VTRC
Virginia Transportation Research Council

We Bring Innovation to Transportation

Evaluating Bat Use of Culverts in Virginia and Opportunities to Streamline Consultation for VDOT Projects

https://vtrc.virginia.gov/media/vtrc/vtrc-pdf/vtrc-pdf/27-R01.pdf

BRIDGET M. DONALDSON
Associate Principal Research Scientist

JONATHAN C. LUU
Research Assistant

Final Report VTRC 27-R01

VIRGINIA TRANSPORTATION RESEARCH COUNCIL
530 Edgemont Road, Charlottesville, VA 22903-2454
vtrc.virginia.gov

Standard Title Page - Report on Federally Funded Project

1. Report No.: FHWA/VTRC 27-R01	2. Government Accession No.:	3. Recipient's Catalog No.:
4. Title and Subtitle: Evaluating Bat Use of Culverts in Virginia and Opportunities to Streamline Consultation for VDOT Projects		5. Report Date: July 2026 6. Performing Organization Code:
7. Author(s): Bridget M. Donaldson and Jonathan C. Luu		8. Performing Organization Report No.: VTRC 27-R01
9. Performing Organization and Address: Virginia Transportation Research Council 530 Edgemont Road Charlottesville, VA 22903		10. Work Unit No. (TRAIS): 11. Contract or Grant No.: 128280
12. Sponsoring Agencies' Name and Address: Virginia Department of Transportation 1221 E. Broad Street Richmond, VA 23219 Federal Highway Administration 400 North 8th Street, Room 750 Richmond, VA 23219-4825		13. Type of Report and Period Covered: Final 14. Sponsoring Agency Code:
15. Supplementary Notes: This is an SPR-B report.		

16. Abstract:

Transportation projects in Virginia frequently require coordination with the U.S. Fish and Wildlife Service (USFWS) to address the potential effects on federally listed bat species. Although existing tools provided by USFWS and the Federal Highway Administration offer effective pathways for many projects, individual coordination is still needed to address some projects, and workload demands are associated with the guidance. Structure assessments for bats represent one area of substantial workload. Although project-specific investigations have been conducted on bat use of structures in Virginia, no systematic, statewide studies have quantified culvert use. This study evaluated opportunities to improve the efficiency and consistency of bat-related coordination through two complementary components: (1) development of a structured framework to guide a follow-up culvert field study intended to better inform culvert survey requirements and decision-making and (2) evaluation of broader streamlining opportunities through interviews with Virginia Department of Transportation (VDOT) staff, Virginia-based USFWS staff, and state departments of transportation and USFWS field office representatives from six other states.

Literature and structure assessment data indicate that bat use of certain culverts is rare and primarily associated with larger concrete structures, with limited evidence of use in smaller or metal culverts that comprise most of VDOT's inventory. Of more than 8,300 bridges and culvert complexes reviewed from Virginia's structure assessment datasets, 2.9% had evidence of bat use. Of those structures, 94.7% were bridges. Landscape analyses showed no clear differences in land cover composition within 500-m and 1-km buffers around bridges and culverts used by bats, and significant (although weak) associations were observed with distance to forest and streams. Findings were used to create a sampling framework for a subsequent field study focused on metal culverts and smaller concrete culverts.

Interviews with 18 practitioners identified some common challenges across VDOT and USFWS staff, including high workloads associated with recurring activities such as tree cutting, structure assessments, and the need for clearer and more consistent project information. State departments of transportation and USFWS field office staff from other states reported similar challenges and described the use of targeted data collection to improve coordination, standardized conservation measures, and state-specific programmatic approaches.

Findings indicate that near-term improvements can be achieved by improving the consistency and clarity of project submittals, identifying project types for streamlining by tracking those that require additional coordination, and initiating the development of a streamlined approach for tree cutting. This report outlines a structured approach for tree-cutting activities that defines recurring scenarios, establishes thresholds for streamlined pathways, and applies standardized conservation measures, while maintaining appropriate review for higher risk conditions. These efforts provide a framework for improving coordination efficiency while supporting data-informed, long-term streamlining strategies.

17. Key Words: Bat surveys, structure assessments, bat consultation	18. Distribution Statement: No restrictions. This document is available to the public through NTIS, Springfield, VA 22161.		
19. Security Classif. (of this report): Unclassified	20. Security Classif. (of this page): Unclassified	21. No. of Pages: 52	22. Price:

FINAL REPORT

EVALUATING BAT USE OF CULVERTS IN VIRGINIA AND OPPORTUNITIES TO STREAMLINE CONSULTATION FOR VDOT PROJECTS

Bridget M. Donaldson
Associate Principal Research Scientist

Jonathan C. Luu
Research Assistant

In Cooperation with the U.S. Department of Transportation
Federal Highway Administration

Virginia Transportation Research Council
(A partnership of the Virginia Department of Transportation
and the University of Virginia since 1948)

Charlottesville, Virginia

July 2026
VTRC 27-R01

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Virginia Department of Transportation, the Commonwealth Transportation Board, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. Any inclusion of manufacturer names, trade names, or trademarks is for identification purposes only and is not to be considered an endorsement.

ABSTRACT

Transportation projects in Virginia frequently require coordination with the U.S. Fish and Wildlife Service (USFWS) to address the potential effects on federally listed bat species. Although existing tools provided by USFWS and the Federal Highway Administration offer effective pathways for many projects, individual coordination is still needed to address some projects, and workload demands are associated with the guidance. Structure assessments for bats represent one area of substantial workload. Although project-specific investigations have been conducted on bat use of structures in Virginia, no systematic, statewide studies have quantified culvert use. This study evaluated opportunities to improve the efficiency and consistency of bat-related coordination through two complementary components: (1) development of a structured framework to guide a follow-up culvert field study intended to better inform culvert survey requirements and decision-making and (2) evaluation of broader streamlining opportunities through interviews with Virginia Department of Transportation (VDOT) staff, Virginia-based USFWS staff, and state departments of transportation and USFWS field office representatives from six other states.

Literature and structure assessment data indicate that bat use of certain culverts is rare and primarily associated with larger concrete structures, with limited evidence of use in smaller or metal culverts that comprise most of VDOT's inventory. Of more than 8,300 bridges and culvert complexes reviewed from Virginia's structure assessment datasets, 2.9% had evidence of bat use. Of those structures, 94.7% were bridges. Landscape analyses showed no clear differences in land cover composition within 500-m and 1-km buffers around bridges and culverts used by bats, and significant (although weak) associations were observed with distance to forest and streams. Findings were used to create a sampling framework for a subsequent field study focused on metal culverts and smaller concrete culverts.

Interviews with 18 practitioners identified some common challenges across VDOT and USFWS staff, including high workloads associated with recurring activities such as tree cutting, structure assessments, and the need for clearer and more consistent project information. State departments of transportation and USFWS field office staff from other states reported similar challenges and described the use of targeted data collection to improve coordination, standardized conservation measures, and state-specific programmatic approaches.

Findings indicate that near-term improvements can be achieved by improving the consistency and clarity of project submittals, identifying project types for streamlining by tracking those that require additional coordination, and initiating the development of a streamlined approach for tree cutting. This report outlines a structured approach for tree-cutting activities that defines recurring scenarios, establishes thresholds for streamlined pathways, and applies standardized conservation measures, while maintaining appropriate review for higher risk conditions. These efforts provide a framework for improving coordination efficiency while supporting data-informed, long-term streamlining strategies.

TABLE OF CONTENTS

FINAL REPORT

EVALUATING BAT USE OF CULVERTS IN VIRGINIA AND OPPORTUNITIES TO STREAMLINE CONSULTATION FOR VDOT PROJECTS

Bridget M. Donaldson
Associate Principal Research Scientist

Jonathan C. Luu
Research Assistant

INTRODUCTION

Regulatory Background

Virginia is home to several bat species with federal or state protection status. Federally and state endangered bats in Virginia include the Indiana bat (*Myotis sodalis*), gray bat (*Myotis grisescens*), Virginia big-eared bat (*Corynorhinus townsendii virginianus*), and northern long-eared bat (NLEB) (*Myotis septentrionalis*). The tricolored bat (TCB) (*Perimyotis subflavus*) is currently proposed for federal listing and is state endangered in Virginia. Additional state-endangered bats include the little brown bat (*Myotis lucifugus*) and Rafinesque's eastern big-eared bat (*Corynorhinus rafinesquii macrotis*), and the eastern small-footed bat (*Myotis leibii*) is recognized by Virginia as a Species of Greatest Conservation Need (Virginia Department of Wildlife Resources [VDWR], 2025).

The Virginia Department of Transportation (VDOT) is frequently required to complete consultation under Section 7 of the Endangered Species Act (ESA) for transportation projects. Section 7 requires agencies working on federally funded or permitted projects to ensure that their actions do not jeopardize federally listed threatened or endangered species or their designated critical habitat. When Section 7 consultation is not triggered, VDOT must still ensure that project activities do not violate the "take" prohibitions under Section 9 of the ESA, which make it unlawful to harm, harass, or kill listed species.

VDOT often consults with the U.S. Fish and Wildlife Service (USFWS) on federally listed and proposed bat species, particularly for projects involving substantial tree cutting and for bridge and culvert work where bats may roost or hibernate. VDOT also coordinates with VDWR for projects that may affect bat species.

VDOT may use the USFWS's Programmatic Biological and Conference Opinion (PBO) for transportation projects in the range of Indiana bat, NLEB, and TCB for projects, "… authorized, funded, or carried out, in whole or in part, by the Federal Highway Administration (FHWA), Federal Railroad Administration, or Federal Transit Administration." The PBO provides a standardized programmatic approach for evaluating project effects and achieving ESA Section 7 compliance. To facilitate use, USFWS developed and maintains a determination key (DKey) to guide FHWA's and state departments of transportation's (DOTs) project-level effect

determinations, along with standardized conservation measures. The PBO streamlines consultation by allowing qualifying projects to proceed under predefined criteria rather than requiring individual project-by-project consultation. The programmatic framework also includes mechanisms for compensatory mitigation, through which certain unavoidable project-level impacts may be offset by contributing to conservation efforts that support bat habitat at a broader scale. Beyond project-level consultation under this framework, Section 7(a)(1) of the ESA provides a complementary basis for federal agencies to support broader, programmatic conservation efforts that are not tied to individual projects (American Association of State Highway and Transportation Officials, 2017).

In March 2024, USFWS released an updated *Range-Wide Indiana Bat and Northern Long-Eared Bat Survey Guidelines*, which includes habitat information and updated survey and assessment guidance for the federally proposed endangered TCB and includes species-specific minimum culvert dimensions for the Indiana bat, NLEB, and TCB used as screening criteria for determining whether bridge and culvert bat assessment may be warranted. This guidance was subsequently updated again in 2026 (USFWS, 2026). In general, after determining if a site is safe to enter, the culvert should be evaluated to determine whether it is generally suitable for bat roosting. The guidelines include species-specific minimum culvert dimensions used as screening criteria for determining whether bat surveys are warranted, generally defined as culverts ≥ 23 feet in length and ≥ 4.5 feet in interior height or diameter for NLEB, ≥ 23 feet in length and ≥ 3 feet in interior height or diameter for TCB, and ≥ 23 feet in length and ≥ 4 feet in interior height or diameter for the Indiana bat (USFWS, 2026).

Later the same year, USFWS released the *Standard Analysis and Implementation Plan for Northern Long-Eared Bat and Tricolored Bat* (USFWS, 2024a) and the associated *Northern Long-Eared Bat and Tricolored Bat Range-Wide Determination Key* (USFWS, 2024b). In December of 2024, USFWS updated the *Programmatic Biological Opinion and Conference Opinion for Transportation Projects in the Range of the Indiana Bat (Myotis sodalis), Northern Long-Eared Bat (Myotis septentrionalis), and Tricolored Bat (Perimyotis subflavus)*, or "2024 PBO" (USFWS, 2024c). In 2025, the *Northeast Endangered Species Determination Key,* which covers the Indiana bat, the gray bat (*Myotis grisescens*), and the Virginia big-eared bat (*Corynorhinus townsendii virginianus*), was also made available to VDOT (USFWS, 2025). These "DKeys" and the 2024 PBO provide tools to support Section 7 compliance under the ESA.

Need for Virginia-Specific Streamlining Approaches

The new and updated tools and frameworks include several changes to improve consistency and consultation efficiencies, such as providing agencies with standardized forms and decision tools, clear work-window recommendations, and offering more predictable effect determinations. Although these tools are designed to support consistent implementation and have improved coordination and efficiency in many cases, not all aspects of the tools fully align with project-specific contexts and state- or region-specific conditions.

In addition, structure assessments for bat occupancy are a substantial workload for VDOT and USFWS staff. Given the extensive inventory of bridges and culverts under VDOT's management, the number of required assessments to evaluate potential bat use is considerable. In

this report, an "assessment" refers to a field inspection of a structure for bat presence, use, or occupancy.

To address recurring coordination and workload challenges associated with bat consultation while maintaining compliance with ESA requirements, some states have developed state-specific approaches, ranging from standardized coordination procedures and screening tools to broader programmatic agreements, or "programmatics." These approaches often incorporate state-specific data to refine survey requirements. For example, the structure survey requirements in Georgia's programmatic agreement are limited to concrete structures greater than 3 feet in height or diameter (Georgia DOT et al., 2023). This approach is based on Georgia's statewide survey efforts, culvert assessment data, and literature indicating low evidence of bat use in metal structures, likely due to limited roosting features (Morris, 2025).

Although there have been project-specific investigations of bat use of structures in Virginia, no systematic studies have comprehensively quantified culvert use. Given the large number of culverts under VDOT's management and the limitations of existing assessment data, additional information is needed to inform a standardized and strategic approach for a culvert assessment field study. The outcome of such an approach can better inform regulatory decisions, particularly for structures where the risk of bat occupancy is uncertain.

Virginia would also benefit from understanding (1) current consultation practices and areas of workload in Virginia and (2) streamlining approaches implemented in other states. Insights from these perspectives can help identify practical approaches for streamlining coordination and review processes.

PURPOSE AND SCOPE

The purpose of this project is to inform the development of streamlining tools that improve the efficiency and effectiveness of bat-related coordination, review, and culvert assessment processes for VDOT projects not currently covered by existing tools.

The objectives of this study include:

1. Developing the initial framework for a targeted culvert field study focused on culvert types for which evidence of bat occupancy is limited or inconclusive.
2. Identifying opportunities to streamline and improve efficiency in the regulatory consultation process, informed by interviews with VDOT, USFWS, and other state practitioners.

METHODS

This research involved seven tasks. Tasks 1 to 6 were designed to meet the first objective of designing a targeted sampling plan for a follow-up culvert field study. This process included compiling and evaluating information from the literature, VDOT's structure inventories, and bat

assessment records to identify key factors influencing bat occupancy and to support the development of the culvert sampling framework.

Task 7 included interviews with practitioners and a synthesis of responses to inform potential pathways for improving the efficiency of the consultation process for VDOT projects.

Task 1: Review the Literature

The literature was reviewed to document bat use of culverts in the United States, with a specific focus on the size and material of culverts with documented evidence of use. The literature was also reviewed for analytical approaches used to evaluate factors influencing structure use, including the spatial scales (e.g., distances and buffer extents) used to characterize surrounding landscape conditions and the statistical methods applied to assess relationships among structure attributes, landscape features, and bat occupancy.

Task 2: Characterize Culverts from VDOT Structure Inventories

Structure and Bridge Division's Inventory

VDOT's Structure and Bridge Division maintains bridges and culverts in VDOT's Structure and Bridge Inventory. This inventory was reviewed to characterize the number of culverts and bridges, as well as their material types and size dimensions.

A drainage structure is typically included in VDOT's Structure and Bridge Inventory if it has an opening area of greater than or equal to 36 square feet (VDOT, 2022). For box culverts, the opening area is calculated as width × height. For example, a single 6-×-6-foot box culvert has an opening area of 36 square feet and would be included. Similarly, four 3-×-3-foot pipes (each with an opening area of 9 square feet) would have a combined area of 36 square feet and would also be included.

This threshold may be met by a single opening or by the combined area of multiple barrels. For structures with multiple barrels, this "culvert complex" shares a single structure identification. A single pipe would require a diameter of approximately 7 feet to meet the 36-square-foot threshold. For multiple barrels, smaller pipes can meet the threshold when combined; for example, three 4-foot diameter pipes have a total opening area of approximately 37.7 square feet.

Maintenance Division's Inventory

VDOT's Maintenance Division maintains culverts that do not meet the size thresholds for inclusion in the Structure and Bridge Inventory. This inventory was also reviewed to characterize the culvert material types and size dimensions.

VDOT began developing an inventory of these smaller culverts (commonly referred to as pipes) in its Highway Maintenance Management System in approximately 2023 (Hetzer, 2026). This inventory includes drainage structures that fall below the Structure and Bridge Inventory

threshold (≥ 36 square feet of opening area). For example, a single box culvert with a 5-×-5-foot opening, a single circular pipe up to approximately 6 feet in diameter, or multiple smaller barrels (e.g., two or three 3- to 4-foot diameter pipes) would be included in this database rather than the Structure and Bridge Inventory.

Task 3: Compile VDOT's Bat Assessment Data

This task focused specifically on VDOT's structure assessment records, which are used to screen VDOT-managed bridges and culverts for evidence of bat use prior to project activities. Assessment records from readily available datasets served as the primary data source for this task. Rather than compiling an exhaustive inventory of all project records (e.g., Biological Opinions and other submissions to USFWS), the analysis focused on electronic datasets that allowed for an efficient assessment of a large, representative sample. This approach was sufficient to meet the study objective of developing a sampling design for a follow-up culvert study, which will provide a more reliable characterization of bat use than assessments conducted opportunistically as part of project reviews.

Survey123 and Earlier Forms

VDOT's Bat Assessment Form, which is based on questions in the USFWS's (2026) Bat Survey Guidelines and approved by the Virginia field office, is used to document information on structures assessed for evidence of bats. Documentation includes structure characteristics, bat presence or absence, bat species (if possible), and evidence of bat use (e.g., visual sightings, guano, or staining). Assessments may be completed using either VDOT's Bat Assessment Form (as a PDF) or through the ArcGIS Survey123 application, which VDOT implemented in 2023. Alternatively, the assessment form included in Appendix C5 of the USFWS (2026) survey guidelines may be completed in lieu of the VDOT PDF form. Although using the application is encouraged, the PDF version remains an acceptable option. Since the application's implementation in 2023, assessments recorded on PDF forms have been typically uploaded to Survey123 to maintain a single data source as best as possible.

VDOT structure assessment data were obtained from both the Survey123 application and the data that had been entered into VDOT's Structure Point Layer (SPOL), a geographic information system (GIS)-based dataset that contains historical bat structure assessments entered from the original PDF versions of the structure assessment form. The assessment data included culverts that are part of the Structure and Bridge Division's inventory and the Maintenance Division's inventory. This assessment data served as the primary dataset for Tasks 4 and 5.

VDOT's Survey123 records were collected between January 24, 2023, when use of the Survey123 application began, and October 21, 2025, and totaled 8,958 entries. A technical review panel member provided earlier records obtained through SPOL; this dataset included records collected between October 23, 2015, and March 4, 2021, and totaled 791 entries. Combined, these datasets included 9,749 records.

The SPOL dataset was processed and merged with the Survey123 dataset to create a unified record of bat assessments spanning two time periods. Within the SPOL dataset, a binary

bat evidence column was derived from three presence indicator fields (Visual, Staining, and Sound), such that any observation with at least one "Yes" response across these fields was assigned a "Yes" value, and all remaining observations were assigned "No." Following this step, the SPOL and Survey123 datasets were merged, and a period label was appended to each observation to distinguish historical records (2015–2021) from recent assessments (2023–2025).

The structure data required additional cleaning and organizing prior to joining them with the bat assessment records. Duplicate entries were removed. Structure material designations were standardized by consolidating any label containing "Steel" into a single (and more commonly used) "metal" category. The cleaned structure inventory dataset was joined to the merged bat assessment data using the Federal Structure ID as the common identifier.

Bat Assessment Data from a Large-Scale VDOT Project

To supplement the electronic datasets and provide an example of a large-scale project involving numerous culvert assessments, data from a recent large-scale project on Interstate 64 (I-64) were also included. In 2024, biological assessments were conducted for the I-64 GAP Segment A and Segment C widening projects in Henrico, New Kent, and James City Counties and Lightfoot Park and Ride in York County. These assessments included culvert assessment results from 99 culverts.

Task 4: Characterize Landscape Context Surrounding Assessed Structures

ArcGIS Pro was used to map locations of structures assessed for bats and to evaluate the broader surrounding landscape context of structures at a statewide screening level. The structure data from Survey123 and earlier forms (described in Task 3) served as the basis for this analysis.

Surrounding land cover was quantified for each structure at two spatial scales to represent both near-structure habitat context and broader landscape settings. Using the U.S. Geological Survey's (USGS) National Land Cover Database (NLCD), a 30-m resolution dataset widely used in bat habitat and occupancy studies was summarized within 500-m and 1-km buffers (Dewitz, 2023). Using buffers of these sizes minimizes classification noise associated with fine-resolution features while capturing meaningful differences in forested, developed, and open landscapes surrounding culverts. The 1-km scale is commonly used to characterize bat habitat associations in road-adjacent analyses and has been justified as a minimum foraging-distance landscape context in transportation-focused work (De La Cruz et al., 2024; Foster et al., 2019; Perez-Jiminez et al., 2024). The 500-m buffer captures local land cover; this buffer size was used in southeastern and central Appalachian bat studies (De la Cruz et al., 2024; Neece et al., 2018; Weber et al., 2020). Land cover area within buffers was summarized by grouping intersected polygons by buffer and NLCD class and summing polygon areas using ArcGIS Pro's Summary Statistics tool.

In addition to land cover composition within fixed buffers, distance to forest and distance to streams were evaluated as indicators of immediate habitat accessibility and riparian corridor use, which can be more relevant to structure-scale bat use than broader landscape composition alone (Weber et al., 2020). Stream proximity was quantified using the USGS's National

Hydrography Dataset high-resolution flowline data (i.e., stream/river classification), downloaded via the USGS National Map Downloader and imported as a feature class in ArcGIS Pro to calculate distance to the nearest stream for each culvert.

GIS-derived data were exported to Excel for analysis, and NLCD land cover classes (15) were aggregated into a reduced set of bat-relevant categories to improve interpretability, following approaches commonly used in U.S. bat and landscape analyses (Comparato, 2023; Weber et al., 2020). Specifically, forest cover was represented by combining deciduous, evergreen, mixed forest, and woody wetlands classes; developed land was represented by combining three developed intensity classes (low, medium, and high); developed open space was retained as a separate "suburban/open" category; and agricultural and open cover was represented by combining pasture/hay and cultivated crops and herbaceous classes. Open water (e.g., lakes, rivers/streams) was retained as a distinct class.

Task 5: Examine Key Factors that Influence Structure Occupancy

Statistical approaches for determining factors that influence bat use were selected after reviewing the final dataset, particularly to assess whether sufficient bat-positive observations were available to support statistical analysis. All comparisons were made between bat-positive and bat-negative structures. The distribution of assessed structures was summarized across key variables, including bat presence, material type, and structure type. Counts of culvert complexes were also summarized by month, VDOT district, ecoregion, and proximity to the nearest stream and forest edge.

For spatial analyses, land cover composition was quantified within 500-m and 1-km radii of the assessed bridge and culvert complex. Statistical analyses were conducted in RStudio to evaluate factors associated with bat presence. Because the dataset included a high proportion of structures without bat detections, zero-inflated models were initially considered; however, because the zero-inflated component was not supported, a standard Poisson regression was selected as the final modeling approach.

Predictor variables included land cover composition at a 1-km radius, proximity to forest and streams, and ecoregion. To address multicollinearity, percent water cover and all 500 m-scale land cover variables were excluded from the final model. Because of both the relatively small number of bat-positive observations and the low explanatory power of the coefficients, statistical analyses were used to support rather than replace trends shown in descriptive tables and figures.

Task 6: Develop a Sampling Framework for a Follow-up Culvert Field Study

The findings from Tasks 1 through 5 were used to develop a sampling framework for a follow-up culvert field study. The framework was designed to focus on culverts in Virginia for which evidence of bat occupancy is limited or underrepresented in existing datasets.

The sampling approach prioritizes culverts based on (1) key factors identified in the literature review, (2) analyses of VDOT's structure inventories, and (3) analyses of VDOT bat assessment data, including culvert size, material type, and landscape context. The sampling

framework was also designed to align with the USFWS's Bat Survey Guidelines for culvert size criteria (USFWS, 2026).

Task 7: Conduct Interviews

The goal of these interviews was to synthesize practitioner perspectives, identify areas of general agreement, and inform potential pathways for improving the efficiency of the consultation process.

Fifteen interviews were held with 18 practitioners, including VDOT and USFWS members of the study's technical review panel, and practitioners in six other states recommended by technical review panel members (Table 1). In some cases, initial contacts in other states referred the research team to colleagues who were more knowledgeable on the topic and better suited for the interview.

Table 1. List of Interviews

State	Agency	Division	Number of Participants
VA	DOT	Central Office and District	6
	USFWS	Virginia Field Office, DOT Liaison, and Headquarters Office	3
TX	DOT	Environmental Affairs	3
NJ	DOT	Environmental	1
SC	USFWS	DOT Liaison	1
GA	DOT	Environmental Services	1
	USFWS	DOT Liaison	1
NC	DOT	Environmental Analysis	1
TN	DOT	Environmental Division	1

DOT = Department of Transportation; USFWS = U.S. Fish and Wildlife Service.

Each practitioner was contacted by e-mail, which included a brief description of the study, a list of interview questions, and notes that the interview would be recorded for note-taking purposes but would not be distributed. Each interview lasted approximately 1 hour. Interview questions were tailored based on whether participants worked on projects in Virginia or in other states. These questions focused on understanding the bat consultation process from a practitioner perspective, including where time and effort are concentrated, what drives inefficiencies, how decisions and coordination occur, and what opportunities exist to standardize and streamline the process based on both in-state experience and approaches used in other states. Appendix A provides the full list of interview questions. To maintain anonymity, responses are presented at the agency and division level rather than attributed to individual participants.

Interview responses were synthesized to characterize bat consultation approaches and identify common themes, areas of agreement, and opportunities for improving the efficiency of the consultation process. Findings are presented separately for Virginia and for other states.

RESULTS AND DISCUSSION

Literature on Culvert Occupancy by Bats in the United States

The literature reviewed focused on peer-reviewed research studies and was supplemented with graduate theses and information provided in the 2024 PBO (USFWS, 2024c). A total of 43 online-accessible studies and reports from the United States that address bat use of bridges and culverts were identified, most of which focus primarily on bridge use. The literature discussed herein includes only those sources that address culvert use.

Of the studies that mention bat use of culverts, early and widely cited literature indicates that bats may use culverts; however, most of these studies are largely observational or bridge-focused and do not provide quantitative data on the number of culverts surveyed or occupied (Bender et al., 2010; Humphrey and Gore, 1992; Jones and Carter, 1989; Keeley and Tuttle, 1999; Kennedy et al., 1974; LaVal, 1967; Trousdale and Beckett, 2004).

Table 2 summarizes peer-reviewed studies or graduate theses in which culverts in the United States were directly assessed or surveyed. Although several studies included assessments of multiple culverts, many were not designed as systematic presence or absence studies across representative samples and, therefore, are not representative of bat occupancy rates. In several studies, bat-occupied culverts were identified as concrete; however, it was often unclear whether metal culverts (or other material types) were also evaluated.

Table 2. Summary of U.S. Studies Evaluating Bat Use of Culverts

State	Species	Number of Structures Assessed	Concrete Culverts Occupied?	Metal Culverts Occupied?	Citation
Texas	Tricolored bat	207[a]	Not reported	Not reported	Meierhofer et al., 2019
Texas	Ozark big-eared bat	4	Yes	Not evaluated	Sandel et al., 2001
Texas	Tricolored bat	44	Yes[a]	Not reported	Leivers et al., 2019
Texas	Tricolored bat	353	57 occupied (material not reported)		Sanchez, 2024
Mississippi	Multiple species include tricolored, southeastern myotis	214	Yes (111)	No[b]	Katzenmeyer, 2016
Mississippi	Southeastern bat; Tricolored bat; Rafinesque's big-eared bat	7	Yes (7)	No	Martin et al., 2005
Georgia	Tricolored bat; Southeastern myotis; Rafinesque's big-eared bat	Not clearly reported	Yes (weep holes)	Not reported	Lutsch et al., 2022
North Carolina	Gray bat; Big brown bat; Tricolored bat	31[a]	Yes	Not reported	Weber et al., 2020
Florida	Southeastern myotis; Tricolored bat; Big brown bat	~102	Yes[a]	Not reported	Smith et al., 2024

[a] Culvert occupancy is reported, but the number of culverts occupied is not disclosed. [b] Culverts assessed were concrete only.

As Table 2 reflects and other literature notes, bat use of metal culverts appears to be rare, and culvert use in general is poorly quantified in peer-reviewed literature (Bender et al., 2010; Keeley and Tuttle, 1999; Trousdale and Beckett, 2004; USFWS, 2024c). Occasional use has been reported in literature syntheses (e.g., Wetzel and Roby, 2023), although such observations are often based on isolated records rather than systematic assessments.

This limited availability of published data on culvert use is also reflected in some southeastern states. For example, in Georgia, culvert assessment datasets have been developed through internal or student research but are not widely accessible (L. Pattavina, personal communication, 2026). However, in North Carolina, a statewide study is underway to quantify bat use of culverts (C. Knepp, personal communication, 2026). This research will complement a recent study documenting bat use of bridges (North Carolina DOT, 2025).

This pattern is consistent with the broader summary of culvert use in the 2024 PBO, which recognizes that culvert use occurs across a range of sizes and materials but is based on a small number of opportunistic observations rather than systematic assessments (USFWS, 2024c). Documented examples include: (1) 66 Indiana bats (*Myotis sodalis*) observed in a metal culvert in Indiana measuring approximately 9 feet in diameter and 180 feet in length; (2) two NLEBs documented in a metal culvert in Missouri approximately 9 feet in diameter and 250 feet in length; (3) TCBs observed in multiple stone culverts in North Carolina, where six of nine culverts were occupied, although specific dimensions were not reported; and (4) a single culvert in Georgia with documented bat use, although species, number of individuals, and culvert dimensions were not clearly specified. Additional records referenced in the PBO indicate that bats have occasionally been observed in very small culverts (e.g., approximately 2 feet in diameter), as Katzenmeyer (2016) documented (also included in Table 2), and reference additional observations such as recent records of NLEB in Mississippi reported in a Bat Conservation International newsletter (McCartney et al., 2024). Across these examples, culvert material is inconsistently documented, with some records identifying metal or stone culverts, whereas others do not specify material type.

Synthesis studies indicate that bat use of culverts has been studied less extensively than bridge use and is typically based on small datasets. These summaries suggest that bats most commonly use larger culverts (approximately 5 to 10 feet in height and greater than 328 feet in length), although smaller structures have occasionally been documented, including culverts as small as 2 feet in height and lengths as short as approximately 23 feet (Keeley and Tuttle, 1999; Wetzel and Roby, 2023). These syntheses also note that bats have been documented using both metal and concrete pipe culverts in the United States (Wetzel and Roby, 2023), although concrete culverts are most frequently reported as used by bats (Keeley and Tuttle, 1999; Smith et al., 2024).

Although studies documenting culvert use are limited in their ability to evaluate occupancy rates, consistent patterns indicate that when bats do occupy culverts, use is most often associated with larger, longer structures that provide more cave-like conditions, including greater internal volume and more stable microclimates (Katzenmeyer, 2016; Leivers et al., 2019; Meierhofer et al., 2019; Sandel et al., 2001; Wetzel and Roby, 2023). The greater use of concrete

culverts is attributed to their more stable thermal conditions and greater surface roughness for roosting (Martin et al., 2005; Sandel et al., 2001).

Sanchez (2024) found that culvert length and surrounding forest cover were positively associated with bat use, indicating that both structural characteristics and landscape context influence suitability. Weber et al. (2020) similarly found that higher occupancy was associated with proximity to forested habitat and riparian corridors.

Some studies indicate that culverts are more frequently used during the winter than the active season, likely because they function as cave-like refugia with stable microclimates (Leivers et al., 2019; Martin et al., 2005; Meierhofer et al., 2019; Sanchez, 2024; Sandel et al., 2001; Walker et al., 1996). This pattern has been documented across multiple regions and species, particularly for TCBs. These findings suggest that efforts to detect bat use of culverts could be effective in some regions during winter months when occupancy may be higher.

Overall, the literature suggests that bat use of culverts is most likely in larger, concrete structures in forested landscapes, and documented use includes winter months. Compared with bridges, however, culvert use remains less frequently documented, and assessment timing and methods influence detection, reinforcing the need for targeted sampling approaches.

VDOT Structure Inventory Data

Bridges and Culverts

VDOT's Structure and Bridge Division's inventory includes 12,202 bridges and 7,730 culvert complexes, representing 15,706 total culverts (an average of 2.0 culverts per complex).

As of April 2026, VDOT's Maintenance Division's inventory included 222,518 culverts (or pipes). Although this number represents the most comprehensive dataset currently available, the completeness of the inventory is uncertain because there is no known baseline of the total number of culverts statewide. At the outset of the inventory effort in 2023, approximately 90,000 culverts were documented, which has since increased to more than 220,000. More than 2,000 culverts were added between January and March 31, 2026. The rate of additions appears to be slowing, suggesting that fewer previously undocumented culverts are being identified (Hetzer, 2026).

Table 3 provides a summary of the number of structures in VDOT's inventories. VDOT's current inventories indicate that VDOT maintains 250,426 structures (12,202 bridges and 238,224 individual culverts).

Table 3. Summary of Structure Data in VDOT's Current Inventories

Inventory	Bridges	Culverts	
		Culvert Complexes	Individual Culverts
Structure and Bridge Division	12,202	7,730	15,706
Maintenance Division	-	-	222,518[a]
Total	**12,202**	7,730	**238,224**

[a] As of April, 2026. Inventory of Maintenance Division culverts is ongoing.

Culverts Relative to USFWS Survey Guideline Thresholds

Table 4 lists the culverts that fall below the minimum size thresholds (23-foot length and 3-foot height or diameter) in the *Range-Wide Indiana Bat and Northern Long-Eared Bat Survey Guidelines* for the Indiana bat, NLEB, and TCB (USFWS, 2026). Only culverts with specified dimensions are included because approximately 27,600 culverts in the Maintenance Division database lack adequate dimensional data to evaluate whether they meet the threshold criteria. As Table 4 reflects, of the 238,224 individual culverts in the current inventories, 177,885 (75%) are below the 3-foot height or diameter threshold in the USFWS guidelines (USFWS, 2026).

Table 4. Culverts (and Culvert Complexes) Below the Minimum Size Thresholds in U.S. Fish and Wildlife Service's (2026) Bat Survey Guidelines

Inventory	Below 23-ft Length Criterion	Below 3-ft Height or Diameter Criterion
Structure and Bridge	132 (66 culvert complexes)	14 individual (7 complexes)
Maintenance Division	0	177,871
Total	**132 (individual culverts)**	**177,885 (individual culverts)**

Figure 1 summarizes the VDOT culverts that meet the thresholds for the culvert length and opening dimensions in the USFWS's (2026) Bat Survey Guidelines, categorized by culvert inventory and material type and size class. Figure 1 uses individual culvert counts rather than culvert complexes to more directly reflect the number of structures that meet USFWS's assessment thresholds and the corresponding level of survey effort.

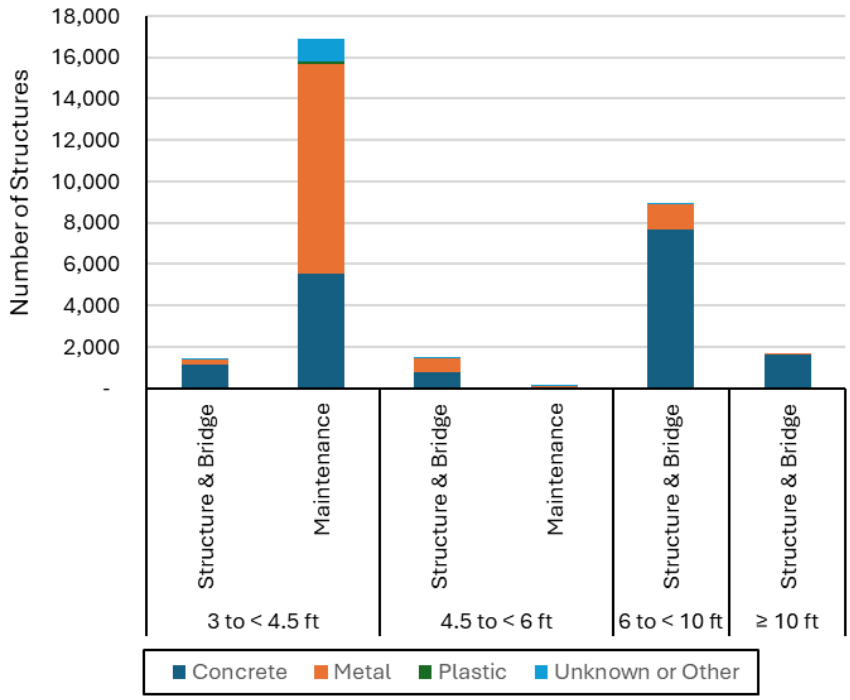
As Figure 1 reflects, current VDOT inventories have approximately 30,552 individual culverts with openings at least 3 feet in height or diameter and 23 feet in length, including:

- 13,502 culverts from the Structure and Bridge inventory, representing 6,751 culvert complexes.
- 17,050 culverts from the Maintenance Division's inventory.

Although Figure 1 illustrates culvert distributions based on opening-height or diameter-size bins, length data were also evaluated for the 30,552 assessment-eligible culverts to determine their size distributions. Approximately one-third of culvert lengths are between 23 and 40 feet (33.8%), one-third are between 41 and 65 feet (33.0%), and one-third are greater than 65 feet (33.2%). The distribution is largely driven by the Maintenance Division inventory, which comprises the majority of culverts and is concentrated at shorter lengths (median approximately 50 feet), in contrast to the Structure and Bridge inventory, which spans a much wider range of lengths (median approximately 74 feet).

Regarding culvert material, 12,366 metal culverts (40.5%) meet the size thresholds for bat assessments. Most metal culverts are between 3 and 4.5 feet in diameter or height (10,356, or 33.9% of all culvert types). There are 6,687 concrete culverts in this smaller size class (10.9%).

These results indicate that most culverts meeting minimum size thresholds are relatively small (3 to < 4.5 feet). They are most frequently constructed of metal, but a large proportion is concrete, reinforcing the importance of evaluating bat use in these common but understudied structure types.



Size Bins	Inventory	Material				Sub-total
		Concrete	Metal	Plastic	Unknown or Other	
3 to < 4.5 ft	Structure and Bridge	1,128	248	-	30	1,406
	Maintenance	5,559	10,108	137	1,107	16,911
4.5 to < 6 ft	Structure and Bridge	806	672	-	22	1,500
	Maintenance	61	70	5	3	139
6 to < 10 ft	Structure and Bridge	7,688	1,200	-	18	8,906
≥ 10 ft	Structure and Bridge	1,622	68	-	-	1,690
Total		16,864	12,366	142	1,180	**30,552**

Figure 1. The Number of Individual Culverts that Meet the Size Thresholds in the U.S. Fish and Wildlife Service's (2026) Bat Survey Guidelines, Separated by Inventory and Size Bins

VDOT's Bat Assessment Data

The evaluated dataset totaled 8,655 assessment records and included structures from both the Structure and Bridge Division and the Maintenance Division. For the following data evaluations, results are typically characterized at the culvert complex level rather than the

individual culvert level, because this perspective better reflects conditions at the site and landscape scale.

Data Summary and Classification

Assessment records indicated whether bats or evidence of bats were present ("yes") or absent ("no"). For this evaluation, structures were classified as bat positive or bat negative based on these responses. In many cases, the type of evidence was also documented (e.g., guano, staining, or live individuals), although this information was not consistently recorded across all entries. Figure 2 summarizes the number of bat-positive and bat-negative structures by structure type.

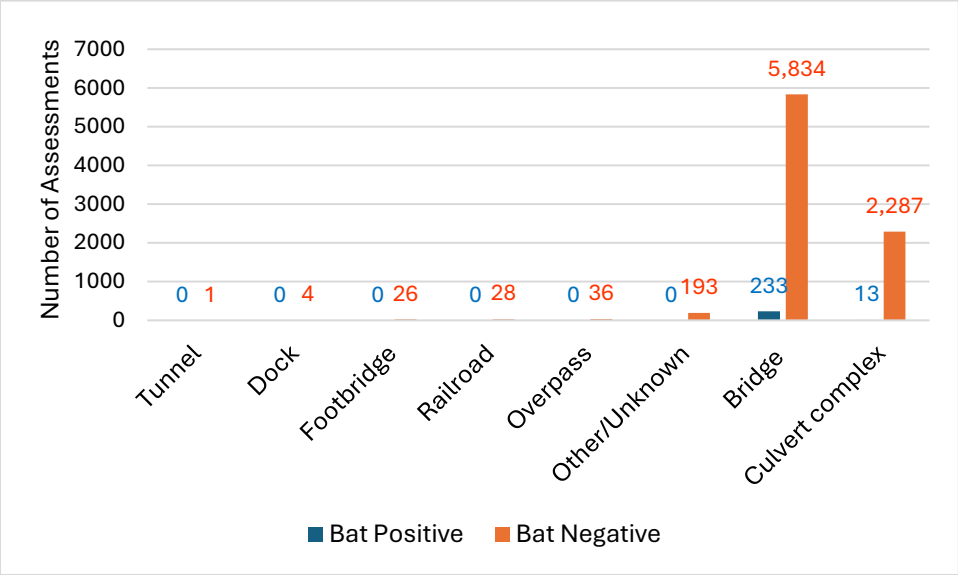


Figure 2. Bat-Positive and Bat-Negative Structure Assessments by Structure Type

Of the structure types evaluated in the assessments, only bridges and culverts had evidence of bats. Bat assessment results are summarized as follows:

- Of the 8,367 bridges and culvert complexes evaluated, 246 (2.9%) had evidence of bats.
- Of the bat-positive structures, 233 (94.7%) were bridges, and 13 (5.3%) were culvert complexes.
- Of the 2,300 culvert complexes, 13 (0.6%) had evidence of bats.

Statistical analyses (i.e., Poisson regression) were conducted to evaluate factors associated with bat presence in structures; however, results for structure-related variables largely confirmed patterns already evident in the figures and tables presented in subsequent sections. Given the limited number of bat-positive culvert complexes in the dataset, relationships between structure characteristics (e.g., material and size) are best reflected by summary tables and figures.

Landscape variables were evaluated using both descriptive and statistical approaches. Because landscape context may influence bat use across structure types, bridges and culverts were combined for these analyses. This larger sample size allowed for a more robust statistical

evaluation of landscape variables. However, given the low number of bat-positive structures, statistical results should not be interpreted as conclusive, and figures and summary tables are used to communicate key findings.

Seasonal Patterns of Bat Occurrence

Across bridges and culvert complexes, the 246 bat-positive observations occurred throughout the year but were most concentrated during the summer and early fall months (Figure 3). Three bat-positive culvert records occurred between December and February. This pattern generally corresponded with the overall distribution of assessments because assessment effort was also greatest from June through October, when 22% to 27% of all assessments were conducted each month. Assessments were conducted less often during winter and spring months, particularly January to December (15% to 18%) and April and May (17% to 18%).

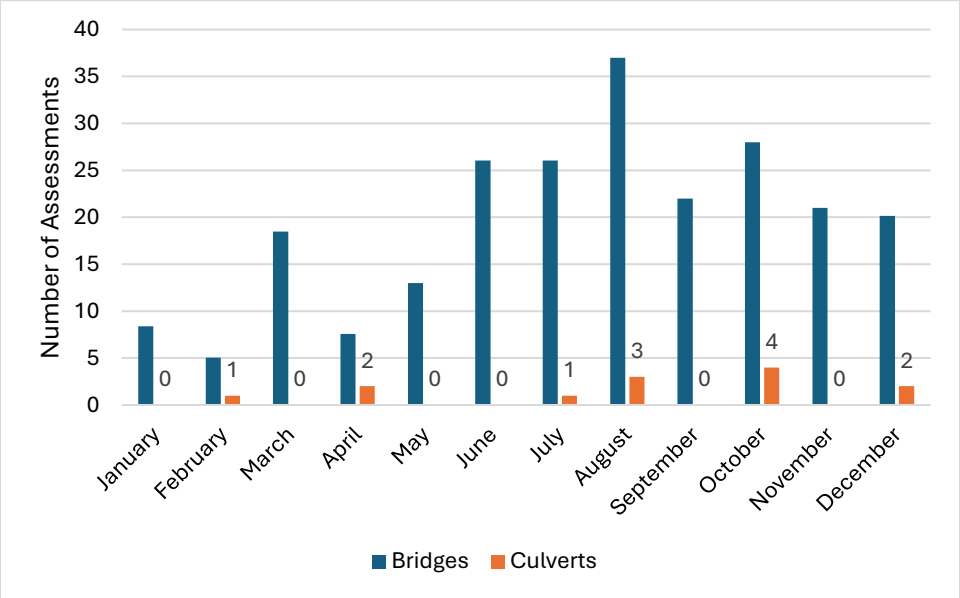


Figure 3. Distribution of Bat-Positive Bridge and Culvert Assessments by Month and Structure Type

Culvert Characteristics Associated with Bat Use

Bat detections were rare across all culvert material types, with 13 detections out of 2,300 assessed structures (0.5%). Detection rates were higher in concrete culverts (0.7%) compared with metal culverts (0.2%), with no detections observed in masonry or material types classified as "other" (Table 5).

Table 5. Bat Occupancy by Culvert Material

Culvert Material	Bat Positive	Bat Negative	Total	Bat Positive (%)
Concrete	12	1,685	1,697	0.7%
Metal	1	579	580	0.2%
Masonry	0	2	2	0.0%
Other	0	21	21	0.0%
Total	**12**	**2,287**	**2,300**	**0.5%**

Table 6 provides additional information on bat-positive culvert complexes. Among the 13 bat-positive culvert complexes, 12 were concrete box culverts, and one structure was a metal pipe (7-feet diameter). Eleven of the box culverts were between 6 and 8 feet in height, and one was 4 feet high (and 6 feet wide).

Table 6. Bat-Positive Culvert Complexes

Date of Assessment	Culvert Type	No. of Barrels	Material	Width (ft)	Height /Dia. (ft)	Length (ft)	Bat Evidence	VDOT District	Ecoregion
12/14/2016	Box	1	Concrete	8	6	70	NA	Bristol	Ridge and Valley
12/14/2016	Box	1	Concrete	6	6	28	NA	Bristol	Ridge and Valley
7/31/2024	Box	3	Concrete	7	7	2,995	NA	Salem	Ridge and Valley
10/22/2024	Box	1	Concrete	10	8	542	NA	Salem	Ridge and Valley
10/22/2022	Pipe	1	Metal	NA	7	304	NA	Lynchburg	Piedmont
10/23/2024	Box	3	Concrete	10	6	224	Visual/ Photos	Salem	Ridge and Valley
2/14/2025	Box	3	Concrete	7	7	340	NA	Hampton Roads	Southeastern Plains
4/2/2025	Box	8	Concrete	6	4	89	NA	Fredericksburg	Southeastern Plains
4/22/2025	Box	3	Concrete	6	6	88	NA	Fredericksburg	Southeastern Plains
8/15/2025	Box	1	Concrete	10	8	109	NA	Northern Virginia	Piedmont
8/18/2026	Box	2	Concrete	6	6	206	NA	Hampton Roads	Southeastern Plains
8/21/2025	Box	4	Concrete	10	6	301	NA	Hampton Roads	Southeastern Plains
8/21/2025	Box	3	Concrete	7	7	347	NA	Hampton Roads	Southeastern Plains

NA = not available.

Spatial Distribution by District and Ecoregion

Figure 4 illustrates the distribution of bat-positive and bat-negative structures, including bridges and culverts. The VDOT district map highlights the uneven distribution of electronic assessment records among VDOT's nine districts, and the ecoregion map provides geographic context for available assessment data. Table 7 provides additional details relative to the ecoregion.

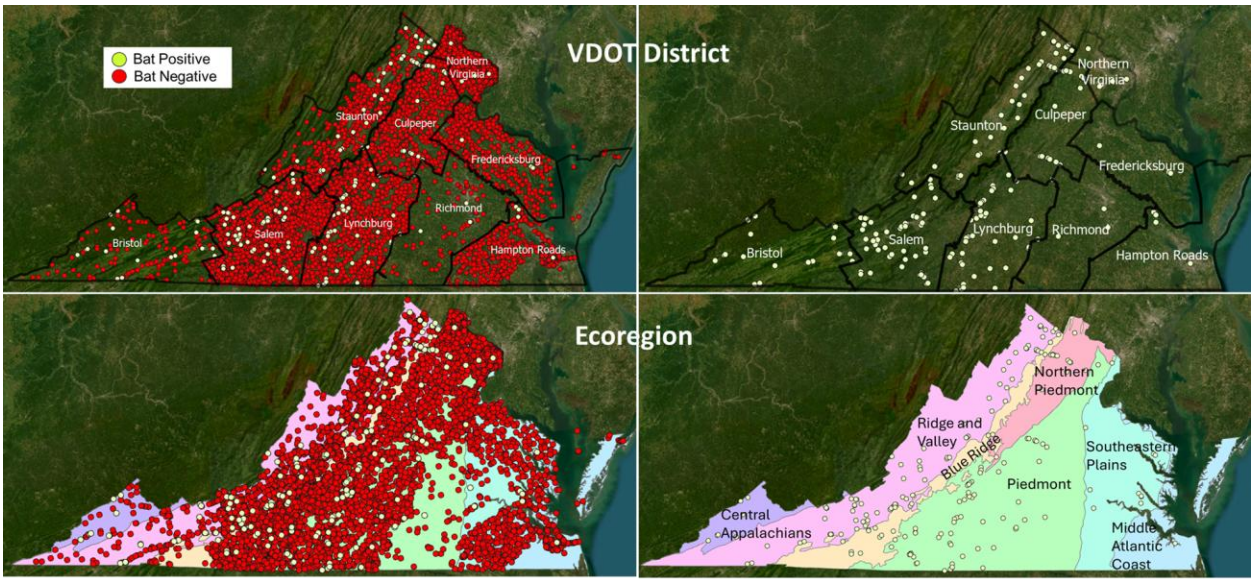


Figure 4. Distribution of Bridge and Culvert Assessment Data by VDOT District and Ecoregion

Table 7. Bridge and Culvert Complex Assessment Results by Ecoregion

Ecoregion	Bat Positive	Bat Negative	Bat-Positive Percentage
Central Appalachians	7	37	15.9%
Ridge and Valley	107	2,103	4.8%
Blue Ridge	11	664	1.6%
Northern Piedmont	18	1,414	1.3%
Piedmont	79	2,568	2.9%
Southeastern Plains	23	975	2.3%
Middle Atlantic Coastal Plain	1	360	0.6%

As Table 7 illustrates, the percentage of bat-positive assessments varied among ecoregions. Both the Central Appalachians and Ridge and Valley regions had significantly higher bat presence ($p < 0.001$), although the Central Appalachians result is based on a smaller sample size.

Land Cover Surrounding Culvert Complexes

Across both the 500-m and 1-m buffers, forest cover generally comprised the largest proportion of surrounding land cover around assessed bridges and culvert complexes. Comparisons of bat-positive ($n = 246$) and bat-negative ($n = 8,121$) structures showed substantial overlap in land cover distributions, with no clear differences between groups (Figure 5). Statistical analysis (i.e., Poisson regression) did not identify any significant differences in bat presence across land cover types within either buffer.

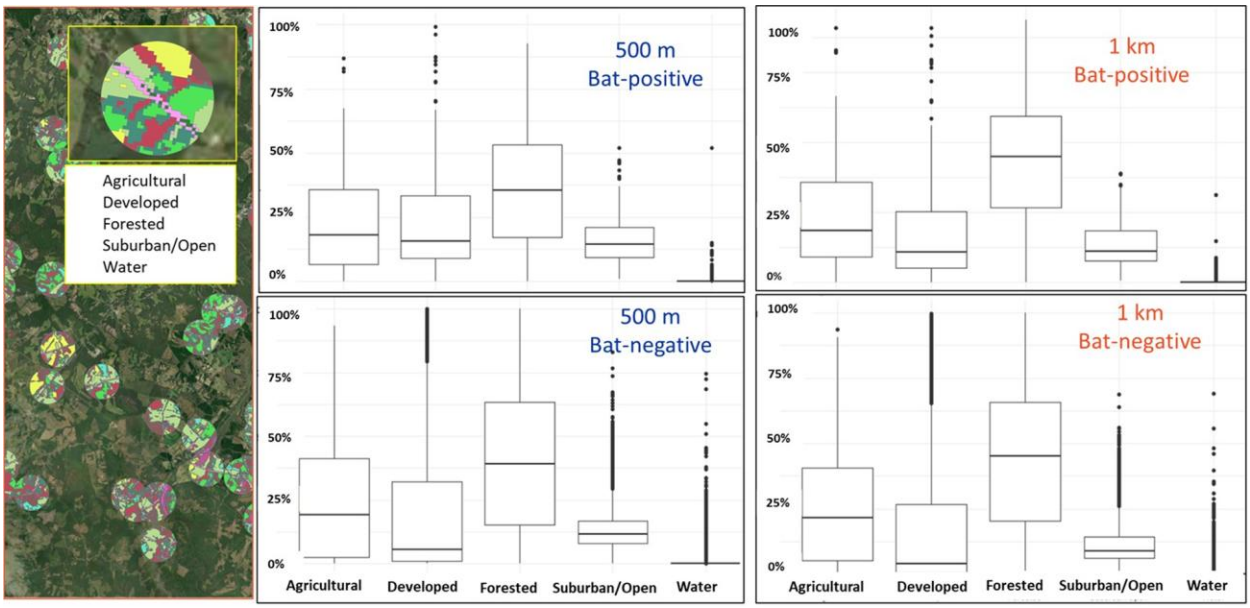


Figure 5. Land Cover Composition Surrounding Bat-Positive (n = 246) and Bat-Negative (n = 8,121) Bridges and Culvert Complexes in 500-m and 1-km Radii

Proximity to Streams and Forest

Distances from each structure (bridges and culverts) to the nearest forest and stream showed broadly similar distributions for both bat-positive and bat-negative sites. Most structures, regardless of bat use, were within 250 feet of forest and stream features, with frequencies declining at greater distances. The distribution of bat-positive sites generally followed the overall distribution of structures across distance bins, with substantial overlap between groups (Figure 6).

Results from the statistical analysis indicated that the distance to a forest was a significant predictor ($p < 0.001$), with higher bat occurrence at structures closer to forested areas; however, the effect size was small ($\beta = -0.00099$), meaning that differences in bat occurrence change only slightly as distance increases. These results suggest that the large sample size partly influenced statistical significance despite the relatively small effect.

The distance to a stream was also statistically significant ($p < 0.001$), but the pattern was less consistent and may reflect broader landscape patterns rather than a direct ecological association.

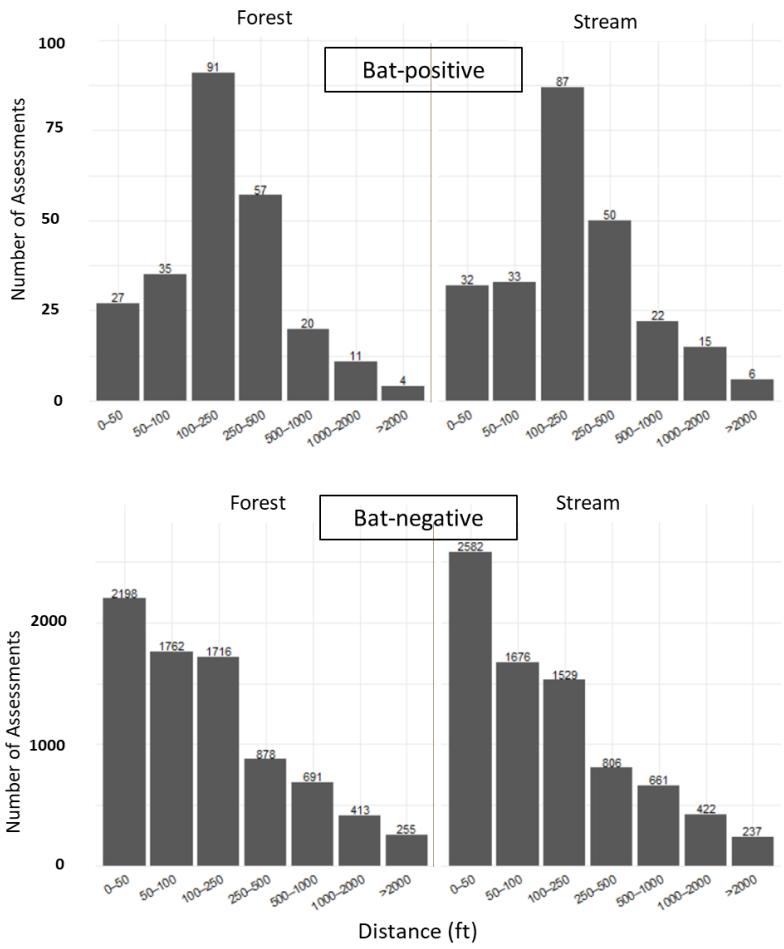


Figure 6. Distance to the Nearest Forest and Nearest Stream from Bat-Positive and Bat-Negative Bridges and Culvert Complexes

Supplemental Dataset

As a supplemental dataset, culvert inspection records from the I-64 Gap Widening Project (Segments A and C) were also reviewed. These records included 99 culverts assessed between 2022 and 2024. Evidence of bats was documented at eight culverts (8.0% of those assessed), including observations in culverts as small as 3.5 feet in diameter. All culverts with evidence of bat use were identified as concrete. Although this dataset is based on a limited number of observations, it is consistent with findings from the electronic datasets, indicating that bat use of culverts is more common in larger concrete structures (typically ≥ 6 feet in height). Appendix B provides more information on this dataset.

Summary of Structure Findings

The following summarizes the key findings from the structure inventory and bat assessment data:

- VDOT maintains a large inventory of structures, including more than 238,000 individual culverts, with most documented in the Maintenance Division database.
- Most culverts in VDOT's inventory are small; approximately 75% fall below the 3-foot height or diameter threshold outlined in the USFWS's Bat Survey Guidelines and are therefore not typically considered for bat assessments.
- The remaining 30,552 culverts meet the USFWS minimum size and length thresholds for survey consideration, representing a substantial number of structures that could require evaluation under current guidance.
- Of the culverts meeting assessment thresholds, most are relatively small (3 to < 4.5 feet in height or diameter), including approximately 10,356 metal culverts (33.9%) and 6,687 concrete culverts (10.9%) within this size class.
- Bat detections in culverts were rare, with only 13 bat-positive culvert complexes identified among approximately 2,300 culvert complexes (0.6%) in the evaluated electronic dataset.
- Based on the electronic dataset and the supplemental dataset of culvert inspection records from the I-64 Gap Widening Project, bat use of culverts was predominantly associated with larger concrete structures (with opening heights or diameters of 6 feet or greater).
- Evidence of bat use in metal culverts was extremely limited, with only one documented detection among assessed structures.
- Seasonal patterns indicate that bat detections occurred throughout the year but were most common during summer and early fall, with limited observations during winter months. However, this pattern generally corresponded with the overall distribution of assessments because the assessment effort was also greatest from June through October.
- Landscape analyses (land cover and proximity to forest and streams) showed substantial overlap between bat-positive and bat-negative culverts, with no clear differences in land cover composition and weak but positive associations with distance to forest and stream.

Culvert Sampling Framework for Culvert Field Study

The sampling framework for a follow-up culvert study was developed based on findings from the literature review, analysis of VDOT structure inventory data, and evaluation of bat-positive and bat-negative assessment records. These sources informed a targeted approach focused on culvert types that represent a substantial proportion of available structures statewide and for which limited evidence of bat occupancy exists. The framework was also designed to align with the size thresholds outlined in the USFWS's Bat Survey Guidelines (USFWS, 2026).

Table 8 summarizes the proposed sampling tiers, which prioritize common culvert types in Virginia that have limited evidence of bat use, while including a smaller set of higher likelihood concrete culverts as controls. This stratified sampling framework groups culverts into size and length "bins" based on diameter (or interior height) and structure length, allowing for systematic evaluation across a range of size classes that meet the criteria in the survey guidelines.

Table 8. Sampling Framework for Culvert Study

Tier	Culvert Class	Culvert Size	Landscape Context	Ecoregion Representation	Purpose/Rationale
Tier 1a (Primary Focus)	Metal culverts	Height/Diameter bins: • 3 to < 4.5 ft • 4.5 to < 6 ft • ≥ 6 ft Length bins: • 23 ft to 40 ft • 41 ft to 65 ft • > 65 ft	• Near forest • More open settings	Ensure distribution across ecoregions	Designed to reduce uncertainty about bat use in metal culverts (e.g., ~ 35 sites[a]).
Tier 1b Small (Primary Focus)	Concrete culverts < 6 ft height/diameter	Height/Diameter bins: • 3 to < 4.5 ft • 4.5 to 6 ft Length bins: • 23 ft to 40 ft • 41 ft to 65 ft • > 65 ft	• Near forest • More open settings	Ensure distribution across ecoregions	Designed to reduce uncertainty about bat use in small concrete culverts (e.g., ~ 35 sites[a]).
Tier 2 (Control Group)	Higher likelihood culverts (> 6 ft concrete culverts, forested/riparian settings)	Height/Diameter bins: • 6 to 10 ft • 10 to 15 ft • > 15 ft Length bins: • 23 to 40 ft • 41 to 65 ft • > 65 ft	Primarily near forest	Distributed across ecoregions as feasible	Designed to provide a control group for confirming detection capability and validating field methods (e.g., ~ 15 to 20 sites[a]).

[a] Final survey effort within each tier should be informed by a power analysis and repeat-visit occupancy design to ensure that the number of structures and visits is sufficient to estimate detection probability, interpret non-detections, and evaluate bat use across culvert classes.

Height/diameter bins were established to align with species-specific minimum culvert dimensions in the USFWS's Bat Survey Guidelines. The lowest bin (3 to < 4.5 feet) includes culverts meeting only the TCB threshold; the middle bin (4.5 to < 6 feet) includes culverts meeting all three species' minimum thresholds; and the upper bin (≥ 6 feet) includes culverts exceeding all thresholds and the sizes most associated with bat use in the literature and the evaluated assessment records. Three culvert length bins (23 to 40 feet, 41 to 65 feet, and greater than 65 feet) were selected to represent an approximately equal distribution across bins, with each containing roughly one-third of the culverts that meet the assessment-eligible criteria.

Sampling is distributed across ecoregions to ensure geographic representation and to account for potential regional variability in bat use. Landscape context was defined based on proximity to forest versus more open settings (because analyses did not show meaningful differences among land cover types but did indicate a weak association with distance to the forest). The framework is intended to be refined for the follow-up study as the budget and timeline are finalized.

Statistical considerations will inform the number of culverts to be surveyed, but a single, fixed sample size cannot be determined precisely in advance because factors, such as how often bats use culverts and how likely surveys are to detect them, are not yet well understood and will have to initially be estimated based on available information and project scope. For example, if researchers assume bats use a certain culvert type very rarely (e.g., small metal culverts), a

relatively large number of those culvert types would need to be surveyed to be reasonably confident that bats do not commonly use the structure type. The research team will establish an initial sample size based on available information and the project timeline. Repeated surveys at selected culverts will then provide information on detection and occupancy, which can be used to refine future sample sizes if needed.

The following will also be incorporated into the study:

- Document culvert age and condition, including features such as accumulated sediment, rust, or surface roughness, which may influence suitability for roosting (for metal culverts in particular).
- Conduct assessments throughout the year, including the winter season (approximately November to March).
- Measure temperatures during each site visit and evaluate variation across seasons to assess thermal stability within culverts. This procedure will provide a better understanding of potential drivers of culvert selection across seasons.
- Design surveys to support statistically defensible conclusions regarding bat use, particularly for metal culverts. The final design should incorporate repeated-visit detection approaches, including estimation of detection probability and latency to detection, to determine the level of assessment effort needed to confidently interpret non-detections.

Summary of Interview Responses

This section summarizes findings from interviews conducted with VDOT staff, Virginia-based USFWS staff, and representatives from other states. Key themes identified from VDOT and Virginia USFWS interviews are presented first, followed by summaries of approaches and experiences from other states.

Overview of VDOT Interviews

Across interviews, VDOT staff described the bat consultation process in Virginia as well intentioned and supported by responsive coordination with resource agencies, while also noting that it can be operationally complex. A consistent theme was a desire to focus more effort on broader and meaningful conservation objectives, supported by more streamlined and predictable processes. Staff emphasized a strong commitment to conservation and indicated that they are often willing to implement bat conservation measures proactively, particularly when expectations are clearly defined early in project development.

Staff noted that the current project-by-project structure, along with sensitivity to specific project triggers, can result in substantial coordination effort across a large number of routine activities. It was also frequently noted that streamlining approaches tailored to Virginia's conditions could help focus time and resources on actions that provide the greatest overall benefit to bat species, while maintaining appropriate protections.

The following section groups interview summaries into key themes:

Areas Where Time and Effort Are Concentrated

- Staff consistently identified tree cutting and bridge- and culvert-related activities as the most frequent drivers of coordination, because of how often they occur and how they intersect with bat habitat considerations. Staff emphasized that the cumulative time associated with documentation, process, and coordination steps across many projects represents a significant overall effort, particularly because many small steps are repeated across routine projects.
- Even with available tools, many projects require project-by-project interpretation and coordination, which is particularly evident for routine activities that often lead to predictable outcomes but still require full documentation and review.
- Uncertainty of project details in the early stages, combined with multiple layers of coordination, can contribute to additional effort later in the process. District staff noted that iterative updates and evolving project scopes can require revisiting earlier coordination steps.
- Available staffing and required review timelines play a role in how quickly projects move through the process. Approaches that reduce the number of projects requiring more intensive review were noted as options to improve overall efficiency.

Areas Where the Current Consultation Process Shapes Workflow

- Projects that remain within well-defined pathways and with clear expectations tend to proceed more efficiently. More complex pathways can introduce additional coordination steps.
- Although staff acknowledge the rationale for differences in how guidance is applied, differences in how projects are documented and processed can create uncertainty and require additional coordination. Some staff also noted that differences in interpretation across districts, newly hired staff, or changes over time can influence both effort and results.
- Existing tools and frameworks, such as the range-wide DKey and the 2024 PBO, provide important structure but do not always align with certain project types. For example, acreage thresholds within the PBO may be exceeded by typical linear projects in Virginia, which can result in projects being routed into more involved consultation pathways. In these cases, additional coordination may be required even when project conditions are relatively routine, without necessarily affecting the overall determination.
- When projects are routed into formal consultation, extended timelines and coordination requirements can create pressure to maintain project schedules, which may result in VDOT requests for increased flexibility in project implementation. In contrast, when conservation measures are defined and agreed on earlier in the process, VDOT staff indicated a greater willingness to implement more protective measures to avoid delays.

Conditions that Support Efficient and Effective Outcomes

- VDOT staff consistently emphasized their commitment to conservation and willingness to incorporate protective measures, particularly when expectations are clear and established early in the process.
- Predictable expectations help staff, particularly new staff, make decisions with greater confidence and incorporate conservation measures more effectively into project planning.
- Staff noted that components of the current framework, such as advance planning around time-of-year restrictions and application of standardized avoidance and minimization measures, could be expanded and streamlined to improve efficiency.

Opportunities for Streamlining and Improvement

- Staff expressed support for developing approaches tailored to Virginia, beginning with common, repeated activities and building toward broader solutions over time.
- Interest exists in approaches that allow effort and resources to be directed toward actions that provide the greatest conservation value, while maintaining effective review across all projects.
- Interest exists in continued efforts for statewide research opportunities and other approaches that could support both coordination and conservation.
- Streamlining approaches for routine, low-risk activities is a commonly identified opportunity. Staff highlighted examples such as small-scale tree cutting and certain categories of culverts or pipes that often result in consistent determinations. These types of activities were noted as suitable for more standardized approaches or clearer thresholds for coordination.
- VDOT staff also expressed interest in better understanding how existing programmatic mitigation mechanisms (e.g., in-lieu fee program under the 2024 PBO) could be more directly considered in streamlining approaches and in exploring other programmatic conservation efforts. For example, ESA 7(a)(1) recovery action that allows the impacts to species to be addressed through monetary contributions rather than project-by-project coordination.

Overview of USFWS Interviews (Virginia Field Office and Headquarters Office)

Across the interviews, USFWS staff expressed openness to streamlining tools or processes, with an emphasis that any changes should be grounded in clearly defined, data-supported needs. Their workload is largely driven by incomplete project information, repeated clarification requests, and a lack of standardization in how projects are described and submitted. Although existing tools such as the DKey are viewed as effective for most projects, USFWS emphasized that opportunities for streamlining should focus on the subset of projects that fall outside those tools or require additional coordination. Identifying these project types and their frequency is an important step in developing new streamlining tools or programmatic approaches.

Data and Decision-Making Framework

- Staff emphasized that streamlining efforts should be based on clearly defined project types for which the application of existing tools may be limited or require additional coordination, including project types for which responses within the DKey direct projects to consultation pathways requiring additional coordination.
- Data needed to support this effort likely exists but has not been compiled or analyzed in a way that informs decision-making. Without this information, it is difficult to design effective streamlining approaches, including programmatic agreements.

Primary Drivers of Workload

- Project descriptions often lack sufficient detail to identify stressors and fully evaluate potential effects, and a significant portion of effort is spent obtaining missing or incomplete project information needed to support determinations.
- Variation in how projects are prepared across districts and consultants contributes to inefficiencies, and staff frequently spend time providing the same guidance repeatedly to different staff.

Opportunities for Improving Consistency and Efficiency

- Standardizing project submittals, including naming conventions and required information, would reduce back-and-forth coordination.
- Clearer guidance on project description requirements and training on how and why to use existing tools may improve consistency and confidence in their application. Simple supporting tools (e.g., guidance summaries or checklists) could also help staff navigate existing processes more efficiently.
- Staff noted that for major corridor improvement projects (e.g., roadway widening), identifying upcoming work and sharing project information earlier could allow for more coordinated approaches, such as batched biological opinions or advance planning for anticipated effects, rather than addressing similar actions through separate, project-by-project consultation

Considerations for Streamlining Approaches

- Streamlining and programmatic approaches are supported where a clear, recurring need is demonstrated.
- Batched or corridor-level approaches may provide efficiencies for large, predictable project types such as roadway widening.
- Developing a programmatic requires substantial time, coordination, and staff capacity, which are currently limited.
- Existing programmatic mitigation mechanisms (e.g., in-lieu fee) provide a pathway for addressing the effects through contributions to broader conservation efforts, which may reduce the need for repeated project-specific mitigation actions.

Overview of Interviews with Other States

Interviews were held with state DOT and USFWS Ecological Services Field Office representatives from Texas, New Jersey, South Carolina, North Carolina, Georgia, and Tennessee. Following the interview, some states provided examples of streamlining documents that are not accessible online; the research team can provide these documents on request.

All states interviewed have developed or were in the process of developing some form of approach to manage consultation workload, ranging from informal practices and internal guidance to more formal, programmatic frameworks. These approaches vary in structure and effectiveness but reflect a common effort to improve consistency and reduce project-by-project coordination. Several states noted challenges similar to those in Virginia, such as high workloads associated with tree cutting and structure assessments, differences in how projects are documented and processed, and state- or region-specific limitations of range-wide tools. In addition, states described challenges related to incomplete or inconsistent project information, which can result in repeated coordination to clarify project scope and support effect determinations. Some states noted that these combined factors contributed to the development of, or ongoing efforts to develop, state-specific programmatic agreements.

Notably, Tennessee and South Carolina have encountered situations in which existing programmatic frameworks and DKeys do not fully align with state-specific conditions and project types, and both are working toward developing statewide bat programmatic approaches tailored to their needs. In contrast, Georgia and North Carolina have already established programmatic agreements supported by extensive state-specific data and clearly defined thresholds, whereas Texas relies more on internal processes and coordination practices because of fewer federally listed bat species in the state.

States consistently emphasized the importance of clear and consistent project information, state-specific data to support decision-making, and standardized approaches for recurring project scenarios. Many states also described taking incremental, data-informed steps to improve consistency and reduce repetitive coordination before pursuing a broader programmatic solution. These findings indicate that many of the coordination challenges identified in Virginia, particularly those related to project information, recurring activities, and consistency, are not unique and have been addressed in other states through state-specific collaborative approaches. Table 9 summarizes key findings from interviews with representatives from other state agencies (i.e., DOT and USFWS field offices), and Appendix C provides additional details on responses from each state. Table 9 includes information on state-implemented “conservation measures” that are developed and used to avoid, minimize, or compensate for the potential effects to listed species; conservation measures can include standard avoidance and minimization measures and other standardized or project-specific actions.

Table 9. Summary of State Approaches to Streamlining Bat Consultation According to Interview Responses

State[a]	State Program-matic	Noted Streamlining Tools[b]			Key Considerations
		Conservation Measures (formal or informal)	Internal Guidance/ BMPs	Funding Mechanism (in-state)	
GA	✓	✓		✓	Required upfront investment, negotiation, and continued funding.
NC	✓	✓		✓	Framing of certain requirements in programmatic adds complexity; a prenotification requirement adds workload.
SC	(✓)	✓			Some projects still fall outside existing tools; statewide programmatic still in development.
TN	(✓)				Many projects fall outside existing tools; statewide programmatic development paused with hope to continue pursuing.
TX		✓	✓		Less formalized structure currently works because of northern long-eared bat limited range; structure is vulnerable if the tricolored bat becomes federally listed.
NJ			(✓)		Limited formal streamlining framework.

BMP = best management practices. [a]All states interviewed have between one and four federally endangered bat species. The northern long-eared bat occurs in all interviewed states except Texas; the tricolored bat (proposed for listing) occurs in all states interviewed. [b] Streamlining measures noted in interviews—GA: Use of standardized conservation measures, combined with a programmatic conservation funding component established as a Section 7(a)(1) recovery action that allows project-based impacts (e.g., tree cutting) to be addressed through monetary contributions rather than project-by-project coordination. NC: Use of standardized conservation measures, supported by defined thresholds (e.g., for tree cutting and structure impacts) and location-based criteria that guide when additional coordination is needed; includes standardized survey protocols. SC: Use of an informal list of conservation measures (Appendix C) and standardized conditions for structure assessments, supporting more predictable determinations and reducing the need for repeated coordination. TN: Hopes to pursue and expand formalization of internal, informal conservation measures through a statewide programmatic; discussions had begun, but progress is paused. TX: Use of internal guidance (e.g., bat exclusion from structures and avoidance and minimization measures) to apply consistent conservation measures and timing considerations across projects. NJ: Use of a decision-support tool to guide consistent application of conservation measures based on project conditions. (✓) SC and TN: Statewide programmatic agreement is in development. NJ: Project-based coordination uses a decision-support tool specific to NJ conditions.

Another consistent theme that emerged from state interviews is that effective streamlining was not solely a function of new tools or agreements but of the underlying mindset behind those approaches. Interviews with other states indicated that streamlining efforts with clear expectations and conservation-focused tradeoffs helped move project-by-project negotiations to more predictable and collaborative processes. These "give-and-take" arrangements, in which agencies agreed on upfront conditions and focused effort on actions that provide meaningful conservation benefits, were noted for building trust not only at the agency level but also for individuals in those agencies. When practitioners, including new employees in those roles, were equipped with streamlined rules that reflect real-world conditions in their state, they were more confident in their decision-making and felt that they were better able to focus on higher value conservation efforts.

Opportunities for Streamlining the Consultation Process

Shared Themes from VDOT and USFWS Interviews

Interviews with VDOT and USFWS staff indicate that many of the challenges associated with bat consultation in Virginia stem from how project information is developed, communicated, and applied during coordination. Both agencies emphasized that existing tools and frameworks, such as the 2024 PBO and DKey, are effective for many projects. However, inefficiencies arise when projects fall outside those tools, when project information is incomplete or inconsistently presented, and in the documentation and coordination steps across many projects.

USFWS staff noted that a significant portion of their workload is associated with obtaining missing or unclear project information needed to support effects determinations. Project descriptions often lack sufficient detail on certain components (e.g., tree cutting, structure work, and extent of disturbance), resulting in repeated coordination for clarification before review can proceed. As a result, even projects that ultimately result in Not Likely to Adversely Affect (NLAA) determinations may involve multiple rounds of communication.

At the same time, VDOT staff described situations in which relatively routine project conditions trigger elevated levels of review, particularly when tools do not align with project types or interpretations change over time. In these cases, similar projects may be evaluated differently, resulting in additional documentation, coordination, and project schedule uncertainty.

Combining these perspectives suggests that improving efficiency will require both (1) addressing USFWS-identified information gaps and (2) reducing the need to repeatedly evaluate common project situations on a case-by-case basis, while maintaining alignment with broader conservation objectives, including those supported through existing programmatic mitigation mechanisms. This process could entail:

- Improving consistency and clarity of project submittals to reduce follow-up coordination.
- Identifying and documenting projects that do not meet the criteria to use the 2024 PBO or to reach an NLAA in the Dkey and therefore require additional coordination (and use the results to inform streamlining discussions).
- Developing consistent approaches for a small number of recurring project scenarios, such as predefined conservation measures that can be consistently applied to Virginia-specific project scenarios.

The following sections build on these themes by describing approaches to improve the consistency and clarity of project submittals, to track and evaluate projects that require additional coordination, and to develop Virginia-specific streamlining tools for recurring project scenarios. Tree cutting is presented first as an initial example of how a streamlining approach could be applied in practice.

An Approach for Streamlining Tree-Cutting Activities

Rationale for a Streamlined Approach

Tree-cutting activities within existing transportation corridors represent a recurring component of bat-related coordination for both VDOT and USFWS. Existing tools, including the PBO and range-wide DKey, provide efficient pathways for many projects and allow most qualifying projects to proceed without additional coordination when NLAA determinations are reached. However, some recurring project scenarios still require project-specific documentation, clarification of project details, or additional coordination when projects do not meet DKey criteria and are routed into more involved consultation pathways. In these situations, coordination requirements can increase workload and extend project timelines.

VDOT commonly uses VDWR's *Time of Year Restrictions and Other Recommendations* guidance as a baseline to avoid adversely affecting bats (VDWR, 2023). Similar conservation measures, including time-of-year restrictions and limits on work at occupied structures, are also commonly incorporated through existing Section 7 consultations for transportation projects (USFWS, 2025). Because these measures are already broadly accepted and routinely applied, they may provide opportunities for streamlining through more standardized pathways for recurring transportation activities, thereby reducing the need for repeated project-specific coordination while remaining consistent with existing consultation frameworks.

A near-term opportunity in Virginia is to build on this existing framework by more clearly defining and consistently applying approaches for a small number of recurring, low-risk tree-cutting scenarios. This effort would not establish new requirements or replace existing tools but would apply current criteria in a more operational and predictable manner.

Although additional information on the frequency and details of tree-cutting scenarios could further inform long-term refinement, VDOT staff already have substantial practical experience with these activities across districts. This experience provides a sufficient basis to begin structured discussions on recurring, low-risk scenarios and potential streamlining approaches in the near term. At the same time, information on how often these scenarios occur can be documented moving forward, allowing thresholds and approaches to be refined over time without delaying initial coordination improvements.

Framework for Streamlining Tree-Cutting Activities

The following framework outlines a structured approach for improving consistency in how recurring tree-cutting activities are evaluated and documented. This approach builds directly on existing PBO criteria and includes the following steps for creating and implementing standardized conservation measures: (1) distinguishing project scenarios, (2) applying thresholds to determine eligibility, and (3) implementing standardized conservation measures.

Step 1: Distinguish among tree-cutting scenarios within the corridor. Apply a framework to distinguish between (1) areas with low potential for suitable habitat and (2) areas with greater potential for suitable or documented habitat.

This approach builds on characteristics already reflected in the PBO (e.g., proximity to roadway, habitat condition, tree size, and timing) and presents them in a Virginia-specific context.

Step 2: Establish tree-cutting thresholds. Establish thresholds to define when recurring project activities within a given scenario may follow a standardized, streamlined pathway. For example, a *de minimis* roadside tree-cutting pathway could be defined for small-scale, routine activities within the existing transportation corridor (e.g., immediate roadside or median areas).

These thresholds would not replace existing effect determination tools or consultation frameworks but instead support more consistent and predictable application of existing pathways for recurring project types. Thresholds could be developed using factors already reflected in the range-wide DKey and PBO processes (e.g., distance from roadway, habitat condition, tree size, and timing) and applied in a consistent manner for common transportation activities.

Projects that meet defined thresholds could continue under a streamlined pathway (i.e., pre-established conservation measures), whereas projects that do not meet thresholds would continue to follow standard review pathways (e.g., DKey- or PBO-based review).

Step 3: Develop standardized conservation measures for tree cutting. Develop a set of predefined conservation measures for the recurring tree-cutting scenarios and associated thresholds identified in Steps 1 and 2. Rather than developing project-specific measures for each project, VDOT and USFWS could agree in advance on a small number of standardized "packages" that can be incorporated directly into project submittals.

Each package would correspond to a specific scenario and threshold combination and include a consistent set of conservation measures (e.g., time-of-year restrictions and phased cutting). Projects following a streamlined pathway would apply these standardized measures, whereas projects requiring standard review would continue to use existing tools to determine project-specific measures.

This approach is consistent with the PBO's reliance on avoidance and minimization measures and with examples from other states that use standardized measures to support efficient reviews (Table 9; Appendix C).

Appendix D provides an example of a tree-cutting approach. Implementation could be developed collaboratively among agencies, drawing on the experience of agency staff. The approach would focus on defining a limited number of recurring tree-cutting scenarios, associated thresholds, and standardized conservation measure packages. During implementation, information could be collected and used to document how frequently these scenarios occur and to support future refinement of thresholds and approaches, as needed. Approaches could also include consideration of how project-level streamlining aligns with broader conservation investments supported through existing PBO mitigation mechanisms.

Options for Near-Term and Long-Term Bat Coordination Improvements

Using the themes presented in the preceding section, Table 10 and Figure 7 summarize an approach to near-term actions that can be initiated now, along with longer-term streamlining considerations. The approach is intended to support development of additional project-level information, as identified by USFWS, while also identifying opportunities to improve efficiency for recurring, high-frequency activities such as tree cutting. It reflects a balance between near-term coordination improvements important to VDOT and longer-term, data-informed refinement of processes important to USFWS. These steps could be implemented incrementally, with the potential to inform broader, programmatic approaches over time where a clear and recurring need is demonstrated.

Table 10. Bat Coordination Approaches for Near-Term and Longer-Term Efforts

Topic Area	Potential Near-Term Implementation Approaches
Project Submittals and Tracking	
Improve the Consistency and Clarity of Project Submittals	• Develop a standardized project submittal template that includes key elements (e.g., structure details and extent of disturbance). • Establish minimum information expectations for projects entering coordination.
Track and Evaluate Projects to Identify Streamlining Opportunities	• Develop a simple tracking form for VDOT districts to document projects that do not meet DKey criteria and that require additional coordination. • Collect information during a defined period (e.g., 1 year), including project type, triggers, and outcomes. • Compile and review results to identify recurring patterns. • Prioritize a small number of recurring scenarios to evaluate options for streamlining. • Track when and how programmatic mitigation (e.g., in-lieu fee) is applied to better understand the scale and use of conservation contributions associated with transportation projects.
Develop Streamlining Options for Tree Cutting	
Distinguish Tree-Cutting Scenarios	• Develop a simple framework to distinguish between disturbed roadside conditions and areas with greater habitat potential. • Align framework with existing criteria in the PBO (e.g., proximity, habitat condition, and tree size).
Determine Tree-Cutting Thresholds and Eligibility	• Define thresholds for routine or *de minimis* tree cutting that determine eligibility for a streamlined pathway. • Apply existing criteria (e.g., proximity to roadway, habitat condition, tree size, timing) in a targeted and consistent manner to evaluate whether projects meet defined thresholds. • Link each scenario and associated thresholds to a defined pathway (e.g., streamlined or standard review), with standardized Conservation Measures applied in streamlined cases and project-specific measures applied through standard review.
Develop Standardized Conservation Measures	• Develop standardized conservation measures for tree-cutting "packages" with predefined measures for recurring tree-cutting scenarios. • Apply standardized conservation measures for low-risk scenarios and consider use of existing programmatic mitigation mechanisms (e.g., PBO compensatory mitigation) when applicable to support broader conservation outcomes. • Document the effectiveness of this approach.
Topic Area	**Potential Longer-Term Implementation Approaches**

Topic Area	Potential Near-Term Implementation Approaches
Using Data to Support Streamlining	• Use tracking results from near-term efforts to identify other recurring project types that do not meet DKey criteria or require additional coordination. • Incorporate findings from the future culvert field study to inform discussions on culvert streamlining opportunities. • Expand any developed tree-cutting Conservation Measures packages to additional recurring project scenarios identified through data collection.
Early Coordination for Recurring or Large Projects	• Identify upcoming projects with repeated or large-scale activities. • Coordinate early with the U.S. Fish and Wildlife Service to define approaches for common components (e.g., tree cutting and structures). • Use early coordination to reduce project-by-project iteration during later stages.
Programmatic Conservation	• Consider how streamlined approaches for recurring, low-risk activities may align with species conservation efforts already supported through existing programmatic mechanisms (e.g., in-lieu fee program) and explore how Section 7(a)(1) of the Endangered Species Act could support broader, programmatic conservation efforts for bat species. • As recurring project types and standardized approaches are developed, evaluate whether a statewide programmatic approach is warranted.
Training and Guidance	• Provide guidance or examples illustrating how project information supports use of existing and new tools. • Conduct training or workshops to improve consistency across districts, including training on any newly developed or refined streamlining approaches.

DKey = determination key; PBO = Programmatic Biological and Conference Opinion.

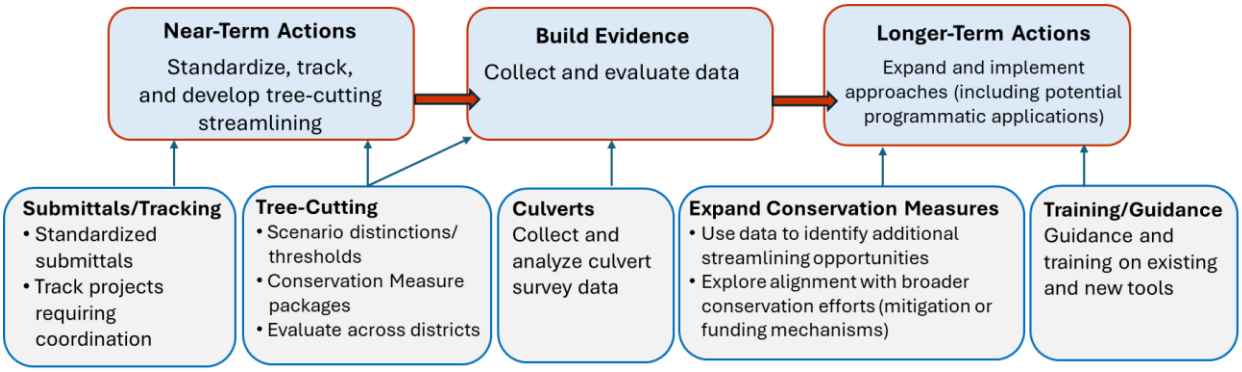


Figure 7. Framework for Streamlining Bat Coordination and Consultation in Virginia

Summary of Findings

Three key findings informed the development of the culvert sampling framework for the culvert field study.

- *Available literature indicates that bat use of culverts in the United States, including roosting and transient use, is relatively uncommon and is most often associated with larger, concrete structures that provide more stable, cave-like conditions*. However, existing studies are largely observational and lack systematic sampling designs, limiting the ability to quantify occupancy rates or draw conclusions about the frequency of use across culvert types. This omission highlights the need for targeted sampling to better inform survey requirements and regulatory decisions.

- *Approximately 30,500 culverts in VDOT's current structure inventories meet USFWS survey size criteria, representing a substantial number of structures that could require assessment*. A large proportion of these culverts are relatively small (3 to < 4.5 ft) and frequently constructed of metal.

- *Analysis of VDOT bat assessment data indicates that bat use of culverts is rare, with detections occurring in less than 1% of evaluated culvert complexes; bat use of culverts was primarily associated with larger concrete box culverts*. Landscape variables showed limited influence on bat occurrence, with positive but weak associations with distance to forest and stream and no clear differences in land cover composition.

Three notable findings helped identify opportunities to improve the efficiency of the regulatory consultation process, which helped inform a list of bat coordination approaches for near-term and longer-term efforts (Table 10):

- *In interviews with DOT and USFWS staff involved in bat-related consultation and project review in six other states, respondents reported challenges similar to those in Virginia, and many states have addressed these challenges through state-specific programmatic approaches, standardized conservation measures, and the use of state-specific data to support decision-making*. Across states, effective streamlining strategies emphasized clear project information, consistent approaches for recurring activities, and a focus on meaningful conservation benefits while maintaining efficient coordination processes.

- *VDOT staff emphasized interest in improving consistency, reducing repetitive coordination for common project types, and focusing effort on actions that provide meaningful conservation benefit*. For example, streamlining approaches that establish clear expectations early in project development may reduce the need for later negotiation under schedule constraints, allowing conservation measures to be applied more consistently and effectively across projects.

- *USFWS staff emphasized the importance of data-driven approaches and standardized submittals to support more efficient and consistent review*. Streamlining opportunities depends on clearly identifying and quantifying the subset of projects that fall outside those tools such as DKeys or project types that require additional coordination.

CONCLUSIONS

- *A structured culvert sampling framework was developed to support data collection for a follow-up field study that will provide a systematic basis for evaluating culvert occupancy and informing future survey guidance and streamlining decisions*. The framework incorporates size-based bins and focuses on underrepresented structure types, particularly metal culverts.

- *Given the support among Virginia agency staff for clearly justified streamlining approaches, alignment can be achieved through a combination of near-term actions and longer-term,*

data-informed efforts. Near-term improvements include improving the consistency and clarity of project submittals, tracking projects that require additional coordination, and developing an initial streamlining approach for common activities such as tree cutting. Longer-term efforts may include using information and tracking data to develop standardized approaches for additional recurring project types and to better understand how existing programmatic mitigation mechanisms (e.g., project-based financial contributions) contribute to broader conservation efforts. These efforts could also consider complementary frameworks such as Section 7(a)(1) of the ESA, and the potential for a formal programmatic approach as recurring needs are identified.

- *A structured approach for recurring activities, such as tree cutting, could improve efficiency by defining a limited number of scenarios, establishing thresholds for streamlined pathways, and applying standardized conservation measures*. The report outlines an approach to streamline tree cutting that builds on existing tools and practitioner experience, allowing common, low-risk activities to be addressed more consistently while maintaining appropriate review for higher risk conditions.

RECOMMENDATIONS

1. *VDOT should convene a working group, including USFWS, and when appropriate, a third party with relevant experience, to begin discussing and advancing potential approaches for improving coordination efficiency identified in this report, particularly those outlined in Table 10.*

IMPLEMENTATION AND BENEFITS

The researcher and the technical review panel (listed in the Acknowledgments) for the project collaborate to craft a plan to implement the study recommendations and determine the benefits of doing so. This process is to ensure that the implementation plan is developed and approved with the participation and support of those involved with VDOT operations. The implementation plan and the accompanying benefits are provided here.

Implementation

Regarding Recommendation 1, within 6 months of this report's publication, VDOT's Environmental Division will develop a working group to facilitate structured discussions on opportunities to improve coordination efficiency, with participation from USFWS and other relevant participants as appropriate. A regular meeting schedule will be established, and VDOT will provide additional staff support as needed. Discussions may draw on the streamlining opportunities identified in this study, among other topics, and future discussions may incorporate findings from the culvert survey study to evaluate potential opportunities for structure-related streamlining.

Benefits

Implementation of Recommendation 1 will support improved coordination between VDOT and USFWS by creating a structured approach for discussing and evaluating opportunities to increase efficiency. This effort can help identify approaches that maintain effective conservation while reducing workload and coordination steps, ultimately supporting efficient and predictable project delivery.

ACKNOWLEDGMENTS

The authors thank the members of the technical review panel for their guidance and input throughout this study, including Kerri Nicholas, Project Champion, VDOT; Joe Felton, VDOT; James Hatcher, VDOT; Lauren Mastro, USFWS; Rachel Case, USFWS; Mark Ford, USGS; Rick Reynolds, VDWR; Amanda Heath, FHWA; John Miller, Virginia Transportation Research Council (VTRC); and Justice Appiah, VTRC. The authors also appreciate the review and valuable insights provided by Mike Fitch of VTRC and Sumalee Hoskin of USFWS. In addition, the authors acknowledge Taylor Parlow, James Lightfoot, Eric Hetzer, and Catherine Bray of VDOT for their assistance in providing and helping interpret structure and survey data. Finally, we thank the many practitioners in Virginia and other states who participated in interviews and shared their experiences, which formed the foundation for much of the report's findings.

REFERENCES

American Association of State Highway and Transportation Officials. *Programmatic Approaches for Transportation and the Endangered Species Act (ESA): FHWA Programmatic Biological Opinions and Agreements*. NCHRP Project 25-25, Task 97. National Cooperative Highway Research Program, Washington, DC, 2017.

Bender, M.J., Castleberry, S.B., Miller, D.A., and Wigley, T.B. Site Occupancy of Foraging Bats on Landscapes of the Southeastern United States. *Journal of Wildlife Management*, Vol. 74, No. 2, 2010, pp. 402–410.

Comparato, N. Assessing the Relationship Between Land Cover Variables and the Diversity of Acoustic Bat Detections in Urban and Rural Areas. *Urban Naturalist*, Vol. 67, 2023, pp. 1–14.

De La Cruz, J.L., Reynolds, R.J., Orndorff, W.D., Malabad, T., Kosič Ficco, K., Powers, K.E., and Ford, W.M. Seasonal Activity Patterns of Northern Long-eared Bats at Hibernacula in Western Virginia. *Journal of the Southeastern Association of Fish and Wildlife Agencies*, Vol. 11, 2024, pp. 196–205.

Dewitz, J. *National Land Cover Database (NLCD) 2021 Products*. U.S. Geological Survey, Reston, VA, 2023.

Foster, J., Linden, D., Blomberg, E., Fisher-Phelps, M., and Ineson, K. *Use of Forested Habitat Adjacent to Highways by Northern Long-Eared Bats*. NETC Project No. 15-1. New England Transportation Consortium, Burlington, VT, 2019.

Georgia Department of Transportation, U.S. Fish and Wildlife Service, and Federal Highway Administration. *Programmatic Agreement for the Assessment of Effects to Federally Listed Bat Species for Transportation Projects in Georgia*. Atlanta, GA, 2023.

Hetzer, E. Email to Bridget Donaldson. March 31, 2026.

Humphrey, S.R., and Gore, J.A. Bats of Florida. In *Rare and Endangered Biota of Florida, Volume 1: Mammals.* S.R. Humphrey (Ed.). University Press of Florida, Gainesville, FL, 1992, pp. 122–136.

Jones, C., and Carter, D.C. Distribution of Bats in the United States. In *Handbook of Mammals of the United States: Bats*, J.S. Findley and C. Jones (Eds.). Texas Tech University Press, Lubbock, TX, 1989, pp. 1–14.

Katzenmeyer, J.B. *Use of Highway Culverts, Box Bridges, and Caves by Winter-Roosting Bats in Mississippi*. Master's thesis. Mississippi State University, Mississippi State, MS, 2016.

Keeley, B.W., and Tuttle, M.D. *Bats in American Bridges*. Resource Publication No. 4. Bat Conservation International, Austin, TX, 1999.

Kennedy, M.L., Best, T.L., and Harvey, M.J. Observations on the Biology of Bats in Tennessee. *Journal of the Tennessee Academy of Science*, Vol. 49, 1974, pp. 112–116.

LaVal, R.K. Notes on the Ecology of *Myotis sodalis*. *Journal of Mammalogy*, Vol. 48, No. 3, 1967, pp. 460–462.

Leivers, S.J., Meierhofer, M.B., Pierce, B.L., Evans, J.W., and Morrison, M.L. External Temperature and Distance from Nearest Entrance Influence Microclimates of Culvert-Roosting Bats. *Ecology and Evolution*, Vol. 9, No. 24, 2019, pp. 14130–14138.

Lutsch, K.E., McDonald, A.G., Gabriel, K.T., and Cornelison, C.T. Roadway-Associated Culverts May Serve as a Transmission Corridor for *Pseudogymnoascus destructans* and White-nose Syndrome in the Coastal Plains and Coastal Region of Georgia, USA. *Journal of Wildlife Diseases*, Vol. 58, No. 2, March 2022, pp. 322–332.

Martin, C.O., Kiser, J.D., and Jenks, J.A. Use of Culverts by Bats in Mississippi. *Southeastern Naturalist*, Vol. 4, No. 3, 2005, pp. 451–462.

McCartney, A.S., Morris, K., and Cross, K.P. Thirty-two New Records for the Northern Long-Eared Bat (*Myotis septentrionalis*) in Mississippi. *Nightwing News*, Vol. 113, No. 2, 2024, pp. 31–32.

Meierhofer, M.B., Johnson, J.S., Leivers, S.J., Pierce, B.L., and Evans, J.W. Bats Use Culverts as Winter Roosts in Texas. *Journal of Wildlife Management*, Vol. 83, No. 3, 2019, pp. 617–626.

Morris, T. An Association of Fish and Wildlife Agencies Resolution for B.A.T.S. (Bats and Transportation Structures) Promoting Cooperation with State Transportation Agencies. International Conference on Ecology and Transportation, Raleigh, NC, 2025.

Neece, B.D., Loeb, S.C., and Jachowski, D.S. Variation in Regional and Landscape Effects on Occupancy of Temperate Bats in the Southeastern U.S. *PLOS ONE*, Vol. 13, No. 11, 2018.

North Carolina Department of Transportation. *Structure Surveys for Bats: Emerging Trends in Frequency of Bat Use in North Carolina Bridges*. Technical Report. Biological Surveys Group, Raleigh, NC, 2025.

North Carolina Department of Transportation. Biological Surveys: Resources for ESA Compliance: T&E Surveys - Section 7 Consultation - Programmatic Agreements, 2026. https://connect.ncdot.gov/resources/Environmental/EAU/BSG/Pages/default.aspx. Accessed April 3, 2026.

Perez-Jimenez, J., Koch, J., Kropczynski, J.N., and Johnson, J.S. *Bats and Bridges: Integrating Biology and Cloud-Based Modeling*. Report No. FHWA/OH-2024/06. Ohio Department of Transportation, Columbus, OH, 2024.

Sanchez, E.M. *Use of Culverts as Diurnal Roosts by Tricolored Bats (Perimyotis subflavus) in East Texas: Exploring Seasonality and Spatial Resource Selection*. Master's thesis. Texas Tech University, Lubbock, TX, 2024.

Sandel, J.K., Benatar, G.R., Burke, K.M., Walker, C.W., Lacher, T.E., and Honeycutt, R.L. Use of Highway Culverts by the Endangered Ozark Big-eared Bat (*Corynorhinus townsendii ingens*) in Oklahoma. *Journal of Mammalogy*, Vol. 82, No. 4, 2001, pp. 1112–1118.

Smith, L.M., Doonan, T.J., and Gore, J.A. Bats Roost in Culverts During Hibernation and Maternity Season in North Florida. *Journal of North American Bat Research*, Vol. 2, No. 4, 2024.

Trousdale, A.W., and Beckett, D.C. Characteristics of Bridges Used by Bats in Mississippi. *Journal of the Mississippi Academy of Sciences*, Vol. 49, No. 2, 2004, pp. 98–104.

U.S. Fish and Wildlife Service. *Standing Analysis and Implementation Plan—Northern Long-Eared Bat and Tricolored Bat Assisted Determination Key, Version 1.0*. Bloomington, MN, 2024a.

U.S. Fish and Wildlife Service. *Northern Long-Eared Bat and Tricolored Bat Range-Wide Determination Key (DKey)*. Washington, DC, 2024b.

U.S. Fish and Wildlife Service. *Programmatic Biological Opinion and Conference Opinion for Transportation Projects in the Range of the Indiana Bat (Myotis sodalis), Northern Long-Eared Bat (Myotis septentrionalis), and Tricolored Bat (Perimyotis subflavus)*. U.S. Fish and Wildlife Service, Federal Highway Administration, Federal Railroad Administration, and Federal Transit Administration, Washington, DC, 2024c.

U.S. Fish and Wildlife Service. *Biological and Conference Opinion: Interstate 64 Gap Segment A and Segment C Widening in Henrico, New Kent, James City Counties and Lightfoot Park and Ride in York County, VA*. Virginia Field Office, Gloucester, VA, 2025.

U.S. Fish and Wildlife Service. *Range-Wide Indiana Bat and Northern Long-Eared Bat Survey Guidelines*. Region 3, Bloomington, MN, 2026.

Virginia Department of Transportation. *Instructional and Informational Memorandum: Large Culverts and Open Bottom Structures*. IIM-S&B-101.1; IIM-LD-263.1; IIM-MD-2022.7.1. Structure and Bridge Division, Richmond, VA, 2022.

Virginia Department of Transportation. I-64 Gap Segment A Widening from MM 204.9 to MM 215.6, 2024a. https://www.vdot.virginia.gov/projects/richmond-district/i-64-gap-segment-a-widening-in-new-kent/.

Virginia Department of Transportation. *Bat Structure Assessment Memo: I-64 Gap Segment C Widening*. Memorandum from VDOT Staff to USFWS and VDOT Staff, Richmond, VA, July 3, 2024b.

Virginia Department of Wildlife Resources. *Time of Year Restrictions and Other Recommendations for Wildlife Species in Virginia*. Richmond, VA, 2023.

Virginia Department of Wildlife Resources. *Virginia Threatened and Endangered Species List*. Richmond, VA, 2025.

Walker, C.W., Sandel, J.K., Honeycutt, R.L., and Adams, C. Winter Utilization of Box Culverts by Vespertilionid Bats in Southeast Texas. *Texas Journal of Science*, Vol. 48, May 1996, pp. 166–168.

Weber, J., O'Keefe, J., Walters, B., Tillman, F., and Nicolay, C. *Distribution, Roosting and Foraging Ecology, and Migration Pathways for Gray Bats in Western North Carolina*. NCDOT Project 2018-36. North Carolina Department of Transportation, Raleigh, NC, 2020.

Wetzel, T., and Roby, P. *Bats Use of Bridges and Culverts*. Project No. TR202208. Missouri Department of Transportation, Jefferson City, MO, 2023.

APPENDIX A. INTERVIEW QUESTIONS

Table A1. Interview Questions

Questions for Virginia Staff
What is your role in your agency and in the bat consultation process?
Process-Level
Can you walk me through your role in the bat consultation process from start to finish?
Where do you typically get involved, and what triggers your involvement?
Where do you see the most time or effort spent in the process?
Efficiency
What types of projects tend to be the most time-consuming?
Where do delays or inefficiency most often occur?
What parts of the process require the most back-and-forth or clarification?
Decision-making
Are there any decisions made repeatedly that could potentially be standardized?
Are there situations where the outcome is generally predictable but still requires full review?
Documentation
What aspects of documentation or submittals take the most time to prepare or review?
Are there areas where documentation could be simplified without affecting quality?
Coordination
What typically drives the need for coordination between VDOT and USFWS?
Are there situations where coordination could be reduced or streamlined?
Approaches
Are there types of projects or activities that could be addressed through standardized approaches rather than case-by-case review?
What would need to be in place for that to work?
Reactions to Other State Approaches
Have you seen approaches in other states that seem to improve efficiency while maintaining compliance?
What aspects of those approaches seem most applicable to Virginia?
Closing
If you could change 2 to 3 things to improve efficiency in the bat consultation process, what would they be?
What risks should we be careful not to introduce when trying to streamline the process?
Are there any data or research needs that could support future streamlining efforts?
Questions for Other States
What is your role in your agency and in the bat consultation process?
Does your state have any streamlining processes or agreements that go beyond the streamlining tools in the USFWS's 2024 updated *Range-wide Indiana Bat and Northern Long-eared Bat Survey Guidelines* or other updated USFWS programmatics or Determination Keys?
What prompted the development of any of the tools or agreements used in your state?
Can you share any documents related to those tools or agreements?
What problems were you trying to solve?
What elements most reduced consultation workload?
What didn't work as expected?
What advice would you give Virginia?

APPENDIX B. BAT ASSESSMENT DATA FROM I-64 GAP WIDENING PROJECTS

Culvert inspection documents for the I-64 Gap Segment A and Segment C Widening projects were reviewed as an additional supplemental source of information. As described previously, the primary dataset for this study consisted of electronic bat assessment survey records, which allowed for an efficient evaluation of a large, representative sample of structures. The I-64 project documentation provides a complementary dataset from a recent large-scale transportation project that underwent formal Section 7 consultation.

Culvert inspections were conducted between 2022 and 2024 for Segment A (VDOT, 2024a) and in 2024 for Segment B (VDOT, 2024b). All surveyed culvert openings ranged from 3.5 to 8 feet in diameter or height. Culvert lengths and widths were not documented. For Segment A, evidence of bats was documented at 4 of the 50 surveyed culverts. For Segment C, 5 bats were observed in 4 of the 49 surveyed culverts. Table B1 lists the information provided in the descriptions of culverts with evidence of bats. The smallest culverts with evidence of bat use were two 3.5-foot pipes in Segment A, but the document did not provide the material type and structure ID.

Table B1. Culvert Inspection Results for I-64 Gap Segments A and C

Segment	Number of Culverts Assessed	Structures with Evidence of Bats		
		Type (and Material)	Height or Diameter (in.)	Description
A[a]	50	Pipe (concrete)	3.5	1 of 3 inspections reported evidence of bats
		Box (concrete)	5	2 of 2 inspections reported evidence of bats
		Pipe (concrete)	3.5	1 of 3 inspections reported evidence of bats
		Pipe (concrete)	6	1 of 3 inspections reported evidence of bats
C	49	Box (concrete)	8	1 bat observed flying through culvert
		Box (concrete)	8	1 bat observed flying through culvert
		Box (concrete)	8	1 bat observed on culvert wall
		Box (concrete)	6	2 bats observed in two separate weep holes

[a] It was noted that the presence of guano, staining, and odor was not observed in any culverts.

APPENDIX C. SUMMARY OF INTERVIEWS FROM OTHER STATES

Texas

Three Texas Department of Transportation (DOT) staff members from the Environmental Affairs Division participated in the interview. Texas has among the highest diversity of bat species of any U.S. state but currently has relatively limited regulatory requirements related to federally listed bats. At the time of this study, only one federally listed bat species, the northern long-eared bat (NLEB), occurs within the state and has a limited distribution. Therefore, consultation requirements for bats are limited compared with states such as Virginia. Although the tricolored bat (TCB) is present in Texas, it has not yet been listed and is not consistently the subject of consultation. As a result, bat-related coordination for transportation projects in Texas is generally less frequent and often driven by project-specific considerations rather than routine regulatory requirements. Nevertheless, Texas DOT staff have developed standardized conservation measures that provide consistent guidance for bridge-related projects.

Key insights include:

- Streamlining currently relies on informal processes rather than formal agreements. However, one respondent emphasized that an in-lieu fee program (similar to Georgia's Programmatic approach) is a preferred and potentially highly effective strategy for improving efficiency and noted that efforts are underway to build interagency support for this approach.
- Standardization of conservation measures through best management practices, particularly for bat exclusion and replacement habitat, serves as a major efficiency driver by providing consistent implementation guidance.
- Dedicated liaison staffing (approximately three to four positions) supporting coordination with regulatory agencies was identified as a key strength in maintaining workflow efficiency.
- Bridge and culvert assessments are not conducted routinely and are generally not required in the absence of federally listed species. Instead, surveys are applied on a case-by-case basis, typically only when large colonies or clear evidence of bat use are present, and are generally limited to situations involving large colonies or clear evidence of bat use. In some cases, bat presence is addressed during construction if conditions change.
- Their current project-by-project approach is vulnerable to changes in species listing status, particularly if additional bat species (e.g., TCB) become listed, which could substantially increase consultation workload.

New Jersey

A staff member from New Jersey DOT (NJDOT) in the Environmental Division participated in the interview. New Jersey has multiple federally listed bat species, including the Indiana bat, NLEB, and the proposed TCB, which is also protected at the state level. As a result, NJDOT operates under a relatively high level of regulatory responsibility with frequent consultation requirements for transportation projects. Bat-related project coordination is common and often requires structured processes to manage workload.

Key insights include:

- NJDOT has developed a semi-formal streamlining framework that combines federal programmatic tools with state-specific processes. In addition to using the U.S. Fish and Wildlife Service (USFWS) determination key (Dkey), NJDOT relies on a project-specific screening chart developed in coordination with the USFWS liaison, which allows staff to reach Not Likely to Adversely Affect (NLAA) determinations for certain projects without requiring individual consultation.
- The project-specific screening chart, which was developed for a range of listed species, functions as an "informal programmatic" tool and is a key factor in improving efficiency. This tool guides users through a structured series of questions and incorporates conservation measures directly into the decision process, reducing the need for repeated coordination with USFWS.
- A centralized bridge bat survey database is an important tool for improving efficiency. The database tracks survey results, methods, and species presence, allowing NJDOT to reuse recent survey data and better inform future project decisions.
- Strong interagency coordination with the state wildlife agency and USFWS supports efficient implementation. The state bat biologist assists with surveys, maintains data, and collaborates on tool development, while the USFWS liaison creates and updates the project-specific screening chart and provides project-specific guidance.
- Bridge and culvert surveys represent a substantial workload, particularly for maintenance projects involving large numbers of structures. NJDOT uses standardized survey forms and guidance but continues to rely heavily on surveys as a primary compliance tool.
- A streamlining opportunity was identified to use survey data to identify structure types or sizes less likely to support bats, with the goal of reducing unnecessary survey requirements.
- Reliance on a single USFWS liaison remains a key constraint. Although coordination processes are well developed, the volume of projects and limited staffing can create bottlenecks.

South Carolina

A staff member from USFWS, serving as the South Carolina DOT (SCDOT) liaison, participated in the interview. The interview highlighted that South Carolina is actively working toward a state-specific bat programmatic agreement because of limitations in applying the range-wide Federal Highway Administration programmatic to state conditions, particularly given differences in bat behavior within the year-round active range. While finalizing the development of the state programmatic, the USFWS field office has implemented key streamlining tools, including a standardized list of conservation measures, programmatic approval of survey methods, and clear thresholds for activities that trigger consultation. These approaches have helped reduce back-and-forth coordination and improve efficiency, although the agencies maintain flexibility to account for project-specific conditions.

Key insights include:

- Region-specific bat behavior was a primary rationale for the development of state-specific tools and an upcoming statewide programmatic agreement, because bats are typically active year round and do not follow traditional hibernation patterns.
- Two primary streamlining tools include:
  - Standardized conservation measures, which serve as a key factor in improving efficiency by helping projects more consistently reach NLAA determinations and reducing back-and-forth coordination with USFWS. USFWS developed these measures using current available information on bat biology and behavior in South Carolina, using the state natural resource agency as a resource for information. Although many of these conservation measures overlap with those in the DKey, the standalone list provides a flexible tool for supporting efficient determinations.
  - Programmatic approval of structure survey methods significantly reduces workload by eliminating the need to review and approve individual study plans for each structure survey.
- Clear thresholds for tree cutting provide predictable decision pathways, allowing projects below the threshold to proceed with conservation measures while larger projects trigger additional consultation.
- Strong interagency coordination between SCDOT and USFWS supports streamlined implementation, enabling the use of standardized tools.

The list of conservation measures was provided to and is available from the research team on request. Select conservation measures include the following.

Hibernating Range:

- Avoid activities resulting in the disturbance or disruption of NLEB and TCB in their hibernacula during hibernation.
- Avoid suitable roost trees within 0.25 mile of a known NLEB and TCB hibernaculum entrance during spring staging (April 1 to May 14) and fall swarming (September 1 to November 15).
- Avoid removing suitable roost trees within 0.25 mile of a known NLEB and TCB hibernaculum.
- If bat evidence or bat sightings are unexpectedly made during structure maintenance or demolition, the contractor will stop work, and USFWS will be notified immediately. No work will resume at the structure location until discussions with USFWS have concluded.
- Culverts (≥ 36-inch manufactured diameter) and bridges should be re-surveyed for bats and signs of bat use within 30 days prior to work that will affect those structures. Any signs of bat use should be promptly reported. Maintenance or demolition can take place once all bats have exited the structure on their own.
- Avoid work activities that will cause chronic noise from a half an hour before official sunset times until a half an hour after official sunrise times, during active season (April 1 through September 30). Note: Chronic noise is noise that is continuous or occurs repeatedly again and again for a long time.

Avoid the use of artificial lighting within 1,000 feet of suitable NLEB and TCB roosting habitat from a half an hour before official sunset times until a half an hour after official sunrise times, during active season (April 1 through September 30), when flightless young are present (i.e., pupping season, May 15 through July 31).

- Report any dead bats found during or after activities have commenced to USFWS immediately.

Year-round active range:

- Snags should be retained where possible across the landscape, when not a safety hazard.
- If bat evidence or bat sightings are unexpectedly made during structure maintenance or demolition, the contractor will stop work, and USFWS will be notified immediately. No work will resume at the structure location until discussions with USFWS have concluded.
- Culverts equal to and greater than 3 feet in manufactured diameter will be re-surveyed for bats and signs of bat use within 30 days prior to work that will affect those structures.
- Avoid work activities that will cause chronic noise from a half an hour before official sunset times until a half an hour after official sunrise times. Note: Chronic noise is noise that is continuous or occurs repeatedly again and again for a long time.
- Avoid the use of artificial lighting within 1,000 feet of suitable roosting habitat from a half an hour before official sunset times until a half an hour after official sunrise times.
- Report any dead bats found during or after activities have commenced to USFWS immediately.

Georgia

Two practitioners (Georgia DOT [GDOT] and USFWS) closely involved in the development of Georgia's statewide bat programmatic agreement were interviewed separately. The agencies coordinated and developed a state-specific approach to bat consultation that replaces routine project-by-project coordination with a predictable, program-level framework. Key components include standardized avoidance and minimization measures, programmatic consultation coverage, and a conservation funding mechanism that offsets the effects at a broader scale. The agreement was developed through significant interagency coordination, supported by dedicated funding, staff resources, and technical expertise, and reflects a "give-and-take" approach to developing and implementing a solution.

Key insights include:

- The programmatic replaces project-by-project consultation with a program-level framework. Rather than preparing a biological assessment and coordinating with USFWS for each project, GDOT operates under a single programmatic consultation that covers routine activities. This approach allows projects to proceed under predefined conditions, with concurrence effectively built into the programmatic, significantly reducing coordination time and documentation.
- The programmatic establishes clear, predictable avoidance and minimization measures that apply across projects, reducing the need for case-by-case decision-making and allowing GDOT to plan and implement projects without repeated coordination.

- Although range-wide tools such as the DKey are useful, they cannot capture the level of detail needed for state-specific conditions and often "kick out" projects that require further coordination. Georgia's programmatic addresses this oversight by implementing state-specific decision tools that allow more projects to proceed without additional review.
- A conservation funding mechanism replaces widespread project-level restrictions. GDOT contributes funding (approximately $4 million annually) to support conservation of high-priority habitats, allowing greater flexibility in activities such as tree cutting. This approach shifts mitigation from individual projects to a broader conservation strategy.
- Tree-cutting restrictions were a major driver of programmatic development. Seasonal restrictions were identified as a significant constraint on project delivery, prompting GDOT to pursue an alternative approach. The programmatic allows limited cutting within defined thresholds, with the effects accounted for through a "take" framework and conservation payments rather than strict time-of-year restrictions.
- The agreement reflects negotiated tradeoffs, in which GDOT accepted certain requirements (e.g., surveys and funding commitments) in exchange for reduced coordination and increased flexibility. Both GDOT and USFWS emphasized that trust and willingness to compromise were critical to developing the agreement.
- Development of the programmatic required substantial time (approximately 18–24 months), funding, and staff effort (with multiple liaisons), including using consultants and frequent coordination meetings. This investment was viewed as necessary to achieve long-term benefits.
- Georgia conducted statewide mist-netting and used research datasets to determine species ranges and inform decisions such as excluding certain structure types (e.g., metal culverts) from survey requirements.
- Georgia developed training programs for DOT staff and consultants to conduct surveys and apply programmatic requirements, reducing reliance on external coordination. This approach supports consistent implementation and improves efficiency across projects.
- Following rollout, Georgia recognized the need for clear user guidance and training to ensure practitioners could effectively apply the programmatic. Supporting materials such as user guides and standard operating procedures are now considered essential components.

Tennessee

One Tennessee DOT (TDOT) practitioner in the Environmental Division participated in the interview. TDOT currently coordinates with USFWS on nearly every project, resulting in a high consultation workload. The agency had been working toward developing a statewide bat programmatic agreement, partly motivated by the anticipated listing of the TCB. Although discussions with USFWS have paused, staff remain interested in advancing this effort. The interview highlights TDOT's need for a state-specific approach, including particular limitations of the DKey for their state, and a strong interest in shifting toward efficient and conservation-focused approaches.

Key insights include:

- TDOT currently coordinates with USFWS on a project-by-project basis, which creates a high workload, particularly for tree-trimming work. In the absence of a programmatic agreement or effective screening tools, consultation occurs.
- The DKey is largely ineffective for their state because of data limitations and decision structure. A key barrier is the requirement to determine whether a project is within documented bat habitat, which TDOT cannot reliably assess because of a lack of a data sharing agreement with their state natural resource agency, which limits access to precise bat occurrence data. As a result, habitat is overestimated (e.g., when using the U.S. Geological Survey/USFWS North American Bat Monitoring Program database, entire quadrangles are flagged even if bat occurrences do not cover the quadrangle), causing many projects expected to be NLAA to be "kicked out" of the DKey and require consultation.
- TDOT previously relied on informal conservation measures developed with long-standing staff. As personnel changed over time, consistency in how these measures were applied became more limited, contributing to slower processes and highlighting the value of more formal, documented agreements.
- One reason noted for pursuing a statewide programmatic is to reduce reliance on repeated surveys and instead direct resources in conservation actions that provide greater ecological benefits, such as habitat protection or restoration within the state.
- A study on bat use of bridges and culverts is planned to provide data to inform streamlining decisions.

North Carolina

One North Carolina DOT (NCDOT) staff member from the Environmental Analysis Unit participated in the interview. North Carolina has developed multiple bat programmatic agreements over time, including region-specific (eastern versus western) and species-specific programmatics, largely driven by the need to streamline requirements that differed across their two USFWS field offices. The interview highlighted that programmatics were pursued primarily to improve consistency in guidance, improve efficiency, and formalize survey protocols based on structure survey datasets. The importance of using state-specific data to inform decision-making was emphasized, particularly for culvert and bridge assessments, and to support positions when federal guidance does not align with local conditions. Although programmatics have improved efficiency, challenges remain that are related to complexities built into their requirements such as prenotification, which can reintroduce project-level coordination. NCDOT emphasized that effective streamlining depends on simplicity, strong supporting data, and alignment between agencies.

Key insights include:

- Variability in guidance across USFWS field offices was a major driver for creating programmatics. Agency staff was interested in reducing project-by-project variability through their programmatics, including when surveys are required and what conservation measures apply.

- The eastern and western field offices in North Carolina have different approaches to consultation, which led to separate programmatics and delayed implementation in some regions.
- It was noted that shifting toward approaches that fund research, habitat protection, or species recovery could be more effective than processes that involve substantial effort with less conservation benefit.
- NCDOT has collected extensive survey information (e.g., ~20 years of data), which allows them to justify survey protocols and refine survey windows.
- Standardized survey protocols were formalized to maintain data consistency over time. NCDOT provides a training video and Standard Operating Procedures for bat habitat assessments (NCDOT, 2026); their survey methods were incorporated into their programmatics.
- NCDOT is finalizing a comprehensive, structured survey of culverts across size classes and materials to evaluate bat use, and findings will be available in the coming months. Data suggest that bat use of culverts is relatively limited, with species such as TCB primarily using culverts seasonally and little evidence of use in smaller culverts or during certain seasons.
- The importance of keeping programmatics straightforward and easy to implement was emphasized. For example, the western programmatic includes a payment system tied to impacts (e.g., seasonal tree cutting within buffer areas), which is complicated and difficult for users to apply. Other complexities include multiple seasonal rules, geographic zones, and a prenotification requirement that, although allow USFWS to review projects quickly, was viewed as somewhat redundant and similar to project-by-project consultation.
- Programmatic features, such as “take” thresholds, can provide flexibility and efficiency. NCDOT established annual thresholds (e.g., acres of cutting and number of structures) based on historical data, allowing most projects to proceed under the programmatic without additional consultation.
- NCDOT tracks all projects using the programmatic through a central unit, allowing them to monitor thresholds, payments, and compliance efficiently.

APPENDIX D. EXAMPLE APPLICATION OF SCENARIO-BASED TREE-CUTTING FRAMEWORK

Table D1 illustrates how a single project type may follow different review pathways depending on site conditions and defined thresholds (as discussed in a previous section of the report). The streamlined pathways apply to clearly defined, lower-risk scenarios, whereas projects with greater potential for effects use additional conservation measures or are not applicable for the streamlined path.

Table D1. Example Application of Scenario-Based Tree-Cutting Framework

Scenario	Project Conditions	Thresholds Met?	Review Pathway	Application of Conservation Measures	Coordination
Scenario 1A: Roadside / Disturbed Corridor (Low Risk)	Tree cutting confined to existing median and roadside within maintained right-of-way; disturbed conditions; no suitable or documented habitat	Yes (e.g., ≤ X acres; within Y ft of roadway; no suitable habitat)	Streamlined	Apply standardized *Conservation Measure Package A* (e.g., time-of-year restrictions, marked cutting limits, stop-work provisions)	Minimal or no additional coordination; consistent documentation
Scenario 1B: Limited Cutting in Suitable Habitat (Low Risk with Controls)	Mostly roadside cutting with minor encroachment into adjacent forest edge or potentially suitable habitat; no documented occurrences; limited extent	Yes (e.g., ≤ X acres total; ≤ Y acres in suitable habitat; limited distance beyond roadway; no high-sensitivity features)	Streamlined	Apply standardized *Conservation Measure Package B* (with more protective measures, e.g., avoid activities with chronic noise, phased cutting)	Minimal coordination; consistent application if thresholds are met
Scenario 2: Higher Habitat Potential (Moderate to Higher Risk)	Tree cutting extends into forested or riparian areas; larger trees present; potential or documented bat habitat; greater extent of disturbance	No (exceeds thresholds or includes higher-risk conditions)	Standard Review (PBO/ DKey-based)	Apply project-specific conservation measures determined through DKey or coordination (may include additional restrictions or consultation)	Project-specific coordination required

DKey = determination key; PBO = Programmatic Biological and Conference Opinion.