District of Columbia is based on the distribution of the NLEB among physiographic provinces in the states and district and NLEB occupancy predictions made by NABat (Udell et al. 2022) A report detailing the methods used to arrive at the focus area is in the administrative file for this standing analysis.

2.3 IPaC and Individual Action Areas

The DKey is made available to agencies and the public via IPaC. The DKey uses GIS data to answer some key questions and to implement certain conservation measures, as described in the next section. To ensure that these geographically sensitive conservation measures are applied correctly, DKey users will have to accurately enter their "project location" in IPaC.

IPaC users enter project locations by uploading GIS data or by using the built-in drawing tools. When in the program the instructions for the user are to "Draw the area where activities will occur." For projects with significant effects to areas outside of where project activities will occur, it's possible that some users will not fully define the action area. This is addressed by an answer to the 'frequently asked question' in IPaC:

- What should be considered when defining a project location?

  When designating your project location in IPaC, the USFWS recommends that you consider not only the physical location of project activities, but also any surrounding area on the landscape where potential effects to species may occur (e.g., delineate all areas that could possibly be affected, including nearby areas that may be affected by runoff, noise, etc.). For projects with a Federal nexus that are required to consult with USFWS under section 7 of the Endangered Species Act, we recommend defining the project location for IPaC as your Action Area; definitions of Action and Action Area can be found at 50 CFR 402.02.

If DKey users define the action area in IPaC according to these instructions, incorrect determination in the DKey would be avoided or minimized due to failure to include the full extent of the affected area.

2.4 Conservation Measures

The DKey does not apply conservation measures in the traditional sense of the definition – that is, recommendations that can be incorporated into an action design to avoid, minimize, or mitigate potential adverse effects on an individual, population, or to the entire species. Instead, our intent is for the DKey to identify and kick out for individual review, any action that would have more than a discountable likelihood of causing adverse effects to the NLEB.

2.4.1 Protection of Known and Potential Hibernacula and hibernating bats

2.4.1.1 Known Hibernacula

The DKey "kicks out" actions for individual review if they would affect any area within 0.5 mile of an entrance to a hibernaculum. For some states the DKey will use embedded GIS data to identify actions that fall within 0.5-mile of a known hibernacula opening. For other states, the DKey will direct users to a webpage where they can find one or more information sources for their state to determine whether their action area occurs within 0.5-mile hibernaculum 'buffer.'

2.4.1.2 Potential Hibernacula

The DKey is also sensitive to the possibility that an action will affect an area that's within 0.5-mile of an opening to a *potential* NLEB hibernaculum – a hibernaculum in which the NLEB has not been recorded. When an action area does not overlap with a known hibernaculum buffer, the Dkey prompts the user to evaluate the area for potential hibernacula by using the recommended assessment process in the USFWS survey guidelines (U.S. Fish and Wildlife Service 2022*a*, p. 57). These guidelines direct users to look for signs of typical NLEB hibernation habitat in the action area – caves and their associated sinkholes, fissures, and other karst features, as well as anthropogenic features such as mines and tunnels.

2.4.2 Protection of Northern Long-Eared Bats in 'Atypical' Hibernacula

To ensure that certain natural atypical hibernacula are considered, we include a question in the key for certain states to ensure that action agencies coordinate with the USFWS on actions that affect areas that contain talus or rock crevices (within cliff or rock faces). NLEB hibernation in talus slopes has been documented in Maine (W. Mahaney, U.S. Fish and Wildlife Service, pers. comm. August 18, 2022); hibernation in crevices in cliffs or rock faces has been documented in Maine and Nebraska, respectively (W. Mahaney, pers. comm.; White et al. 2020, entire). Although documented thus far only in those two states, USFWS biologists also suspect use of talus or rock crevices in Alabama, Arkansas, Georgia, Illinois, Indiana, Iowa, Kansas, Maine, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Vermont, West Virginia, and Wyoming. Therefore, the DKey will direct users to field offices for individual coordination when actions may affect these 'atypical' potential hibernacula in those states.

2.4.3 Blasting and drilling

The DKey includes a series of questions to ensure that blasting is not carried out where it could damage hibernacula or harm hibernating NLEBs. In some states (Alabama, Arkansas, Kentucky, New York, and Ohio), all blasting actions are excluded from the DKey for individual review. In those states FWS staff concluded that the risk posed to NLEBs by blasting may be too great even when known or potentially suitable hibernacula were not known to occur within the affected area. In other states, DKey users may only proceed with the key if the action will not include drilling, blasting or other activities that could affect known or potentially suitable hibernacula. Impacts also include changes to hydrology or air flow that may impact the suitability of hibernacula.

2.4.4 Protection of spring staging/fall swarming habitat

Geographic data is also used in the DKey to exclude (for individual coordination) actions that affect any area within 5 miles of a known NLEB hibernacula opening. For some states the DKey will use embedded

GIS data to notify users when their actions fall within a 5-mile buffer of hibernacula openings. In other states, the DKey will direct users to a webpage to help with this determination.

In staging/swarming areas, the DKey allows for a pre-determined 'not likely to adversely affect' (NLAA) conclusion for prescribed fire when its effects are restricted to the hibernation period. Although note that if the fire is likely to affect any area within 0.5 mile of a hibernaculum, an NLAA conclusion in the DKey is not possible. For tree removal within staging/swarming buffers, DKey users could get an NLAA determination if the tree removal is carried out during the hibernation period, does not exceed 10 acres, and does not fragment a forested connection between forest patches of at least 5 acres each. As with the effects of prescribed fire, tree removal that occurs within 0.5 mile of a hibernaculum would not be eligible for a pre-determined NLAA outcome in the DKey regardless of the timing or extent of the tree removal.

2.4.5 Protection of 'summer' Habitat and tree-roosting Northern Long-Eared Bats

2.4.5.1 Northern Long-Eared Bat Conservation Buffers – Protecting Areas with Recent Records of Summer Use

The DKey includes several measures that are intended to facilitate enhanced protection of the NLEB and its habitat in areas where there are recent records of its occurrence during the summer active period. These "conservation buffers" include the areas within 3-mile of NLEB captures or acoustic detections and within 1.5-miles of known NLEB roosts (U.S. Fish and Wildlife Service 2022*a*, p. 54). To determine where these measures will apply in some areas, the DKey will rely on embedded GIS data provided by ESFOs. Individual ESFOs also determined which NLEB records should be used as reliable indicators of current use in establishing summer use conservation buffers. In areas where GIS data is not incorporated into the DKey, users will be directed to a USFWS website to find out how to contact the appropriate agency to determine if the action area overlaps with a known northern long-eared bat conservation buffer.

2.4.5.2 Tree Removal

2.4.5.2.1 Active Season Tree Removal

To ensure that tree removal does not affect NLEBs directly, the DKey kicks out any action that includes tree removal in suitable summer habitat during the active season unless there is sufficient evidence of the species' absence. The timing of the active season – when NLEBs may be present outside of hibernacula and using trees for roosting – varies depending on geographic location and proximity to hibernacula. NLEBs inhabit forest near hibernacula earlier in the spring and later in the fall than outside of staging and swarming areas, respectively. To ensure that project proponents appropriately consider the timing of any tree removal relative to the potential presence of the NLEB in the affected area, the DKey directs users to a state-by-state list of active season dates.

Actions that include tree removal during the active season may be eligible for a pre-determined consultation outcome of 'not likely to adversely affect' if there is sufficient information that the NLEB is probably absent, based on a presence/probable absence summer bat survey that targeted the northern long-eared bat in the action area. The survey will have to have followed the USFWS Range-wide Indiana Bat and Northern Long-Eared Bat Survey Guidelines (U.S. Fish and Wildlife Service 2022*a*), must have been conducted within the last five years, and the results will have to have been confirmed as valid by the ESFO. To ensure that the ESFO has recognized the survey results as valid, DKey users will be prompted to upload that confirmation. If the survey was conducted without pre-approval of the methods by FWS, the DKey user will have to coordinate with the ESFO and receive and upload both survey results and field office authorization of the survey design – the same coordination and approval will be needed for any survey that is older than five years.

2.4.5.2.2 Winter Tree Removal

To minimize the likelihood that tree removal during the hibernation period will not adversely affect the species indirectly, the DKey kicks out actions that include tree removal across an area of 10-acres or more.

2.4.5.3 Prescribed Fire

Unless surveys adequately demonstrate the probable absence of the NLEB, prescribed fire that will affect suitable summer habitat for the NLEB when the species may be present will not be eligible for a NLAA outcome in the DKey. This will minimize the likelihood that NLEBs will be exposed to harmful heat and flames or other indirect effects of fire during the active period.

2.4.6 Protection of Northern Long-Eared Bats in Bridges and Culverts

2.4.6.1 Types of Bridge Actions Likely to be Excluded/Covered Under the DKey

The DKey includes measures to ensure that it does not inappropriately provide 'not likely to adversely affect' determinations for actions that involve work on bridges or culverts. The DKey mostly excludes actions that are eligible to be covered under the Range-wide Programmatic Consultation for Indiana Bat and Northern Long-eared Bat for transportation actions (Transportation Programmatic). Many of the bridge actions that may affect the NLEB will be covered under the procedures adopted for that programmatic consultation.

DKey users may have actions, however, that do not have a nexus to any of those three agencies or for which project proponents choose to use the rangewide key. This may include, for example, bridge actions carried out by a federal land management agency or actions carried out by state or local governments that lack federal assistance.

2.4.6.2 Geographically Specific Measures and Transportation Structure Assessments

In several states, the USFWS opted to direct any action that may affect a bridge and that was not covered by the Transportation Programmatic to the field office for individual review – those states include Georgia, Kansas, Mississippi, Missouri, and North Dakota. In New Jersey, the DKey will direct users online to bridge evaluation guidelines specific to the state. In all other states within the range, proponents of bridge actions will have to carry out a site-specific bridge/structure assessment, coordinate directly with the USFWS field office, or both. For assessments of bridge and certain other transportation structures that NLEBs may inhabit (e.g., culverts), the DKey directs users to Appendix D of the User's Guide for the Range-wide Programmatic Consultation for Indiana Bat and Northern Long-eared Bat and the associated Bridge/Structure Bat Assessment Form. The DKey instructs users to coordinate with ESFOs before applying the results in the key to ensure that they use only valid results.

Culverts are handled a little bit differently in the DKey than bridges. In no state are actions automatically kicked out for ESFO coordination due to effects to a culvert. Instead, proponents of any action that will affect a culvert that is greater than 4 feet tall and 130 feet in length will have the same choices as for many bridge actions – conduct a structure assessment using the same guidance as discussed above for bridges or coordinate with the ESFO. NLEBs These dimensions are slightly smaller than the minimum dimensions of culverts in which the NLEB has been documented, based on a review the available information for the species conducted in 2022 by the USFWS Asheville, Norther Carolina Ecological Services Field Office and that are described below in the section 5.6, below. The smallest-diameter and shortest culverts in which NLEBs have been documented was in Louisiana and were 4.5 feet tall and 131 feet long (Nikki Anderson, unpublished data, March 23, 2022). We undercut these dimensions slightly to minimize the chance that the DKey would provide a 'not likely to adversely affect' determination for work on a culvert in which NLEBs were present. We will check with each USFWS ESFO in the range of the species each year to ensure that these dimensions are appropriately conservative.

There is no record of the NLEB using bridges for roosting in either New Hampshire or Vermont, except for covered bridges (S. Von Oettingen, New England Ecological Services Field Office, Concord, NH, pers. comm. 2022). Therefore, the Dkey will pull out for individual review actions that affect covered bridges in these two states, but not if they affect other bridge types.

2.4.7 Protection of Northern Long-Eared Bats in Buildings

2.4.7.1 Intentional Exclusion of Bats from Buildings

To ensure that intentional exclusion of bats from a building or structure is not likely to adversely affect NLEBs, the DKey will not provide a predetermined consultation outcome for any action that includes this activity. The DKey directs users to seek assistance from USFWS to help determine whether NLEBs may be present. The key also provides guidance to ensure that the exclusion, if eventually carried out, is done in a way that would avoid harm to bats.

2.4.7.2 Removal, Modification, or Maintenance of Buildings with Bats

To help ensure that removal, modification, or maintenance of human-made structures (barns, houses, or other buildings) does not adversely affect NLEBs, actions that include any of those activities will not be eligible for a predetermined NLAA outcome if the structures are known or suspected to contain roosting bats.

2.4.8 Potential Impacts of Increased Vehicle Traffic – Ensuring Adequate Review

Increased vehicle traffic may pose a risk to NLEBs due to effects of increased risk of collision and noise (see Effects to Foraging and Drinking Bats, below). Actions eligible for the national bat transportation programmatic will be addressed outside of the range wide key. Therefore, this conservation measure will apply to those transportation actions that fall outside the scope of that consultation.

To ensure that risks to the NLEB caused by increased vehicular traffic are adequately considered by action proponents and USFWS, the range wide DKey poses the following questions for actions whose effects occur within 1000' of suitable NLEB habitat:

1. Will the action directly or indirectly cause construction of one or more new roads that are open to the public? Or, will the action include or cause any construction or other activity that is reasonably certain to increase average daily traffic on one or more existing roads? Or, will the action include or cause any construction or other activity that is reasonably certain to increase the number of travel lanes on an existing thoroughfare?

2. Will any new road, increased traffic, or new lands go through any area of contiguous forest that is greater than or equal to 10 acres in total extent or will any new road pass between two patches of contiguous forest that are each greater than or equal to 10 acres in extent and are separated by less than 1,000 feet?
3. If the answer is 'yes' to each question, the action is ineligible for the key and the action proponent will be directed to coordinate with the USFWS ESFO unless the answer is yes to the following question – "For every 1,000 feet of new road that crosses between contiguous forest patches, will there be at least one place where bats could cross the road corridor by flying less than 33 feet (10 meters) between trees whose tops are at least 66 feet (20 meters) higher than the road surface?"

The DKey deals with other potential effects of transportation actions in other series of questions, including effects to habitat and effects of artificial lighting.

2.4.9 Addressing Exposure to Water-Borne Contaminants

NLEBs may be exposed to water-borne contaminants in drinking water and in aquatic invertebrate prey. Water for drinking is known to be important for other myotid bats and it's presumed that NLEBs also drink routinely from surface water sources (Adams and Hayes 2008, p. 1115, Geluso et al. 2018, p. 288). Although NLEBs may prey primarily on terrestrial insects, they do sometimes prey on aquatic insects (Broders et al. 2014, p. 321).

To minimize the likelihood that actions will raise a significant risk of exposure to water-borne contaminants, actions for which the answer is 'yes' to either of the following two questions will be kicked out for individual coordination:

1. Will the proposed action involve the creation of a new water-borne contaminate source (e.g., leachate pond pits containing chemicals that are not NSF/ANSI 60 compliant)?
2. Will the proposed action involve the creation of a new point source discharge from a facility other than a water treatment plant of storm water system?

2.4.10 Lighting

To avoid or minimize the likelihood that artificial lighting could adversely affect NLEBs, the DKey kicks out actions that include temporary or permanent lighting within 1000' of suitable NLEB habitat unless they include certain conservation measures. In other words, actions that include lighting may be eligible for a 'not likely to adversely affect' determination when they include the following measures:

1. The use of downward-facing, full cut-off lens lights (with same intensity or less for replacement lighting) when installing new or replacing existing permanent lights.
2. Or, if using the Backlight, Uplight, Glare (BUG) system developed by the Illuminating Engineering Society, will all three ratings (backlight, uplight, and glare) be as close to zero as is possible, with a priority of "uplight" of 0?

Even when projects include the two measures above, they must also ensure that any temporary lighting is directed away from suitable habitat during the active season to be eligible for a 'not likely to adversely affect' determination via the key.

3 Action Area

The action area is the entire range for the NLEB in the United States (Fig. 1).

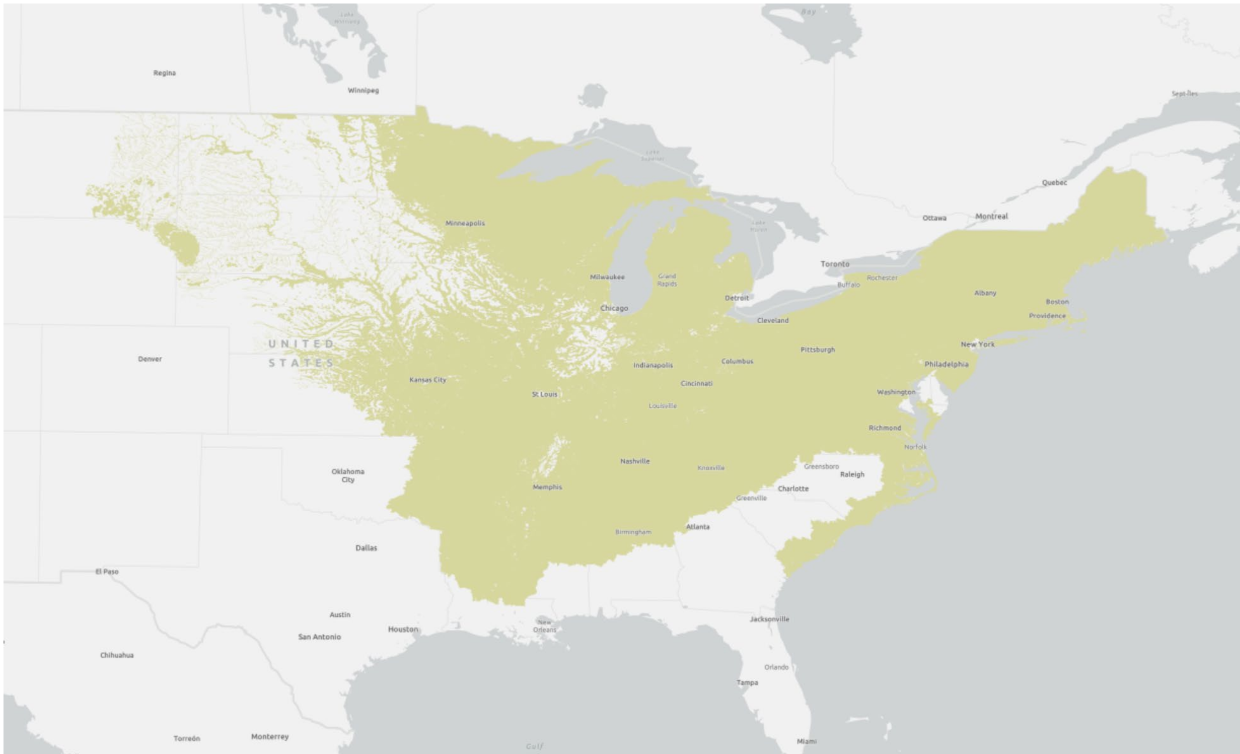

Figure 1. Range of the northern long-eared bat in the United States.

4 Covered Species – Northern Long Eared Bat

The only species covered in the DKey is the endangered NLEB.

4.1 Species Habits and Habitats

NLEBs spend winter hibernating in caves, mines, or similar structures, preferring areas with constant temperatures, high humidity, and no strong air currents. The “active season” includes the portion of the year that the species is not hibernating. During summer, NLEBs typically roost underneath bark or in cavities, crevices, or hollows of both live trees and snags (standing dead trees) that are typically ≥3 inches diameter at breast height. To a lesser extent, NLEBs may roost in manmade structures, such as barns and sheds.

NLEBs forage for insects in upland and lowland forests, woodlots, and tree-lined corridors. When available, NLEBs will use narrow lines of trees to move between forest patches to avoid crossing open fields and may “rarely venture more than a few meters from forest” (White et al. 2017, p. 8). Fall swarming near hibernacula occurs between the summer and winter seasons. Swarming sites play an important role in maintaining genetic diversity because mating and copulation occurs during swarming and because they attract members of multiple summer colonies (Kurta et al. 1997, p. 479, Lowe 2012, p. 51, Randall and Broders 2014, p. 114).

4.2 Species Status in the Action Area

The NLEB is one of the species most impacted by white-nose syndrome. Due to declines caused by white-nose syndrome and continued spread of the disease, the NLEB was listed as threatened under the ESA on April 2, 2015. In 2022 USFWS completed a species status assessment (SSA) for the NLEB, which included a thorough review of the species' taxonomy, life history, and ecology (U.S. Fish and Wildlife Service 2022*b*, entire). The SSA informed the USFWS's proposal to reclassify the NLEB as endangered (87 FR 16442), which published on March 23, 2022.

For additional information on the NLEB, including the SSA, visit: https://www.fws.gov/species/northern-long-eared-bat-myotis-septentrionalis.

5 Effects Analysis

5.1 Effects of Noise

5.1.1 Effects of Noise to Foraging and Drinking Bats

Exposure to intense noise could have adverse effects on NLEBs ability to use affected areas for foraging by impairing perception of sounds made by prey. Gleaning bats like the NLEB "rely on listening for prey rustling sounds to find food (i.e. `passive listening')" (Schaub et al. 2009, p. 3174). In a controlled study, greater mouse-eared bats – another gleaning species – were allowed to forage in silent chambers or those with three different noise treatments. The bats avoided areas exposed to sources of intense noise, including that resembling noise of vehicle traffic (Schaub et al. 2009, p. 3179). The bats also avoided noise whose structure resembled vegetation noise, but at an intensity that may only occur during storms (Schaub et al. 2009, p. 3174). The "click-like" noise used in their study to resemble the noise of rustling vegetation may have impaired the bats' "perception of prey-rustling clicks" (Schaub et al. 2009, p. 3179). NLEBs are "active gleaners" – they glean, but use echolocation to detect their prey (Faure et al. 1993). The authors concluded that their results suggested that foraging areas within 50 meters of highways and presumably also to other sources of intense broadband noise "are degraded in their suitability as foraging areas for the greater mouse-eared bat" and that the number of vehicles would affect the intensity of the degradation (p. 3179).

Other sources of noise, like loud music, can have a similar and distracting effects on foraging and also drinking (Domer et al. 2021, p. 499). Noise can distract bats and when attempting to forage in noisy areas they increase sonar pulses and are less successful in locating and capturing prey (Bunkley and Barber 2015, p. 1, Allen et al. 2021, p. 1). Noise effects on bat foraging and other behaviors will vary in relation to volume, proximity, and duration of noise. Effects from noise attenuates with distance; for example, two studies found no or insignificant effects of traffic noise to bats when bats were more than 50-150 meters (m) from the noise source (Schaub et al. 2009, p. 3179, Bonsen et al. 2015, p. 355). Pallid bats' foraging efficiency was reduced when exposed to "noise playbacks replicating acoustic conditions as far away as 640 m from a major road and 320 m from a natural gas compressor station bunk(Bunkley and Barber 2015, p. 1120).

Song et al. (2020, p. 17) exposed bats to a recording made at a bridge and played back at an intensity intended to mimic exposure roosting in crevices of the bridge. The exposed bats fed and weighed more and had a higher concentration of thyroid hormones (Song et al. 2020, p. 1922). The authors concluded that increased feeding was probably a result of the stress response to the noise and noted that weight gain is an expected result of a physiological stress response. In an experiment that exposed free-living bats to recorded traffic noise in England, *Myotis* species substantially decreased their activity in experimental areas where they were exposed to the noise (Finch et al. 2020, p. 4). They found no evidence of habituation across the approximately 2-3 month duration of the two study periods in 2017 and 2018 (Finch et al. 2020, p. 3-5). The lesser response to ultrasound compared to noise in the sonic spectrum indicated that the noise acted "through general deterrence and avoidance" as opposed to interfering with echolocation (Finch et al. 2020, p. 5). In Germany, successful foraging bouts decreased "and search time drastically increased" for greater mouse-eared bats (*Myotis myotis*) when exposed to noise intended to simulated conditions 7.5 meters from a road (Siemers and Schaub 2011, p. 1646). Similar results were found for pallid bats (*Antrozous pallidus*) "when exposed to played-back traffic and gas compressor station noise in the laboratory" (Bunkley and Barber 2015, p. 1116). Pallid bats are a gleaning species, a trait shared by the NLEB, and increased time needed to locate prey generated sounds by two- to threefold when exposed to both types of noise. Like the findings of Finch et al. (2020) for *Myotis* species, Luo et al. (Luo et al. 2015, p. 3278) found that noise acted as an aversive stimulus and did not mask prey echoes.

Some bats – for example, the piscivorous *Noctilio albiventris* – are versatile in their use of different pulse types and apply that versatility when "faced with noisy conditions" (Yantén et al. 2022, p. 6). This species increased feeding in response to traffic noise, presumable due to challenges in detecting and locating prey "under noisy conditions" despite their ability to vary the duration of their echolocation pulses (Yantén et al. 2022, p. 4).

5.1.2 Effects of Noise on Roosting Bats

Noise produced during construction or implementation phases of actions and more permanently during operational phases could cause NLEBs to respond adversely. Adverse responses could include increased exposure to predators, energy depletion, and physiological stress. An individual's response to this stressor is dependent on the magnitude of the noise, the proximity of the individual to the source, and an individual's level of habituation to the stressor.

Noise could cause NLEBs to flush from roosts where they would face an increased risk of predation. Clutter-adapted gleaning species, like the NLEB may be particularly vulnerable to predators due to their typically low and slow flight (Mariton et al. 2023, p. 7).

There is experimental evidence that bats can habituate quickly to exposure to "repeated and prolonged noise" when in torpor, but that they become more sensitive to noise as torpor progress towards night (Luo et al. 2014, p. 1072).

Some bat species, like the greater mouse-eared bats, may commonly roost where they are exposed to noise – e.g., in church towers near loud bells and in highway bridges (Schaub et al. 2009, p. 3178). These areas may remain useful for roosting, however, due to the short duration and low frequency of church bell use and by roosting in the structure of bridges where "high frequency components of traffic noise will be strongly attenuated" (Schaub et al. 2009, p. 3178).

5.1.3 Sources of Chronic or Intense Anthropogenic Noise

In addition to vehicle traffic, sources of chronic or intense anthropogenic noise that have been found to cause adverse effects in wild terrestrial organisms include compressor stations (Kleist et al. 2018); large concentrations of humans (i.e., crowds; Duarte et al. 2011); military training (vehicles, aircraft, and encampments, Gese et al. 1989); and low-altitude jet aircraft (Maier et al. 1998). Other potential sources of adverse anthropogenic noise include oil and gas extraction, construction, and mining (Jerem and Mathews 2021).

5.2 Effects of Artificial Lighting

Bat species like the NLEB that fly late at night, forage in narrow spaces, and that are adapted for "flight within cluttered vegetation" are consistently found to avoid or reduce activity in areas lit artificially (Threlfall et al. 2013, Pauwels et al. 2019, p. 1, Voigt et al. 2021). Late species tend to be "gleaning or flutter-detecting" clutter-adapted species with a prey base – e.g., moths – that are abundant throughout the night (Threlfall et al. 2013, Mariton et al. 2023, p. 7). The NLEB is a clutter-adapted gleaning species and so we presume that it would also be characterized as a "late species" and this is consistent with NLEB activity patterns analyzed by Gorman (2023, p. 41). Artificial light can delay onset of nightly activity in these "late species", which are active mostly during the darkest hours (Mariton et al. 2022, 2023). Late species are also typically slow flyers, vulnerable to predation at higher light levels (Lacoeuilhe et al. 2014, p. 7). We should note that NLEBs also fly from perches to catch insects in the air (i.e., "hawking", Ratcliffe and Dawson 2003).

Numerous studies involving bat species like the NLEB suggest that artificial light could reduce the suitability of an area for foraging and cause them to avoid lit areas. In Connecticut, lighting negatively affected little brown bat activity and decreased their use of a lit wetland for foraging (Seewagen and Adams 2021, p. 5640). In England, activity of *Myotis* species declined significantly under orange, white, and green light – impacts of red light were also negative, but not significantly so (Zeale et al. 2018, p. 5912). In France, lighting had a significant negative effect on *Myotis* species activity whether the lighting was on for the entire night or for only partial nights (Azam et al. 2015, p. 4336-4337). In Italy, bat activity declined at lit sites "mainly due to the response of the most abundant species, *Myotis daubentonii*" (Russo et al. 2019, p. 1671). In France, lighting intensity had mixed effects on bats, but the effect was significantly negative for *Myotis* species (Lacoeuilhe et al. 2014, p. 3). The light-negative species included aerial hawking and primarily gleaning bats, the two foraging habits used by NLEBs – no gleaning bat species were among light-tolerant species (Lacoeuilhe et al. 2014, p. 4). In the Netherlands, feeding of pond bats (*M. dasycneme*) was reduced by 60% on nights when they were exposed to artificial light versus dark control nights (Kuijper et al. 2008, p. 37). In England and Wales, experimental exposure even to low levels of LED lights reduced activity of *Myotis* species (Stone et al. 2012, p. 2458).

Citing Azam et al. (2018) and Pauwels et al. (2019), Schroer et al. (2020, p. 11) stated that "The behavior of light-sensitive bats can be impaired within the radius of up to 50 m distance to the light source, even if the luminance level is as low as 1 lux" (lx). Azam et al. (2018, p. 130) actually detected streetlight avoidance at values below 1 lux[1] by *Myotis* species and Serotine bat (*Eptesicus serotinus*) at 50 m from a streetlight (Azam et al. 2018, p. 123). They did not detect avoidance at 100 m and recommended "separating streetlights from ecological corridors by at least 50m and to limit vertical light trespass on vegetation to less than 0.1 lx to allow their effective use by light-sensitive bats" (Azam et al. 2018, p. 130). Typical full moon light levels alter the flight activity of bats and are about 0.1 lux (Voigt et al. 2018, p. 8 and 34).

Projects that incorporate certain conservation measures that will limit the 'spill' of light into habitat suitable for the NLEB will qualify for predetermined 'not likely to adversely affect' determinations in the key In England, *Myotis* species remained active near lit areas as long as the experimental light treatments were blocked by a hedge, "indicating that good management of light spill, can mitigate disturbance to" these bats (Zeale et al. 2018, p. 5915).

5.3 Loss and Degradation of Aquatic Resources

NLEBs may be affected by a reduction in stream length over which they forage and by a reduction in habitat available for aquatic insects. Water quality degradation, because of increased sedimentation during construction, could reduce the densities of aquatic insects that bats consume. Bats may have to fly farther to access foraging resources. Actions that will directly impact streams will require a permit or authorization from the U.S. Army Corps of Engineers conditioned with Best Management Practices (BMPs) to minimize sedimentation onsite and downstream. We expect the effects of sedimentation of aquatic resources to be temporary and minimal due to the scale of qualifying actions, the temporary nature of the activity, and the use of the BMPs.

5.4 Tree Removal, Loss of Foraging and Commuting Habitat

Some actions included in the Proposed Action will involve tree removal. Tree removal could affect NLEBs by the loss and/or fragmentation of foraging and commuting habitat and the removal and loss of roost trees. Actions that implement the conservation measures for NLEBs will not result in a gap in forested habitat of greater than 1,000 feet or isolate habitat. Due to the minimal scale of the removal, we expect any effects to the NLEB from loss of foraging and commuting habitat to be insignificant.

5.5 Tree Removal, Loss of Roost Trees

5.5.1 Northern Long-Eared Bat Roost Trees

NLEBs roost in live trees and snags (standing dead trees) ≥3 inches diameter at breast height (dbh) that have exfoliating bark, cracks, crevices, and/or cavities. NLEBs select roosts to optimize thermal conditions and so preferences for tree species and roost characteristics (e.g., live v. dead; canopy position and solar exposure, etc.) vary with difference in ambient temperatures based on weather and climate (Patriquin et al. 2016, p. 53). NLEBs typically roost singly or in maternity colonies underneath bark or more often in cavities or crevices of both live trees and snags (Sasse and Pekins 1996, p. 95, Foster and Kurta, Allen 1999, p. 662, Owen et al. 2002, p. 2, Carter and Feldhamer 2005, p. 262, Perry

[1] A lux is "a unit of illumination equal to the direct illumination on a surface that is everywhere one meter from a uniform point source of one candle intensity or equal to one lumen per square meter" ("lux," Merriam-Webster.com Dictionary, https://www.merriam-webster.com/dictionary/lux. Accessed 1/11/2023).

and Thill 2007, p. 222, Timpone et al. 2010, p. 119, Silvis et al. 2015*a*, p. 758). Individual trees may be considered suitable roosting habitat when they exhibit characteristics of suitable roost trees and are within 1,000 feet of forest.

5.5.2 Avoiding Effects of Roost Removal in Occupied Habitat during the Active Season

To avoid effects to NLEBs while they are roosting in trees, suitable roost trees will only be removed in habitat likely to be inhabited by the NLEB during the timeframe when the species is not likely to be present unless site-specific information (e.g., habitat model) demonstrates that they are not likely to be using the habitat in the Action Area. Northern Long-Eared Bat Roosting Habitat and Habits

Examples of habitats that are *not* suitable for the northern long-eared bat include:

- Individual trees that are greater than 1,000 feet from forested areas;
- Trees in predominantly unforested, developed portions of urban areas (e.g., street trees, downtown areas, scattered yard trees); and,
- Pure stands of trees less than 3-inch dbh that do not contain larger trees.

5.5.2.1 Northern Long-Eared Bat Maternity Colonies and Importance of Colony Cohesion

NLEB colonies retain their identity and exhibit high site fidelity between years (Silvis et al. 2015*b*). Fitness benefits of colonial roosting include minimizing the physiological stress of lactation, creation of more favorable thermal conditions, and cooperative rearing of young (Olivera-Hyde et al. 2019). A colony's use of the same general roosting area from one year to the next may occur due to the return of at least some individuals from the prior year – either juveniles (e.g., Silvis et al. 2015*b*, p. 11) or adults. NLEB females have been shown to roost together for multiple summers in the same location and individual females have been captured returning to the same small area for at least five consecutive summers (Foster and Kurta, Allen 1999, p. 665, Patriquin et al. 2010, Perry 2011).

5.5.2.2 'Fission-Fusion' Colony Dynamics and Adaption to Roost Loss

Despite retaining their identity from year to year, composition of NLEB colonies is normally in flux, with individuals frequently departing to be solitary or to form smaller groups before returning to the main spatially discrete unit or network – i.e., fission-fusion (Barclay and Kurta 2007, p. 44, Garroway and Broders 2007, p. 961). As part of this behavior, NLEBs switch tree roosts often (Sasse and Pekins 1996, p. 95), typically every 2 to 3 days (Foster and Kurta 1999, p. 665; Owen et al. 2002, p. 2; Carter and Feldhamer 2005, p. 261; Timpone et al. 2010, p. 119). Patriquin et al. (2016, p. 55) found that NLEB roost switching and use varies regionally in response to differences in local ambient conditions that affect the suitability of individual roosts to provide optimal thermal conditions.

NLEBs are likely adapted to roost loss because their roosts are typically ephemeral (Silvis et al. 2015*b*, p. 2). The species experiences roost loss "at some low background level, with periodic pulses of increased roost loss after intense disturbances from fire, wind throw, ice damage, insect outbreak, or certain types of forest management actions" (Silvis et al. 2015*b*, p. 2). After experimental roost removal (see Silvis et al. Tree Removal Simulation and Experiment in Kentucky, below), two NLEB colonies used at least 42 and 35 roosts, respectively, and there was little apparent re-use of individual roost trees between years (Silvis et al. 2015*b*, p. 7, 10).

5.5.2.3 Effects of White-Nose Syndrome on Local Roost Tree Selection

Reductions in colony sizes because of white-nose syndrome (WNS) may be affecting roost tree selection. When selecting roosts, NLEBs adapt to local forest structure and opportunities to roost with other NLEBs (Foster and Kurta, Allen 1999, p. 668, Silvis et al. 2016, p. 12, Hyzy et al. 2020, p. 62, Kalen et al. 2022, p. 165). Reduced colony sizes post-WNS may have altered NLEB preferences for species and tree sizes in some areas due to "decreased social thermoregulatory potential" (Kalen et al. 2022, p. 165). This may exaggerate trends in certain roosting patterns observed before WNS (Kalen et al. 2022, p. 165). At one study area, for example, NLEBs preferred high, exposed roosts in "large, dominant" eastern hemlock snags with high solar exposure (Kalen et al. 2022, p. 165). This local preference was facilitated by previous mortality of eastern hemlock coupled with a need for enhanced solar exposure for thermoregulation. At another site, the authors hypothesized that a reduction in the size of roosts post-WNS was also a response to a change in thermoregulatory needs of smaller colonies (Kalen et al. 2022, p. 165). At that site, NLEBs preferred small red maples (*Acer rubrum*) over moderately sized black locust (*Robinia pseudoacacia*) snags due to features that may have contributed to 'greater thermal inertia' in the former (Kalen et al. 2022, p. 165).

5.5.2.4 Indirect Effects of Roost Removal during 'winter' – Potential for Take (Harm)

Winter tree clearing that removes roosts and fragments colonies could harm NLEBs by increasing stress, reducing opportunities to roost in thermally suitable microenvironments, and reducing benefits accrued from cooperating rearing of young. The likelihood that any winter tree clearing project is likely to take (e.g., "harm") a NLEB depends on (1) the likelihood that the tree removal overlaps with an unknown NLEB colony roosting area, (2) the extent of tree (roost) removal, (3) the intensity of tree removal, (4) the availability of an alternating roosting area known to the colony, and (5) whether roosts are likely to be limiting after tree removal. NLEBs ability to persist in an area from which roosts have been removed may be related to the number of roosts used by the species, the degree of roost specialization, and local roost availability. NLEBs may use many roosts within a single season.

5.5.2.4.1 Silvis et al. Tree Removal Simulation and Experiment in Kentucky

To evaluate the effects of roost removal on the NLEB, Silvis et al. (2015, p. 5) removed a primary roost and five secondary roosts, respectively, from the roosting area of two NLEB colonies in a heavily forested area of Kentucky. No roosts were removed from the roosting area of a third colony. In the year after roost removal, NLEBs persisted in each area and did not appear to change their colony roosting areas (Silvis et al. 2015*b*, p. 10). Despite the 'consistent patterns of space use between years' by the colonies, few individuals were recaptured in the second year – "colony identity" remained intact although turnover among the individuals that comprised each colony was high (Olivera-Hyde et al. 2019, p. 724). The return of juveniles from the first year may have been key in retention of the colonies' identities despite the high colony turnover (Silvis et al. 2015*b*, p. 10-11). Female NLEBs "exhibit fidelity to a general geographic area", but they may not settle into the precisely same areas as in previous years (Olivera-Hyde et al. 2019, p. 724).

Although the identity of each colony persisted, Silvis et al. (2015*b*, p. 12) detected signs of a "segmented roost network" in the colony from which five secondary roosts were removed. Those five roosts constituted 24% of the roosts identified during radio-tracking of colony members. This was consistent with a previous simulation in which removal of about 20% of roosts resulted in a 50% chance of colony fragmentation (Silvis et al. 2014, p. 287).

5.5.2.4.2 Likelihood of 10-Acre Tree Removal Causing Colony Fragmentation

Although adapted to ephemeral roosts, some extent of roost removal may interfere with maternity colony cohesion (Silvis et al. 2014, 2015*b*). Tree removal significant enough to fragment a colony may resemble the "periodic pulses of increased roost loss after intense disturbances" referred to by Silvis et al. (2015*b*, p. 2), including timber harvest.

For winter tree removal to cause adverse effects to NLEBs due to maternity colony fragmentation, each of the following would have to occur:

1) *the tree removal would have to overlap with a NLEB maternity colony* – tree removal would have to take place in an area where NLEBs are likely to return in the spring to reoccupy a colony area or to form new roosts – i.e., in an area likely to be occupied by the NLEB; and,
2) *enough roosts would have to be removed to cause colony fragmentation* – the extent and intensity of roost removal must cause an increase in roost loss above the "low constant background level" (Silvis et al. 2015*b*, p. 2) of the affected area, to a degree that a colony is likely to fragment.

5.5.2.4.3 Likelihood of Overlap

Tree removal projects proposed within 3.0 miles of NLEB captures or detections, within 1.5 miles of a known roosts, and within 5.0 miles of hibernacula will not be eligible for a predetermined NLAA determination in the key, but there is some likelihood that a tree removal project ≤10 acres could overlap with an undocumented NLEB colony. The likelihood of any individual 10-acre tree clearing project overlapping with an area to which a NLEB colony is likely to return in the spring to use as a maternity area is likely low. In the standing analysis that FWS completed for the NLEB interim consultation framework, we assessed the likelihood of an area approximately equal in size to the core area of a NLEB maternity colony (about 150-167 acres) being 1) occupied by the species and 2) subject to timber harvest sometime during the one year from April 2023 to April 2024. Based on that analysis the likelihood of that occurring might vary from one region to another due to differences in the density of NLEB colonies and timber harvest activity. In no region, however, did it exceed about 0.001%. That was also the approximate likelihood that any maternity-sized area would be affected by *non-forestry* activities that would include tree removal during the maternity season – such activities may be even less likely during the hibernation period, which occurs mostly during winter.

Allowing for predetermined NLAA outcomes only for tree clearing up to 10 acres in extent during the hibernation season will likely mean that only small-scale projects will be eligible to conclude consultation using the key.

5.5.2.4.4 Considerations in Fragmented Forest Landscapes

Movement distances, foraging areas, and roosting areas used by female northern long-eared bats may be smaller in fragmented forest landscapes than in landscapes with larger amounts of suitable forest cover (Henderson and Broders 2008*a*, p. 959). In these areas, the extent of available forest patches may constrain northern long-eared bat foraging areas and could even increase use of alternative roosts (e.g., buildings, Henderson and Broders 2008*a*:959-960). Our analyses above do not explicitly address the vulnerability of NLEB colonies in landscapes where forested habitat is fragmented, therefore we will monitor how frequently this aspect is used in fragmented forest landscapes to help determine whether adjustments are needed to ensure against inaccurate NLAA outcomes.

5.5.2.4.5 Planning for and Monitoring Aggregate Effects of Projects Covered by the Determination Key
To understand and track the aggregate impact on the likelihood of colony fragmentation of concurring on numerous projects through the key, especially in fragmented landscapes, we will monitor the potential aggregate effects of the projects 'cleared' via the determination key. To do this, the key includes a series of survey questions for projects that include winter tree clearing so that we can track the nature, extent, and locations of tree clearing associated with projects that receive NLAA determinations in the key.

5.5.2.4.6 Effects of Tree Removal on Use of Connecting Habitats During the Breeding Season
Although northern long-eared bats may rarely traverse non-forested areas of 1,000 feet or more, they are frequently observed using vegetated corridors, such as tree lines, to travel among suitable forest patches. Because they may connect important foraging and roosting habitats, removal of forested corridors (regardless of size/area of corridor) could severely fragment available habitat and result in adverse effects to northern long-eared bats. Therefore, projects that remove connective corridors between forest patches warrant project-specific consideration and coordination with the Service.

Some trees used by summer roosting males may be removed. Males have been found roosting in smaller diameter trees than females and may be more tolerant of shaded sites (Kurta and Rice 2002). Adult males of most species of bats likely enter torpor in summer more frequently than reproductive females, and hence, can likely use a wider range of roosting situations than females (Barclay and Kurta, in press). The current information suggests that males are more flexible in their summer roosting habitat requirements and could likely better adapt to tree removal than females.

Qualifying actions will not remove trees within 0.5 miles of a known NLEB hibernacula. Because of this, it is unlikely for spring staging habitat to be in an action area. Some trees used by fall swarming bats may be removed while they are unoccupied. The limited studies on roosting habitats of NLEBs in fall have shown that roost switching occurs every two to three days (Kiser and Elliot 1996, Gumbert et al. 2002). The conservation measures limit the number of potential roost trees that may be removed, making it unlikely that any action would remove a significant portion of trees used during fall swarming.

5.6 Effects to Northern Long-Eared Bats using Bridges or Culverts

The following is adapted from the USFWS' *Programmatic Biological Opinion for Transportation Projects in the Range of the Indiana Bat and Northern Long-Eared Bat* – as revised in January 2023.

5.6.1 Occurrences of Bats in Transportation Structures

Twenty-four of the 45 U.S. species of bats have been documented using bridges, culverts, and other structures as artificial roosts (Keeley and Tuttle 1999), including Indiana bats and NLEBs. Bats roosting during the day are often found in expansion joints and other crevices, in contrast, night bat roosts are often found in open areas between support beams that are protected from the wind (Keeley and Tuttle 1999).In western North Carolina, many *Myotis* species of bats (*Myotis sodalis*, *Myotis lucifugus*, *Myotis leibii*, *Myotis grisescens*, and *Myotis septentrionalis*), as well as big brown bats (*Eptesicus fuscus*), tri-colored bats (*Perimyotis subflavus*), and Mexican free-tailed bats (*Tadarida brasiliensis*) have been found roosting in bridges (Susan Cameron, USFWS, pers.comm.).

NLEBs have been found using bridges as artificial roosts as well, including the following types of bridges: parallel box beam, pre-stressed girder, cast-in-place, and I-beam. Feldhamer et al. (2003) surveyed 232 bridges in southern Illinois and found four species of bats, including NLEBs, using 15 bridges. In Louisiana, Ferrara and Leberg (2005) documented seven NLEBs out of 902 bridges surveyed in 2002 to 2003 (4% of total bats detected). Of 53 bridges surveyed at night, only 15% were occupied, and the only species was Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) (i.e., the seven NLEBs detected were using the bridges as day roosts). However, Kiser et al. (2002) reported NLEBs using bridges as night roosts as well.

Of the 37 bridges visited in Benedict and Howell's study in 2005 and 2006 in Iowa (Benedict and Howell 2008), two NLEBs were found under two different concrete bridges (one was a lactating female; the sex of the other was not clear in the report). Also, a NLEB bachelor colony using a timber bridge was found in Iowa in 2013 (K. McPeek, U.S. Fish and Wildlife Service, Moline, IL, pers. comm.). In Missouri, a bat survey conducted for a mine tailings impoundment associated with the Brushy Creek Mine in Reynolds County documented two NLEBs using a 250 ft (76.2 m) long corrugated metal culvert pipe for roosting. This pipe culvert carries Lick Creek under County Road 908 and is 9 ft in diameter (Droppelman 2014). The survey results in Tennessee have indicated that NLEBs have showed no preference in roosting sites. In addition to bridges and culverts, the survey documented NLEBs in barns, porches, mobile homes, and telephone poles when potential roost trees were nearby and available (J. Griffith, Service, pers. comm.). Data collected across the state of North Carolina show no evidence that NLEBs are using culverts in the state, though most surveys, until recently, were limited to culverts measuring 5 ft tall by 200 ft long. Only the following species were documented using culverts as roosting sites in North Carolina: gray bat, southeastern bat (*M. austroriparius*), tricolored bat, big brown bat, Mexican free-tailed bats, and Rafinesque's big-eared bat. Further, five survey efforts for NLEBs in bridges and culverts in Eastern North Carolina have failed to detect the species roosting in these structures.

5.6.2 Bridge/Culvert Characteristics

Many studies have documented the characteristics of bridges and culverts being used as artificial roosts by bats. Kiser et al. (2002) identified bridges built with concrete girders being used by Indiana bats and NLEBs to range from 45.9 to 223 ft (14 to 68 m) in length, and 26.2 to 39.3 ft (8 to 12 m) in width. All the bridges were over streams and all but one bridge was bordered by forested, riparian corridors connected to larger forested tracts. The riparian forest was within 9.4 to 16.4 ft (3 to 5 m) of the bridges. Traffic across the bridges ranged from less than 10 vehicles per day to almost 5,000 vehicles per day.

In Keeley and Tuttle's (1999) study, most bat species using artificial roosts chose concrete structures with crevices that were sealed at the top, at least 6-12 in deep, 0.5 -1.25 in wide, 10 ft or more above the ground, and typically not located over busy roadways. Feldhamer's (2003) reported an average height for 9 of the roosts was 16.7 ft (5.1 m) above the ground. It was not noted if any species showed a preference for a bridge type, or if any maternity or bachelor colonies were discovered.

Cleveland and Jackson (2013) reported bats (species unreported) roosting in 55 of 540 bridges examined in Georgia. Bats were found in 78 percent (43 of 55 roost bridges) of roost bridges with transverse crevices, but only 7.2 percent (4 of 55 roost bridges) were found in roost bridges with parallel crevices and 7.2 percent (4 of 55 roost bridges) of roost bridges with a combination of transverse and parallel crevices. All roost bridges either spanned water or were within 0.62 miles (1 km) of water. Roost bridges had open flyways with at least 6.56 ft (2 m) under their roost.

Ormsbee et al. (2007) noted that the largest numbers of night-roosting bats are often located in the warmest chambers of bridges, which tend to occur at either end and are located over land. Whereas, central chambers over water are less suitable (as a result of greater exposure to air currents and convective heat loss) for night-roosting. Adam and Hayes (2000) also reported higher occupancy in end chambers than center chambers. Feldhamer et al. (2003) reported that when occupied bridges in Southern Illinois spanned flowing water, areas of the bridge that were occupied by bats were situated over land.

Bridge and culvert characteristics have been studied to help determine bat roosting potential. Keeley and Tuttle (1999) describe the ideal day roost bridge characteristics for crevice-dwelling bat species to be bridges with a roost height of 10+ ft (3+ m) above the ground and culverts between 5 and 10 ft (1.5 and 3 m) tall and 300 ft (100 m) or more long. An evaluation of 44 culverts by Boonman (2011) determined lowest height and cross-sectional area amenable to bats are 0.4 m (1.3 ft) and 1.2 m^2 (3.9 ft^2), respectively. Also, 15 box culverts along Interstate Highway 45 in southeast Texas documented *Myotis austroriparius*, *Perimyotis subflavus* and *Eptesicus fuscus* in culverts varying 1.2 – 2.2 m (3.9-7.2 ft) height, 1.2-1.8 m (3.9-5.9 ft) width, and 60-120 m (197-394 ft) length, commonly with standing water and entranceway vegetation (Smith and Stevenson 2015). In New Mexico, 2016 unpublished data from Smith and Stevenson documented minimum culvert heights of 0.6 m (2 ft) and .93 m (3 ft) for *Myotis* spp. and *Corynorhinus townsendii*, respectively.

Katzenmeyer (2016) conducted a comprehensive assessment of transportation structures in Mississippi between November and March from 2010 to 2015. Although NLEBs were not observed, the survey recorded five other bat species and their abundance in 16 caves and 214 culverts. Over the five-year period, 3,789 roosting bats were recorded in caves and 16,812 were detected in culverts, with tri-colored bats and southeastern myotis most abundant. Katzenmeyer documented 111 of the culverts (smallest size being 30 ft [9.14 m] long and 2 ft [0.61 m] tall) being used for winter roosting by five different bat species: Rafinesque’s big-eared bat, southeastern myotis, big brown bat, tricolor bat, and Brazilian free-tail bat. All five species were detected in culverts as short as 109 ft (33.4 m) long, but only tricolored bats were found in smaller culverts (smallest being 30 ft (9.14 m) long and 2 ft (0.61 m) tall). This study shows the range of bat species using bridges and culverts for roosting, as well as the range of structure characteristics supporting the varies species.

In 2020, the U.S. DOT Volpe National Transportation Systems Center (Volpe Center), on behalf of Federal Highway Administration, in collaboration with the Service, conducted an analysis of structure assessment forms that had been uploaded through the Information for Planning and Consultation (IPaC) system, and the Georgia Department of Natural Resources (GADNR) provided an Excel file of structure assessment forms. The information from both sources was combined to create a “bats in structures assessment form database” that contains a total of 2,378 structure assessments from 2015 to 2019. Evidence of bats (all species) was observed at 260 (11 percent) of these structures (see Table 1). Where evidence of bats was observed, 184 structures (71 percent) included information on the species present and no Indiana or NLEBs were reported across all structure types.

Table 1. Bat evidence structure statistics.

Structure Type	Total Bat Evidence Entries	% of Total Bat Evidence Entries	% of Structure Type with Bat Evidence	Total No Bat Evidence Entries	% of Total No Bat Evidence Entries
Bridge (total=1,148)	84	32%	7.3%	1,064	50%
Culvert (total=689)	140	54%	20.3%	549	26%
Unknown (n=541)	36	14%	6.7%	505	24%
Total:	*260*	*100%*		*2,118*	*100%*

An additional analysis was conducted using the bats in structures assessment form database to assess how culvert size might influence the presence of bats. Of the 689 culverts assessed, 154 (23 percent) were associated with culvert size data, and—of those—53 indicated presence of bats (see Table 2 for more detail). Where evidence of bats was observed in culverts with a reported height, 100 percent also reported species information; as noted above, none of the species identified included Indiana bat or NLEB. The minimum height of a culvert where an assessment form indicated signs of bat presence was 2 ft and the maximum height was 9.84 ft. Of the culverts with a reported height under 4 ft, five (15 percent) contained evidence of bats (see Table 3).

Table 2. Culvert assessments with size data.

Culvert Assessment	Size Information Included?	Number of Culverts	Percent of Total
No Evidence of Bats	No	448	65%
No Evidence of Bats	Yes	101	15%
Evidence of Bats	No	87	13%
Evidence of Bats	Yes	53	8%
Total:		*689*	*100%*

Table 3. Evidence of bats in culvert with reported size.

Culvert size class (reported height)	Culverts with No Evidence of Bats	Culverts with Evidence of Bats	Percent of Size Class with Evidence of Bats	Percent of Total
Under 4ft	34	6	15%	26%
4ft and above	67	47	41%	74%
Total:	*101*	*53*		*100%*

Bektas et al. (2018) assessed 517 bridges in Iowa for evidence of bat roosting. Logistic regression models were used to identify transportation structure, land cover distribution, and predicted bat species distribution characteristics that increase the probability of bat roosting (Bektas et al. 2018). The study showed that physical bridge characteristics alone could not be used to distinguish bat roost potential. Land cover and bat species distribution data combined with physical bridge characteristics help identify structures with the higher probability of bat roosting.

The data compiled from the publications above identifies culverts with day roosting bats to range from 1.3 ft (0.4 m) (Boonman 2011) to 10 ft (0.4m – 3m) (Keeley and Tuttle 1999) in height. However, the bat species identified varied widely and thus likely the wide range in size characteristics. Also, the Volpe Center analysis revealed only 15 percent of culverts under 4 ft had evidence of bat use, yet neither Indiana bat nor NLEBs were identified in that culvert.

Based on the information available pertaining to culvert height suitability for NLEB roosts, culverts less than 4 ft in diameter will be considered unlikely to provide suitable roosting habitat for the NLEB.

Until further data can rule out low bridges as potential roost sites, it is not possible to exclude them from requiring an assessment. Additionally, excluding broad categories of bridges based on their physical characteristics such as their composition does not seem feasible. It is possible that bridge roosting characteristics change over time as concrete may begin to spall, which would in turn provide roosting sites. Smith and Stevenson (2015) further support the idea that the physical characteristics described by Keeley and Tuttle (1999) are a set of ideal characteristics and not a list of definitive criteria required by bat for roosting.

5.7 Effects of Roads

5.7.1 Risk of Collisions with Vehicles

Roads pose a risk of vehicle collisions for the NLEB and at least some other imperiled bats, although documenting roadkill is difficult, and a combination of factors influence the magnitude of the risk. Important factors include traffic volume and noise, proximity of the road to roosting and foraging sites, and vegetation height near the road. In at least one case, the threat of roadkill to an imperiled bat species prompted a collaboration between biologists and highway engineers to evaluate how the species crossed a highway, to and install safe crossing points (Wray et al. 2006).

In Europe, efforts to study, design, and test measures to minimize bat roadkill seem to be common relative to the U.S. (e.g., Sołowczuk and Kacprzak 2022). Although risk of bat roadkill, in general, appears design to be higher at locations with greater traffic volume (Fensome and Mathews 2016, p. 319), bat roadkill has been detected on roads with as few as 1,100 vehicles per day (Vuk et al. 2014) and bat roadkill is likely to occur even on unpaved roads. Ramalho et al. (2021) did not find bat carcasses along the dirt roads they surveyed but suspected that bat-vehicle collisions on dirt roads are "especially underestimated" due to low carcass detectability. The difficulty of finding bat carcasses may result in significant underestimates of roadkill of NLEB and other bats (Russell et al. 2009, p. 57).

The risk of vehicle collisions for NLEBs may be highest when forest suitable for foraging or roosting is present along both sides of a road and where traffic volume is not too high to discourage crossing (see Roads as Barriers to Commuting Bats, next section). In Pennsylvania, Indiana bats and little brown bats flew through or along the edge of forest when approaching a highway and fewer bats crossed where canopy cover was "lacking adjacent to the highway" (Russell et al. 2009, p. 49). The use of wooded corridors by Indiana bats were consistent with a study in Michigan where Indiana bats "did not fly over open areas" (Murray and Kurta 2004, p. 203). In France, increasing distance to trees and decreasing tree height were associated with a decrease in bat density at roads (Roemer et al. 2021, p. 1).

We are not aware of highway crossing studies like that of Russell et al. (2009) for the NLEB, but we would also expect NLEBs to remain under, within, or along the edge of forest when near roads. NLEBs are tied heavily to closed canopy and interior forest (Henderson and Broders 2008*b*, p. 952, Pauli et al. 2017, p. 879). Tall canopy on both sides of the road may provide safe places to cross if the distance is not too great. Where the tree canopy was high (>20m), bats crossed well above traffic. Where it was low (≤6m), they crossed the highway lower and closer to traffic and were more likely to be struck by vehicles (Russell et al. 2009, p. 55). Based on their observations, Russel et al. (2009, p. 58) concluded that bats would fly from one high canopy to another without descending to vehicle height as long as the canopy to canopy crossing distance was 20 meters or less.

5.7.2 Roads as Barriers to Commuting Bats

Bats' avoidance of vehicle noise and vehicles themselves could result in roads becoming a barrier, restricting access of commuting bats to foraging habitats (Zurcher et al. 2010, p. 339). Simulations of bat activity based on Indiana bat data in related to road networks founds that roads with only moderate traffic volume (e.g., >10 vehicles/5-minutes) may act as "filters" where vehicle collisions may be the primary concern whereas those with high traffic volume (>200 vehicles/5-minutes) as barriers to movement (Bennett et al. 2013, p. 979). For comparison, traffic volume at the time of the highway-crossing study discussed in the previous section was about 8,569 vehicles per day – about 30 vehicles/5-minutes (Russell et al. 2009, p. 58). Significant roadkill was documented in that study and the road did not function as a barrier – but as a partially permeable filter.

NLEBs are likely to avoid or reduce time spent foraging near roads depending on the intensity of noise on the roads, which depends in part on traffic volume (Schaub et al. 2009, p. 3179 - see 5.1.2 Effects of Noise to Foraging and Drinking Bats, above). When vehicles were present, 60% of documented Indiana bats exhibited avoidance behavior, reversing course at an average of 10 m from automobiles, suggesting that bats perceive vehicles as a threat and are more likely to crossroads with low traffic volume (Zurcher et al. 2010, p. 337). Well-established major roads have been proven to have significant long-term negative impacts on bat populations such as a decline in species diversity and overall decline in bat activity (to a distance of at least 1-6 km) near roadways (Berthinussen and Altringham 2012, p. 88). The decline in activity and diversity of bats was only mitigated by roadsides where there was increased continuity in habitat including hedgerows and tree cover lining both sides of the road (Berthinussen and Altringham 2012, p. 85). Roads restricted habitat accessibility for barbastelle bats (*Barbastella barbastellus*) and Bechstein's bats (*Myotis bechsteinii*), but the effect was related to the species' foraging ecology and wing morphology (Kerth and Melber 2009, p. 270). Foraging ecology of gleaning and woodland species were more susceptible to the barrier effect than high-fliers that feed in open spaces (Kerth and Melber 2009, p. 270).

5.7.3 Effects of Roads and the Determination Key

In the DKey, we assume that NLEBs are unlikely to fly across an unforested area that is greater than 1000 feet wide and that NLEBs are unlikely to inhabit forest unless it is present as a contiguously forested area of 10 acres or more. This is based on the propensity for NLEBs to remain in or near forested habitat and to generally avoid open areas. It is consistent with studies along roads that have found evidence that clutter-adapted Myotis species "may be deterred by the road-gap due to risks associated with sensory limitations and preference towards flying close to vegetation" (Chapman 2022, p. 44-45).

We explain in the DKey that contiguous forest may consist of multiple forest patches that are separated by less than 1000 feet of non-forested area – for example, two forest patches of 5 acres each would constitute 10 acres of contiguous forest if the two patches were within 1000 feet of one another. If a new road, new travel lanes, or other actions that are likely to increase vehicle traffic are proposed for an area where suitably large, forested habitat patches are present within

6 Ongoing Review of the Determination Key's Accuracy and Validity

The USFWS DKey sponsor will review the DKey at least annually to ensure that the DKey is based on the best available information and that it is sufficiently conservative to ensure that no actions would receive incorrect consultation outcomes of 'no effect' or 'not likely to adversely affect.'

6.1 Annual Review of the DKey

6.1.1 Ensuring Use of Best Available Information – Soliciting Key Information from USFWS Field Offices

Each year, no later than March 1, the USFWS will answer the following questions, record the answers in the administrative record for the DKey, and take appropriate action to revise the key to ensure accurate outcomes, as needed. The DKey sponsor will send an email to each USFWS ES Field Office in the range of the species with the following questions.

1) Is there any evidence to indicate that the NLEB may use bridges – other than covered bridges – for roosting in New Hampshire or Vermont?
2) Has the NLEB been detected using a culvert whose interior dimensions are smaller than 4.0 feet in diameter or less than 130 feet in length?

Additional questions will be added to this annual review, as needed. In addition to seeking out key information directly from USFWS field offices, the DKey sponsor will also review published scientific literature for new and relevant information – see 6.1.3, below.

6.1.2 Ensuring use of Accurate GIS Data

In addition to addressing each of the questions listed above, each year no later than March 1 the DKey sponsor will also reach out to each of the ESFOs in the range of the NLEB to determine whether the GIS data incorporated into the DKey is still accurate and based on the best available information. If revisions or updates are necessary, the sponsor will request the updated information from the ESFO and will incorporate it into the DKey. Updates to the underlying GIS data will also be made as needed throughout the year.

6.1.3 Ensuring the Use of Best Available Information

The DKey sponsor will also ensure that appropriate revisions are made to the key considering any new information that indicates additional or more stringent conservation measures are needed to ensure correct conservation outcomes. The DKey sponsor will use this standing analysis to assess any new information for potential revisions to the DKey. The sponsor will evaluate new information at least during the annual reviews and revise the DKey, as needed, but may also do this anytime during the year.

6.1.4 Reinitiation of Consultation

We will have to ensure that consultation is reinitiated via the DKey, as needed, for actions where discretionary Federal involvement or control over the action has been retained or is authorized by law. The section 7 regulations contain four triggers for reinitiation of consultation (50 CFR 402.16). Only one applies to FWS' use of the standing analysis and the DKey – "If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered" [50 CFR 402.16(a)(2)]." The remaining triggers either do not apply to the standing analysis and DKey (1 and 4) or would be the responsibility of the action agency (3).

When USFWS changes the standing analysis and the DKey due to new information, we will use the "major update" function in IPaC if the changes could mean that any prior NLAA determinations are no longer correct. After implementing a major update, users will see a notification in IPaC that there has been a change in the DKey that may affect the accuracy of the prior determination. These notifications will be visible when they view their project list in IPaC or are looking directly at an individual project. The language will clarify that reinitiation may be required if discretionary Federal involvement or control over the action has been retained or is authorized by law.

6.1.5 Field Office Auditing Use of the Key

The DKey sponsor will check the Information entered into the DKey at least annually to look for anomalies in the data entered by users to the survey questions. Data anomalies may be indicated by especially large numbers in one year versus another or for individual actions relative to others.

7 Literature Cited

Adam, M. D., and J. P. Hayes. 2000. Use of bridges as night roosts by bats in the Oregon Coast Range. JOURNAL OF MAMMALOGY 81.

Adams, R. A., and M. A. Hayes. 2008. Water Availability and Successful Lactation by Bats as Related to Climate Change in Arid Regions of Western North America. Journal of Animal Ecology 77:1115–1121.

Allen, L. C., N. I. Hristov, J. J. Rubin, J. T. Lightsey, and J. R. Barber. 2021. Noise distracts foraging bats. Proceedings of the Royal Society B: Biological Sciences 288:20202689.

Azam, C., C. Kerbiriou, A. Vernet, J.-F. Julien, Y. Bas, L. Plichard, J. Maratrat, and I. Le Viol. 2015. Is part-night lighting an effective measure to limit the impacts of artificial lighting on bats? Global Change Biology 21:4333–4341.

Azam, C., I. Le Viol, Y. Bas, G. Zissis, A. Vernet, J.-F. Julien, and C. Kerbiriou. 2018. Evidence for distance and illuminance thresholds in the effects of artificial lighting on bat activity. Landscape and Urban Planning 175:123–135.

Barclay, R. M. R., and A. Kurta. 2007. Ecology and Behavior of Bats Roosting in Tree Cavities and Under Bark. Pages 17–60 *in*. Bats in Forests: Conservation and Management. The Johns Hopkins University Press, Baltimore, Maryland.

Bektas, B. A., Z. Hans, B. Phares, E. Nketah, J. Carey, M. K. Solberg, and K. McPeek. 2018. Most Likely Bridges as Roosting Habitat for Bats: Study for Iowa. Transportation Research Record 2672:1–10.

Benedict, R. A., and D. L. Howell. 2008. Use of building and bridges by Indiana bats (Myotis sodalis) and other bats in Iowa 2005-2008. Report submitted to the U.S. Fish and Wildlife Service and the Iowa Department of Natural Resources.

Bennett, V. J., D. W. Sparks, and P. A. Zollner. 2013. Modeling the indirect effects of road networks on the foraging activities of bats. Landscape Ecology 28:979–991.

Bonsen, G., B. Law, and D. Ramp. 2015. Foraging Strategies Determine the Effect of Traffic Noise on Bats. Acta Chiropterologica 17:347–357.

Boonman, M. 2011. Factors determining the use of culverts underneath highways and railway tracks by bats in l-owland a- reas.

Broders, H. G., L. J. Farrow, R. N. Hearn, L. M. Lawrence, and G. J. Forbes. 2014. Stable isotopes reveal that little brown bats have a broader dietary niche than northern long-eared bats. Acta Chiropterologica 16:315–325.

Bunkley, J., and J. Barber. 2015. Noise Reduces Foraging Efficiency in Pallid Bats (Antrozous pallidus). Ethology 121.

Carter, T. C., and G. A. Feldhamer. 2005. Roost tree use by maternity colonies of Indiana bats and northern long-eared bats in southern Illinois. Forest Ecology and Management 219:259–268.

Chapman, J. 2022. Activity Levels of Bat Species at Interstate Highway Sites with and without Wildlife Underpasses in the Washington Cascades. All Master's Theses. <https://digitalcommons.cwu.edu/etd/1775>.

Cleveland, A. G., and J. G. Jackson. 2013. Environmental factors influencing the status and management of bats under Georgia (USA) bridges. Proceedings of the 2013 International Conference on Ecology and Transportation (ICOET 2013).

De La Cruz, J. L. 2022. Northern Long-eared Bat Occupancy Modeling for New England - Draft Status Report. Virginia Tech University.

De La Cruz, J. L., S. Deeley, M. Muthersbaugh, S. Freeze, N. Kalen, and A. Silvis. 2019. Occupancy and detection probability of northern long-eared bats and other WNS-impacted species in the northeastern United States. U.S. Fish and Wildlife Service, Hadley, MA.

Domer, A., C. Korine, M. Slack, I. Rojas, D. Mathieu, A. Mayo, and D. Russo. 2021. Adverse effects of noise pollution on foraging and drinking behaviour of insectivorous desert bats. Mammalian Biology 101:497–501.
Droppelman, P. L. 2014. Bat Survey Report Myotis sodalis Indiana bat, Myotis grisescens Gray Bat, Myotis septentrionalis Northern long-eared bat, Mine Tailings Impoundment Brushy Creek Mine Doe Run Company Reynolds County, Missouri. Eco-Tech Consultants, Inc.
Duarte, M. H. L., M. A. Vecci, A. Hirsch, and R. J. Young. 2011. Noisy human neighbours affect where urban monkeys live. Biology Letters 7:840–842.
Faure, P. A., J. H. Fullard, and J. W. Dawson. 1993. The gleaning attacks of the northern long-eared bat, Myotis septentrionalis, are relatively inaudible to moths. Journal of Experimental Biology 178:173–189.
Feldhamer, G. A., T. C. Carter, A. T. Morzillo, and E. H. Nicholson. 2003. Use of Bridges as Day Roosts by Bats in Southern Illinois.
Fensome, A. G., and F. Mathews. 2016. Roads and bats: a meta-analysis and review of the evidence on vehicle collisions and barrier effects. Mammal Review 46:311–323.
Ferrara, F. J., and P. L. Leberg. 2005. CHARACTERISTICS OF POSITIONS SELECTED BY DAY-ROOSTING BATS UNDER BRIDGES IN LOUISIANA. Journal of Mammalogy 86:729–735.
Finch, D., H. Schofield, and F. Mathews. 2020. Traffic noise playback reduces the activity and feeding behaviour of free-living bats. Environmental Pollution 263:114405.
Foster, R. W., and Kurta, Allen. 1999. Roosting Ecology of the Northern Bat (Myotis septentrionalis) and Comparisons with the Endangered Indiana Bat (Myotis sodalis) | Journal of Mammalogy | Oxford Academic. Journal of Mammalogy 80:659–672.
Garroway, C. J., and H. G. Broders. 2007. Nonrandom association patterns at northern long-eared bat maternity roosts. Canadian Journal of Zoology 85:956–964.
Geluso, K., E. C. Keele, N. M. Pauley, I. R. Gomez, and S. P. Tye. 2018. Night-Roosting Behaviors for the Northern Long-Eared Myotis (Myotis septentrionalis) Under a Bridge Revealed by Time-Lapse Photography. American Midland Naturalist 179:287–293.
Gese, E. M., O. J. Rongstad, and W. R. Mytton. 1989. Changes in Coyote Movements Due to Military Activity. The Journal of Wildlife Management 53:334–339.
Gorman, K. M. 2023. Ecology of northern long-eared bats (Myotis septentrionalis) in a coastal setting after the introduction of White-nose Syndrome. <https://vtechworks.lib.vt.edu/handle/10919/113209>. Accessed 25 Jan 2023.
Grider, J. F. 2020. Summer occupancy and habitat characteristics of the northern long-eared bat in northern Georgia. Ph. D. Dissertation, University of Georgia, Athens.
Henderson, L. E., and H. G. Broders. 2008*a*. Movements and Resource Selection of the Northern Long-Eared Myotis (Myotis septentrionalis) in a Forest—Agriculture Landscape. Journal of Mammalogy 89:952–963.
Henderson, L. E., and H. G. Broders. 2008*b*. Movements and Resource Selection of the Northern Long-Eared Myotis (*Myotis septentrionalis*) in a Forest—Agriculture Landscape. Journal of Mammalogy 89:952–963.
Hyzy, B., R. Russell, A. Silvis, W. Ford, J. Riddle, and K. Russell. 2020. Investigating maternity roost selection by northern long-eared bats at three sites in Wisconsin. Endangered Species Research 41:55–65.
Jerem, P., and F. Mathews. 2021. Trends and knowledge gaps in field research investigating effects of anthropogenic noise. Conservation Biology 35:115–129.
Kalen, N., M. Muthersbaugh, J. Johnson, A. Silvis, and W. Ford. 2022. Northern Long-eared Bats in the Central Appalachians Following White-nose Syndrome: Failed Maternity Colonies?

Katzenmeyer, J. B. 2016. Use of Highway Culverts, Box Bridges, and Caves by Winter-Roosting Bats in Mississippi. M.S. Thesis, Mississippi State University, Mississippi State, MS.

Keeley, B. W., and M. D. Tuttle. 1999. Bats in American bridges. Bat Conservation International, Inc., Austin, TX.

Kiser, J. D., J. R. MacGregor, J. D. Bryan, and A. Howard. 2002. Use of concrete bridges as nightroosts in the Indiana Bat: biology and management of an endangered species. Bat Conservation International, Inc., Austin, TX.

Kleist, N. J., R. P. Guralnick, A. Cruz, C. A. Lowry, and C. D. Francis. 2018. Chronic anthropogenic noise disrupts glucocorticoid signaling and has multiple effects on fitness in an avian community. Proceedings of the National Academy of Sciences 115:E648–E657.

Kuijper, D., J. Schut, D. van Dullemen, H. Toorman, N. Goossens, J. Ouwehand, and H. Limpens. 2008. Experimental evidence of light disturbance along the commuting routes of pond bats (Myotis dasycneme). <https://www.semanticscholar.org/paper/Experimental-evidence-of-light-disturbance-along-of-Kuijper-Schut/c4c4670dea10e46ff0d2ac7188c2f2b0db6b1e55>. Accessed 4 Jan 2023.

Kurta, A., J. Caryl, and T. Tipps. 1997. Bats and Tippy Dam: species composition, seasonal use, and environmental parameters. Michigan Academician 29:473–490.

Lacoeuilhe, A., N. Machon, J.-F. Julien, A. L. Bocq, and C. Kerbiriou. 2014. The Influence of Low Intensities of Light Pollution on Bat Communities in a Semi-Natural Context. PLOS ONE 9:e103042.

Lowe, A. J. 2012. Swarming behaviour and fall roost-use of little brown (Myotis lucifugus), and northern long-eared bats (Myotis septentrionalis) in Nova Scotia, Canada. M.S. Thesis, St. Mary's University, Halifax, Nova Scotia. <https://library2.smu.ca/bitstream/handle/01/25125/lowe_amanda_j_masters_2012.PDF?sequence=2>.

Luo, J., B.-M. Clarin, I. M. Borissov, and B. M. Siemers. 2014. Are torpid bats immune to anthropogenic noise? Journal of Experimental Biology 217:1072–1078.

Luo, J., B. M. Siemers, and K. Koselj. 2015. How anthropogenic noise affects foraging. Global Change Biology 21:3278–3289.

Maier, J. A. K., S. M. Murphy, R. G. White, and M. D. Smith. 1998. Responses of Caribou to Overflights by Low-Altitude Jet Aircraft. The Journal of Wildlife Management 62:752–766.

Mariton, L., C. Kerbiriou, Y. Bas, B. Zanda, and I. Le Viol. 2022. Even low light pollution levels affect the spatial distribution and timing of activity of a "light tolerant" bat species. Environmental Pollution 305:119267.

Mariton, L., I. Le Viol, Y. Bas, and C. Kerbiriou. 2023. Characterising diel activity patterns to design conservation measures: Case study of European bat species. Biological Conservation 277:109852.

Murray, S. W., and A. Kurta. 2004. Nocturnal activity of the endangered Indiana bat (*Myotis sodalis*). Journal of Zoology 262:197–206.

Olivera-Hyde, M., A. Silvis, E. M. Hallerman, W. M. Ford, and E. R. Britzke. 2019. Relatedness within and among northern long-eared bat (Myotis septentrionalis) colonies at a local scale. Canadian Journal of Zoology 97:724–735.

Ormsbee, P. C., J. D. Kiser, and S. I. Perimeter. 2007. Importance of night roosts to the ecology of bats. Chapter 5. Page 368 *in*. M. J. Lacki, J. P. Hayes, and A. Kurta. Forests: Conservation and management. John Hopkins University Press, Baltimore, Maryland.

Owen, S. F., M. A. Menzel, W. M. Ford, J. W. Edwards, B. R. Chapman, K. V. Miller, and P. B. Wood. 2002. Roost tree selection by maternal colonies of northern long-eared Myotis in an intensively managed forest. General Technical Report NE-292. USDA Forest Service - Northeastern Research Station.

Patriquin, K. J., M. L. Leonard, H. G. Broders, and C. J. Garroway. 2010. Do social networks of female northern long-eared bats vary with reproductive period and age? Behavioral Ecology and Sociobiology 64:899–913.

Patriquin, K., M. Leonard, H. Broders, W. Ford, E. Britzke, and A. Silvis. 2016. Weather as a proximate explanation for fission–fusion dynamics in female northern long-eared bats. Animal Behaviour 122:47–57.

Pauli, B. P., P. A. Zollner, and G. S. Haulton. 2017. Nocturnal habitat selection of bats using occupancy models. The Journal of Wildlife Management 81:878–891.

Pauwels, J., I. Le Viol, C. Azam, N. Valet, J.-F. Julien, Y. Bas, C. Lemarchand, A. Sanchez de Miguel, and C. Kerbiriou. 2019. Accounting for artificial light impact on bat activity for a biodiversity-friendly urban planning. Landscape and Urban Planning 183:12–25.

Perry, R. W. 2011. Fidelity of Bats to Forest Sites Revealed From Mist-Netting Recaptures. Journal of Fish and Wildlife Management 2:112–116.

Perry, R. W., and R. E. Thill. 2007. Roost selection by male and female northern long-eared bats in a pine-dominated landscape. Forest Ecology and Management 247:220–226.

Ramalho, D. de F., D. Resende, T. F. de Oliveira, R. A. L. Santos, and L. M. de Souza Aguiar. 2021. Factors influencing bat road casualties in a Neotropical savanna. Perspectives in Ecology and Conservation 19:189–194.

Randall, J., and H. G. Broders. 2014. Identification and Characterization of Swarming Sites used by Bats in Nova Scotia, Canada. Acta Chiropterologica 16:109–116.

Ratcliffe, J. M., and J. W. Dawson. 2003. Behavioural flexibility: the little brown bat, Myotis lucifugus, and the northern long-eared bat,M.septentrionalis , both glean and hawk prey. Animal Behaviour 66:847–856.

Roemer, C., A. Coulon, T. Disca, and Y. Bas. 2021. Influence of local landscape and time of year on bat-road collision risks. Peer Community Journal 1. <https://peercommunityjournal.org/articles/10.24072/pcjournal.59/>. Accessed 13 Jan 2023.

Russell, A., C. Butchkoski, L. Saidak, and G. McCracken. 2009. Road-killed bats, highway design, and the commuting ecology of bats. Endangered Species Research 8:49–60.

Russo, D., F. Cosentino, F. Festa, F. De Benedetta, B. Pejic, P. Cerretti, and L. Ancillotto. 2019. Artificial illumination near rivers may alter bat-insect trophic interactions. Environmental Pollution 252:1671–1677.

Sasse, D. B., and P. J. Pekins. 1996. Summer Roosting Ecology of Northern Long-eared Bats (Myotis septentrionalis) in the White Mountain National Forest. Pages 91–101 *in*. Victoria, British Columbia, Canada. <https://www.for.gov.bc.ca/hfd/pubs/Docs/Wp/Wp23/Wp23_10.pdf>.

Schaub, A., J. Ostwald, and B. M. Siemers. 2009. Foraging bats avoid noise. Journal of Experimental Biology 212:3036–3036.

Schroer, S., B. J. Huggins, C. Azam, and F. Hölker. 2020. Working with Inadequate Tools: Legislative Shortcomings in Protection against Ecological Effects of Artificial Light at Night. Sustainability 12:2551.

Seewagen, C. L., and A. M. Adams. 2021. Turning to the dark side: LED light at night alters the activity and species composition of a foraging bat assemblage in the northeastern United States. Ecology and Evolution 11:5635–5645.

Siemers, B. M., and A. Schaub. 2011. Hunting at the highway: traffic noise reduces foraging efficiency in acoustic predators. Proceedings of the Royal Society B: Biological Sciences 278:1646–1652.

Silvis, A., W. M. Ford, and E. R. Britzke. 2015*a*. Day-roost tree selection by northern long-eared bats—What do non-roost tree comparisons and one year of data really tell us? Global Ecology and Conservation 3:756–763.

Silvis, A., W. M. Ford, and E. R. Britzke. 2015*b*. Effects of Hierarchical Roost Removal on Northern Long-Eared Bat (Myotis septentrionalis) Maternity Colonies. PLOS ONE 10:e0116356.

Silvis, A., W. M. Ford, E. R. Britzke, and J. B. Johnson. 2014. Association, roost use and simulated disruption of Myotis septentrionalis maternity colonies. Behavioural Processes 103:283–290.

Silvis, A., R. W. Perry, and W. M. Ford. 2016. Relationships of three species of bats impacted by white-nose syndrome to forest condition and management. U.S. Department of Agriculture Forest Service, Southern Research Station., Asheville, NC. <https://www.srs.fs.usda.gov/pubs/gtr/gtr_srs214.pdf>.

Smith, H. J., and J. S. Stevenson. 2015. Best Management Practices for Bat Species Inhabiting Transportation Infrastructure. Adapted from Smith, H.J., & Stevenson, J.S. (2013). Linking conservation and transportation: a bats in bridges report. New Mexico Department of Transportation Task No. 5372-33. Developed as part of the White-nose Syndrome National Response Plan. Available at https://issuu.com/rdwildlifemanagement/docs/crwg__bats_in_bridges__bmps___feb_2.

Sołowczuk, A., and D. Kacprzak. 2022. Identification of the Key Determinants of Bats' Altitude Increase over the S3 Expressway in Poland with Mesh Screens Applied. Sustainability 14:15324.

Song, S., Y. Chang, D. Wang, T. Jiang, J. Feng, and A. Lin. 2020. Chronic traffic noise increases food intake and alters gene expression associated with metabolism and disease in bats. Journal of Applied Ecology 57:1915–1925.

Stone, E. L., G. Jones, and S. Harris. 2012. Conserving energy at a cost to biodiversity? Impacts of LED lighting on bats. Global Change Biology 18:2458–2465.

Threlfall, C. G., B. Law, and P. B. Banks. 2013. The urban matrix and artificial light restricts the nightly ranging behaviour of Gould's long-eared bat (Nyctophilus gouldi). Austral Ecology 38:921–930.

Timpone, J. C., J. G. Boyles, K. L. Murray, D. P. Aubrey, and L. W. Robbins. 2010. Overlap in Roosting Habits of Indiana Bats (Myotis sodalis) and Northern Bats (Myotis septentrionalis). The American Midland Naturalist 163:115–123.

Udell, B. J., B. R. Straw, T. L. Cheng, K. Enns, W. F. Frick, B. Gotthold, K. M. Irvine, C. Lausen, S. Loeb, J. Reichard, T. Rodhouse, D. Smith, C. Stratton, W. E. Thogmartin, and B. E. Reichert. 2022. Status and Trends of North American Bats Summer Occupancy Analysis 2010-2019 North American Bat Monitoring Program | May 2022. <https://ecos.fws.gov/ServCat/Reference/Profile/144755>. Accessed 6 Mar 2023.

U.S. Fish and Wildlife Service. 2022*a*. Range-wide Indiana bat & northern long-eared bat survey guidelines. <https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines>. Accessed 10 May 2022.

U.S. Fish and Wildlife Service. 2022*b*. Species Status Assessment Report for the Northern long-eared bat (Myotis septentrionalis) Version 1.1. Bloomington, MN. <https://www.fws.gov/sites/default/files/documents/Species%20Status%20Assessment%20Report%20for%20the%20Northern%20long-eared%20bat-%20Version%201.1%20%282%29.pdf>.

Voigt, C., C. Azam, J. Dekker, J. Ferguson, M. Fritze, S. Gazaryan, F. Hölker, G. Jones, N. Leader, D. Lewanzik, H. Limpens, F. Mathews, J. Rydell, H. Schofield, K. Spoelstra, and M. Zagmajster. 2018. Guidelines for consideration of bats in lighting projects.

Voigt, C. C., J. Dekker, M. Fritze, S. Gazaryan, F. Hölker, G. Jones, D. Lewanzik, H. J. G. A. Limpens, F. Mathews, J. Rydell, K. Spoelstra, and M. Zagmajster. 2021. The Impact Of Light Pollution On Bats Varies According To Foraging Guild And Habitat Context. BioScience 71:1103–1109.

Vuk, I., M. Đurović, and P. Presetnik. 2014. First data on bat traffic casualties in Montenegro. Vesperlilio 17:89–94.

Vuk, I., M. Đurović, and P. Presetnik. 2015. First data on bat traffic casualties in Montenegro.

White, J. A., P. Freeman, and C. A. Lemen. 2017. Habitat selection by the Northern Long-eared Myotis (*Myotis septentrionalis*) in the Midwestern United States: Life in a shredded farmscape. Transactions of the Nebraska Academy of Sciences and Affiliated Societies 37:1–10.

White, J. A., P. W. Freeman, H. W. Otto, and C. A. Lemen. 2020. Winter Use of a Rock Crevice by Northern Long-Eared Myotis (Myotis septentrionalis) in Nebraska. Western North American Naturalist 80:114–119.

Wilken, E., F. Jimenez Nava, and G. Griffith. 2011. North American Terrestrial Ecoregions —Level III. Commission for Environmental Cooperation, Montreal, Canada.

Wray, S., P. Reason, D. Wells, W. Cresswell, and H. Walker. 2006. Design, installation, and monitoring of safe crossing points for bats on a new highway scheme in Wales. Pages 369–379 *in*. Proceedings of the 2005 International Conference on Ecology and Transportation. Center for Transportation and the Environment, Raleigh, NC.

Yantén, A. V., A. Cruz-Roa, and F. A. Sánchez. 2022. Traffic noise affects foraging behavior and echolocation in the Lesser Bulldog Bat, Noctilio albiventris (Chiroptera: Noctilionidae). Behavioural Processes 203:104775.

Zeale, M. R. K., E. L. Stone, E. Zeale, W. J. Browne, S. Harris, and G. Jones. 2018. Experimentally manipulating light spectra reveals the importance of dark corridors for commuting bats. Global Change Biology 24:5909–5918.

Zurcher, A. A., D. W. Sparks, and V. J. Bennett. 2010. Why the bat did not cross the road? Acta Chiropterologica 12:337–340.