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Bat Conservation Strategy for Forest Service-Managed Lands of the Eastern United States

Eastern Region (R9)
Southern Region (R8)

Developed in Collaboration with:

USDI Fish and Wildlife Service, Midwest Region (R3)

USDI Fish and Wildlife Service, Northeast Region (R5)

USDI Fish and Wildlife Service, Southeast Region (R4)

USDI Fish and Wildlife Service, Southwest Region (R2)

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EXECUTIVE SUMMARY

Purpose and Intent for the Bat Conservation Strategy

The Forest Service, in collaboration with the U.S. Fish and Wildlife Service, has developed this *Bat Conservation Strategy for National Forest System Lands of the Eastern United States* (BCS) to contribute to the conservation of the Indiana, northern long-eared, little brown, and tricolored bats on National Forest System lands in the Eastern and Southern regions of the Forest Service. The BCS is an assemblage of best available scientific information and associated management considerations designed to promote bat conservation and potentially contribute to the long-term recovery of these four bat species.

The regional foresters in Regions 8 and 9 have committed to working with the FWS toward shared goals of bat conservation. The BCS is one tool that will help both agencies achieve shared bat conservation goals. The BCS is a foundational component of a broader, proactive strategy that will also include monitoring commitments as well as conferencing and consultation products for BCS species that will establish consistent and efficient streamlined procedures at the programmatic and project levels. Collectively, these commitments and products are expected to advance bat conservation on National Forest System lands across the eastern United States.

The following goals were the focus for developing the BCS:

- Contribute to the conservation and recovery effort of BCS species across FS Regions 8 and 9 at the landscape scale through a consistent approach to project design and program delivery.
- Minimize negative impacts to BCS species on National Forest System lands across the eastern United States.
- Foster a landscape that promotes habitat resilience to potential ecosystem threats (such as but not limited to climate change, mesophication, and invasive species) and potentially supports long-term recovery of BCS species.
- Protect remaining known bats by protecting and improving habitat conditions in and adjacent to known hibernacula.
- Protect remaining known bat populations by protecting and improving habitat conditions around known maternal roost colonies.

The purpose of the BCS is to provide relevant scientific information and management considerations for FS land managers in Regions 8 and 9 to reference when planning and implementing their activities. The BCS includes information to inform future management; establishes a foundation for management consistency; offers necessary management flexibility; and retains future management options. Thus, this information may be incorporated into products such as National Environmental Policy Act (NEPA) documents, land management plans, biological assessments, or program implementation plans as appropriate, but has no formal standing as official direction or policy.

The FS intends to carry conservation measures (CMs) and conservation recommendations (CRs) forward from the BCS to inform programmatic and project-level design and ESA Section 7 consultation, with a shared understanding with the FWS that applicable CMs will be required for projects to qualify for a new two-tiered, streamlined consultation process. The overarching intent of this work is to support consistent, efficient, and effective ESA Section 7 consultations in the future, in shared support of bat conservation outcomes.

How this Document is Organized

The BCS is a compilation of BASI (including descriptions of suitable bat habitat and how management actions can potentially affect bats and suitable habitat) and management considerations in the form of management goals, objectives, and corresponding conservation measures and recommendations that contribute to bat conservation and potentially support long-term recovery based on the BASI. The conservation measures and recommendations, concepts, and habitat-based outcomes developed in this BCS improve upon existing bat conservation efforts being implemented by the FS.

The BASI and management considerations are organized by those pertaining to:

- Management of long-term bat habitat (Chapter 2);
- Known hibernacula and habitat in the vicinity of hibernacula (Chapter 3); and
- Known roosts and roosting habitat (Chapter 4).

Additional information such as bat activity dates, descriptions of suitable bat habitat, a glossary, and other supporting information is found in the appendices.

Applying Information from the Bat Conservation Strategy

The goals, objectives, conservation measures (CMs), and conservation recommendations (CRs) are designed to inform land managers of management considerations that promote bat conservation and potentially support long-term recovery. The management considerations and scientific information will be incorporated into project development, programs, land management plans, and future ESA Section 7 consultations, as appropriate. These elements of the BCS will help:

- Inform conferencing and consultation processes at the programmatic and project levels;
- Inform project development and implementation through the identification of bat conservation opportunities and management considerations; and
- Provide updated scientific information that can be incorporated into future effects analyses.

The science and management considerations included in the BCS will foster consistent management of BCS species and their habitat across National Forest System lands in FS Regions 8 and 9. Expectations for incorporating BCS information must be balanced with:

- Health and safety concerns;
- Objectives for management of other resources, including other rare species; and
- Compliance with other laws, regulations, policies, or official direction.

Integrating the Bat Conservation Strategy and Section 7 Consultation

Establishment of a 7(a)(1) Bat Conservation Program

The BCS is a foundational component of a broader Endangered Species Act (ESA) Section 7(a)(1) strategy in FS Regions 8 and 9 that will also include monitoring commitments and ESA Section 7(a)(2) conferencing and consultation products for BCS species that will establish consistent and efficient streamlined procedures at the programmatic and project levels. Collectively, these commitments and products will support bat conservation at an unprecedented geographic scale.

New 7(a)(2) Two-Tiered, Streamlined Consultation Process

Using the BCS as a foundation, the FS and FWS are collaborating to develop a new two-tiered consultation framework for project work on National Forest System lands in Regions 8 and 9 that will establish a more efficient avenue for 7(a)(2) consultation for the four BCS species. This framework will be available for project-level consultation on BCS species when appropriate CMs are incorporated into the project design. When it is not possible to incorporate all appropriate CMs from the BCS into a project, or when emergency responses are necessary to protect human life and safety, the project may not qualify for the two-tiered consultation process. However, units will still be able to follow other established consultation avenues to fulfill their consultation obligations under the ESA.

Integrating the BCS with Project Planning

The CMs and CRs in the BCS are a set of actions that serve to benefit, minimize, or avoid potential adverse effects to BCS species that should be considered for all project work where appropriate. Both CMs and CRs are integral parts of the overall BCS to promote proactive conservation and potentially support long-term recovery of the BCS species and habitats. The BCS was developed with a shared understanding that relevant CMs will be required for future projects in Regions 8 and 9 when using the two-tiered, streamlined consultation process, while CRs should be incorporated into project design to the extent practicable.

Integrating the BCS with Land Management Plans

The scientific information and management considerations in the BCS can inform the development and decision-making for broad-scale land management plans to ensure long-term bat conservation goals can be realized. It is important to note that the CMs and CRs in the BCS are not forest plan components nor does the BCS by itself amend or revise any forest plan. However, the updated scientific information and management considerations may be a starting point in considering revisions or amendments to existing plan direction, originally developed using outdated information. However, units must comply with 36 CFR 219 before any amendments or revisions to a land management plan can be adopted.

Bat Conservation Strategy and Monitoring Opportunities

Monitoring will contribute to the successful implementation of the management considerations included in the BCS. Monitoring results will also contribute to the broader understanding of species status and increase our understanding of how management activities may positively or negatively affect bats and habitat, thereby informing future adaptive management. The FS is committing to work with partners to help develop questions and strategies to validate key assumptions through surveys, monitoring, and research. Through this process, the FS's objective is to manage forest resources in a manner that promotes long-term ecosystem health, including bat habitat, while minimizing short-term impacts to bats.

Implementation Support for the Bat Conservation Strategy

To support implementation of the BCS, bat location information, monitoring plans, implementation guides, trainings, and other resources may be developed as needed and made available to FS and FWS personnel, contractors, and other practitioners.

CHAPTER 1 INTRODUCTION

Shared Goals for Bat Conservation

Populations of four forest-dwelling bat species, Indiana bat (*Myotis sodalis*), northern long-eared bat (*M. septentrionalis*), little brown bat (*M. lucifugus*), and tricolored bat (*Perimyotis subflavus*), hereafter referred to as the "BCS species" (see Figure 1-1 for species' range map), have plummeted in much of the eastern United States and Canada (Cheng et al., 2021). While white-nose syndrome (WNS), caused by a non-native, invasive fungus (*Pseudogymnoascus destructans* (Pd)), remains the primary threat to these species[1], the U.S. Forest Service (FS) recognizes the role the Agency plays in providing high-quality habitat to support remaining populations and promote long-term recovery through forest and resource management. Forest management has the potential to both positively and negatively impact bats and bat habitat. Therefore, forest management will play a crucial role in BCS species conservation going forward.

In line with our Agency's strategic plan goal: "*to sustain our nation's forests and grasslands*", we are working towards fostering resilient, adaptable ecosystems by promoting actions that support habitat diversity and species diversity across time and space. Active management is crucial to this goal given the threats these ecosystems face, such as mesophication (where conditions favor shade-tolerant species; Nowacki and Abrams 2008), non-native invasive species invasions, fire exclusion, and climate change.

It is the desire of the land managers in the Southern and Eastern regions of the FS (Region 8 and Region 9, respectively) to proactively contribute to the conservation and recovery of bat species severely impacted by WNS by ensuring continued availability of high-quality habitat for these species. There is also a desire to understand the potential impacts management activities may have on these species and to avoid, minimize, or mitigate potential negative impacts to the extent possible while implementing a multiple-use program of work under our land management plans.

To achieve these desired goals, FS Regions 8 and 9 collaborated with the U.S. Fish and Wildlife Service (FWS) to develop this bat conservation strategy (BCS) and related tools to support conservation of the four BCS species on National Forest System lands in FS Regions 8 and 9. The purpose and design of the BCS are to inform practitioners of science-based, proactive land management opportunities that will enhance bat conservation efforts beyond current practices. Applying these considerations across project work at a multi-regional scale is expected to advance bat conservation on National Forest System lands.

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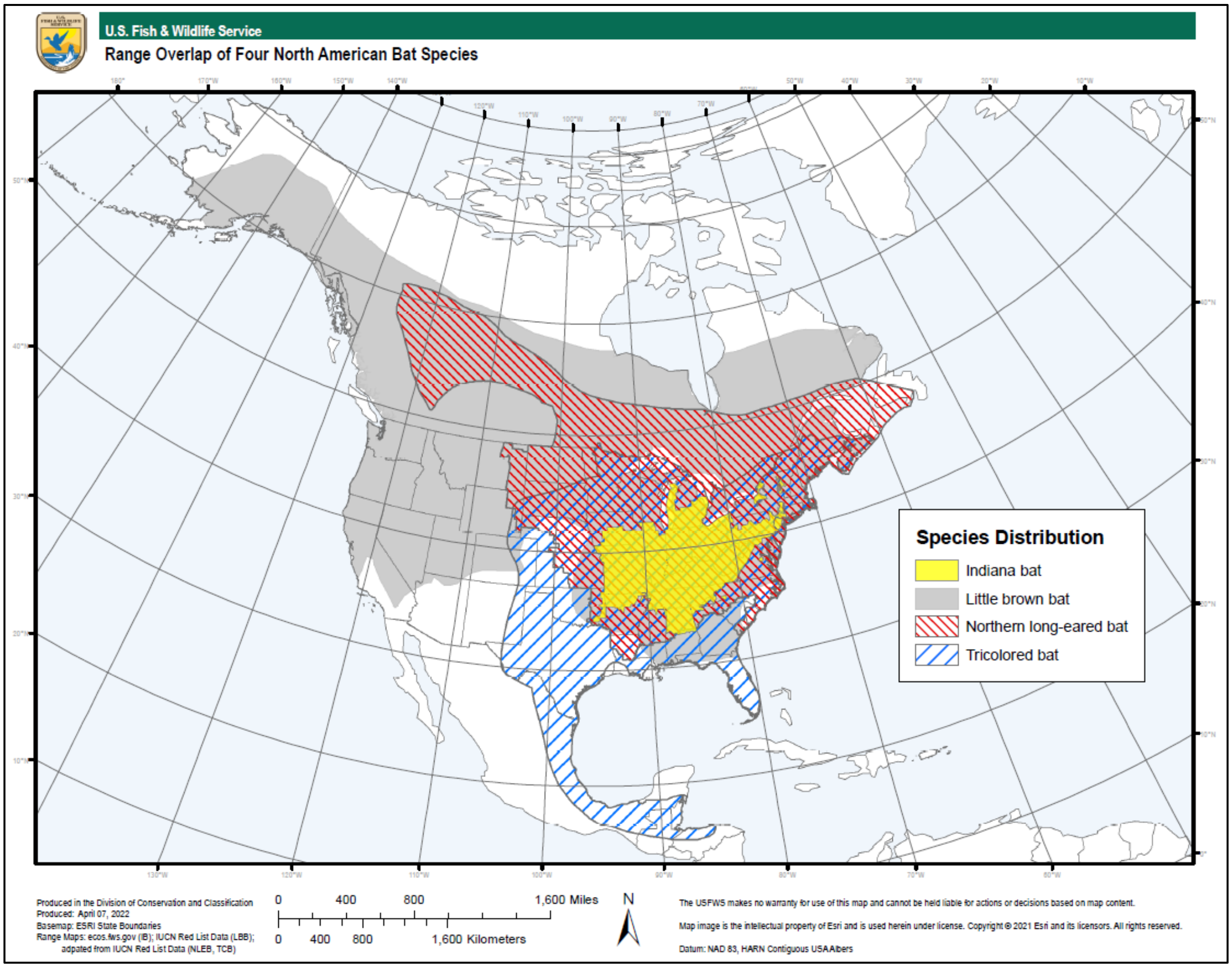
[1] National and international efforts are underway to reduce the impacts of white-nose syndrome (WNS) although to date, there are no proven measures to reduce the severity of impacts on a large scale. For more information on WNS treatment research, visit https://www.whitenosesyndrome.org/ and https://www.nfwf.org/programs/bats-future-fund.

Figure 1-1. Range map for the four BCS species.



To maximize conservation benefits to bats, Forest Service units in Regions 8 and 9 should incorporate the appropriate management considerations outlined in the BCS (including goals, objectives, conservation measures (CMs), and conservation recommendations (CRs)) into proposed actions as well as other planning documents to the extent feasible. These management considerations can be incorporated as design criteria that can be implemented at the program or site-specific level to minimize harm to BCS species and promote long-term habitat integrity and availability. However, it is important to note that the BCS does not establish new agency policy or direction. Therefore, the elements of the BCS are not land management plan components nor does the BCS amend or revise any Forest Service land management plan.

The overarching goals of collaboration between FS Regions 8 and 9 and the FWS are:

- To further the conservation and recovery of the four BCS species on National Forest System lands in FS Regions 8 and 9 (covering approximately 23 million acres) by acting on the Agency's ESA Section 7(a)(1) responsibilities;

- To establish a streamlined and efficient programmatic approach to Section 7(a)(2) consultation for projects on national forests in FS Regions 8 and 9 in response to reclassification of northern long-eared bat, anticipated listings of the tricolored and little brown bat as well as the already listed endangered Indiana bat, each of which has been affected by WNS. Programmatic approaches are expected to result in greater consistency across the regions, improved outcomes for bat conservation, shorter process times, and more effective use of staff capacity; and
- To develop reasonable risk management approaches to ensure the continued availability of high-quality habitat for BCS species while also carrying out other mission priorities (multi-use mandate) on National Forest System lands. Management approaches were developed using updated science and professional judgement.

These goals would support expected ongoing work between the FS and FWS on bat conservation and recovery over time, allow for adaptation to changed conditions, and monitor outcomes for surviving bat populations and their associated habitat at landscape scales.

Purpose and Intent for the Bat Conservation Strategy

The BCS is an assemblage of best available scientific information (BASI) and associated management considerations in the form of management goals, objectives, and corresponding conservation measures (CMs) and conservation recommendations (CRs) that contribute to bat conservation and potentially support long-term recovery. The BCS is a foundational component of a broader ESA Section 7(a)(1) strategy in FS Regions 8 and 9 that will also include monitoring commitments and ESA Section 7(a)(2) conferencing and consultation products for BCS species that will establish consistent and efficient streamlined procedures at the programmatic and project levels. Collectively, these commitments and products will support bat conservation at an unprecedented geographic scale.

The intent of the BCS is to inform project design and implementation, consultations, and forest planning in FS Regions 8 and 9 by:

- Reflecting BASI on the BCS species;
- Reflecting our understanding and assumptions of management impacts on those species;
- Providing useful concepts for consideration in land management planning and actions; and
- Providing useful information to inform monitoring needs and opportunities.

The BCS has no formal standing as official direction or as a decision. Rather, the purpose of the BCS is to provide relevant scientific information and management considerations for FS land managers in Regions 8 and 9 to reference when planning their activities through NEPA documents, land management plans, biological assessments, and/or program implementation plans. This document is therefore pre-decisional and deliberative and is subject to change as new information becomes available.

Guiding Principles

White-nose syndrome has caused steep and widespread declines in bat populations in a short period of time. The locations of surviving bats remaining on the landscape during the summer active season is largely unknown. Developing an effective conservation strategy when so little information exists is a daunting challenge, especially when our ability to detect surviving bats that may occur in virtually any forested habitat, tree, cave, mine, and rock crevice within a vast landscape is extremely limited. Regardless of the limitations of current knowledge, the FS must deliver on its mandate to accomplish a robust program of work that provides for vital ecosystem services and forest products across National Forest System lands. The BCS therefore, provides information to inform future management; establishes a foundation for management consistency; offers necessary management flexibility; and retains future management options. In the face of a high degree of scientific uncertainty, the BCS team relied on the following guiding principles in developing the BCS:

- Use the best scientific information available about bat life history, ecology, and habitat needs. The team relied on information from research throughout the range of each species, recognizing that behavior and habitat use may vary depending on the geographic area. Where no information exists, the team made assumptions or inferences based on the collective experience and professional judgment of team members and other scientists in developing management considerations;
- Consider the habitat requirements of other wildlife species, including those where management and habitat needs may conflict with those for the BCS species. Although other species that occupy National Forest System lands may benefit from or be hindered by management activities carried out by the FS, the effect of actions on these species has not been considered or evaluated for this strategy; management considerations for other species and resource management needs must be weighed against bat conservation needs at the site-specific level;
- Develop a useful, proactive plan to conserve forest-dwelling bats on National Forest System lands in FS Regions 8 and 9;
- Consider the balance between reducing the potential for short-term harm, injury, or killing of BCS species, taking advantage of long-term opportunities to conserve, restore, and enhance bat habitats, and meeting the Agency's multiple-use management responsibilities, strategic goals, and overall mission;
- Retain future options and management flexibility to fulfill both our obligations to conserve species and deliver services to the public and modify project implementation as needed if more conclusive information concerning BCS species management is identified;
- Management considerations must be broad and general enough to apply to suitable bat habitat across a broad landscape and inform a wide-range of management activities.

The following BCS goals were developed with these guiding principles in mind:

1. Contribute to the conservation and recovery effort of BCS species across FS Regions 8 and 9 at the landscape scale through a consistent approach to project design and program delivery.
2. Minimize negative impacts to BCS species on National Forest System lands across the eastern United States.
3. Foster a landscape that promotes habitat resilience to potential ecosystem threats (such as but not limited to climate change, mesophication, and invasive species) and potentially supports long-term recovery of BCS species.
4. Protect remaining known bats by protecting and improving habitat conditions in and adjacent to known hibernacula.
5. Protect remaining known bat populations by protecting and improving habitat conditions around known maternal roost colonies.

What are the Expectations for Using the BCS?

The regional foresters in Regions 8 and 9 committed to work with the FWS toward shared goals of bat conservation through a collaborative agreement. The BCS was developed as a tool to help achieve those shared goals for bat conservation. Thus, forest managers should incorporate the science and all appropriate CMs and CRs from the BCS into proposed actions as well as other planning documents to the extent feasible while also achieving other management objectives. It is expected that the CMs appropriate to the management activity will be required when the two-tiered, streamlined consultation process is used in future projects, while CRs should be incorporated into project design to the extent practicable. However, no portion of the BCS takes precedence over human health and safety and other emergency responses[2].

When circumstances arise that make it impossible to adhere to all appropriate CMs for a given activity, including but not limited to emergency situations or where management objectives for a planned project cannot be achieved, units should discuss those circumstances with their local FWS field office or regional threatened and endangered species biologist for additional recommendations or mitigations for bat conservation that may be more appropriate for the project. See Bat Conservation Strategy and Section 7 Consultation for more information on ESA consultation approaches and compliance.

2 For clarity, occasional hazard tree cutting of potentially bat-suitable trees during the bat non-hibernation period to protect human health and safety are not considered an "emergency" for the purposes of consultation. Rather, cutting of hazard trees that pose an imminent threat to human safety are described more fully in the Hazard Tree Management section in Chapter 2 and are regarded as a necessary part of the BCS consultation process.

Scope of the Bat Conservation Strategy

Landscape

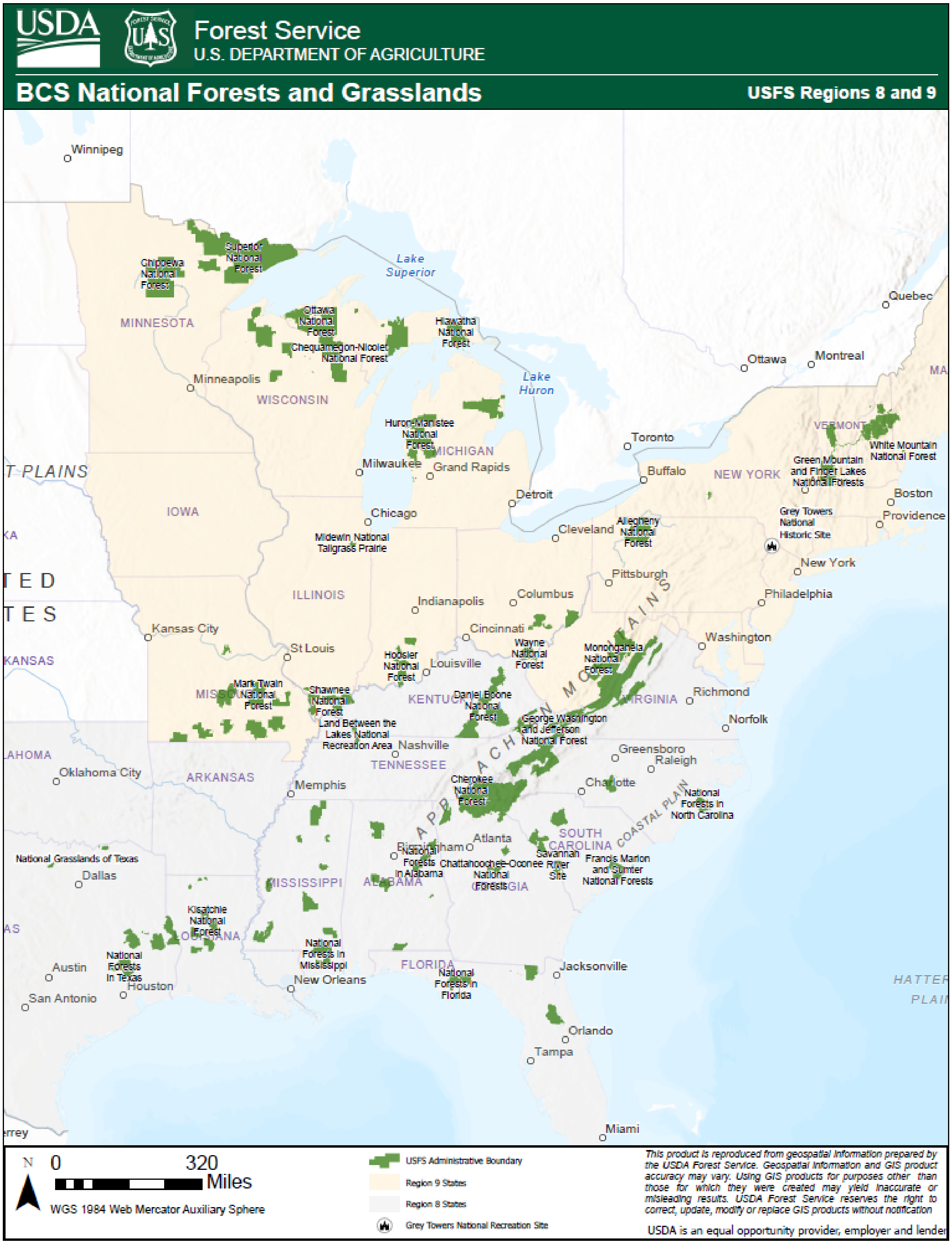
The BCS was developed to inform management activities executed under 32 land management plans across 27 administrative units in the National Forest System, plus additional administrative units managed by the FS in the Region 8 and 9 footprints (See Table 1-1 and Figure 1-2). The total area covers approximately 23 million acres in the eastern United States. Although the science and management considerations may be useful for managers across all ownerships, the BCS was specifically developed to inform the implementation of programs of work on FS units in FS Regions 8 and 9 where one or more of the four BCS species occur and where the FS has decision-making authority.

Table 1-1. List of Forest Service administrative units and associated land management plans included in the BCS.

Administrative Unit	Accompanying Land Management Plan(s)
Allegheny National Forest	Allegheny
Chattahoochee-Oconee National Forest	Chattahoochee-Oconee
Chequamegon-Nicolet National Forest	Chequamegon-Nicolet
Cherokee National Forest	Cherokee
Chippewa National Forest	Chippewa
Daniel Boone National Forest	Daniel Boone
Francis Marion-Sumter National Forest	1. Francis Marion 2. Sumter
George Washington-Jefferson National Forest	1. George Washington 2. Jefferson
Green Mountain-Finger Lakes National Forest	1. Green Mountain 2. Finger Lakes
Hiawatha National Forest	Hiawatha
Hoosier National Forest	Hoosier
Huron-Manistee National Forests	Huron-Manistee
Kisatchie National Forest	Kisatchie
Land Between the Lakes National Recreation Area	Land Between the Lakes National Recreation Area
Mark Twain National Forest	Mark Twain
Midewin National Tallgrass Prairie	Midewin
Monongahela National Forest	Monongahela

Administrative Unit	Accompanying Land Management Plan(s)
National Forests and Grasslands in Texas	National Forests and Grasslands in Texas
National Forests in Alabama	National Forests in Alabama
National Forests in Florida	National Forests in Florida
National Forests in Mississippi	National Forests in Mississippi
National Forests in North Carolina	1.Nantahala-Pisgah 2. Uwharrie 3. Croatan
Ottawa National Forest	Ottawa
Shawnee National Forest	Shawnee
Superior National Forest	Superior
Wayne National Forest	Wayne
White Mountain National Forest	White Mountain
Savannah River Site	No land management plan
Grey Towers National Historic Site	Administrative site; No land management plan available
Experimental forests managed by the Northern Research Station and Southern Research Station	May be included in the land management plan for the nearest national forest

Figure 1-2. Map of the Forest Service administrative units included in the scope of the Bat Conservation Strategy.



Management Activities Considered in the Development of the Bat Conservation Strategy

The BCS was developed with the majority of the common or "routine" management actions identified under land management plans in mind. Such activities are generally executed using well-established methods and tools, and therefore, the potential effects to BCS species habitat are largely predictable. The types of management actions considered include but are not limited to:

- Vegetation management via timber harvest with the intent to maintain or regenerate forest cover (all even-aged, uneven-aged, or salvage prescriptions included);
- Ecosystem conversion (conversion of one ecological type to another (native) ecological type where appropriate);
- Intermediate vegetation management treatments (i.e., mechanical cutting, frilling, girdling, herbicide basal bark, cut stump, foliar spray);
- Prescribed fire (including fireline construction, snagging, reconstruction, and maintenance);
- Non-native and native invasive species management (including insect and disease control);
- Rangeland (grazing/hay allotment) management;
- Wildlife habitat improvements (non-vegetation management) such as nesting box installation, water level management at ponds and lakes, woody debris introduction to impoundments, establishment or maintenance of wildlife openings (includes tree removal, prep, planting, etc.);
- Stream, wetland, and watershed management, enhancement, and restoration;
- Planting vegetation;
- Hazard tree cutting;
- Firewood cutting and/or gathering;
- Construction of new, or expansion, modification, realignment, or decommissioning of maintenance level of 1, 2, and 3 roads;
- Modification, realignment, or decommissioning of maintenance level 4-5 roads outside of existing, cleared rights-of-way (i.e. trees are already cleared);
- Maintenance and decommissioning, including culvert and bridge maintenance or replacement, and replacement or construction of stream passage structure for aquatic organism passage (AOPs);
- Construction and rehabilitation of temporary roads created to support other management activities;
- Recreation site maintenance, construction, and development, including tree clearing, for trail heads, trail corridors, boat launches, picnic areas, campgrounds, day use areas (except as noted below in the Management Activities Not Considered in the Development of the Bat Conservation Strategy section);

- Other infrastructure and facility maintenance or improvements such as at repeaters, cell towers, SST's, pavilions, employee office grounds and buildings, paint or herbicide sheds, pole barns, garages, tool sheds, campgrounds, trailheads, etc.;
- New routine special use authorizations and expansions/modifications of existing routine special use authorizations (exceptions noted below); and
- Renewal of existing special use authorizations of any kind when there is no new forest clearing associated.

Management Activities Not Considered in the Development of the Bat Conservation Strategy

Management actions that were not considered in the development of the BCS include activities that are generally uncommon, use methods and tools that are not well established, or where there may be high levels of variability in the tools and methods used. Such actions may also be executed at a scale or under circumstances that are not always predictable and therefore, can result in greater uncertainty for how bats may be affected. These "atypical" actions often are initiated by proposals or applications submitted to the Forest Service by other entities (for example, special use applications, funded agreements, or other mechanism) or Forest Service actions that may be driven by unforeseen circumstances. Atypical actions not considered in the development of the BCS may include but are not limited to:

- Oil, gas, and mineral-related activities and occupancy;
- Construction, widening, or expansion of rights-of-way other than those to private property (such as but not limited to new utility transmission lines or pipelines);
- Construction, widening, or expansion of maintenance level 4 and 5 roads;
- Construction or expansion of wind and solar farms;
- Construction or expansion of ski resorts and similar large-footprint developments;
- Other projects that permanently alter suitable bat habitat greater than 20 acres; and
- Emergency response activities.

Because of the uncertainty that exists with these types of management actions, and because impacts from activities associated with these atypical actions can also be uncertain as a result, a consistent set of management considerations could not be developed that would provide predictable conservation outcomes for bats for these types of actions. However, the CMs and CRs found in the BCS should provide a starting point for discussions in ESA consultation or in project planning. Coordination with the FWS may be required to determine if projects would be consistent with the BCS or if additional conservation measures may be appropriate for the site-specific action.

Further study is needed to increase our understanding of the methods and tools used for these types of activities and the potential impacts they may have on bats and suitable bat habitat. Future iterations of the BCS may include these types of activities if new information becomes available that reduces the uncertainty of how these activities may affect bats and reasonable management considerations can be developed based on that information.

What does the BCS include?

As described briefly in the Purpose and Intent for the Bat Conservation Strategy section above, the BCS is a compilation of BASI (including descriptions of suitable bat habitat and how management actions can potentially affect bats and suitable habitat) and management considerations in the form of management goals, objectives, and corresponding CMs and CRs that contribute to bat conservation and potentially support long-term recovery based on the BASI. The CMs and CRs, concepts, and habitat-based outcomes developed in this BCS improve upon existing bat conservation efforts being implemented by the FS.

The BASI and management considerations are organized by those pertaining to:

- Management of long-term bat habitat (Chapter 2);
- Known hibernacula and habitat in the vicinity of hibernacula (Chapter 3); and
- Known roosts and roosting habitat (Chapter 4).

Additional information such as bat activity dates, descriptions of suitable bat habitat, a glossary, and other supporting information is found in the appendices.

Suitable Bat Habitat

The four BCS species generally occupy forested habitats during the summer and hibernate in caves and similar structures during winter across most of their ranges. In coastal zones, these species are typically active year-round as the climate is milder in these areas and bats rarely enter an extended torpor (i.e. hibernate). Through the rest of the ranges for these species however, a hibernation period is typical. Therefore, the particular characteristics of both summer and winter bat habitats and the differences in seasonal and latitudinal bat behavior must be considered. These species can potentially be found in a wide range of suitable summer and winter habitats. Ecosystem types, habitat use, and behavior for these species are geographically variable. However, there are some commonalities across all four species.

For the purposes of the BCS, suitable summer habitat is generally defined as habitat consisting of a wide variety of forested/wooded habitats where bats roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields, and pastures. This includes forests and woodlots containing potential roosts (i.e., live trees and/or snags ≥5 inches DBH for Indiana and little brown bat; >3 inches DBH for northern long-eared bat) that have exfoliating bark, cracks, crevices, and/or cavities), as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Tricolored bats are roost generalists and typically roost in foliage;

they are unlikely to use very small trees or saplings. In addition, BCS bat species use anthropogenic structures such as but not limited to bat boxes, bridges, culverts, and buildings.

For the purposes of the BCS, suitable winter habitat is generally characterized by cave, or cave-like site(s) that are used for extended periods of torpor (i.e., hibernation) during winter months. Hibernation sites are typically thermally stable, subterranean sites most typically associated with caves and karst landforms but also include sites that function in a similar manner (e.g., mines, emergent rock features, railroad tunnels, culverts, hollow concrete dams). Large hibernacula that can support thousands of bats are limited on the landscape. Conversely, some smaller caves, structures, or other landscape features that are used by individuals or smaller colonies may not be as limiting, yet they are still important for overall species perseverance (Perry and Jordan 2020).

More descriptive summaries of suitable bat habitat, including species-specific information, is provided in Appendix A. In certain cases, local site-specific knowledge may lead the FS and FWS field office to mutually agree that a particular habitat does not provide suitable bat habitat. In those cases, the CMs and CRs relative to the proposed activities would not apply if there is not suitable bat habitat.

Bat Ecology and Behavior where Bats are Active Year-Round

Rather than extended hibernation periods, which is common in colder climates, BCS species in coastal zones only enter a brief torpor lasting days rather than months when temperatures substantially drop, although there are some exceptions in coastal zones where some BCS bats may be hibernating for a longer period of time in winter while other bats are still active on the landscape.

Bats, especially males and non-reproductive females, enter torpor to conserve energy outside of hibernation, and it takes time to arouse to full activity (Dickinson et al. 2009). The lowest ambient temperature recorded for a normothermic NLEB is 37.4°F (Jordan 2020), although some NLEBs go into torpor at higher temperatures (a range of 37.4–55.6°F has been recorded). The average lowest temperature within this range was 46.5°F, which closely matches observations that NLEBs can still be caught down to 45°F (Armstrong, pers. comm. 2023). Similar behavior has been observed in other species. For instance, when ambient temperatures dropped below 50°F, red bats were slow to arouse from torpor, which leads to increased response times when confronted with disturbances (Thomas et al. 1990, Layne et al. 2021, Dickinson et al. 2010). All bats may use torpor during periods of sub-optimal foraging, such as cold or wet weather (Dickinson et al. 2009) and when air temperatures are below 40°F during periods that bats are generally active on the landscape, bats are likely in a deeper torpor that requires more time to arouse (Jordon 2020). Therefore, conducting management activities at these temperatures are more likely to impact the species due to the species' inability to avoid the activity.

Given the lack of species-specific data across the BCS bats, research is needed to understand the emergence of torpor across their ranges and in response to management actions. Forty degrees will be applied at this time as a basis of emergence from torpor across the range of species until further species-specific information is gathered on this key biological threshold. Bats that are active year-round can also have a longer breeding season compared to bats in other areas in the species' ranges. Since bats in coastal zones are potentially present in forested landscapes at any time and pups may be present for longer periods of time compared to other areas where they occur, there is a greater potential for management activities to adversely affect individuals. The activity periods when BCS species are expected to be active on the landscape or hibernating are provided in Appendix B. Activity period timeframes are specific to each forest or district as indicated.

Even within coastal zones where the climate is generally mild, there can be variability in winter weather that affects bat behavior. For the purposes of the BCS, coastal zones are further dissected into two zones where Coastal Zone 1 refers to areas where temperatures can fall below 40°F for short periods, which can cause BCS species to enter into a brief torpor to conserve energy. Low temperatures in these areas are most likely to occur between December 15 and Feb 15. In Coastal Zone 2, temperatures are highly unlikely to drop below 40°F for an extended period; BCS species in this zone are not expected to enter periods of brief torpor.

For the purposes of the BCS, Table 1-2 lists the FS units that lie in coastal zones where bats generally do not hibernate for extended periods. The coastal zone that applies to each FS unit is provided. The coastal zone that applies to each unit may be modified in the future if additional information becomes available that indicates a change would be appropriate. There are some circumstances where some BCS bats may be hibernating in an area and where others are still active on the landscape. See the Hibernacula in Coastal Zones section in Chapter 3 for a discussion on how hibernacula located within the coastal zones should be addressed.

Table 1-2. Forest Service units in Coastal Zones 1 and 2[3].

Administrative Unit	Forest or District	Coastal Zone
Chattahoochee-Oconee National Forest	Oconee RD	1
Kisatchie National Forest	Caney RD Catahoula RD (in part) Kisatchie RD (in part) Winn RD	1
Kisatchie National Forest	Calcasieu RD Catahoula RD (in part) Kisatchie RD (in part)	2

[3] Units that are not included in Table 1-2 are in colder areas where bats are expected to hibernate for extended periods.

Administrative Unit	Forest or District	Coastal Zone
National Forests in Alabama	Conecuh NF (all) Talladega NF (Oakmulgee RD (in part) and Talladega RD (in part) Tuskegee NF (all)	1
National Forests in Alabama	Conecuh NF (in part)	2
National Forests in Florida	All	2
National Forests in Mississippi	Bienville NF De Soto NF (Chickasawhay RD and De Soto RD (in part)) Delta NF Homochitto NF (in part)	1
National Forests in Mississippi	De Soto NF (De Soto RD (in part)) Homochitto NF (in part)	2
National Forests and Grasslands in Texas	Angelina NF (in part) Davy Crockett NF (in part) Sabine NF (in part)	1
National Forests and Grasslands in Texas	Angelina NF (in part) Davy Crockett NF (in part) Sabine NF (in part) Sam Houston NF	2
Francis Marion and Sumter National Forests	Francis Marion NF Sumter NF (Enoree and Long Cane RDs)	1
National Forests in North Carolina	Croatan NF Uwharrie NF	1
Savannah River Site	All	1

Conservation Measures and Recommendations

The CMs and CRs outlined in chapters 2, 3, and 4 are designed to be proactive and broadly applicable to bats and their habitats on National Forest System lands in the FS Regions 8 and 9. The CMs and CRs are intended to provide a set of baseline considerations for BCS species management that are flexible and adaptable enough to be applied across the broad geographic range and diverse ecological communities these species inhabit.

The CMs and CRs were developed collaboratively between the FS and FWS to improve bat habitat management outcomes and reduce risks associated with FS management activities on BCS species in suitable bat habitats. However, it is important to note that even with applying all appropriate CMs and CRs into a project, some adverse effects could still occur where BCS species are present on the landscape. The intent of the BCS is not to avoid all adverse impacts to the BCS species. Rather, the intent is to minimize impacts to known locations and to identify proactive measures that will encourage long-term suitability and availability of BCS species habitat. If there is a site-specific circumstance where full avoidance may be desirable, units should work with their local FWS field office to identify additional or alternate design criteria that will achieve full avoidance of BCS species.

Incorporating CMs and when possible, CRs, into project activities is intended to minimize potential short-term adverse impacts to known and unknown BCS species while providing the long-term habitat conditions and management flexibility needed to achieve broader forest management goals and potentially support long-term bat recovery. This in turn will contribute to long-term habitat availability and overall conservation of BCS species by fostering ecosystem integrity.

The CMs will be applied and CRs should be applied where and when appropriate to a given management action. Conservation measures and recommendations designed for the broader landscape (Chapter 2), apply to all suitable BCS species habitat throughout all National Forest System lands included in the BCS (Table 1-1). When activities occur within a hibernaculum, roost, or maternity capture buffer (Chapter 3 and Chapter 4), all applicable CMs for long-term habitat, roosts, and hibernacula must be applied as appropriate to the type of buffer. If CMs for the buffered area are more restrictive than CMs or CRs for long-term habitat for the same management activity, the most protective CM takes precedence. Likewise, when multiple buffers overlap (such as a primary roost buffer that overlaps with a secondary roost buffer), the most protective CM takes precedence.

Additional considerations must be provided to areas where bats are active year-round (i.e. coastal zones units identified in Table 1-2) because there is no time of year when BCS species are likely to be absent from the landscape; therefore, the BCS is designed to provide protections during the periods when bats may be most vulnerable – especially during the pup season and when brief cold periods occur. Any differences in how CMs would apply to the coastal zone units noted in Table 1-2 are described in the applicable CMs. Where no geographic differences are noted, they would apply as written in all areas.

Throughout this document, the scientific literature that supports the CMs and CRs is cited where it exists. But in some cases, limited empirical information is currently available. In these cases, assumptions or inferences were made based on the collective experience and professional judgment of team members from the FS and FWS, with additional input from other subject matter experts.

Informing Project Planning, Forest Planning, Consultations, and Future Monitoring Efforts

The goals, objectives, CMs, and CRs are designed to inform land managers of management considerations that promote bat conservation and potentially support long-term recovery. The management considerations and scientific information will be incorporated into project development, programs, land management plans, and future ESA Section 7 consultations, as appropriate. These elements of the BCS will help:

- Inform conferencing and consultation processes at the programmatic and project levels;
- Inform project development and implementation through the identification of bat conservation opportunities and management considerations; and
- Provide updated scientific information that can be incorporated into future effects analyses.

The science and management considerations included in the BCS will foster consistent management of BCS species and their habitat across National Forest System lands in FS Regions 8 and 9. Expectations for incorporating BCS information must be balanced with:

- Health and safety concerns;
- Objectives for management of other resources, including other rare or at-risk species; and
- Compliance with other laws, regulations, policies, or official direction.

The collaborating agencies intend to carry CMs and CRs forward from the BCS to inform programmatic and project-level design and ESA Section 7 consultation, with a shared understanding that applicable CMs will be required for projects to qualify for a new two-tiered, streamlined consultation process.

Bat Conservation Strategy and Section 7 Consultation

Forest Service management activities have the potential to result in short-term adverse effects and incidentally take federally-listed species. At the same time, forest management is expected to provide for long-term benefits to habitat quality and availability, potentially supporting species recovery. Under provisions of the Endangered Species Act, federal agencies are instructed to use their authorities to carry out programs for the conservation of listed species, and ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of critical habitat (16 USC 1536).

The BCS will also help the Forest Service fulfill obligations under the ESA, specifically sections 2(b), 2(c)(1), 7(a)(1), and 7(a)(2).

Section 2(b) states,

> *"The purposes of this Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section."*

Section 2(c)(1) states,

> *"It is further declared to be the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act."*

Section 7(a)(1) states,

> *"The Secretary shall review other programs administered by him and utilize such programs in furtherance of the purposes of this Act. All other Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to section 4 of this Act."*

Section 7(a)(2) states,

> *"Each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency (hereinafter in this section referred to as an "agency action") is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with affected States, to be critical, unless such agency has been granted an exemption for such action by the Committee pursuant to subsection (h) of this section. In fulfilling the requirements of this paragraph each agency shall use the best scientific and commercial data available."*

To achieve our obligations under ESA Sections 2(b), 2(c)(1), and 7(a)(1), the Forest Service must manage our ecosystems to improve habitat conditions for federally listed species. Obligations under ESA Section 7(a)(2) are achieved through the consultation process.

Establishment of a 7(a)(1) Bat Conservation Program

The BCS is a foundational component of a broader ESA Section 7(a)(1) strategy in FS Regions 8 and 9 that will also include monitoring commitments and ESA Section 7(a)(2) conferencing and consultation products for BCS species that will establish consistent and efficient streamlined procedures at the programmatic and project levels. Collectively, these commitments and products will support bat conservation at an unprecedented geographic scale. Many of the conservation measures around hibernacula will provide conservation benefits to the BCS species. The CRs are intended to highlight additional opportunities to provide conservation benefits while further mitigating adverse effects during implementation.

New 7(a)(2) Two-Tiered, Streamlined Consultation Process

The BCS will be the foundation in establishing a more efficient avenue for 7(a)(2) consultation under the Endangered Species Act (ESA) for the four BCS species. The FS and FWS are collaborating to develop a new streamlined consultation framework for project work on National Forest System lands in Regions 8 and 9. The FS and FWS will use the CMs, CRs, and scientific information from the BCS as a foundation to develop a two-tiered, programmatic consultation framework that will establish a streamlined consultation process for qualifying, site-specific projects that may affect BCS species in compliance with ESA Section 7(a)(2). When it is not possible to incorporate all applicable CMs from the BCS into a project, the project will not qualify for the two-tiered consultation process. However, units will still be able to use other established consultation avenues to fulfill their consultation obligations under the ESA.

- ***Tier 1:*** Eastern and Southern regional foresters intend to initiate programmatic consultation on the anticipated maximum programs of work for each unit included in the scope of the BCS. Conservation measures from the BCS, monitoring, and reporting elements will be included. This step includes the analysis required to determine the effects Forest Service management actions have on bats as required for the consultation process. A programmatic biological opinion is expected at the end of the Tier 1 step. The FS and FWS will establish an efficient, streamlined process to complete consultation at the project level (Tier 2) when conservation measures from the BCS and monitoring requirements are included in future projects.

- ***Tier 2:*** Unit staff will complete project-level consultation for projects that incorporate the terms and conditions, reasonable and prudent measures, and monitoring requirements from the Tier 1 biological opinion and the applicable CMs and CRs from the BCS as appropriate to the project activities proposed. The Tier 2 step builds on the analysis completed during the Tier 1 programmatic consultation. While project-level consultation must still be completed, it will be considerably faster than the traditional project-level process. Additional time savings are expected because the project-level consultation will require only site-specific information about each project proposed, which is expected to be documented through a streamlined form rather than a lengthy biological assessment that is used for the traditional consultation process.

For projects to qualify for the streamlined consultation process, the applicable CMs included in the BCS will be mandatory actions and design features at the project level. Conservation recommendations would be discretionary, though are highly encouraged as they provide additional conservation benefits to the BCS species. The streamlined process could be used for new projects proposed or for existing projects where reinitiation of consultation is needed or desired for one or more of the BCS species.

If there are site-specific circumstances that would prevent a unit from following all appropriate CMs for a particular project and therefore, not qualifying for the streamlined process, or when emergency responses are necessary to protect human life and safety, then the FS would retain the discretion to meet ESA consultation requirements by working with their local FWS field office and following other established 7(a)(2) processes. Although FS land managers are still encouraged to incorporate appropriate CMs and CRs into project design to the extent feasible in these circumstances, the ability to use traditional ESA consultation processes will maintain line officer discretion by providing the flexibility needed to meet situational objectives.

The streamlined consultation process would only apply for BCS species; other consultation requirements and procedures may exist for projects that will affect other species and critical habitats. Species impacts should be discussed with local forest or district biologists to determine if other species may be affected so consultation may be completed as required to comply with the ESA.

Bat Conservation Strategy and Project Planning

When units are planning new projects, they should first determine which BCS species may have known locations (roosts or hibernacula) within or adjacent to their project area. Once that is complete, units need to determine which chapters and CMs and CRs of the BCS will apply to the project based on location, species status, and type of activities being planned. The CMs and CRs in the BCS are a set of actions that serve to benefit BCS species by providing for long-term suitable habitat, or that minimize, or avoid potential adverse effects to BCS species. The CMs and CRs should be considered for all project work where appropriate. Both CMs and CRs are integral parts of the overall BCS to promote proactive conservation and potentially support long-term recovery of the BCS species and habitats. The BCS was developed with a shared understanding that the CMs will be incorporated into future projects in Regions 8 and 9 when using the two-tiered, streamlined consultation process, while CRs should be incorporated into project design to the extent practicable.

However, CMs and CRs may not be implementable in all cases, based on site-specific circumstances or the nature of a particular project. When a unit cannot incorporate all appropriate CMs into a project, the streamlined process that will be established may not be appropriate to complete ESA consultation. However, other established avenues for consultation will still be available separate from the BCS two-tiered consultation framework. See the Bat Conservation Strategy and Section 7 Consultation section above for more details on the avenues available for project-level consultation.

Incorporating Tribal Interests, Indigenous Traditional Ecological Knowledge, Sacred Sites, and Historical Interests into Bat Conservation

Early in project-level and forest planning processes, units are encouraged to consider how bat conservation may intersect with sacred sites, historic properties, traditional cultural uses, or other tribal and heritage interests. Interests may include the bats themselves as species of cultural importance or the landscapes, areas, and features bats inhabit. For example, caves, rock outcrops, shelters and similar features can have significant tribal interest and may also be used by bats for hibernation, roosting, and other life functions. Man-made structures and other bat features may have cultural significance. Such situations represent shared opportunities for conservation and management of bats and cultural interests.

Tribal Engagement

Early tribal engagement in the planning process can inform how BCS species and their habitat can best be managed to serve mutual interests between tribes and the FS. This early engagement is important not only when there are known sites in the area but is also needed to begin conversations around additional sacred sites or tribal interests that the FS may not already be aware of. Tribal engagement in this vein represents opportunities for co-stewardship, as well as early and proactive coordination, with Indian tribes to increase collaboration and strengthen relationships, leading to better project and resource outcomes.

Several tools exist to assist units with engaging tribes and fostering collaborative relationships. The Region 8 *Tribal Engagement Guidance Checklist template NFMA and NEPA* is one tool available for developing tribal engagement strategies during project-level planning. The Region 8 *Tribal Engagement Guidance Checklist template Forest Plan Revision* document is available as a starting point for tribal engagement during forest plan revision. Other useful tools, such as the Administration's memo on *Indigenous Traditional Ecological Knowledge and Federal Decision Making*[4] and the Agency's action plan on *Strengthening Tribal Consultations and Nation-to-Nation Relationships*[5], are also available.

Project managers, forest planners, and line officers are encouraged to reach out to their forest or regional tribal liaisons during the conceptual phase of project planning and early in the revision process to identify tribal engagement needs and strategies as tools and agency guidance may change.

Other Heritage Considerations

Man-made structures and other features can also have cultural or historical importance. Coordination with heritage staff (including consultation as appropriate) is also needed before

[4] https://www.whitehouse.gov/wp-content/uploads/2021/11/111521-OSTP-CEQ-ITEK-Memo.pdf

[5] https://www.fs.usda.gov/sites/default/files/fs_media/fs_document/Strengthening-Tribal-Relations.pdf

structures, administrative sites, caves, mines, or other features are modified when managing for bats.

Bat Conservation Strategy and Land Management Plans

Land management plans include desired future conditions, standards, guidelines, objectives, and other components related to the management of National Forest System lands and resources at ecosystem scales. Implementation of ecosystem stewardship projects across 32 land management plans in FS Regions 8 and 9 can benefit BCS species by creating, maintaining, or improving habitat across these vast ecosystems. The scientific information and management considerations in the BCS can inform the development and decision-making for these broad-scale plans to ensure long-term bat conservation goals can be realized through improved forest conditions in the face of stressors such as succession, wildfire, invasive species, and climate change.

Information in the BCS may differ from existing land management plan direction. It is important to note that the CMs and CRs in the BCS are not forest plan components nor does the BCS by itself amend or revise any forest plan. If plan direction conflicts with or is more restrictive than the CMs and CRs in the BCS, the plan direction must be prioritized as required by law or regulation.

The updated scientific information and management considerations may be a starting point in considering revisions or amendments to existing plan direction, that were originally developed using information that is now outdated. However, units must comply with 36 CFR 219 before any amendments or revisions to a land management plan can be adopted.

Bat Conservation Strategy and Monitoring Opportunities

Monitoring Elements in the Streamlined Consultation Process

The BCS includes avoidance, minimization, and conservation measures focused around known and historic hibernacula, occupied roosts, and maternity capture sites. Within these sites, bat species and number of bats or reproductive condition, respectively, will determine the management considerations that are appropriate for hibernacula (Chapter 3) and roosts (Chapter 4). As such, monitoring elements will be included as a component of the Tier 1 step in the two-tiered streamlined consultation process.

Monitoring of ongoing species use and population levels as well as site conditions at these known locations will contribute to our long-term understanding of where surviving bats remain on the landscape and will allow for appropriate management adjustments as situations change for known locations.

Additionally, little is known regarding how BCS species may be influenced by climatic stressors. The influence of climate change on the spread and effects of white-nose syndrome are also largely unknown. Understanding how BCS species adapt to these influences represents an area in need of further research.

Additional Monitoring Opportunities

Additional monitoring will contribute to the broader understanding of species status and increase our understanding of how management activities may impact bats and habitat so opportunities to reduce those impacts further can be explored. This will enable the FS to make further contributions to bat conservation and potentially support long-term BCS species recovery. A monitoring plan is in development and will be included as a component of the two-tiered, streamlined consultation process.

A primary assumption of the BCS is that on-going FS management of landscapes provides long-term benefits to bats by providing and sustaining suitable roosting and foraging habitat. In addition, it is assumed that the BCS conservation measures minimize any activities' short-term impacts on bats, however it is unknown how bats respond in both the long and short-term to those management activities.

The FS is committing to work with partners to help answer these questions and validate these assumptions through surveys, monitoring, and research. Through this process, the FS's objective is to manage forest resources in a manner that promotes long-term ecosystem health, including bat habitat, while minimizing short-term impacts to bats.

Implementation of the monitoring plan will help ensure that buffers around known locations are in place as intended and that conservation measures and recommendations are applied as appropriate. Data gathered through the BCS will be the primary source of information that can lead to further understanding the bats' use of their habitat. Known non-reproductive capture sites and acoustic detections are indicative of potential use of an area by a BCS species during the active season. While the BCS does not include conservation measures or recommendations specific to these types of sites; however, revisiting these sites through future monitoring efforts may improve our knowledge of the bat's use of the landscape. This location and species information may be used to develop and validate occupancy models, monitor the bat's response to management activities, determine the effectiveness of conservation efforts, etc.

Additional research items (such as, but not limited to, delineating bat home ranges and foraging areas, response to vegetation management, activity periods in areas where bats are active year-round, etc.) may also contribute to the FS's understanding of how the bats use their habitat and respond to FS management. As more information is gathered, conservation measures and recommendations may be adjusted to incorporate the best available science.

Future monitoring commitments will include but may not be limited to:

- Developing a prioritized list of research and additional monitoring needs;
- Providing support (e.g., fund, collaborate, partner, etc.) to accomplish priority research and monitoring needs; or

- Establishing a team or committee across each Region/sub-region along with FWS and other partners to focus and further prioritize bat research and monitoring needs.

Updates to the Bat Conservation Strategy

The BCS was based on the best available scientific information at the time it was written, although an exhaustive literature review and synthesis are not provided. Instead, the focus in preparing the BCS was to present information that is representative of our general knowledge regarding BCS species and that informed development of CMs and CRs.

Given the limited information currently available regarding the distribution of surviving bats post-WNS and our understanding of the risks management activities pose to bats remaining on the landscape, it is recommended that an interagency review be conducted periodically, at regular intervals to consider new research, monitoring results, modeling, changes in species or population status, and other relevant information. If substantial new science has developed at any time or if species status reviews are conducted by the USFWS, those may be examples of potential triggers for reviewing and considering updates to the BCS. Management considerations should be adjusted as appropriate based on new information as well as our learning on the feasibility and effectiveness of the CMs and CRs in meeting bat conservation and project implementation objectives.

Implementation Support for the Bat Conservation Strategy

To support implementation of the BCS, bat location information, monitoring plans, implementation guides, trainings, and other resources may be developed to assist FS and FWS personnel, contractors, and other practitioners in their understanding of how elements of the BCS can be incorporated into project-level and forest planning and implementation. Additionally, tools and information that support use of the two-tiered, streamlined consultation process should be generated as needed. It is recommended that the BCS and any additional resources developed for field use be made available to FS and FWS practitioners so they can be easily accessed.

Finally, it is recommended that a board or committee (comprised of FS and FWS representatives and/or other partners) be established to:

- Prioritize survey and monitoring efforts;
- Oversee data collection and management;
- Develop a framework for periodic reviews and updates to the BCS;
- Develop training and other resources for practitioners so the elements of the BCS and the streamlined consultation process are implemented as intended; and
- Explore public and tribal engagement needs and opportunities as appropriate.
- Identify and prioritize information needs as they arise.

This group should include oversight functions and the authorization needed to assemble working groups as needed to carry out these functions.

CHAPTER 2 LONG-TERM HABITAT MANAGEMENT

Introduction

The four bat species covered in this BCS have global ranges that cross numerous ecological communities encompassing various habitat types and disturbance regimes. As such, each species is adapted to a range of ecological conditions, but there are some species-specific differences. Some activities will benefit some species more than others, but the overall goal is to maintain or restore aspects of ecosystems that will potentially improve bat survival and health as well as provide functional connectivity for multi-species bat populations across a diversity of forest conditions.

National Forests collectively provide some of the largest, most contiguous landscapes of forested habitat and highest quality areas for forest bats in the eastern United States. Active land management can promote bat conservation and potentially support long-term recovery. Therefore, the focus of this chapter is to provide FS managers practicable, achievable, and proactive conservation measures and recommendations to incorporate into regular planning for FS management activities. These conservation measures and recommendations will improve habitat for bats over time and avoid and reduce potential negative effects while accomplishing the agency's land stewardship objectives.

The four BCS species have similar overall needs in a general sense since they are all considered "cave bats" that typically migrate in spring and fall; spend summers in maternal roost colonies in or near forested habitats; and traditionally hibernate in caves, mines, or other structures in localities where insect prey is lacking during winter. Their basic needs include access to water, connectivity of habitats, a variety of forest types, structures, ages, and compositions, canopy cover and canopy gaps, roost sites with specific types of characteristics, plentiful insect resources, and access to hibernacula with suitable characteristics. An exception may occur in the southern portions of the USA and in coastal zones where the climate does not typically preclude access to insect prey during winter, thus, not necessitating typical months-long hibernation or the need for traditional hibernation resources. Providing for these elements at both a landscape and project-specific scale is important in ensuring suitable bat habitats persist or are created over time. The FS is uniquely positioned to provide these needs by managing large landscapes in perpetuity for sustainability and multiple uses. This chapter will inform FS managers on proactive bat conservation considerations that can be incorporated into ongoing routine management activities. This is accomplished by providing specific measures, when available, or describing desirable habitat outcomes that can be planned into projects through the interdisciplinary team process.

By managing for healthy and diverse landscapes, the FS provides suitable bat habitat resulting in the full range of components needed in differing bat species' life histories now and into the future. Bats inhabiting suitable bat summer, spring emergence, and fall swarming habitat are likely to enter and exit winter hibernation in good health, improving their ability to survive WNS exposure and successfully reproduce. In many forested landscapes, management is necessary to maintain or work towards restoring ecosystems that experienced anthropogenic changes to natural disturbance regimes and in considerations of climate change induced drivers and stressors. Management practices, aimed at providing diverse, high quality forest habitat, often involves short-term but high-intensity activities such as--but not limited to--prescribed burning, thinning, and salvage, can have temporary, adverse effects to local bats, with the goal of providing sustainable, long-term habitat suitability outcomes on a landscape or population scale. Although the conservation measures and recommendations were developed with special consideration for the BCS species, general guidance provided herein is likely to benefit other forest-dependent bat species, irrespective of their status under the ESA.

This chapter is largely based on previous bat-related guidance developed by the FS (USFS 2015) and Johnson and King (2018). The latter document was based on USFS (2015) but was developed in collaboration with professional foresters and wildlife biologists representing state and federal agencies, academic institutions, private conservation organizations, and other interested groups and individuals in response to catastrophic population declines of many bat species due to WNS. Another resource used extensively was the Taylor et al. (2020) Forest Management and Bats booklet. Habitat management is not the primary cause for these drastic bat population declines for the BCS bats, but careful management can aid in reducing effects of WNS and the potentially support long-term recovery of bat populations across their ranges.

Conservation Measures and Recommendations Applicable to Suitable Habitat on the Broader Landscape

The CMs and CRs outlined below (as defined in Chapter 1) are designed to be proactive and broadly applicable to bats and their habitats on National Forest System lands in the FS Regions 8 and 9, providing a set of baseline considerations that are flexible and adaptable enough to be applied across the broad geographic range and diverse ecological communities these species inhabit. The four bat species covered in this BCS have global ranges that cross numerous ecological communities encompassing various habitat types and disturbance regimes. As such, each species is adapted to a range of ecological conditions, but there are some species-specific differences. Some activities will benefit some species more than others, but the overall goal is to maintain or restore aspects of ecosystems that will potentially improve bat survival and health as well as provide functional connectivity for multi-species bat populations across a diversity of forest conditions.

This chapter discusses landscape-level considerations for the BCS species, through National Forest System management. The conservation measures appropriate to the management action should be applied wherever applicable and when it does not conflict with forest plan direction, stated objectives for other federally threatened or endangered species, designated critical habitat, or imminent threats to human safety.

Conservation measures and recommendations in this chapter apply to the following elements:

1. Vegetation management: silviculture, prescribed fire, and salvage
2. Creation and management of forest openings and gaps and permanent land use conversion
3. Hazard tree management
4. Streamside and riparian zone management
5. Pesticide use for non-native invasive species (NNIS) management and silvicultural applications

Special use authorizations are not addressed separately in the BCS as many permitted activities often associated with special uses (such as tree cutting; hazard tree management; permanent land use conversion; pesticide use; and the construction, operation, maintenance, demolition, and rehabilitation of structures and roads) are generally similar to the activities conducted for other types of management. Thus, for special use authorizations, the CMs and CRs in the BCS should be applied as appropriate for the activities and facilities authorized, including when authorized activities will occur within a hibernaculum buffer (Chapter 3) or roost or maternity buffer (Chapter 4). If an activity associated with an authorization is not addressed in the BCS or if you are authorizing an "atypical" activity (as described in the (Management Activities Not Considered in the Development of the Bat Conservation Strategy section), coordination with the FWS may be required to determine if projects would be consistent with the BCS or if additional conservation measures may be appropriate for the site-specific action. The CMs and CRs found in the BCS should provide a starting point for discussions in ESA consultation or in project planning.

The management considerations for this chapter are expressed as LTH for "long-term habitat", G for "goal", O for "objective", CM for "conservation measure", and CR for "conservation recommendation".

LTH-G-1: Promote active and ongoing protection, management, and creation of suitable bat roosting and foraging habitat for BCS species as a key element of a multiple use mission in conjunction with achieving other land stewardship objectives.

LTH-O-1: Improve both roosting and foraging habitats, with an emphasis near known hibernaculum and roost buffers.

Landscape Considerations Applicable to all National Forest Management

BCS species require a suitable amount and arrangement of habitat to support all aspects of their life history, including foraging, roosting, reproduction, spring emergence, fall swarming, and winter hibernation (Fuentes-Montemayor et al. 2017). The size and characteristics of these habitat types vary depending on species (see Table 2-1 and Chapter 3 and Chapter 4) and geographic location (see Silvis et al. 2016), but habitat features necessary for all essential life stages must be present to support a bat through its life cycle to ensure survival and healthy individuals. Bats have different temporal and spatial habitat needs and preferences. No single type of forest management is best for all bats (Lacki et al. 2007, Bergeson et al. 2018, 2021b), so understanding the over-arching needs of bats as well as some of the similarities and differences between the BCS species are needed to successfully manage habitats for a variety of bats over the long term. To accommodate a healthy bat community, FS managers should provide forests of varying age and size class, tree species composition (both overstory and understory), density, and structural complexity per individual forest plan (Loeb and O'Keefe 2006, Taylor et al. 2020). Different ecosystems and their stand characteristics may favor different bat species in different geographic areas, but some general forest habitat landscape metrics of composition and configuration are beneficial for all four bats regardless of geographic area. These landscape metrics include well-distributed mosaics of native forest types (Bergeson et al. 2021a, Bergeson et al. 2021b) that will provide adequate amounts of suitable foraging and maternity habitat, access to water resources, and connectivity of such habitats.

BCS species are especially vulnerable during hibernation; in early spring (when a bat's body condition may be compromised from hibernation and the effects of WNS); and when pregnant or during the pup season. Therefore, protection and enhancement of related habitat features as well as the forest matrix surrounding hibernacula (Chapter 3) and maternity roosts (Chapter 4) during these critical periods are the primary focus of the BCS to reduce any secondary effects from WNS or to improve the health of bats to combat the effects of WNS. Considering management of the forest matrix surrounding key local habitat features in terms of composition and configuration is also important, because specific management activities may affect the success of local bat colonies, even if a specific roost tree or hibernaculum is unaffected (Fuentes-Montemayor et al. 2017). Actively managing the forest matrix to provide suitable bat habitat over time (i.e., decades and centuries) is also important for bat population recovery and expansion in the future (Silvis et al. 2015b, Loeb 2020).

Table 2-1. Summary and comparison of general foraging and roosting requirements in the non-hibernation period for the four BCS bats[6] (See Appendix A for additional details on habitat requirements)

Feature or Activity	Indiana bat	Northern long-eared bat	Little brown bat	Tricolored bat
Roost Trees	Dead, sometimes live; under loose bark or in crevices; maternal roosts typically larger diameters and require solar exposure both during cold, wet, and excessively hot weather. Males tend to seek less-exposed roosts (e.g., live trees, primarily shagbark hickory, and higher canopy cover)	Roost generalists: live or dead; cavity, crevices, and under bark; small or large diameters, tree can have solar exposure but not required (i.e., often associated with relatively high canopy cover)	Dead or storm-damaged, sometimes live trees; cavities, crevices, and under loose bark; maternal roosts typically larger diameters and require solar exposure	Live or dead trees; in dead, seldom live, leaf clusters among foliage; solar exposure seasonally variable; in South, cavities in live trees during winter
Use of Man-made Roosts?	Yes, but less common than trees; solar-exposed rocket-style bat box or simulated bark roosts preferred and have occasionally been found in buildings	Yes, but use less than trees; bat boxes, sometimes crevices in buildings (e.g., in walls or other tight spaces)	Yes, man-made structures, esp. attics, bat boxes; typically used more often than trees, if available	Yes, but use less than trees; open, lighted areas, (e.g., under porch roofs). Culverts, bridges and other transportation structures can have summer and winter use
Roost Tree Species	Oak, hickory, cottonwood, elm, maple, pine, and other species that typically develop required micro-habitat (e.g., large areas of sloughing bark or crevices)	Pine, oak, maple, ash, black locust and suppressed understory trees (e.g., sassafras, sourwood, dogwood, redbud) that develop cavities or loose bark	Primarily oak and maple, also less often in shagbark hickory and red elm	Primarily deciduous forest, especially in oaks; occasionally in pine-dominated stands and in pine

[6] Sources: Indiana bat (USFWS 2007, Bergeson et al. 2018, Carter 2006), northern long-eared bat (e.g., Bergeson et al. 2021b, Gorman et al. 2022), little brown bat (e.g., Bergeson et al. 2015), and tricolored bat (USFWS in Prep: draft Species Status Assessments for 12-month findings, Perry et al. 2007).

Feature or Activity	Indiana bat	Northern long-eared bat	Little brown bat	Tricolored bat
Roost Tree Habitat	Bottomland, riparian, wetland, or upland; choose roosts in hydric habitats and along edges of harvest openings	Upland forest; do not avoid managed stands (e.g., harvest, prescribed fire), and sometimes use trees within them	Riparian, open forest, edge, near water	Upland or riparian, retention areas within or near partially harvested stands (i.e., more open)
Roost Area Fidelity	Yes, but with frequent roost switching within an area	Yes, but with frequent roost switching within an area	Yes, especially man-made roosts, but still switch roosts regularly	Yes, especially compared to other foliage-roosting bats
Foraging Habitat	Forested streams, upland trails, edges, ponds, in open understory conditions, canopy gaps, woods roads	Cluttered forest conditions under forest canopy in uplands: paths, edges of harvest areas, forested ponds, streams, and cluttered riparian habitat (e.g., upland swamps)	Forested areas over water, along margins of lakes and streams	Forested streams with open spaces, edge habitats, uplands and bottomlands, large reservoirs, and other water bodies
Clutter	Clutter-tolerant	Clutter-adapted	Clutter-tolerant	Clutter-tolerant
Foraging Strategy	Aerial hawker (see Faure et al. 1993)	Gleaner and aerial hawker	Aerial hawker and less often gleaner	Aerial hawker

Many bats, including BCS species, show some degree of site fidelity, both in summer and winter (e.g., Thompson 2006, Perry 2011) often returning each year to the same general areas. Bats may move between nearby hibernacula in the winter. For many social tree-roosting species, bats in maternity colonies return to suitable forested habitat patches within and between years, switching roost trees within those areas every 2–5 days during a single breeding season (e.g., Sasse and Pekins 1996, Foster and Kurta 1999, Menzel et al. 2002a, Veilleux and Veilleux 2004, Carter and Feldhamer 2005, Timpone et al. 2010, Bergeson et al. 2015). This roost-switching behavior likely serves multiple ecological functions, such as reduced parasite loads and thermoregulation. Roost switching can also maintain long-term social relationships between individuals from a colony. Social interactions among colony members may be important in identifying potential new roosts (Willis and Brigham 2004, Johnson et al. 2012, Silvis et al. 2014a, Webber and Willis 2016).

As roost trees deteriorate, new ones must take their place, or the area will ultimately lose its suitability as roosting habitat. Colonies with access to larger areas of suitable roosting and foraging habitats tend to be more stable than those where individuals must travel greater distances to obtain food or locate new primary roosts (Silvis et al. 2014b). Thus, at a landscape scale, a compositional or structural diversity of forest vegetation around hibernation and maternity sites is generally desirable, whether natural-caused or a result of management (e.g., silviculture, prescribed fire). For example, timber harvests can be used to mimic natural disturbances by creating forest canopy openings that provide more sunlight to potential roost trees (Bergeson et al. 2018 and 2021b) and improve foraging habitat for some species by reducing tree density. Furthermore, harvest prescriptions that maintain more canopy cover or retain larger-diameter trees may be desirable for interior-forest species. Prescribed fire and timber harvests also can be used to thin (i.e., “declutter”) forests (Loeb 2020) and encourage the recruitment of new trees, creating a source for future roost trees over time. Because each of the four BCS species have unique foraging and roosting requirements, a temporally staggered mix of silvicultural treatments and exclusion areas may be required to sustain high levels of bat diversity on a landscape scale (Law et al. 2016).

The scale at which bat species perceive their environment is influenced by variation in the distribution of resources, as well as by species-specific differences in ecological traits (Jachowski et al. 2016, Meyer et al. 2016, Silvis et al. 2016, Fuentes-Montemayor et al. 2017). Landscape-level planning requires integration of habitat needs at different spatial scales to which all the following elements and measures should be applied to create suitable bat habitats now and in the future. Broad-scale habitat condition includes a diversity of forest types across all age classes and non-forest habitats (e.g., grasslands, wetlands, scrub-shrub, water, etc.) that will produce a mosaic of different habitat conditions conducive to multiple bat species (Silvis et al. 2016). In addition to habitat availability, the size and distribution of different habitat conditions (age distribution, composition) is also critical to meeting life history requirements of many species. At the local scale, future conditions beneficial to maintaining BCS species populations require the presence of suitable maternity habitat for a given species within commuting distance of suitable foraging habitats and water sources (Owen et al. 2004). Likewise, productive foraging habitat, water sources, and suitable roosts near a hibernaculum provide suitable fall swarming and spring emergence habitat, allowing bats to put on critical weight before hibernation (Hall 1962, LaVal and LaVal 1980, Kunz et al. 1998), and can potentially support long-term recovery in the spring from WNS impacts experienced during hibernation.

To assist with basic overall understanding of habitat use by the BCS species, Table 2-1 provides an overview of their general habitat needs in a comparison format, acknowledging that each bat species may use a wide variety of specific habitats across its geographic range.

Vegetation Management: Silviculture, Salvage, and Prescribed Fire

Forest vegetation management can affect foraging habitat, maternity and day roosts, hibernacula, and fall swarming and spring staging habitat at multiple spatial scales and time scales. Given the scale and timing of management treatments, there usually will be a far larger proportion of closed canopy systems available within FS ownership than young forest. Forests in the FS Regions 8 and 9 were unsustainably logged in the 19th and early 20th centuries, followed by regrowth and aggressive fire suppression. Today's forests did not re-grow with natural disturbance regimes, including landscape-scale herbivory and regular fire under which bat communities evolved. The lack or alteration of these natural disturbance regimes has resulted in higher tree and vegetation densities (i.e., clutter, which is described in more detail below), especially at the landscape level, and shifting plant species composition also known as mesophication (Nowacki and Abrams 2008, Abrams 1992, Lorimer 2001, Guyette et al. 2012).

Cable et al. (2021) reported that allocating resources close to hibernacula may yield the greatest return on those investments, and the same is likely true around existing roosts. Thus, in this document we encourage informed active management in national forests, especially around bat maternity roosts and hibernacula to ensure they retain long-term suitability (Silvis et al. 2015b). Forest plans also include standards and guidelines that direct how vegetation should be managed to achieve those conditions.

Vegetation management can consist of various activities partitioned into two main categories that simulate natural disturbance: manipulation and management of trees (silviculture) and fire (prescribed fire). Active forest management can result in the creation, enhancement, and conservation of bat habitat over broad areas and time scales to benefit bats (Silvis et al. 2012) and other native flora and fauna. Vegetation management practices that sustain and enhance diversity of ecosystems, including composition, structural and age class diversity, and snag (i.e., standing dead tree) condition and abundance can be important tools in providing diverse habitat for bats, particularly when fire and other natural disturbance regimes have been suppressed or altered (Johnson et al. 2012, Bergeson et al. 2018, Ford et al. 2021). Because bats have variable spatial and temporal habitat needs (both within and across species), a heterogeneous landscape is advantageous even for forest interior (i.e., clutter-adapted) species, assuming the area is predominantly forested (Broders et al. 2006, Perry et al. 2007, Henderson and Broders 2008, Bergeson et al. 2018, 2021b). Here we provide a vision for habitat outcomes using silvicultural and prescribed fire management activities across landscapes to benefit the BCS species and the bat community at large.

In coastal zones (see Table 1-2), BCS species typically do not hibernate (with rare exceptions as noted in the Hibernacula in Coastal Zones section in Chapter 3). Instead, bats can be active on the landscape year-round in these areas and often have a longer breeding season compared to bats in other areas in the species' ranges. However, bats may become less active when air temperatures drop below 50°F and go into torpor for short periods of time when temperatures drop below 40°F. Therefore, when management activities are proposed during the active season within bat buffers, the ability of bats to arouse from torpor below 50°F should be considered.

In year-round areas, 40°F has been used to determine when direct impacts from tree cutting may occur to torpid bats roosting in trees (Armstrong, pers. comm. 2023). Setting temperature restrictions at 40°F will protect year-round active bats in torpor from injury or death as the bats are expected to be more capable of flying above this temperature. Within coastal zones, units should consider delaying activities occurring below 40°F on the forested landscape until ambient temperatures are above 40°F to allow bats a greater ability to respond to disturbances. To address these behavioral differences, some CMs provide additional protections when temperatures may drop below 40°F. Any differences that would be applicable to coastal zone forests are noted in specific CMs. Where no geographic differences are noted, the CMs would apply as written in all areas.

Silviculture

Potential Benefits and Impacts of Silvicultural Management

Silviculture is the science of controlling the establishment, growth, composition, and health of forests and woodlands and is one type of vegetation management. Vegetation management can affect foraging and roosting habitat for bats through both changes in the physical structure of habitat and resultant changes in the availability and recruitment of suitable roosts as well as prey abundance, diversity, and availability (Lacki and Schwierjohann 2001, Lacki et al. 2009a). However, silvicultural treatments may have a greater effect on roosting than foraging or commuting habitat use (Loeb 2020). Silvicultural practices can manipulate forest structure and composition through mechanical means. Herbicide is another silvicultural tool that can alter structure and recruitment of desired forest structure. In heavily forested landscapes, small patch cuts, variable-density thinning, and uneven-age management prescriptions (e.g., group selection) can provide important habitat heterogeneity for bats and may increase use relative to adjacent undisturbed forest (Hayes and Loeb 2007). Potential beneficial effects of vegetation management to bats may include but are not limited to the creation of snags, canopy gaps that increase solar exposure to existing and potential roost trees, travel corridors, a reduction in midstory clutter, and increased foraging opportunities (e.g., creation of hard edges, increased mobility, insect prey detection and likely foraging success). Silvicultural practices such as two-age harvests, shelterwood harvests (e.g., one or two entry), thinning, single-tree selection, and group-selection treatments are compatible with bat management, providing suitable habitat for closed canopy species, such as the northern long-eared bat, while also providing habitat for other species adapted to more open canopy conditions (Owen et al. 2003, Broders and Forbes 2004, O'Keefe 2009, Titchenell et al. 2011, Sheets et al. 2013, Bergeson et al. 2018, 2021b). Harvested units with variable retention of overstory size class and composition can provide valuable habitat for bats in an otherwise homogeneous forested landscape. Under even-age vegetation management, retaining overstory trees may provide seed sources as well as roost sites, cavity trees and other wildlife habitat resources, protect seeps, and provide structural diversity (Leak et al. 2014), including in streamside management zones.

While exceptions exist, studies in different geographic areas consistently have found an overall increase in bat activity in disturbed habitats (e.g., Brooks 2009, Loeb and O'Keefe 2011, Titchenell et al. 2011, Cox et al. 2016). Loeb (2020) mainly attributes the increase to creation of edge that attracts bats for foraging and commuting. This suggests habitat structure that allows for more efficient foraging is more important than prey abundance in determining spatial and temporal foraging patterns of forest bats (Morris et al. 2010, Dodd et al. 2012, Blakey et al. 2016). Restoration, overstory removal, clearcut, and other silvicultural treatments should be kept within proportion of seral community distribution of forest plan guidelines. Even within previously clearcut areas, thinning of dense regrowth can enhance the revegetating forest as foraging habitat for both open- and clutter-adapted bats (Perry et al. 2007, Blakey et. al. 2016). For off-site stands or vegetation communities outside their natural range, e.g., upland loblolly pine (*Pinus taeda*) plantations or white pine (*P. strobu*s) plantations in the Midwest, clearcuts may be a tool to replace stands and move them toward a desired future condition.

Forest clutter may be described as dense horizontal and vertical vegetative growth as is characteristic where invasive plants or native weedy species dominate the under- or midstory; in stands regenerating post-harvest with high stem density; or in more mature stands not recently subjected to natural disturbance or management. Bat species are influenced by and interact with their environment based on the level of clutter present. Open-adapted species prefer spaces with overall little or no clutter (e.g., forest openings, above tree canopy, edges or over water), while clutter-tolerant species are better able to interface with a wider range of vegetative conditions (e.g., forest gaps, forest trails, edges). Clutter-adapted (or "forest interior") species will generally use densely vegetated environments but may also tolerate somewhat open or edge habitats. Indiana, little brown, and tricolored bats seem to be open adapted or clutter tolerant and respond positively to management that reduces clutter. Northern long-eared bats appear to be the main exception and are often detected in mature, cluttered forests and roost in interior forest sites (Loeb and O'Keefe 2006, Menzel et al. 2002b), although several studies have found this species is tolerant of forest management, especially in well-forested areas (e.g., Owen et al. 2003, Silvis et al. 2015b). For example, in a south-central Indiana study, forest management that included both even- and uneven-aged harvest methods did not appear to affect northern long-eared bats' choice of roosts (Bergeson et al. 2021b) and in Arkansas, they preferred roosting in shelterwood-thinned areas, which do not retain as much canopy cover as uneven-aged harvest methods (Perry et al. 2007, Perry and Thill 2007a).

The broad-scale conversion to mesic vegetation (where shade and high-moisture- tolerant species are dominant) is a pervasive problem across the range of the BCS species caused by past fire suppression and lack of silvicultural management (Abrams 1992, Lorimer 2001, Guyette et al. 2012, Perry 2012). Silvis et al. (2012) suggest forest disturbance may play a large role in bat roost selection. Due to the sweeping change in under- and midstory structure and composition resulting from mesic invasion, active management is needed to reset disturbance-dependent forested ecosystems or risk losing oak- and pine-dominated forest communities upon which many bats depend (Lacki et al. 2016, Bergeson et al. 2018, Ford et al. 2021). Furthermore, disturbances caused by both native and non-native invasive insects and diseases such as emerald ash borer, beech bark disease, spongy moth and hemlock woolly adelgid can contribute to overstory canopy gaps, resulting in a response of increased understory and midstory vegetation (e.g., “clutter”).

Forest plans outline the proportions of seral stages that should be maintained across the landscape for habitat diversity and forest sustainability. Providing a diversity of habitats provides more niche space for the BCS species and the bat community as a whole. Emphasizing the management and maintenance of late seral stage habitats would be beneficial for BCS species. These habitats provide unique features often under-represented in more intensively managed landscapes, typically represent quality bat habitats (e.g., more large-diameter trees and snags and more complex structural characteristics) (Krusac and Mighton 2002) and are preferred for roosting by many bat species (Perry et al. 2007).

Roost trees

The most direct influence of vegetation management on bat populations is the creation or destruction of roost trees both in the short and long term. The BCS species use a variety of characteristics on both snags (standing dead) and live trees, including loose or exfoliating bark, cavities, crevices, and suspended dead leaf clusters in the canopy (Table 2-1). Due to the relative impermanence of tree roosts from natural and anthropomorphic disturbance, bats have likely adapted to roost loss (Silvis et al. 2015b). Although silvicultural harvest can result in the loss of potential roost trees, a variety of management practices may aid in the reduction of risk associated with disturbing or harming active maternity colonies during timber harvest, including but not limited to (Bergeson et al. 2018, Loeb 2020):

- Conserving and managing riparian and wetland areas for bats;
- Leaving snags and live trees with known roost characteristics (especially in clusters and near edges of harvest patches;
- Maintaining a minimum basal area of potential roost trees during harvest; and
- Employing seasonal restrictions, where warranted.

The BCS species typically roost in trees or snags during summer and, therefore, vegetation management can play a key role in providing or enhancing roost habitat during bat active season. While specific roost tree and associated landscape characteristics vary among the BCS species depending on geographic location and habitat availability, a few characteristics are common to most maternity colony habitats. For example, most bats prefer to roost in large-diameter (> 18 inches diameter at breast height [DBH]; e.g., USFWS 2007, Lacki et al. 2009a), taller trees and snags, which generally persist longer than smaller snags and can support more roosting bats (Russo et al. 2004, Kalcounis-Rüppell et al. 2005, Baker and Lacki 2006, Lacki et al. 2012, Bergeson et al. 2018). Therefore, the identification and inclusion of such trees in residual patches during timber harvesting is important, as is ensuring existing blocks of later seral stage forested habitats (as defined in forest plans) are left to maintain existing roost habitat (Perry et al. 2007). In addition, roost-switching is common and retention of a network of suitable roost trees in close proximity is considered an important characteristic in selection of roost trees by reproductive females (Willis and Brigham 2004, O'Keefe 2009, Patriquin et al. 2010, Johnson et al. 2012, Silvis et al. 2014a). Retaining or creating larger-diameter snags (>18-inches DBH) during regeneration harvests can help ensure a supply of roost trees exist during forest regeneration (Lacki and Schwierjohann 2001; see the Hazard Tree Management section for more details). To provide more snags on the landscape for a longer period of time, Schroder and Ward (2022) recommend two snag creation techniques applied to various tree species (e.g., maple, hickory, oak). Techniques include 1) applying herbicide after a single line of hatchet cuts or 2) using a chainsaw to cut two parallel, horizontal grooves through the bark several inches apart. Snags should be monitored for roost suitability and replenished as needed. Canopy gaps allow sunlight to warm roost trees, providing warm microclimates maximizing growth rates of young bats (Johnson et al. 2009; also see Creation and Management of Forest Openings section below for more details). Species-specific roost characteristics are detailed in Chapter 4.

Hibernacula

Although summer bat roosting and foraging habitat have received much attention, there has been little to no study of bat use in habitats around important bat hibernacula. The landscapes surrounding hibernacula provide essential roosting and foraging habitat for bats, especially during spring and fall. In fall they mate and must accumulate body fat reserves for hibernation and in the spring after emergence from hibernation they must restore body fat depleted during hibernation (Raesly and Gates 1987) and repair tissue damage that may have occurred from WNS infection during hibernation (Lacki et al. 2015). Conservation of forest cover and management of areas near hibernacula to provide additional snags may increase available roosts during the fall and spring (Perry et al. 2016). Vegetation management (e.g., prescribed fire; Lacki et al. 2009b) and other habitat manipulation (e.g., the creation of water sources, such as road ruts, ephemeral pools, and ponds, particularly in areas lacking water, such as dry ridgetops; Kiser and Elliott 1996, Biebighauser 2002) in the vicinity of known hibernacula may also increase insect prey availability for bats during these critical periods. In addition, vegetation management within a forested landscape can provide edge habitat frequently used by bats for commuting and foraging and can strongly influence both short- and long-term prey availability in an area (Hayes and Loeb 2007, Loeb 2020). Given the limited study of habitats around hibernacula, this may be identified as an adaptive management objective for further study.

Reducing clutter may improve flyways, and thus foraging areas, maintain air-flow around hibernacula and may create more structural diversity in these areas given the lack of past management activities. Reducing clutter may involve tree cutting and timber stand improvement, herbicide application, and prescribed fire (Bearer et al. 2016, Loeb 2020). Mechanical operations timed to avoid spring staging and fall swarming events near hibernacula (Chapter 3) may benefit BCS bats. Smoke sensitive habitats around hibernacula or maternity roost trees need to account for accumulated fuel to mitigate smoke impacts from prescribed fire. Additionally using prescribed fire around hibernacula will reduce fuel loads and gradually open and shift habitat toward desired future conditions while reducing clutter. However, to mechanically reduce clutter around hibernacula, a hybrid approach of girdling (mechanical or herbicide) may be of greatest benefit to recruit large-diameter standing snags, while also removing encroaching or competing vegetation, which can include saplings 3 inches DBH or less. These activities would mitigate and spread-out fuel accumulations and produce needed snags, while reducing fuel and resulting smoke management concerns.

The objectives, conservation measures, and recommendations for silviculture and snag management provided below are based on aspects of bat ecology and are meant to be consistent with forest plans, healthy forests initiatives, and a sustainable supply of forest products while providing for long-term bat habitat conservation. Many forest plans contain snag retention guidelines that must continue to be followed and which typically incorporate flexibility such that objectives are achieved at the landscape level, even if they are not always achieved or possible at the individual stand level.

LTH-O-2: Ensure vegetation management practices sustain and enhance the diversity of habitats, snags, and features important to the BCS species across the landscape and in perpetuity.

Conservation Measures and Recommendations for Silviculture & Snag Management:

LTH-CM-2.1: Provide for the continuous availability of suitable bat roosts on the landscape by retaining trees and snags as appropriate to the vegetation type present, to the extent practicable, and as consistent with overall project objectives. During the planning process for any vegetation management project, document how retention of suitable trees and snags has been carefully considered and addressed. Considerations to determine the size, number, spacing, and species of snags to be retained may include:

- The likelihood that BCS species are present and the likelihood that suitable roost habitat may exist within the project area;

- Natural range of variability of the vegetation type;
- Favoring larger snags (≥12-inches DBH when available) that may be more desirable to BCS species;
- Snag retention guidance from the applicable land management plan;
- Site-specific management objectives.

Note: This CM does not apply when and where there is a conflict with safety (e.g., clearing for log landings or harvest access) or where it conflicts with management for other federally threatened or endangered species or designated critical habitat (rationale for exceptions shall be documented in the project file). Salvage harvest following weather events or insect and disease outbreaks that require timely management action are addressed separately in LTH-CM-2.8 and 2.9. Snag cutting as a safety issue related to fireline construction is addressed separately in LTH-CR-3.1, 3.2, and 3.3.

LTH-CM-2.2: During the bat summer occupancy period (see Appendix B for local dates) in suitable bat roosting habitat, application of herbicides to native tree and plant species as a silvicultural tool will use the most target-specific application methods to avoid or minimize effects to bats. Refer to the Pesticide Use and Non-Native Invasive Species (NNIS) Management section for more information on herbicide use.

LTH-CR-2.3: To ensure roosting resources do not become limited over time, retain an average of 9 larger live trees per acre suitable for bat roosting within the activity area defined as the harvest area, adjacent streamside management zones, forested corridors, and both within and between stand reserve patches. This can include a combination of trees, particularly focusing on trees that have or may develop suitable roost characteristics for the BCS species that may be present (see Appendix A for a description of suitable habitat for each BCS species). This aims to provide suitable future roost habitat that is generally well-distributed across the landscape.

LTH-CR-2.4: To reduce the effects of mesophication, reduce forest clutter including midstory density where needed to improve foraging and roosting conditions. This may include reducing tree densities through thinning, midstory removal, timber stand improvement cuts, prescribed fire, or other management actions.

LTH-CR-2.5: In landscapes dominated by continuous canopy with little structural diversity, create habitat diversity, such as small canopy gaps and openings (such as 0.25 to 2 acres in size) and edge habitats to improve prey production, as well as foraging and commuting habitats.

LTH-CR-2.6: To create the complex structural and compositional diversity the BCS species require, retain and manage blocks of later successional forest (as defined in the appropriate forest plan). (e.g., large, widely spaced trees, low midstory density, rich understory diversity, and availability of large-diameter snags) and juxtapose them with different age classes and forest conditions.

LTH-CR-2.7: When recruiting and creating new snags, prioritize tall, larger-diameter (>18 inches DBH) native trees appropriate to ecological context over smaller ones, species that are known to produce bat-suitable characteristics (i.e., slabs of loose barks, cracks, or cavities) when dying and dead, and ensure they are well-distributed across the landscape, particularly where natural roosts are in short supply. For locations with low site index (i.e., smaller diameters), select the largest available trees for snag recruitment.

Salvage Harvest

Salvage harvest refers to the cutting of timber resources damaged by natural or human-caused disturbance events (e.g., ice, wind, flooding, tornados, hurricane, wildfire, etc.) or at risk of substantial damage from insect and disease outbreaks (e.g., southern pine beetle, Asian longhorn beetle, oak wilt, etc.). Ecologically, these events affect succession and can drastically change the resulting structure and composition of forested bat habitat. These events prompt salvage and other management intervention by the FS when and where feasible for various economic, safety, and ecological purposes. Typically, the intent after disturbance events includes such actions as reclaiming timber that still has value, curtailing additional damage and economic loss, reducing fuel build-up and safety hazards, setting a trajectory towards the desired future conditions (typically per forest plan guidance for a given area), and treatment of non-native invasive plant infestations. It is in the interest of the FS to take advantage of such disturbance events to manage towards resilient and desired ecosystems and desired future conditions per forest plan direction. The scale of salvage harvest varies depending on the disturbance vector. Natural events often far exceed the scale of any type of management implemented by the FS in any given year and often result in a large recruitment of snag resources at the landscape scale, which in turn creates bat-suitable roost habitat. The FS is rarely able to perform a complete salvage harvest across the entire disturbance event due to operational constraints and lack of capacity of people, planning, funding, timing, and a limited merchantable shelf life for damaged material. Inevitably much of the affected habitat is left untouched and thus available for bat habitat.

Salvage harvest contrasts with typical silvicultural harvest in that snags, damaged, and dead-and-down trees are often removed to mitigate safety hazards and hazardous fuel accumulation (smoke and wildland urban interface), to mitigate insect and disease damage and spread, and to make it possible to steer the trajectory of reforestation to desired species. Depending on the type and scale of the disturbance event, the number of standing trees remaining will vary and thus will require a tailored approach for each salvage operation. All salvage operations that occur within the BCS framework must adhere to the conservation measures and follow recommendations whenever possible. However, when a unit is unable to apply all appropriate CMs from the BCS due to site-specific circumstances, consultation with the FWS outside of the BCS may be required.

Three main scenarios for salvage harvest exist:

1. *Events such as ice storms, tornadoes, hurricanes, floods, and wildfire that create more bat habitat (i.e., damaged and dying trees) in the affected area than they typically destroy.*

   The FS typically removes only a portion of residual trees from weather-based events, due to constraints around implementation capacity, access, timing, and forest plan management direction. It is often the case with such events that the FS is only capable of salvaging a fraction of the affected acres and the remaining stands that are not salvaged typically provide an abundance of potential bat habitat in the vicinity. The larger the event, the more material that remains is a general rule. In many cases, the priority is to remove downed and leaning trees in roadways, trails, or near other infrastructure such as campgrounds or trailheads.

2. *Events such as ice storms, tornadoes, hurricanes, floods, and wildfire that leave no bat habitat (i.e., complete loss of all trees) in the affected area.*

   In these cases, the edges of the event may have some damage where suitable roosts may still be available, however, leave-tree requirements often cannot be achieved and, thus, flexibility in clean-up operations is necessary. Typically, the priority would be to remove down and leaning trees in roadways, trails, or near other infrastructure. Follow up treatments in the interior may also occur.

3. *Native or non-native insect or disease outbreaks where the needed response is variable, depending on a variety of factors, such as species and novelty of the invader, rate of spread, ecosystem affected, associated environmental conditions (e.g., weather and climate), etc.*

   In the case of insect and disease outbreaks (e.g., southern pine beetle, Asian longhorn beetle, oak wilt, decline events, etc.), the FS may opt for total removal of both damaged and green-tree (i.e., healthy, living) timber resources in and around outbreaks to limit the spread and protect the surrounding forest resources. Novel, non-native species will likely induce a full-scale control effort, however, only the tree species affected by the insect or disease is typically removed, leaving standing trees. Sometimes the affected trees are not salvaged, depending on the chosen treatment method, and thus, may provide suitable bat habitat, e.g., southern pine beetle snags were used by Indiana bats in the southern Appalachians (O'Keefe and Loeb 2017).

Due to the spontaneous and typically unpredictable nature of these events, response time is critical to protect residual forests, public safety, and merchantability. The type of response is guided by silvicultural, ecological, biological, and other FS specialist input as well as management area direction in forest plans. For a salvage project to be covered under the BCS framework, the following measures and recommendations apply.

Note: All related conservation measures, recommendations, and timing restrictions described in chapters 2, 3, and 4 also apply in tandem with the following guidance wherever sufficient forest structure still exists post-disturbance, unless an express exception is provided.

Conservation Measures for Salvage Harvest:

LTH-CM-2.8: If salvage harvest occurs following a weather-driven disturbance event, retain at least a minimum 5% of the impacted area (unsalvaged in contiguous or dispersed clumps), if available, of the largest size class or best bat roost characteristics unless removal is required to mitigate subsequent risks for insect and disease outbreaks. This does not apply if it is determined the area no longer contains suitable bat habitat. Retention strategies will be coordinated with the local FWS field office. Timing restrictions may apply within roost or hibernaculum buffers. If it is critical to remove trees during the seasonally restricted period, coordinate with FS biologist and FWS; stand-alone consultation may be necessary.

LTH-CM-2.9: For insect and disease outbreaks and decline events, cut the minimum number of trees required to prevent or contain the spread. This does not apply if it is determined the area no longer contains suitable bat habitat. Retention strategies will be coordinated with the local FWS field office. Timing restrictions may apply within roost or hibernaculum buffers. If it is critical to remove trees during the seasonally restricted period, coordinate with FS biologist and FWS; stand-alone consultation may be necessary.

Prescribed Fire

Fire historically maintained a mosaic of forests, grasslands, savannas, and open woodlands throughout much of North America, including much of the eastern United States (Abrams 1992, Lorimer 2001, Guyette et al 2012, Perry 2012). During the 20th century, fire suppression and resulting fire exclusion caused many forests that were previously open and park-like to succeed to dense, closed-canopy forests (Lorimer 2001, Van Lear and Harlow 2002, Nowacki and Abrams 2008, Fan et al. 2011), since fire-dependent, forested ecosystems require fire to maintain forest structure and composition.

Many plant and animal species are now at-risk in forest and grassland systems across eastern North America due to structural and compositional changes associated with fire suppression (Wilcove et al. 1998). There has been reluctance to use prescribed fire as a management tool around hibernacula (due to smoke management and disturbance of vegetation features) and known roost trees even though the long-term beneficial effects to habitat are desirable (Torrey

2018). Active disturbances such as prescribed fire are needed, not only to achieve desirable structural characteristics, but also to maintain fire-dependent species and ecosystems used by bats (e.g., O'Keefe and Loeb 2017). Prescribed fire managers need to work with biologists to identify appropriate methods for, and timing of, prescribed fire events to minimize impacts to bats during vulnerable periods, such as spring staging, fall swarming, hibernation, and pup season. Bats are relatively mobile, and with careful planning and an understanding of bat ecology, most potential impacts can be resolved through spatial and temporal planning. For example, low-intensity fire (low to moderate severity) can be applied successfully in fire-adapted ecosystems while mitigating any potential impacts to known bat assets such as maternity trees or habitat immediately adjacent to the entrance of a hibernaculum.

Potential Benefits and Impacts of Prescribed Fire

Land managers use prescribed fire to meet many forest management objectives, including hazardous fuel reduction, preparing sites for seedling germination and establishment, improving wildlife habitat structure and composition, controlling insects and disease, and ecological restoration (Waldrop and Goodrick 2012). These prescribed fires may affect bats directly through heat, smoke, and carbon monoxide, or indirectly through modifications in habitat and changes in their food base (Dickinson et al. 2009, Tormanen and Garrie 2021). Burning may have positive, negative, or no effect on bat ecology, and potential effects may vary among bat species, time of year, fire frequency, ambient temperatures, and intensity of burns (Johnson et. al. 2010, Perry 2012, Ford et. al. 2016, Perry et. al. 2016).

Prescribed fire has cumulative properties that have positive effects on forest composition and structure for BCS species. For example, fire may reduce understory and midstory clutter and create small canopy openings and edge that are used by many species of bats for foraging and may increase insect production (Blanco and Garrie 2020, Carter et al. 2002, Keyser and Ford 2006, Lacki et al. 2009b, Perry 2012, Austin et al. 2018, Torrey 2018). In addition, regularly burned areas may have lower tree densities, less clutter, more open canopy (Austin et al. 2018), and potentially greater numbers of suitable pine snags >16 inches (Baldwin et al. 2023), but snag dynamics in hardwood systems are less studied. Some studies suggest fire may provide favorable hardwood roosting and foraging conditions for many species and may be especially important to female bats during summer (Perry 2012, Ford et al. 2016). Furthermore, planned prescribed burns often reduce fuel loads and the intensity of unplanned wildfires, which can occur during any time of year, including the maternity season when pregnant females and nonvolant pups may be present, and may result in more negative effects to bat communities.

Burn unit preparation and developing infrastructure for prescribed fires (e.g., firelines, drop points, helicopter landing zones, etc.) may affect bats initially as trees are removed but long-term beneficial effects to bats may also be realized from prescribed burns, such as the reduction of fuel loads, wildfire prevention, improvements to forest structure and composition, and recruitment of snags. Firelines and other infrastructure can create foraging corridors and edge habitats that can benefit bats by creating additional habitat diversity (Austin et al. 2018, 2020).

Disturbance from noise and felling of trees and snags during fireline construction could cause direct mortality, especially during the maternity season if flightless young are present in the burn area, or if bats are in torpor and are less able to mobilize and escape.

Smoke and heat from prescribed fire could also disturb bats. Many bats roost high in trees, thus, low-intensity fires are less likely to cause injury than high-intensity fires (Rodrigue et. al. 2001, Dickinson et al. 2010). Fire intensities and other conditions that cause leaf scorch in overstory trees will be detrimental to bats if they are unable to quickly escape approaching flames (Dickinson et al. 2010). Consequently, burning during the pup season or cold periods during the active season may be detrimental to colonies of the BCS bats if individuals cannot escape. Therefore, smoke and firing conditions in terms of effects to bats need to be adequately understood and managed.

LTH-O-3: Proactively use prescribed fire as a management tool to shape the structure and composition of suitable bat habitat and mitigate smoke impacts to known bat hibernacula and roost features important to the BCS species across the landscape in perpetuity.

Conservation Recommendations for Prescribed Fire Planning and Implementation:

LTH-CR-3.1: To the maximum extent practicable, pre-plan cutting of bat-suitable trees and snags (i.e., routine hazard trees) associated with fireline construction and preparation to avoid the summer occupancy period, especially when pregnant females and flightless young may be present (see Appendix B for local dates). Also, for coastal zone units, winter tree removal should occur at temperatures of 40°F or above when roosting bats are less likely to be in torpor and more able to escape.

LTH-CR-3.2: For tree and snag cutting associated with fireline construction and preparation avoid cutting trees to the extent possible during the summer occupancy period. Review training materials as available and/or work with a knowledgeable FS biologist to understand how to identify potential roosts for BCS bats present in your locality. These steps will help to protect and avoid roosts during fireline construction.

LTH-CR-3.3: When conducting prescribed fire activities within streamside and riparian zones, take steps to reduce the risk of a potential roost being consumed or when the integrity of a potential roost could be compromised.

LTH-CR-3.4: Use low or moderate intensity prescribed fire during the summer occupancy period (see Appendix B for local dates). Exceptions would include ecosystems such as sand pine, jack pine and areas where high-intensity fires are needed to maintain or create habitat for associated rare, threatened or endangered species (e.g. Kirtland's warbler, Florida scrub jay, golden-winged warbler).

LTH-CR-3.5: In habitats with large fuel accumulations, consider weather, fuel moisture, or other local conditions, or design burn units so the resulting heat and smoke is minimized, especially in smoke-sensitive areas or during the summer occupancy period (see Appendix B for local dates).

LTH-CR-3.6: Conduct prescribed fires at 40°F or above to mitigate potential bat impacts when bats may be present on the landscape. When possible, conduct prescribed burning when temperatures are above 50°F to further allow for avoidance.

Forest Openings and Permanent Land Use Conversion

For the purposes of the BCS, we define "forest openings" as areas within forested landscapes with little to no overstory canopies that often support early successional habitats and are usually created through disturbance (Greenberg et al. 2011). Forest openings are typically either created or maintained as part of the natural ecosystem through natural events (such as wildfire, ice storms, or wind events) or through active vegetation management. Forest openings generally retain some characteristics and vegetation that may provide for prey, water, or other life needs for BCS species, even when trees and snags are removed. In contrast, "permanent land use conversion" refers to areas that are managed for purposes other than ecosystem or vegetation management. These areas are often, but not always, associated with development. Areas that are subject to permanent land use conversion are not likely to provide suitable bat habitat and are likely to be avoided by BCS species as they do not provide favorable opportunities for roosting, foraging, drinking, or traveling.

Creation and Management of Forest Openings

Forest openings range in size from a single treefall to hundreds of acres and result from numerous natural and anthropogenic disturbances. Natural disturbances may include wind, ice, wildfire, lightning, tornados, hurricanes, pathogens, insects and diseases, flooding, beaver activity, grazing, tree fall, and landslides (Rosell et al. 2005, White et al. 2011). Anthropogenic causes may include forest harvesting, prescribed fire, and creation of wildlife openings, range allotments, roads, and rights-of-way (Rankin and Herbert 2014). Natural openings include special ecosystems such as glades and high-mountain balds.

It is unclear in the literature what size or types of openings are optimal for bats, and the terms used are often relative, such as "large" or "small" rather than specifying actual acreages. Use may be influenced by a number of factors besides just size, including bat adaptations, surrounding forest structural characteristics, predation risk, and food availability (Loeb and O'Keefe 2011). The commonality between different types of openings is the input of sunlight to the forest floor, providing for diverse under- and mid-story growth, open flight space, and solar exposure of trees on the edges of the opening. The permanence of these openings varies depending on size and how and why they were created or maintained. For example, harvested areas are usually regenerated either naturally or through planting and only remain as early successional habitat for a relatively short time (e.g., <20 years), whereas wildlife openings and rights-of-way are typically maintained in grasses, forbs, and shrubs over long periods through active management.

Early successional habitats are integral components of ecosystems and need to be maintained as such within larger forested landscapes (Swanson et al. 2011). Many plants and animals depend on early successional habitats and the decline of these habitats over the latter part of the 20th century has resulted in the decline of associated species (Hunter et al. 2001, Litvaitis 2001, Thompson and DeGraaf 2001, Warburton et al. 2011). Thus, numerous efforts are currently underway to restore early successional and open habitats throughout forests of the eastern U.S. (Rankin and Herbert 2014), and many forest plans encourage the re-establishment of such under-represented habitats. Furthermore, many forest plans contain recommended proportions of early successional and open habitats. BCS species can benefit from these openings but require a level of forested connectivity between habitat patches (Swystun et al. 2001, Murray and Kurta 2004, Henderson and Broders 2008).

Potential Benefits and Impacts of Forest Openings

One effect to bats of creating openings through timber harvest is the potential loss of roost trees, particularly large-diameter snags (Hayes and Loeb 2007). Further, many of the live trees that are harvested represent potential future roosts. Wildfire and prescribed fire can also result in the loss and creation of large snags (Baldwin et al. 2023), although small snags are often created (Horton and Mannan 1988, Randall-Parker and Miller 2002, Stephens and Moghaddas 2005, Bagne et al. 2008). Thus, if sufficient snags are not available throughout the rest of a particular area, then creating openings through harvest or fire may reduce roosting habitat. At the local scale, BCS species are often reluctant to use large open areas (Swystun et al. 2001, Murray and Kurta 2004, Henderson and Broders 2008) but may use the edges of forest openings as foraging and travel corridors. A study by Brooks et al. (2017) found that both *Myotis* and tricolored bats were present in openings of 46 ac on the Nantahala National Forest. Taylor et al. (2020) stated some bat species will not forage in the center of large (>120 ac) cut areas; bat species in the study were not specified.

Creating openings also may affect the insect prey base for bats. Dodd et al. (2012) found butterfly and moth abundance were negatively related to disturbance, whereas fly species abundance and diversity were positively related, and beetles were unaffected. Some studies have found greater insect abundance in early successional habitats than in mature forest (Lunde and Harestad 1986, Dodd et al. 2012), whereas others found insect abundance and diversity decline after harvesting (Grindal and Brigham 1998 and 1999, Burford et al. 1999, Dodd et al. 2008, Morris et al. 2010). However, with some exceptions, studies in different geographic areas consistently have found an overall increase in BCS species activity in disturbed habitats (e.g., Brooks 2009, Loeb and O’Keefe 2011, Titchenell et al. 2011, Cox et al. 2016, Torrey 2018).

This suggests habitat structure that allows for more efficient foraging is more important than prey occurrence in determining spatial and temporal foraging patterns of BCS species (Morris et al. 2010, Dodd et al. 2012, Blakey et al. 2016).

Although creating openings in forested landscapes may have some negative effects on bats, openings are commonly used by the BCS species for foraging and may represent important habitats for them (Loeb and O'Keefe 2011). For example, bats use openings for foraging and commuting much more than interior forests in several ecosystems (Erickson and West 1996, Krusic et al. 1996, Grindal and Brigham 1998, 1999, Ellis et al. 2002, Tibbels and Kurta 2003, Mehr et al. 2012, Sheets et al. 2013). Openings and gaps are commonly used by species such as the little brown bat and tricolored bat (Ford et al. 2005, Loeb and O'Keefe 2006, Schirmacher et al. 2007). Edges between openings and mature forest are particularly important foraging and commuting areas (Furlonger et al. 1987, Hogberg et al. 2002, Hein et al. 2009, Morris et al. 2010, Jantzen and Fenton 2013, Loeb 2020). Edges may be important habitats because they are often more protected from wind and thus, increase foraging and commuting efficiency (Verboom and Spolestra 1999). Insect abundance is also greater along edges (Lewis 1970, Morris et al. 2010) and edges may serve as navigation aids (Verboom et al. 1999, Furmankiewicz and Kucharska 2009) and provide protection from predators (Clark et al. 1993, Walsh and Harris 1996, Verboom and Spolestra 1999). Thus, one of the most beneficial aspects of creating openings in forested habitats for bats is the creation of edge habitat, such as small trails, edges along harvested stands and lakes, and areas above streams that are not overgrown with vegetation.

Large openings are rarely used for roosting although tricolored bats and some non-BCS bat species have been documented using snags, stumps, or small trees in clearcuts (Vonhof and Barclay 1997, O'Keefe et al. 2009). However, bats often roost near or at the edge of openings (Callahan et al. 1997, Carter and Feldhamer 2005, Bergeson et al. 2018). During cooler periods, bats may prefer to roost near forest edges to reduce thermoregulatory costs as roosts on forest edges likely receive more solar radiation (Barclay and Kurta 2007). Since many bats forage in open areas, they may also roost close to edges to reduce their commuting costs to these foraging areas (Kunz and Lumsden 2003, O'Keefe et al. 2009).

Factors Affecting Use of Forest Openings by Bats

There is a lot of uncertainty related to which factors affect or are important to BCS species in relation to openings. The use of openings may depend heavily on species and geographic location. One factor that determines bat use in an area is a bat species' tolerance for clutter in their foraging landscape. The wing morphology and acoustic call structures of smaller bats such as *Myotis* species and tricolored bats may indicate they are adapted for slower, more agile flight in clutter, but how much opening or edge habitat used varies by species and other variables (Wright et al. 2021). For instance, little brown bats are known to often forage along edges and over open water (but also sometimes in cluttered environments; Patriquin and Barclay 2003, Broders et al. 2006, Bergeson et al. 2013) and tricolored bats also tend to use stands with more open midstories (Yates and Muzika 2006, Bender et al. 2015).

The shape of an opening determines the amount of edge relative to its area. Given the importance of edge habitat for many species, shape is an important characteristic to consider. However, the amount of edge necessary to sustain bats may vary with scale. For example, Bender et al. (2015) found occupancy of managed stands by big brown (*Eptesicus fuscus*) bats decreased with increasing amount of edge in the landscape. A study by Morris et al. (2010) in a managed pine plantation indicated edges were used extensively by several aerial-hunting bat species, including the big brown bat, but avoided by *Myotis* species. While Brooks et al. (2017) found no substantial difference in bat activity between interiors and edges of openings in the Nantahala National Forest of North Carolina, higher levels of activity in elongated openings suggested bats preferred openings with more edge relative to the opening area.

Few studies have addressed the relationship between position of openings on the landscape and bat use. One factor that may be important is proximity to water as riparian areas often are used more frequently than upland habitats (Walsh and Harris 1996, Racey 1998, Grindal et al. 1999, Ellis et al. 2002, Owen et al. 2004, Ellison et al. 2005, Brooks 2009). No studies have examined how use of openings varies with distance to water, but distance to water does not appear to be an important variable in models of forested stand use in most of the East (Loeb and O'Keefe 2006, Yates and Muzika 2006, Johnson et al. 2008, Hein et al. 2009, Bender et al. 2015).

LTH-O-4: In the context of creating and encouraging habitat diversity, maintain and encourage forest openings (e.g., small canopy gaps, wildlife openings, glade restoration, various timber harvest activities, etc.) as important landscape features for bat conservation and to potentially support long-term recovery providing for diversity in size, location, and composition of opening types with a focus on enhancing suitability for BCS species.

Conservation Recommendations for Forest Opening Creation and Management:

LTH-CR-4.1: Create snags within forest opening edges where snags are limited, focusing on tall, large-diameter snags to provide residual roosting sites for some bat species. Ideally, snags in openings will be left in clumps or in pockets of residual trees to reduce wind-fall and support colony roost networks.

LTH-CR-4.2: Design forest openings during vegetation management to maximize the amount of edge relative to opening area (e.g., long and narrow openings, or those with irregular edges) appropriate to local ecosystem conditions, to provide a greater amount of foraging habitat and predator protection.

Tree Clearing for Permanent Land Use Conversion

Given that the FS is a multiple use agency, resource managers may also make decisions about activities that result in permanent habitat loss (or such long-term land use conversion so as to be relatively permanent). Lands that are not created or managed as part of the natural ecosystem (such as recreation areas, facilities, or administrative development, permitted special uses (e.g., access roads, utility rights-of-way and pipelines, communication facilities, hayfields, etc.), road construction or reconstruction, etc.), are not likely to be used by BCS species as habitat.

Bats may still continue to use the edges created by such long-term land use changes; however, this may be dependent on the scale of habitat lost. A minimal amount of habitat loss in an otherwise forested area will may affect bat foraging and roosting activities. However, Divoll and O'Keefe 2018 suggested that bats can adapt to a certain amount of land use change. Bat response to permanent land use conversion likely varies by bat species, geographic location, and local conditions, such as the degree of forest cover.

The 2023 Range-wide Indiana Bat and Northern Long-eared Bat Survey Guidelines (FWS 2023) state that "[i]ndividual trees may be considered suitable habitat when they exhibit characteristics of suitable roost trees and are within 1,000 feet of other forested/wooded habitat." The FWS also surmised that "a project that would remove or otherwise adversely affect ≥20 acres of early successional habitat containing trees between 3 and 5 inches (7.6-12.7 cm) DBH would require coordination/consultation with the USFWS FO to ensure that associated impacts would not rise to the level of take" and that "this number is based on observations of bat behavior indicating that such an isolated tree (i.e., ≥1000 feet) would be extremely unlikely to be used as a roost [for the NLEB]". Additionally, the FWS concluded that for tricolored bats, "highly developed urbanized areas generally devoid of native vegetation (including isolated trees surrounded by expansive anthropogenic development) are considered unsuitable habitat" (FWS 2023).

Extrapolating from information in the 2023 guidelines and in applying professional judgement and experience, for the intent and purpose of the BCS, 20 acres will define a threshold for "acceptable" habitat loss on the basis of individual activities. If this 20-acre threshold is exceeded for the activity or series of related activities, then separate consultation may be required.

Conservation Measure and Recommendation for Permanent Land Use Conversion:

LTH-CM-4.3: For any one activity or series of related activities requiring tree clearing for purposes of permanent land use conversion on up to 20 acres, tree cutting is prohibited from the beginning of the summer occupancy period to the end of the pup season (see Appendix B for local dates). For coastal zone units, also prohibit tree cutting when temperatures are below 40°F when roosting bats are likely to be in torpor.

LTH-CR-4.4: Limit tree clearing for permanent land use conversion to ≤10 acres and/or complete tree cutting activities during the hibernation season to avoid impacts. For coastal zone units, also avoid tree cutting when temperatures are below 40°F and roosting bats are likely to be in torpor.

Hazard Tree Management

Even though many are ephemeral, suitable bat roost sites are often considered the most important habitat component for cavity- or crevice-roosting bats. Therefore, one of the most important actions forest managers can take to maintain local bat populations is to provide a continuous supply of suitable roost trees (Silvis et al. 2016, Taylor et al. 2020) to provide shelter for bats and their pups. Snags are standing dead trees that can provide important roosting structures for bats under loose bark and in cavities and crevices (Taylor et al. 2020). Leaving snags that provide roosting opportunities on the landscape can provide essential habitat for a variety of bat species. The creation, recruitment, and retention of large-diameter snags can provide important habitat for tree-roosting bats, particularly near known roost areas, suitable foraging areas, water, and areas with low snag densities. Sites with a high abundance of suitable roost trees are often used by maternity colonies of species such as the Indiana bat and northern long-eared bat. In addition to providing a place to raise young, such roosting sites provide protection from predators and the elements as well as a central location for social interactions and communications.

The creation and retention of snags is an integral part of forest management and bat conservation. At times, the goal of conserving bat habitat conflicts with the necessity of ensuring human safety, particularly when it comes to dead and dying trees, which may be considered hazardous. To the extent prudent and practicable, FS managers should remove safety threats posed by hazardous trees in a way that avoids and minimizes harm to bats that may be using these trees as roosting habitat. This can be achieved in some cases with proactive planning aimed at cutting trees outside periods when BCS species may be present, and at other times by evaluating options or employing emergence surveys (Appendix C), when feasible, to ensure bats are not present when the tree is felled. Overall, the loss of suitable bat habitat to hazard tree cutting is considered relatively small in comparison to what is available on the landscape. A thoughtful approach to hazard tree management will result in minimal effects to bats while also ensuring the safety of all personnel and the public.

For the purposes of the BCS, hazard trees are divided into two categories: high priority and routine. High-priority hazard trees are defined as individual trees that need unforeseen but immediate or urgent cutting to protect human health and safety as well as property and infrastructure (e.g., workers at a project site in the woods or forest users in and around roads, trails, campsites, or other improvements). Such “high priority” safety hazards may be cut down when and where needed with a few exceptions within roost buffers (see Chapter 4). Routine hazard trees (typically in high-use areas such as campgrounds, trail intersections, trail corridors around facilities, and along rights-of-way) likely allow for advanced planning to cut hazard trees at times when least (or less) likely to affect roosting bats (i.e., during hibernation season, outside of the maternity and pup seasons, and in coastal areas when temperatures are 40°F or above). There may also be instances where storms, winds, or other events cause unplanned and unavoidable situations where a number of hazard trees need be removed. In such cases, such as immediate cleanup to protect human safety, coordination with FWS may be appropriate to determine if additional considerations may be needed to protect or minimize effects to bats. We can't address all scenarios here, so it is expected that FS personnel will discuss and evaluate whether hazard trees fall into the high-priority or routine category as needed.

Improving field identification of potential bat roosts will aid in the success of bat conservation. Bat tree/habitat training is a valuable bat conservation tool for everyone involved in hazard tree evaluations. It is recommended that FS employees and contractors likely to be involved in hazard tree removal have the ability to assess potential bat presence in hazard trees and perform emergence surveys. Contact your Forest or Regional Biologist to discuss available training materials.

Note: not all hazard trees are potential bat-suitable roost trees or vice versa. If a hazard tree is not "bat-suitable," i.e., does not provide potential bat-roosting habitat (e.g., no loose or exfoliating bark, cracks, cavities, or clusters of dead leaves), then it may be removed without further consideration to roosting bats. However, such a distinction requires knowledge of bat-suitable roost characteristics. Refer to Appendix A for a more detailed list of roost tree characteristics and requirements and seek relevant training.

LTH-O-5: Implement bat-friendly hazard tree management practices to protect unknown roosts whenever feasible.

Conservation Recommendation for Hazard Tree Management:

LTH-CR-5.1: To the maximum extent practicable, pre-plan implementation of all forest plan activities (except during silvicultural activities) that include routine hazard tree evaluation and cutting (e.g., in areas such as campgrounds, trail intersections, trail corridors, around facilities, and along established rights-of-way) to avoid the summer occupancy period (see Appendix B for local dates). For coastal zone units, also avoid winter tree removal when temperatures are below 40°F when roosting bats are likely to be in deep torpor and unable to escape. When pre-planning is not possible, line officers, with input from biologists, will consider whether emergence surveys (see Appendix C) prior to felling bat-suitable hazard trees is appropriate. See also LTH-CR-3.1, 3.2, and 3.3 for fireline guidance.

Note: When emergence surveys are planned outside of a roost buffer, coordination with the local field office is recommended prior to conducting the survey. See RMC-CM-19.4 and RMC-CM-20.3 for hazard tree management and emergence survey guidance planned within a roost buffer.

Streamside and Riparian Zone Management

The availability of stream and riparian resources can have a variety of direct and indirect effects on bats and their distributions. Although these features can represent a relatively small proportion of the landscape, they often provide more concentrated areas of roosting sites, water, and suitable foraging habitats (Perry and Thill 2007b, O'Keefe et al. 2013, Taylor et al. 2020), although this may not strictly apply in mountainous regions with higher elevations due to cold air drainage. Bats depend on them for drinking and foraging, as aquatic insects are an important prey resource for the BCS species. In fact, bat foraging activity is often higher over streams than in non-riparian habitats (Owen et al. 2004, Menzel et al. 2005, Lloyd et al. 2006, Gorman et al. 2022). Stream pools, wetlands, wet meadows with pooled water, and other water bodies with unobstructed access are critical drinking and foraging resources for forest bats. Streamside and riparian zones often provide late-successional habitat and roost trees for many species, can be used as commuting corridors, and may act as connectors between different habitat types. In coniferous forests, roosts of foliage-roosting bats that prefer broadleaf deciduous trees are often concentrated within riparian zones because they usually contain more broadleaf vegetation than the surrounding conifer stands (Taylor et al. 2020). Thus, maintaining the integrity of riparian habitats is critical to bat conservation.

Forest riparian buffers and adherence to state best management practices (BMPs) are considered effective at protecting water quality in riparian areas. Note, however, that BMPs are designed for water-quality protection, which may not fully support habitat needs for wildlife that use these areas. Narrow zones will allow sunlight penetration and subsequent development of a dense midstory layer that may be unfavorable to bats and other wildlife species. Thus, wider buffers than BMPs typically require may be merited to provide more diverse riparian forests and to mimic mature forest conditions (O'Keefe et al. 2013, Taylor et al. 2020).

LTH-O-6: Provide managed stream and riparian zones for BCS species at the landscape scale with an emphasis on enhancing or creating features important for foraging, drinking, and roosting, including perpetuating a diversity of native habitats with diverse forest structure, canopy cover, age classes, and snags within those zones.

Conservation Recommendations for Streamside and Riparian Zone Management:

LTH-CR-6.1: Maintain streamside and riparian zones of at least 150 feet around perennial streams and other water bodies to the extent practicable. Within these zones, encourage restoration and maintenance of native ecosystem composition, structure, processes, and connectivity to improve roost and foraging habitat.

Pesticide Use and Non-Native Invasive Species (NNIS) Management

Non-Native and Invasive Plants

Non-native and invasive plants often out-compete native vegetation and reduce native plant diversity with the potential to dramatically alter forest habitat and structure. For example, some invasive plants such as Oriental bittersweet (*Celastrus orbiculatus*), Japanese honeysuckle (*Lonicera japonica*), Asian bush honeysuckles (*Lonicera* spp.), buckthorn *(Rhamnaceae spp.)* and kudzu (*Pueraria lobata*) can outcompete and overgrow native trees. Invasive species, such as Russian olive (*Elaeagnus angustifolia*) or Chinese privet (*Ligustrum sinense*), modify forest stand structure, resulting in decreased use of some riverine habitat by bats due to inhibited tree regeneration and loss of insect diversity (Ulyshen et al. 2009, Hendricks et al. 2016). Riparian and water features areas provide some of the best sources of shelter, food, and water available to bats on the landscape and should, therefore, be a high priority for treatment. These habitats often provide late-successional habitat and roost trees, open or low-clutter commuting corridors, and connectivity between other habitats.

Non-native plants disrupt habitat structure and terrestrial food webs by reducing the insect biomass available for insectivores such as bats (Tallamy 2004, Tallamy et al. 2010, McNeish et al. 2017). For example, tree-of-heaven (*Ailanthus altissima*) modifies stand structure as it takes over forest gaps and this can change the invertebrate community in the surrounding area; an important food source for bats (Sladonja et al. 2015). In addition, non-native species such as burdock (*Arctium* spp.) may pose a threat of entanglement and mortality for bats (Norquay et al. 2010). Thus, eradication and control of invasive plants often indirectly supports the maintenance of suitable habitat for bats. However, care is needed to minimize disturbance to and application of chemicals near known bat maternity colonies and hibernacula (see Chapter 4).

Studies of pesticide residues in bats are not extensive (O'Shea and Clark 2002, Sandel 1999, EFSA PPR Panel 2019). It is important to note these studies looked at toxicity of agricultural insecticides, not the herbicides the FS typically uses to control invasive species. In another study, the FWS looked at environmental contaminant in bats in the northeastern U.S. (Secord et al. 2015). Direct exposure to pesticides and herbicides is not likely since applications would occur during the day when bats are not active, except in the case of aerial broadcast applications. However, indirect exposure from residues of pesticides and herbicides may occur. Pesticide additives, such as adjuvants and surfactants, while not the active ingredient of the pesticide, can be toxic as well. The ecological fate and effects of pesticides are complex and various ecological studies have found unexpected effects on biological systems. Minimizing the use of pesticides is a good practice that is consistent with the principles of integrated pest management as described in Forest Service Manual 2900. When use is essential for meeting management objectives, applying in a way that reduces contact with non-target plants and animals is warranted.

Non-Native and Invasive Insects

Biological invasions are one of the largest environmental threats to the maintenance of natural forest ecosystems in North America and elsewhere (Liebhold et al. 1995). Invasive forest insect pests (and diseases) can cause massive mortality events across extensive forestlands. Apart from the staggering economic losses attributed to exotic insect pests such as the spongy moth (*Lymantria dispar L*), emerald ash borer (*Agrilus planipennis*) and Asian long-horned beetle (*Anoplophora glabripennis*) (Wallner 1997, Aukema et al. 2011), these pests can have devastating impacts on the health, productivity, species richness, and overall biodiversity in eastern U.S. forests, including bat communities. For example, the emerald ash borer killed hundreds of millions of ash trees (an important roost tree for Indiana bats in some areas) and spongy moth larvae eat leaves of a large variety of trees, including ash, oak, and maple, also important roost trees for a variety of tree-roosting bats. Hemlock wooly adelgids kill trees, which may result in short-term roosting habitat (e.g., northern long-eared bats), but infestations also result in changed forest composition, particularly in riparian areas, which could affect native insect prey resources for bats (Adkins and Rieske 2015). Pesticides, including both herbicides and insecticides, can be valuable tools in maintaining a healthy forest. Silviculture is an important part of an integrated pest management program and can be a valuable tool in the prevention, mitigation, and restoration of forest ecosystems threatened by introduced pests. Silvicultural applications may include attempts to eradicate or substantially limit the range of the pest or may prevent further spread by altering stand structures and tree species composition and improving tree vigor (Waring and O’Hara 2005). The use of herbicides rather than mechanical site-preparation methods may be used on erodible sites to protect water quality. Insecticides can be used to control certain insect infestations, especially where outbreaks are localized. Limited infestations that allow for treatment of individual tree(s) within the stand would be consistent with the intent of the BCS to protect roosting habitat and the integrity of the surrounding habitat.

LTH-O-7: Follow Integrated Pest Management principles for invasive species management to maintain and enhance bat habitats, while minimizing impacts to BCS species.

Conservation Measure for Pesticide Use:

LTH-CM-7.1: Aerial spraying and ground-based broadcast application of pesticides that are directed into trees that could affect roosting bats shall be avoided during the bat summer occupancy period. Use of targeted pesticide application methods or ground-based broadcast application of pesticides that are directed downward in suitable bat roost habitat, like spot-spraying, hack-and-squirt, basal bark injections, cut-stump, or foliar spraying to minimize affecting non-target plants and animals is allowable. Aerial application of *Lymantria dispar* pheromone treatments are permissible at any time of year.

Bat Use of Transportation Structures, Buildings, and Other Anthropogenic Structures

Humans and human development have affected and changed bat roosting ecology, particularly in situations where natural roosts have become scarce and in more urbanized areas. Anthropogenic structures such as but not limited to bridges, tunnels, homes, offices, outbuildings, culverts, etc. have become increasingly important in certain situations for some cavity and crevice roosting bats. The structures favored by bats tend to simulate the structural and functional characteristics found naturally in cliffs, caves, or trees. Due to these similarities to natural roosts, some bats easily take advantage of artificial roosting opportunities. In the forested environment where natural bat roosts may not be limited, anthropogenic structures can also exist and take a variety of forms, allowing numerous roosting opportunities and associated implications for management, bat conservation and public health. The BCS considers bat boxes and similar bat-specific constructed roost structures in the same context as natural tree roosts (see Chapter 4).

LTH-O-8: Identify and manage transportation structures, buildings and other anthropogenic structures used as roosts or hibernacula by BCS species.

Conservation Measures and Conservation Recommendations for Potential Bat Use of Transportation Structures, Buildings and Other Anthropogenic Structures

LTH-CM-8.1: For maintenance, repair, or replacement activities for transportation structures suitable for roosting (see Appendix G for a description of suitable bridge and culvert characteristics), knowledgeable individuals shall inspect the structure for bat presence at a time of year when BCS bats may be present in the structure and complete an inspection form. Surveys will be valid for the current and next calendar year. If a bat survey indicates there is no evidence of bat use, the work may occur year-round. If there is evidence of bat use, the structure shall be identified as a roost or hibernaculum according to HMC-CM-9.1 or RMC-CM-18.1 (as appropriate to the use observed); apply buffers as appropriate and follow the applicable CMs and CRs.

LTH-CM-8.2: Prior to any bat-disturbing activities (e.g. repair, maintenance, renovation, demolition, etc.) at buildings or similar anthropogenic structures where there is a reasonable likelihood of bat presence, conduct status assessments to determine BCS bat occupancy (e.g., direct observation, guano, roost staining, etc.) and use of the structure (see Appendix G for a description of characteristics of structures that may be used by BCS species). If no BCS or unidentified bats are present, the activity can occur at any time. If there is evidence of bat use, the structure shall be identified as a roost or hibernaculum according to HMC-CM-9.1 or RMC-CM-18.1 (as appropriate to the use observed); apply buffers as appropriate and follow the applicable CMs and CRs.

CHAPTER 3 HIBERNACULUM MANAGEMENT AND CONSERVATION

Introduction

Overwintering, spring staging, and fall swarming periods are important and sensitive life stages for bats. These periods correspond to when bats congregate in some of the highest densities throughout the year, often surrounding or within caves or cave-like hibernacula. Colder seasonal temperatures necessitate lower metabolic rates for bats for the maintenance of body fat reserves (Cryan P.M. and J.P. Veilleux 2007). These periods are characterized by bouts of short-term torpor, often performed in trees or other roosts surrounding hibernacula in the spring and fall. During the winter months, longer periods of hibernation for bats are critical, and disturbances during these periods can be fatal. Thus, management activities and forest users have a greater potential to interact negatively with bats during sensitive periods of fall swarming, hibernation, and spring staging. An express purpose of the BCS is to ensure actions enacted or permitted by the FS protect and enhance these crucial habitats and ensure harm to bats is minimized to every extent practicable.

Cave and cave-like hibernacula (e.g., mines, emergent rock features), some of which may support thousands of bats, are a limited feature on the landscape and are prioritized for protection under the BCS. As part of the BCS's approach to bat conservation, all hibernacula are surrounded by an inner buffer which protects the physical characteristics of the hibernaculum itself, with additional buffers added to minimize impacts in areas where a high number of bats occur.

In addition to bat use of hibernaculum and near-hibernaculum habitats in the fall, winter, and spring periods, these areas also have the potential to provide summer roost habitat. When summer roosts are documented near a hibernaculum, the conservation measures and recommendations outlined in Chapter 4 would apply, in addition to the measures outlined in this chapter.

Categories for hibernaculum abundance and seasonal staging and swarming areas have been delineated for the BCS bat species. Abundance thresholds are based on similarities and differences in individual BCS bat species' ecology and abundances within hibernacula across the 32 national forests. Buffer distances for the BCS bat species are delineated based on abundance thresholds to adequately protect seasonal staging and swarming areas surrounding hibernacula. Both BCS bat abundances and hibernaculum buffer categories were created through a compilation of information gleaned from peer-reviewed scientific literature, scientific reports, government documents, and collective professional judgement from FS and FWS biologists.

Hibernaculum abundance levels are typically determined by internal hibernaculum counts. However, northern long-eared bats are difficult to locate during internal hibernaculum surveys and often roost out of sight. Furthermore, some hibernacula are unsafe for human entry (e.g., abandoned mines), and internal counts cannot be conducted. In those instances, fall or spring harp trapping provides the best available data and is a suitable alternative method for determining hibernaculum abundance for the BCS species.

The management considerations for this chapter are expressed as HMC for "hibernaculum management and conservation", G for “goal", O for “objective”, CM for “conservation measure”, and CR for “conservation recommendation”.

HMC-G-9: Protect hibernacula that are known to be or are likely to still be occupied by BCS species.

HMC-O-9: Apply protections around known, historic, and newly-discovered hibernacula.

Currently-Occupied, Historic, and New Hibernacula

Protection of Currently-Occupied Hibernacula

Local information on known hibernacula was compared to post-WNS dates for each unit (See Appendix D) to determine which hibernacula may still be actively used by BCS species. Fungal detections were not used to establish post-WNS dates because the fungus can be present in hibernacula before the disease is detected. When a FS unit had forest specific data as to when their bat populations crashed post-WNS, the post-WNS date should be 2 years after the earliest confirmed disease in a county within a unit, based on the WNS spread map. In coastal zones, WNS largely has not been detected. Therefore, all confirmed accounts of BCS species occupancy should be considered when evaluating whether buffers should apply to a known location. Appendix D includes WNS detection and post-WNS dates that apply to each FS unit for the purposes of the BCS.

Hibernacula in Coastal Zones

In coastal zones (see Table 1-2), BCS species typically do not hibernate; instead, bats typically go into short periods of torpor when temperatures drop below 40°F. However, rare circumstances may occur when site-specific conditions provide a suitable environment where BCS species exhibit typical hibernation behaviors, but for shorter periods than would generally be seen in colder climates. When BCS species are found to be hibernating within the coastal zones, these sites should be identified as hibernacula and hibernaculum buffers and the corresponding CMs and CRs shall be applied to these sites as appropriate. Coastal zones do not have hibernation, spring staging, or fall swarming dates defined in Appendix B. Therefore, when hibernacula are identified in coastal zones, activity dates from that state’s hibernation zone would apply. If the state does not have a hibernation zone, then dates from the closest hibernation zone would apply.

Incorporating hibernaculum CMs and CRs provides a level of protection to bats utilizing the surrounding swarming and staging habitat. Unlike the hibernation zone, however, bats are likely still present and active in the surrounding landscape year-round and may be exposed to stressors outside the hibernaculum during the hibernation period. To determine if an inactive bat found during colder periods within the coastal zone is likely in temporary torpor or in hibernation, and to verify the appropriate activity dates for the coastal zone hibernaculum, coordinate with your local FWS field office.

Conservation Measure for Currently-Occupied Hibernacula:

HMC-CM-9.1: Implement a primary, secondary, and tertiary hibernaculum buffer around hibernacula that are known to be or are likely to still be occupied by BCS species, as appropriate to the BCS species and abundance present. Apply the appropriate conservation measures and recommendations within these buffers as appropriate to the management activity.

Protection of Historic Hibernacula

Historic but currently unoccupied hibernacula potentially remain important for species recovery. Although bat abundance in these sites may be reduced or eliminated due to WNS, absence of bats in a hibernaculum can be difficult to prove, as bats may roost out of sight, and occupancy of a site may vary from year to year. Ideally, these sites would become reoccupied if bat populations recover post-WNS. Furthermore, many hibernacula have specific in-cave conditions (e.g., microclimate, hydrology, etc.) that led to bat use pre-WNS. Additional caution should be exercised around these sites to ensure management activities do not alter the conditions and surrounding landscape that contributed to their historical bat use. Therefore, historic hibernacula will be protected by a primary hibernaculum buffer, and the conservation measures and recommendations associated with this buffer will apply to historic hibernacula as appropriate. If a natural or man-made disaster renders a hibernaculum permanently unusable by bats (e.g., complete collapse of mine shaft, earthquake, permanent inundation, etc.), the local unit, in coordination with the FWS field office, may remove all protective hibernaculum buffers.

Conservation Measure for Historic Hibernacula:

HMC-CM-9.2: Implement a 500-foot primary hibernaculum buffer around historic hibernacula and apply all primary hibernaculum buffer conservation measures and recommendations to historic hibernacula.

Protection of Newly-Discovered Hibernacula

When new or previously unknown hibernacula occupied by BCS species are discovered, these sites should be provided with protections as described for currently-occupied hibernacula.

Conservation Measure for Newly-Discovered Hibernacula:

HMC-CM-9.3: When a newly occupied or previously unknown hibernaculum is discovered on or adjacent to National Forest System lands, apply relevant conservation measures as appropriate to the BCS species and abundance present. A new hibernaculum is verified as a hibernaculum by visual observation of hibernating bats or by mist netting or harp trapping the portal or entrance to the hibernaculum feature (i.e., fall or spring acoustic surveys alone are not sufficient for confirming a new hibernaculum).

Overarching Protections for Hibernacula

Hibernating bats are sensitive to disturbance from a variety of sources. During extended periods of torpor associated with hibernation, their metabolic rate slows, and arousing from this torpid state is a slow and energetically expensive process. For bat species affected by WNS, winter arousal events can be detrimental. This fungal disease severely alters the torpor-arousal cycle in hibernating bats, causing depletion of fat reserves and dehydration (Reeder et al. 2012). In many cases, WNS-affected bats leave hibernacula early during mid-winter periods, often succumbing to freezing, starvation, or potentially lethal inflammatory responses. For that reason, a variety of objectives and conservation measures deal with avoiding impacts to bats during the critical overwintering period.

HMC-G-10: Conserve and improve habitat conditions in and adjacent to hibernacula and protect the bats that use these habitats.

Smoke and Noise Management Near Hibernacula

Prescribed fire is a management tool commonly used in National Forests to restore habitat and reduce hazardous fuels. When prescribed fire is conducted adjacent to a hibernaculum, there is potential for hibernating bats to be aroused by smoke, which is energetically taxing and could increase the risk of injury or mortality under certain conditions.

HMC-O-10: Minimize impacts to hibernating bats from smoke and noise.

Conservation Measures for Smoke and Noise Management Near Hibernacula:

HMC-CM-10.1: Designate hibernacula as smoke-sensitive receptor in prescribed fire burn plans. Avoid smoke influences on hibernaculum entrance(s) by using methods and strategies that will achieve this objective.

Major construction and geotechnical work that creates a substantial vibration or change in noise level (e.g., blasting, pile driving, use of rock drill) has the potential to alter bat behavior temporarily or permanently (FWS 2018) and in certain cases, may even impact the structural integrity of a hibernaculum.

Although there is limited information on buffer distances suitable for protecting a hibernaculum from the effects of vibration, many states use 0.5 miles as the distance within which adjacent landowners must be notified of blasting, and this distance has been used as a clear boundary of where to analyze effects to a hibernaculum (FWS 2018). The intent of buffering activities that could cause vibrations is to limit the potential disturbance to BCS species within the hibernaculum and to limit anything that may disrupt the unique environment of the hibernaculum. Determining whether a proposed activity may impact the structural integrity of a hibernaculum shall be discussed between the local FS and FWS field office, and it shall be documented in the relevant Hibernaculum Management Plan, as needed (see Hibernacula Management Plans section below).

HMC-CM-10.2: Activities (such as blasting, pile driving, hydraulic drilling, and similar geotechnical activities) that may create vibrations or increase noise levels at a hibernaculum are prohibited under the following circumstances:

- within 0.5 miles of a hibernaculum during the hibernation period that would impact BCS species within the hibernaculum; or
- at any distance throughout the year that would threaten the structural integrity of a hibernaculum.

Coordinate with your local FWS field office to determine if the activity would be noticeable to hibernating bats or would threaten structural integrity at a hibernaculum.

Access Management and Use of Hibernacula

Unauthorized entry of caves and mines used by BCS bats can potentially disturb hibernating bats or lead to modification of the habitat and thermal regime in the hibernaculum. Conversely, authorized entry of caves by responsible parties, with proper precautions for minimizing impacts to hibernating bats (such as WNS decontamination procedures), can yield valuable monitoring data on hibernating bat populations. The intent of the BCS is not to restrict *all* entry of caves and mines, but to restrict *unauthorized* entry to known hibernacula and those suspected to be used by BCS species. Conservation measures to restrict unauthorized access to these features are expected to be implemented as part of broader cave, abandoned mine land, recreation, heritage, and other resource management programs that manage these features. However, units are encouraged to incorporate these protection activities in site-specific project proposals when appropriate.

HMC-O-11: Restrict unauthorized entry to known hibernacula and those suspected to be used by BCS species.

Conservation Measures for Access Management and Use of Hibernacula:

HMC-CM-11.1: Restrict unauthorized access to all hibernacula known or suspected to be used by BCS species to avoid negative impacts to bats or hibernaculum suitability. The appropriate method of restricting unauthorized access (such as through closure order, bat-friendly physical barriers, signage, etc.; also see HMC-CM-11.3) may be determined by the local unit. Access may be authorized to facilitate conservation-related activities, research, tribal uses, recreation, and other uses as appropriate or allowable by treaty, law, regulation, other rights, or agreement where authorized activities would not negatively impact BCS species or hibernaculum suitability, unless the Fish and Wildlife Service has authorized or permitted activities that may have adverse effects to BCS species as applicable. Limit authorized access to periods when bats are not present (i.e. outside the fall swarming, hibernation, and spring staging periods) to limit disturbance to bats, unless entry is explicitly recognized as a project to benefit bat conservation and recovery; to address issues of human health and safety; or as authorized by tribal treaty or other rights.

HMC-CM-11.2: White-nose syndrome decontamination protocol shall be required for any underground access.

Signage, gates, and fences are effective ways to control access to caves. However, without proper planning with bat movement in mind, gates can serve as a barrier to bats, and in some cases, may restrict airflow and impact the hibernaculum's internal temperature (Currie 2002, Herder 2003, Pugh and Altringham 2005, Spanjer and Fenton 2005, Fant et al. 2009, and Tobin and Chambers 2017).

HMC-CM-11.3: Construct physical barriers (such as gates and fences) at priority hibernation sites (as determined by the local unit) that pose a risk to the public or that have prior history of unauthorized and/or frequent entry. Barriers will have a bat-friendly design, and post-construction observations will be completed to ensure bats are able to successfully enter and exit. Install signage and/or surveillance in addition to a physical barrier as needed, or when construction of a physical barrier is not possible due to site-specific conditions.

There are numerous documented modifications to bat hibernacula that have impacted the site's suitability as bat hibernation habitat. Early barrier design gave little regard to bats, leading to declines at many hibernation sites (Pugh and Altringham 2005). In other cases, natural disasters or a lack of vegetation management may result in restricted bat access into hibernacula, as trees, shrubs, and vines have grown over the opening to the hibernaculum. The BCS recognizes the sensitive nature of these hibernation sites, as well as the need to occasionally conduct management activities to ensure bat accessibility to hibernacula, as determined by local trained staff. When these activities have the potential to impact air flow or temperature in a hibernaculum, they would be done in coordination with FWS.

HMC-O-12: Restore and enhance priority hibernacula.

Conservation Measure and Recommendations for Restoring and Enhancing Priority Hibernacula:

HMC-CM-12.1: Manage vegetation at portals and entrances of known and historic hibernacula to ensure accessibility of BCS species as needed. Management activities shall occur outside the hibernation period unless debris is inhibiting bat accessibility, in which case, debris shall be removed as soon as possible.

HMC-CR-12.2: In coordination with FWS, replace older and/or improperly designed gates with those that better facilitate bat movement in and out of hibernaculum entrances or to allow access for bat monitoring activities.

HMC-CR-12.3: In coordination with the FWS, heritage staff, and tribes as appropriate, restore historical air flow if hibernaculum received modifications from past use (e.g., dirt piled at entrance, show cave modifications, etc.) that have impacted suitability for BCS species. Restoration efforts should be conducted when bats are not present (i.e., summer activity period).

Transportation Structures, Buildings, and Other Anthropogenic Structures Used as Hibernacula

Certain transportation structures (e.g., bridges, culverts), buildings, and other anthropogenic structures (such as hydropower dams) have the potential to provide bat hibernation habitat. As such, care should be taken to avoid impacts to bats when working on these structures. Coordinate with your local biologist or FWS field office to determine if the structure may be suitable for BCS species prior to initiating maintenance, repair, or replacement activities. If a structure is suitable for BCS species, occupancy survey methodologies for these structures shall be conducted, consistent with those used by the local state Department of Transportation (for transportation structures) or local, regional, or national USFWS guidance (for all types of structures).

HMC-O-13: Reduce negative impacts to bats hibernating within buildings and other anthropogenic structures (e.g., bridges, tunnels, homes, offices, outbuildings, culverts, etc.) or conduct humane exclusion in tandem with suitable alternative accommodation in coordination with FWS.

Conservation Measures for Anthropogenic Structures Used as Hibernacula:

HMC-CM-13.1: For structures used as a hibernaculum, occupancy surveys shall be conducted by a qualified individual prior to maintenance, repair, or replacement of existing structures (e.g., bridges, culverts, buildings, etc.) when BCS species may be present (as described in LTH-CM-8.1 and 8.2). If a bat survey indicates no BCS species are present in these structures, the work may occur year-round.

For construction, maintenance, repair, or replacement activities where there is evidence of bat use of the structure (see LTH-CM-8.1 and 8.2):

- Conduct the work at a time of year when bats are not using the structure.
- If planned maintenance, repair, replacement, or demolition activities must occur when BCS species are present, coordinate with FWS prior to activities taking place to identify appropriate steps to avoid or minimize adverse impacts; the project may require consultation outside the BCS.

HMC-CR-13.2: If structures (e.g. bridges, culverts, buildings, etc.) with documented bat use are no longer needed, consider leaving them on site to continue providing bat habitat. If they must be replaced, strive to incorporate similar hibernation opportunities into the new structure (or provide an alternate structure) to the extent practicable.

Hibernaculum Abundance Thresholds and Buffers

As bats prepare to enter hibernation during the fall swarming period and later emerge during the spring staging period, bats coalesce in forested habitats around hibernacula. Associated with this seasonally localized abundance of bats is an elevated risk of impacting BCS species from management activities. In general, the risk of impacts to BCS species and the hibernaculum itself is expected to increase the closer activities occur to a hibernaculum. In addition, the risk of encountering a BCS species during management activities increases with higher bat populations within a hibernaculum and surrounding area (i.e. staging and swarming habitat). The conservation approach outlined below allows certain forest management activities to occur within staging and swarming habitat, but also considers factors such as bat colony abundance, relative risk of impacting bats, and compatibility of land management activities with bat conservation and habitat improvements.

Abundance Thresholds

BCS bat abundances and hibernaculum buffer categories were created through a compilation of information gleaned from peer-reviewed scientific literature, scientific reports, government documents, and collective professional judgement from FS and FWS biologists. The abundance thresholds were numerically delineated with possible values of high, medium, and low abundance. Hibernacula with a low abundance level receive a primary buffer, those with a medium abundance have a primary and secondary buffer, while those with a high abundance have a primary, secondary, and tertiary buffer.

Abundance threshold values are unique to each species (see Table 3-1), except in the case of Indiana bat and little brown bat. For these two species, which were considered the same species until 1928 (Miller and Allen 1928), a combined threshold is used because of their similarity in physical appearance, ecology, and typical roosting location within a hibernaculum (Bergeson et al. 2013, Freeman 1981, Lee and McCracken 2004). The combined threshold values for Indiana bat and little brown bat are based on hibernaculum abundance thresholds in the most recent draft Indiana bat recovery plan (FWS 2007). Similar abundance thresholds were developed for the other BCS bat species through an interagency process that utilized the professional judgement of bat experts familiar with the population status and distribution of each species, while also recognizing the variability in the abundance of these species across their geographic ranges.

Table 3-1. Hibernaculum abundance thresholds by species. Numbers are based on internal hibernaculum counts unless noted otherwise.

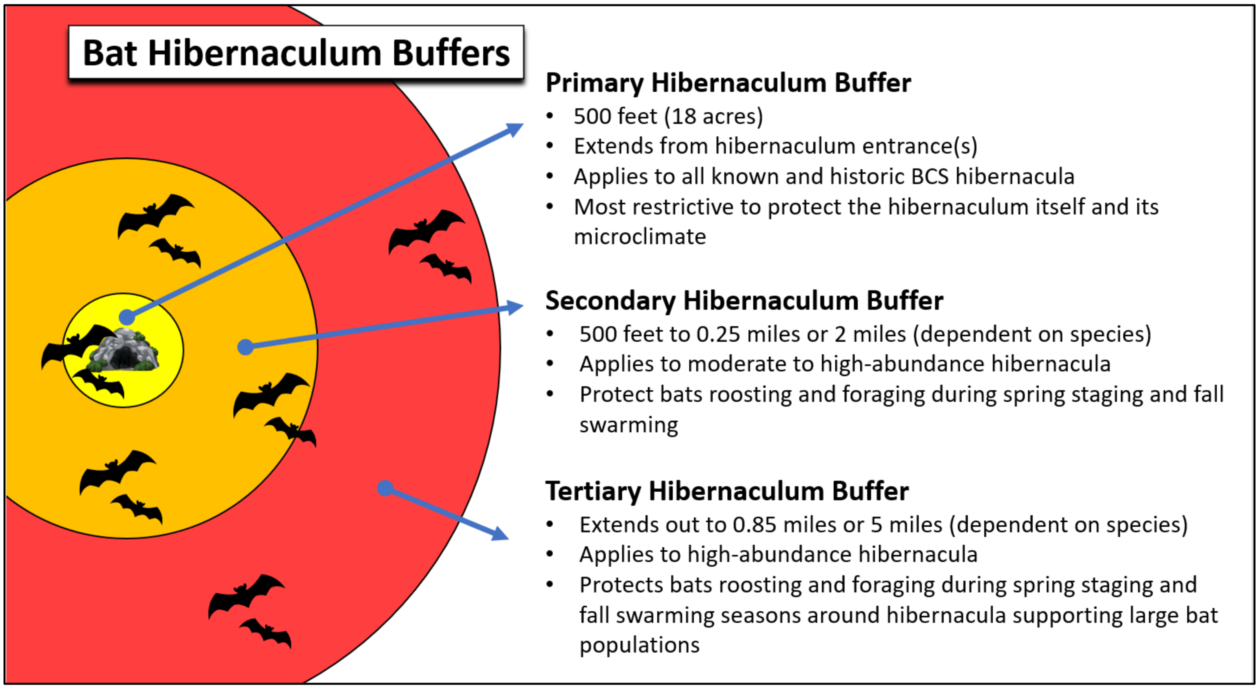
Species	Low Abundance	Moderate Abundance	High Abundance
Indiana bat + Little brown bat (combined count)	1-19	20-4999	≥ 5000
Northern long-eared bat (internal count)	Not applicable	1-4	≥ 5
Northern long-eared bat (harp trap survey[7])	1-9	10-19	≥ 20
Tricolored bat	1-9	10-19	≥ 20

Hibernaculum Buffers

Hibernacula with higher abundance carry a greater risk of impacting bats in the forested zones around them, especially during the swarming and staging periods. As part of the approach to hibernaculum management in the BCS, all hibernacula are surrounded by at least one, and up to three, concentric circular buffers with different management activities allowable or prohibited at certain times of year in each buffer depending on the risk of that activity negatively impacting bats (Figure 3-1). Buffer distances for the BCS bat species are delineated based on abundance thresholds and provide protection to bats in the seasonal staging and swarming areas surrounding hibernacula. Hibernacula with a higher abundance of BCS bats have larger buffers, while those with fewer bats have smaller buffers, dependent on species.

[7] Northern long-eared bats often roost out of sight from internal hibernaculum surveys, so additional guidance is provided where fall or spring harp trapping is used as an alternative method of determining abundance for this species. If both internal hibernaculum surveys and harp trapping are used at a site, whichever observation type results in the largest buffer must be used.

Figure 3-1. Visual depiction of bat hibernaculum buffers



A 500-foot primary hibernaculum buffer will be applied to all hibernacula known to be occupied or that were historically-occupied by at least one BCS species. The intent of the primary hibernaculum buffer is to avoid disturbing bats during the swarming, hibernating, and spring staging periods, protect the physical characteristics of the hibernaculum, and maintain habitat and micro-climate conditions around the site.

In addition to the scientific information documented in Table 3-2, we relied on professional judgement and experience to develop the species-specific secondary and tertiary buffers. The secondary and tertiary hibernaculum buffers are designed to minimize (rather than avoid) impacts where a higher abundance of BCS bats is expected to occur. The goal of secondary and tertiary buffers is, to the extent practicable, minimize potential adverse effects to BCS species using staging and swarming areas around a hibernaculum while also allowing flexibility to meet competing forest management objectives (e.g., multiple-use mandate as an agency). Successful management of BCS habitat around hibernacula includes balancing the need to protect BCS bats using these unique sites and providing the long-term habitat necessary to sustain populations of BCS species. Thus, the goal for developing buffers and management considerations for the BCS is to minimize potential adverse impacts where and when management may pose the greatest risks and avoiding a "hands off" approach that could lead to a long-term decline of the habitat.

Table 3-2. Rationale of the secondary and tertiary buffer sizes around moderate and high abundance hibernacula.

Species	Secondary Buffer Size (miles)	Tertiary Buffer Size (miles)	Rationale for Buffer Size
Indiana bat and little brown bat	2	5	In Arkansas, 36 male Indiana bats were tracked to 162 locations in August–October with an average distance of 1.5 miles from roost to hibernacula (Perry et al. 2016). In Nova Scotia, 26 little brown bats were tracked to 42 locations for 13 days in September, with 80% of locations within 2 miles of hibernacula, although furthest location was 8.1 miles from hibernacula (Lowe 2012).
Northern long-eared bat	0.25	0.85	In Oklahoma, three northern long-eared bats were tracked to 84 locations in September–October, with 23% of swarming locations within 0.25 miles of the hibernaculum, and an average swarming distance of 0.83 miles (ESI 2018). In Nova Scotia, six Northern long-eared bats were tracked to 12 locations in September, with 67% of swarming roosts within 1.2 miles of the hibernaculum, and an average swarming distance of 2.2 miles for males and 3.0 miles for females (Lowe 2012).
Tricolored bat	0.25	0.85	In Oklahoma, 50% of swarming tricolored bat roost locations were within 0.25 miles of the hibernaculum, though the maximum swarming distance was 3.6 miles (ESI 2018). In Michigan, a juvenile female tricolored bat roosted in trees 0.5 and 1.2 miles from the swarming site in August-September (Kurta et al. 1999). In Tennessee, 18 tricolored bats were tracked to 46 swarming roosts, with a mean distance of 0.12 miles from the hibernaculum (range 0.02 - 0.3 miles; Tate 2020).

The sizes of these buffers vary according to the ecology of the bat species present in a particular hibernaculum to protect seasonal staging and swarming areas surrounding hibernacula (Table 3-3 and Figure 3-2). For example, Indiana bat and little brown bat have been documented traveling relatively far from hibernacula during staging and swarming, while northern long-eared bat and tricolored bat typically stay much closer to the hibernaculum during this period (Cope and Humphrey 1977, Lowe 2012, Perry et al. 2016, Roby et al. 2019). For that reason, Indiana bat and little brown bat have a larger secondary and tertiary hibernaculum buffer than the other two BCS bats. In situations where multiple covered species occur in a single hibernaculum, the most protective (i.e. the largest) buffer size would be applied as described in Table 3-3 and Figure 3-2.

Table 3-3. Staging and swarming habitat buffers based on winter colony abundance (from Table 3-1). Distances shown below are distance from hibernaculum entrance(s).

Species and Abundance Thresholds	Primary Hibernaculum Buffer	Secondary Hibernaculum Buffer	Tertiary Hibernaculum Buffer
Indiana bat and/or little brown bat (combined count)—High Abundance	500 feet	2 miles	5 miles
Indiana bat + Little brown bat (combined count)—Moderate Abundance	500 feet	2 miles	None
Indiana bat + Little brown bat (combined count)—Low Abundance	500 feet	None	None
Northern long-eared bat or Tricolored bat—High Abundance	500 feet	0.25 mile	0.85 mile
Northern long-eared bat or Tricolored bat—Moderate Abundance	500 feet	0.25 mile	None
Northern long-eared bat or Tricolored bat—Low Abundance	500 feet	None	None
Hibernaculum with Unknown Abundance[8]	500 feet	0.25 mile	0.85 mile

[8] A hibernaculum with unknown abundance levels is treated as a high-use tricolored bat hibernaculum.

Figure 3-2. Summary of bat hibernaculum abundance thresholds and associated buffers.

		Primary Hibernaculum Buffer (all hibernacula)	Secondary Hibernaculum Buffer	Tertiary Hibernaculum Buffer
Indiana Bat and/or Little Brown Bat (combined count)	**Bat Pop. Size:** **Buffer Distance:** **Buffer Area:**	1+ bats 500 ft 18 acres	20+ bats 2 miles 8,042 acres	5000+ bats 5 miles 50,265 acres
Northern Long-Eared Bat[*] or Tri-colored Bat (*Population size based on fall or spring harp trapping	**Bat Pop. Size:** **Buffer Distance:** **Buffer Area:**	1+ bats 500 ft 18 acres	10+ bats 0.25 miles 126 acres	20+ bats[‡] 0.85 miles 1,460 acres (‡Default for hibernacula with unknown abundance)
Northern Long-Eared Bat [†] (†Population size based on internal visual counts)	**Bat Pop. Size:** **Buffer Distance:** **Buffer Area:**	1+ bats 500 ft 18 acres	1+ bats 0.25 miles 126 acres	5+ bats 0.85 miles 1,460 acres

In some cases, a hibernaculum may have known bat populations but the species and abundance may be unknown (e.g., a mine that is unsafe for human entry). At the time this BCS was written, there were 26 hibernacula in FS Region 8 and 40 hibernacula in FS Region 9 identified as being occupied by unknown BCS species or abundance within 5 miles of National Forest System lands in FS regions 8 and 9. For a hibernaculum where bat use is confirmed but species and abundance levels are unknown, the site shall be treated as a high-abundance northern long-eared or tricolored bat hibernaculum until monitoring data indicates otherwise (see Table 3-3). The FWS as well as state fish and wildlife agencies have been monitoring Indiana and little brown bat hibernacula for numerous years and have a good understanding of hibernacula locations for these two species. Therefore, while not certain, it is generally unlikely that few, if any, unknown Indiana and little brown bat hibernacula still exist. Additionally, prior to WNS impacts to bat populations, tricolored bats occupied most known hibernacula found on National Forest Systems lands in FS Regions 8 and 9. Conversely, less is known regarding hibernacula for northern long-eared bats on National Forest System lands so there is a lower level of confidence in our understanding of hibernacula for these species. Because there is confidence in our understanding of where Indiana, little brown, and tricolored bats may still hibernate on National Forest System lands, but lower confidence regarding northern long-eared bat hibernacula, it is assumed that the majority of hibernacula with unknown species would be occupied by northern long-eared bats. Therefore, we will apply the northern long-eared bat buffer distances to hibernacula occupied by unknown bat species. Additionally, if the abundance of the bat population occupying a hibernaculum is unknown, the highest threshold buffer for northern long-eared bats (i.e. tertiary buffer) will be applied.

Applying and Modifying Hibernaculum Buffers

To determine which activities are allowable or prohibited around a specific hibernaculum:

1. Identify its abundance level by species using the highest category applicable (Table 3-1);
2. Delineate where swarming and staging zones occur for the species present (Table 3-3); and
3. Refer to BCS objectives for hibernaculum buffers outlined below (HMC-O-14, HMC-O-15, and HMC-O-16).

All hibernaculum buffers are circular by default since it is difficult to incorporate site-specific considerations across such a broad landscape. However, for the purposes of the BCS, the tertiary buffer can be modified if: site-specific information indicates a different shape is more biologically appropriate; the local FS and FWS field units may mutually agree to modify the buffer shape and/or size; and agreement to modify the tertiary buffer is documented in an applicable hibernaculum management plan. Primary and secondary hibernaculum buffers cannot be modified under the BCS.

For the purposes of the BCS, initial species abundance was based on the highest count of hibernating individuals over the preceding 6-year period. If monitoring indicates a change in the abundance level of a hibernaculum, then the buffer size applied to the site may be adjusted as appropriate as specified in the monitoring elements of the Tier 1 consultation process. However, the 500-foot primary hibernacula buffer would still be applied to all historic hibernacula, even if no longer used by bats (i.e., it would be treated as a low-abundance hibernaculum), as these sites would still be suitable for BCS species and could potentially be occupied again in the future. Adjustments to the buffer size applied to a hibernaculum shall be discussed with the local FWS field office before implementing any change to the buffer.

BCS Species' Hibernacula Occurring Outside National Forest System Lands

Situations may exist where BCS species' hibernacula occur outside, but near National Forest System managed lands. While these "off-Forest" hibernacula and associated features are not managed by the Forest Service, occupying bats are using the surrounding landscape that may include adjacent National Forest System lands. Where Forest Service managers are aware of BCS bat occupied hibernacula occurring within 5 miles of National Forest System lands, evaluate these sites and apply BCS buffers as described in Table 3-3 as appropriate. If a primary, secondary, or tertiary buffer applied to an off-Forest hibernaculum extends into and overlaps with National Forest System lands, then all CMs and CRs will be applied as described to the overlapping portions. See Figure E-1 for an example of a conceptual application of BCS buffers for off-Forest BCS features.

Off-forest hibernacula themselves and portions of the associated buffers that are off National Forest System lands would not typically be managed by the FS. However, if the FS has other management authority regarding these off-forest hibernaculum (such as an agreement, funding, or another mechanism or authority), then the buffers and associated CMs and CRs should be implemented within the entire buffer area where possible and as consistent with the intent of the BCS. The applicability of this management authority would only extend for the space and duration in which the FS has responsibility for the feature or has management responsibility for actions that occur within the buffered areas. At such time the FS management authority and responsibility ceases, the provisions of the BCS would no longer apply to those areas outside National Forest System managed lands.

Primary Hibernaculum Buffers

The intent of the primary hibernaculum buffer is to avoid disturbing bats during hibernation, fall swarming, and spring staging whether they are hibernating or roosting in trees surrounding the feature. Other considerations for the conservation of overwintering bats include ensuring ingress and egress of bats, maintaining the physical characteristics of the hibernaculum entrances, limiting unnecessary human intrusion into hibernacula (due to disturbance, as well as limiting potential spread of WNS), and maintaining the subsurface hydrology and airflow that contribute to the microclimate of hibernacula. Note that the Salvage Harvest section in Chapter 2 contains other measures that apply to hibernaculum buffers.

HMC-O-14: Establish a 500-foot primary hibernaculum buffer around all hibernacula centered on each portal or entrance. If managing vegetation (including salvage) in the primary hibernaculum buffer, the intent must be to improve bat roosting and foraging habitat (e.g. may include clearing vegetation around the entrance to facilitate ingress and egress, promoting structural diversity, etc.).

Conservation Measures and Recommendations for Primary Hibernaculum Buffers

HMC-CM-14.1: Prohibit, year-round, management activities that are not consistent with the intent of the primary hibernaculum buffer:

- Construction of new roads or trails;
- Vegetation management when it is not the project's sole or primary purpose to improve roosting and foraging habitat for bats;
- Firewood cutting of any standing snags or trees; and
- Harvesting of special forest products that may be a component of a potential spring staging and fall swarming roost(s) (e.g., shagbark hickory bark, Spanish moss, etc.).

Note: Where a BCS hibernaculum is within or near a building or other anthropogenic structure occupied by BCS or unidentified bat species, routine administrative activities, such as grass mowing, garbage collection, restroom cleaning, campsite maintenance, fee collection, camping, etc., can proceed outside of the hibernaculum. Coordinate with a FS biologist if there are questions whether an administrative activity can be considered routine as it relates to BCS species. If valid human health and safety concerns or other extenuating reasons exist that make the application of the primary hibernaculum buffer impossible or the buffer itself would severely impact or alter the maintenance, use, and function of the building or structure in question, evaluation of protection measures may be necessary on a case-by-case basis with FS biologist input and in coordination with FWS. Also see the Roosts in Buildings and Other Anthropogenic Structures section if the structure is used as a summer roost.

HMC-CM-14.2: Prohibit any tree and snag cutting in the primary hibernaculum buffer during the swarming and staging periods unless the tree is deemed a high-priority hazard tree requiring immediate cutting.

HMC-CM-14.3: Aerial spraying and ground-based broadcast application of pesticides that are directed into trees that could affect roosting bats shall be avoided in the primary hibernaculum buffer during the swarming, staging, and summer occupancy period. Use of targeted pesticide application methods or ground-based broadcast application of pesticides that are directed downward in suitable bat roost habitat, like spot-spraying, hack-and-squirt, basal bark injections, cut-stump, or foliar spraying to minimize affecting non-target plants and animals is allowable. Aerial application of Lymantria dispar pheromone treatments are permissible at any time of year.

HMC-CR-14.4: Conduct hibernaculum improvement measures (e.g., WNS treatments and abatement) in coordination with FWS.

HMC-CR-14.5: In the primary hibernaculum buffer, reroute existing roads or trails where the impacts from the use or maintenance of the road or trail may have adverse impacts to known roosts.

Prescribed Fire in Primary Hibernaculum Buffer

HMC-CM-14.6: When conducting prescribed fire in the primary hibernaculum buffer around currently-occupied hibernacula* (Table 3-1), the following conditions must be met:

- Designation of the hibernaculum as a smoke sensitive receptor (HMC-CM-10.1).
- Improvement of bat habitat must be an objective of the burn.

- Prohibit burns during the fall swarming period.

- Minimum air temperature of 40°F when prescribed fire enters the primary hibernaculum buffer during the spring staging and summer occupancy period.

- Avoid high-intensity fire when using aerial firing tools.

- Avoid hovering with helicopters within the buffer during the hibernation and spring staging periods to minimize potential noise impacts to bats and temporary changes to the airflow of the hibernaculum.

*Note: Historic hibernacula are excluded from the restrictions in this measure; however, the historic hibernaculum must be designated as a smoke sensitive receptor in the burn plan (HMC-CM-10.1).

Secondary Hibernaculum Buffers

HMC-O-15: Implement a secondary hibernaculum buffer around moderate and high abundance hibernacula using a variable size buffer (Table 3-3) surrounding each portal or entrance to hibernacula.

Conservation Measures and Recommendation for Secondary Hibernaculum Buffers

HMC-CM-15.1: Prohibit, year-round, management activities that are not consistent with the intent of the secondary hibernaculum buffer:

- Construction of new, or expansion, modification, or realignment of maintenance level 4-5 roads outside of existing, cleared rights-of-way (i.e. trees are already cleared).

- Firewood cutting of any standing snags or trees.

- Harvesting of special forest products that may be a component of potential spring staging or fall swarming roost(s) (e.g., shagbark hickory bark, Spanish moss, etc.).

HMC-CM-15.2: Design vegetation management activities to favor retention of mature age classes within the secondary hibernaculum buffer. Minimize creation of habitat in the 0–10 age class unless it is part of a managed wildlife opening. If greater than 10% of land in the secondary hibernaculum buffer is already in a non-forested land cover (e.g., development, agriculture, maintained openings), do not create more open land, unless the primary purpose is to improve roosting and foraging habitat for bats. Regenerating forest would not be considered non-forested land cover for this criterion. This measure can be exempted if a hibernaculum management plan is in place that provides for alternative management of the landscape.

HMC-CM-15.3: Prohibit the following activities during the spring staging and fall swarming periods (see Appendix B for local dates) in the secondary hibernaculum buffer:

- Timber harvest, salvage, and associated activities that involve tree cutting (e.g., construction of temporary roads to facilitate timber harvest).

- Regeneration harvests in the secondary hibernaculum buffer (e.g., clearcuts) greater than 40 acres in size. Note: situations may arise where exceeding the 40-acre limit for regeneration harvest in this zone is necessary to manage for another federally threatened or endangered species, designated critical habitat, or to restore a native ecosystem (depending on the habitat that would be treated). Coordinate with the local FWS field office to determine if the specific situation would be consistent with the BCS.

HMC-CM-15.4: Aerial spraying and ground-based broadcast application of pesticides that are directed into trees that could affect roosting bats shall be avoided in the secondary hibernaculum buffer during the swarming, staging, and summer occupancy period. Use of targeted pesticide application methods or ground-based broadcast application of pesticides that are directed downward in suitable bat roost habitat, like spot-spraying, hack-and-squirt, basal bark injections, cut-stump, or foliar spraying to minimize affecting non-target plants and animals is allowable. Aerial application of *Lymantria dispar* pheromone treatments are permissible at any time of year.

HMC-CM-15.5: When maintenance of existing roads, trails, and recreation sites involves tree cutting in the secondary hibernaculum buffer, it shall be conducted outside of the swarming and staging seasons (see Appendix B for local activity dates).

HMC-CM-15.6: Prescribed fire may occur year-round in the secondary hibernaculum buffer, but if conducted during the staging/swarming period, the air temperature must be 40°F or above at the time prescribed fire enters the secondary hibernaculum buffer.

HMC-CR-15.7: Conduct prescribed fires in secondary hibernaculum buffers when air temperatures are 50°F or above to allow for additional reduction of adverse effects.

Tertiary Hibernaculum Buffers

HMC-O-16: Implement a tertiary hibernaculum buffer around high abundance hibernacula using a variable size buffer (Table 3-3) surrounding each portal or entrance to the hibernacula.

Conservation Measures for Tertiary Hibernaculum Buffers

HMC-CM-16.1: Prohibit management activities that are not consistent with the intent of the tertiary hibernaculum buffer year-round:

- Firewood cutting of any standing snags or trees.
- Harvesting of special forest products that may be a component of a potential spring staging or fall swarming roost (e.g., shagbark hickory bark, Spanish moss, etc.).

HMC-CM-16.2: Prohibit the following activities in the tertiary hibernaculum buffer during the spring staging and fall swarming periods:

- Construction of new, or expansion, modification, or realignment of maintenance level 4-5 roads outside of existing, cleared rights-of-way (i.e. trees are already cleared).

HMC-CM-16.3: Within the tertiary hibernaculum buffer, minimize creation of habitat in the 0–10 age class unless it is part of a managed wildlife opening. If greater than 20% of land in the THB is already in a non-forested land cover (e.g., development, agriculture, maintained openings), do not create more open land, unless the purpose is to improve roosting and foraging habitat for bats. Regeneration harvests (e.g., clearcuts) may not exceed 40 acres. This measure can be exempted if a hibernaculum management plan is in place that provides for alternative management of the landscape.

HMC-CM-16.4: Aerial spraying and ground-based broadcast application of pesticides that are directed into trees that could affect roosting bats shall be avoided in the tertiary hibernaculum buffer during the swarming, staging, and summer occupancy period. Use of targeted pesticide application methods or ground-based broadcast application of pesticides that are directed downward in suitable bat roost habitat, like spot-spraying, hack-and-squirt, basal bark injections, cut-stump, or foliar spraying to minimize affecting non-target plants and animals is allowable. Aerial application of *Lymantria dispar* pheromone treatments are permissible at any time of year.

Hibernaculum Management Plans

HMC-O-17: Utilize hibernaculum management plans to consolidate relevant, site-specific hibernaculum information and manage hibernacula and surrounding landscape to support current and future bat populations.

Following publication of this BCS, the FS, in coordination with the FWS and other partners, will develop hibernaculum management plans for hibernacula occurring on or adjacent to National Forest System lands. Hibernaculum management plans will ensure all parties have a common understanding of how a site will be managed and take unique, site-specific conditions into consideration. One hibernaculum management plan may cover multiple hibernacula. See Appendix F for additional hibernaculum management plan considerations and example plan outline.

Conservation Measures and Recommendations for Hibernaculum Management Plans

HMC-CM-17.1: Develop hibernaculum management plans for currently occupied high-abundance hibernacula within 5 years of the BCS being initially released to units.

HMC-CM-17.2: Beginning 5 years after the BCS is initially released to units, a hibernaculum management plan shall be in place prior to initiation of management activities when activities are planned within a primary and secondary hibernaculum buffer, regardless of abundance.

HMC-CR-17.3: Within the first 5 years after the BCS is initially released to units, develop a hibernaculum management plan prior to initiation of management activities when activities are planned within any hibernaculum buffer, regardless of abundance.

HMC-CR-17.4: Develop hibernaculum management plans for currently occupied hibernacula with moderate or low abundance of BCS species or for hibernacula that are currently unoccupied but historically held a high abundance of BCS species.

CHAPTER 4 ROOST MANAGEMENT AND CONSERVATION

Introduction

Many bat species congregate during the summer in maternity colonies, including the four species of the BCS, although males and non-reproductive females may roost individually. Pups born during this period are incapable of flying for several weeks and both females and pups are particularly vulnerable to disturbance or mortality during this time period. While females can and do move pups between roosts, they may not have time, such as in the case of a rapidly moving forest fire or when a tree is felled. This issue is exacerbated by BCS species' low reproduction rates; bat populations require a long time to recover from substantial population losses (Racey and Entwistle 2000, Kunz and Fenton 2003). Thus, roosting locations, particularly maternity roost areas, are critical for the integrity and continuation of bat populations. However, we also acknowledge that informed management around roosts may be integral to suitable roost creation or maintenance now and in the future (Silvis et al. 2015b).

Protection of roost locations is a critical component to the overall BCS. This chapter addresses five important aspects of non-hibernation roost protection including:

- Historic and known suitable roosts – describes criteria for incorporating previously documented (pre-BCS) bat roosts into the BCS and implementing applicable roost buffers;
- Primary roost buffer – describes the most protective buffer around known BCS species non-hibernation roosts. *Applies to all known, maternity, and non-maternity bat roosts*;
- Secondary roost buffer – describes the buffer around known maternity roosts for BCS species designed to provide protection for unknown, alternate roosts that may be in the vicinity of the known roost. *Applies to all known maternity roosts only;*
- Maternity capture buffer – describes the buffer around confirmed captures of reproductively-active female and juvenile BCS species (aka "maternity captures") designed to provide protection for unknown roosts that may be in the vicinity of the capture location. *Applies to maternity captures only;*
- Roosts in buildings and other anthropogenic structures – describes the use of buildings and other human-made structures by bats as roosts, steps to assess bat use, and recommendations for mitigating negative effects to bats when structural-related activities are necessary; and
- Criteria for removing or modifying roost buffers or maternity capture buffers – considerations and steps to take when a roost has fallen down; is no longer accessible to bats; no longer possess the characteristics of a suitable roost; or new information indicates a change in where or how a roost or capture buffer is applied would be appropriate.

The BCS species use several different natural and human-made structures for meeting their general, and species-specific roosting requirements. Refer to Appendix A for more information on roosting preferences for each BCS species. The BCS will consider bat boxes and similar bat-specific constructed roost structures in the same context as natural tree roosts. Although these roosts are artificial, in most cases their placement and function on the landscape most closely matches that provided by tree roosts than other human-made structures.

The management considerations for this chapter are expressed as RMC for "roost management and conservation", G for "goal", O for "objective", CM for "conservation measure", and CR for "conservation recommendation".

Historical and Known Suitable Bat Roosts

BCS species exhibit site fidelity and regularly return year after year to re-use roosts that remain suitable or use various other roosts within the same roost area. In general, roost trees are an ephemeral resource with some remaining suitable for less than five years (e.g., snags) from time of discovery, but depending on condition (i.e., typically live trees) and species (due to inherent longevity of some trees species compared to others), some may remain suitable for ten years or more (Ford et al. 2021). As natural roost availability changes over time (e.g., decades), a maternity colony's roost area (secondary roost buffer) likewise shifts within the larger home range to meet the colony's life requisites (e.g., take advantage of better roosting habitat, be closer to better foraging habitat, etc.). In contrast, roosts in buildings and other anthropogenic structures often remain occupied for substantially longer periods than natural roosts. For this reason, specific guidance is provided for bat roosts in the Roosts in Buildings and Other Anthropogenic Structures section below.

Over the years and prior to the onset of WNS, the FS and bat research partners have documented many bat roosts. A component of the BCS is to determine whether these previously documented roost(s) can and should be re-located and, if so, to assess the current suitability and incorporate those determined to be such into the BCS. For those previously documented roosts found or assumed to still be suitable, it is important to determine if they are actively being used by BCS species after the anticipated population declines resulting from WNS.

To identify known roosts that are likely still occupied by BCS species, we relied on local post-WNS dates that were based on confirmed disease on any species of bat. Fungal detections were not used to establish post-WNS dates because the fungus can be present in hibernacula before the disease is detected. When a FS unit had forest specific data as to when their bat populations crashed post-WNS, the post-WNS date should be 2 years after the earliest confirmed disease in a county within a unit, based on the WNS spread map. In coastal zones, WNS largely has not been detected. Therefore, all confirmed accounts of BCS species occupancy should be considered when evaluating whether buffers should apply to a known location. Appendix D includes WNS detection and post-WNS dates that apply to each FS unit for the purposes of the BCS.

It is recognized that the Forest Service should not be unduly burdened with protecting roosts or roost areas discovered prior to WNS that are now less likely to harbor BCS bats in any substantial numbers due to intense population declines. Thus, all BCS species' roosts that were documented prior to the issuance of the BCS must be evaluated for ongoing suitability as a bat roost to determine if they will be considered "historic" and not protected or "known suitable" and included in protections under the BCS. Note: for purposes of the BCS, snag roosts documented greater than 10 years before issuance of the BCS are defined as unlikely to provide ongoing roosting suitability and will not require additional verification because, typically within this timeframe, bark falls off snags or they fall over or get snapped off. BCS bats, if they survived WNS, will have moved or drifted as their roost areas naturally changed with loss of roosts that are no longer suitable (as described previously). Without a suitable tree present to monitor, it is difficult to determine ongoing bat presence in the area without intensive surveys, which are not required currently. Thus, such snag roosts shall be considered "historic" without any additional verification and will not receive ongoing protections. However, historic roost locations should be retained in the records and considered a priority focus for future bat monitoring efforts.

Apply Conservation Measure RMC-CM-18.1 to first categorize your documented roosts as either "historic" (i.e., receives no ongoing protections) or "known suitable". For *known suitable roosts*, select the appropriate BCS protection(s) to apply as outlined in the Primary Roost Buffer and Secondary Roost and Maternity Capture Buffers sections below. NOTE: once this initial categorization as "historic" or "known suitable" is completed for all roosts that were documented *prior* to the issuance of the BCS, all applicable buffers and conservation measures and recommendations for *known suitable roosts* remain in place until conditions are met to remove roost buffers, as described at the end of this chapter. Furthermore, any new roosts documented after the BCS takes effect also become *known suitable roosts* and are subject to all the same conditions as described (RMC-CM-18.2).

RMC-G-18: Protect known roosts and enhance known maternal roost areas.

RMC-O-18: Protect previously identified roosts and maternal roost areas according to the categorizations defined in RMC-CM-18.1.

Conservation Measures to Determine Historic and Known Suitable Bat Roosts

RMC-CM-18.1: Classify all bat non-hibernation roosts documented prior to the issuance of the BCS as either "historic" or "known suitable" using these criteria:

- ***Historic roosts:*** Any documented roost (i.e., trees, bat boxes, and buildings and other anthropogenic structures) of BCS bats that:

- is verified by a FS biologist as no longer suitable (e.g., fallen to the ground or lost all suitable roosting characteristics, such as exfoliating bark or leaf clusters), or

- is a snag roost that is 10 or more years after its first documentation without additional follow-up showing it is still suitable (i.e., snags roosts are assumed to be unsuitable after 10 years and do not require verification, unless a unit has evidence to the contrary).

Roost buffers and associated CMs and CRs do not apply to historic roosts under the BCS. Historic roosts, whether deemed unsuitable or no longer present, and the surrounding habitat should be considered priority areas to focus future bat survey efforts to locate new maternity roosts or confirm likely absence of BCS species.

- ***Known suitable roost***: Any documented roost of BCS species (i.e., trees, bat boxes, and buildings and other anthropogenic structures), not already deemed an historic roost, that remains potentially suitable must be considered *known suitable* until deemed unsuitable by an FS biologist or proven otherwise using criteria for removing primary or secondary buffers (see the Criteria for Removing or Modifying Roost or Capture Buffers section). *Known suitable roosts* shall receive a primary roost buffer (RMC-O-19), and for those documented as maternity roosts, also apply a secondary roost buffer (RMC-O-20A).

Refer to Appendix A for general and species-specific roost characteristics that can be used when making roost suitability determinations.

RMC-CM-18.2: Consider all roosts documented after issuance of the BCS as *known suitable* until deemed unsuitable by trained FS staff or proven otherwise using criteria for removing primary or secondary buffers (see the Criteria for Removing or Modifying Roost or Capture Buffers section). *Known suitable roosts* shall receive a primary roost buffer (RMC-O-19), and for those documented as maternity roosts, also apply a secondary roost buffer (RMC-O-20A).

Primary Roost Buffer

As described, the BCS species will either congregate in maternity colonies during the summer active season to give birth and raise their young, or roost individually or in small groups in non-maternity roosts. When individuals are geographically concentrated, single unpredictable events (e.g., a severe windstorm that results in the loss of one or more active maternity roosts) can impact many individuals and perhaps the entire colony. At maternity roosts, females and young are particularly vulnerable to disturbance during the time when young are incapable of flying, referred to as the pup season (see Appendix A). Females and pups depend on roosts, and the availability of other nearby roosts, for their reproductive success and survival. The same can be said for non-maternal colonies or solitary roosting bats. Although they may be in smaller groups and potentially more scattered across the landscape, they equally depend on the availability of current and future potential roost opportunities. Individuals that survive a disturbance event by fleeing their roost may need to search for new roosting sites, in turn increasing their exposure to potential predation. Additionally, they may experience increased energy expenditures while in search of an alternate roost site.

RMC-O-19: Implement a 150-foot primary roost buffer centered on all *known suitable roosts* (includes maternity and non-maternity roosts) of BCS species to protect the integrity and function of the roost itself and avoid impacts to roosting bats.

A primary 150-foot buffer around a known suitable roost (maternity and non-maternity) (FWS 2016a) will safeguard the roost and its current condition, characteristics, and associated microclimate from direct effects. Furthermore, known roosts will be protected from intentional damage or destruction (e.g., felling, burning, girdling, etc.) at all times of year, so long as they continue to exhibit bat-suitable roosting characteristics, with an exception for imminent threats to human safety. A primary roost buffer, once established, will remain in place until such time as the respective roost is determined to be unusable or unsuitable following the Criteria for Removing Roost or Capture Buffers outlined below.

The conservation measures that follow cover typical FS actions and activities that could occur within a designated 150-foot primary roost buffer and are prohibited during specific times of year. They address prohibited activities that could occur at any time or those that may only occur during the summer occupancy period or the pup season. Of the two designated bat activity periods, the summer occupancy period typically defines the non-hibernation period when bats are active in their summer habitats. The pup season is the critical time within the summer occupancy period when pregnant female bats are giving birth and young bats are unable to fly. Of these two bat activity periods, actions will be most restricted during the pup season when BCS bats with young are the most vulnerable as well as in coastal areas when temperatures fall below 40°F and bats may enter a brief torpor. It is critical to protect the roost and inhabitants from potential direct effects. For example, hazard tree cutting of potentially suitable roost trees is prohibited during the pup and summer occupancy period within the primary roost buffer, unless safety considerations absolutely require it. In such circumstances, conservation measures may be required, see below.

During the summer occupancy period, excluding the period defined as the pup season, certain actions and activities may be consistent with the intent of the 150-foot primary roost buffer. For example, allowable activities include prescribed fire, NNIS control, recruitment of new snags (e.g., girdling) when deemed necessary, and limited harvest specifically designed to improve bat roost habitat needs or minimize effects to BCS species (e.g., no tree cutting ≥ 12″ DBH (USFWS 2007; Lacki et al. 2009a); cutting of off-site competitive species in high-basal area stands). Other activities considered to have no effect or beneficial effects to bats are allowable on a case-by-case basis with FS biologist input, in coordination with FWS. Activities such as construction of skid roads and trails within known primary roost buffers are prohibited. Please note: the Salvage Harvest section in Chapter 2 contains other measures that apply to roost buffers. If bats are found roosting in a bridge, culvert, building, or other anthropogenic structure, also see the Roosts in Bridges, Culverts, Buildings and Other Anthropogenic Structures below.

Conservation Measures for Primary Roost Buffers

RMC-CM-19.1: Known roost trees shall not be cut down for any purpose or at any time of year without prior coordination with FWS; any exemptions should be a rare occurrence.

RMC-CM-19.2: Prohibit the following management activities year-round within the primary roost buffer as they are not consistent with the intent of the buffer:

- Firewood cutting of any standing snags or trees.
- Permanent tree removal and forest conversion activities (includes living and standing dead suitable roost trees).
- Commercial or personal use collection/harvest activities of special forest products that have negative effects to BCS species or their habitats, such as any item(s) deemed to be a component of or contribute to the characteristics of potential roost sites will be prohibited from harvest (e.g., shagbark hickory bark, Spanish moss, etc.). Such activities must be evaluated and approved on a case-by-case basis in coordination with a FS Biologist.
- Construction of new roads or trails.
- For any other activity that may impact a known roost or surrounding habitat within 150 feet of the known roost that is not specified in the conservation measures and recommendations for the primary roost buffer below, coordinate with a FS Biologist.

Note: Where a roost is present in or near an administrative area, routine administrative activities, such as grass mowing, garbage collection, restroom cleaning, campsite maintenance, fee collection, camping, etc., can proceed. Coordinate with a FS biologist if there are questions whether an administrative activity can be considered routine as it relates to BCS species. If the roost is within a building or other anthropogenic structure, see the Roosts in Buildings and Other Anthropogenic Structures section below.

RMC-CM-19.3: Within the primary roost buffer, prohibit all tree cutting (includes living and standing dead suitable roost trees) during the summer occupancy period* (see Appendix B for local dates) unless there is an imminent threat to human safety. Coordinate with FS biologist and FWS if tree cutting within the primary roost buffer is necessary; stand-alone consultation may be necessary if direct or indirect impacts to the known roost could occur.

Additional considerations for tree cutting within the primary roost buffer include:

- If a high-priority hazard tree must be cut, see RMC-CM-19.4.
- Timber harvest conducted outside the summer occupancy period is allowable but must be designed to improve bat roosting and foraging habitat or respond to forest health issues (i.e., salvage). Activities must retain live trees ≥12-inches DBH and all snags, where safety allows.
- Management for insect and disease outbreaks and other forest health issues (such as oak decline) conducted during the hibernation period is allowable. Only the minimum number of trees required to prevent or contain the spread should be cut.
- Maintenance to existing roads or trails is allowable but only the minimum number of trees necessary should be cut.

* Coastal Zone Units Only: Where bats are active year-round, prohibitions apply when temperatures are below 40°F (when bats may enter a brief torpor).

RMC-CM-19.4: During the summer occupancy period (see Appendix B for local dates) cutting of high-priority hazard trees within the primary roost buffer is prohibited unless the following conditions are met:

- Prior to removal, conduct an emergence survey (see Appendix C protocol) when air temperatures are above 50°F.
- If bats are not observed during the survey, cut tree within 24 hours of survey.
- If bats are observed during the survey, coordinate with FWS prior to cutting.

When emergence surveys are planned within a roost buffer, coordination with the local FWS field office is required prior to conducting the survey. Modification to the protocol could be appropriate depending on the BCS species that may be present.

RMC-CM-19.5: During the summer occupancy period* (see Appendix B for local dates), direct disturbance to the known roost, (e.g., coring, tagging, sounding, etc.) that could result in mortality, injury, or roost abandonment by any bats is prohibited.

*Coastal Zone Units Only: Where bats are active year-round, disturbance to the known roost is also prohibited when temperatures are below 40°F when bats may enter a brief torpor.

RMC-CR-19.6: For trees in the primary roost buffer other than the known roost, avoid direct disturbance to trees (e.g., sounding, girdling, coring, tagging, etc.) during the summer occupancy period that could result in the mortality, injury, or roost abandonment by bats in undocumented roost trees. When such activities are planned for the known roost tree, refer to RMC-CM-19.5.

RMC-CM-19.7: In the primary roost buffer, prescribed burning shall be conducted outside of the pup season to minimize smoke impacts around roost trees and to avoid burning roost trees. If burning during the pup season must be conducted to achieve specific restoration objectives low intensity burning conditions shall be targeted to minimize effects and coordination with FS Biologist and FWS must occur; project may require consultation outside the BCS).

RMC-CM-19.8: During prescribed fire within a primary roost buffer, create a fuel break around all known roosts to avoid burning roost trees.

RMC-CR-19.9: Reroute existing roads or trails within the primary roost buffer where the impacts from the use or maintenance of the road or trail may have additional adverse impacts to known roosts.

During the bat hibernation period (see Appendix B), most FS activities and actions can take place within the primary roost buffer as long as they do not negatively change or destroy the identified roost tree itself or the surrounding habitat and microclimate conditions within the buffer. However, if a bridge, culvert, building, or other anthropogenic structure is used as a hibernaculum, see the Transportation Structures, Buildings, and Other Anthropogenic Structures Used as Hibernacula section.

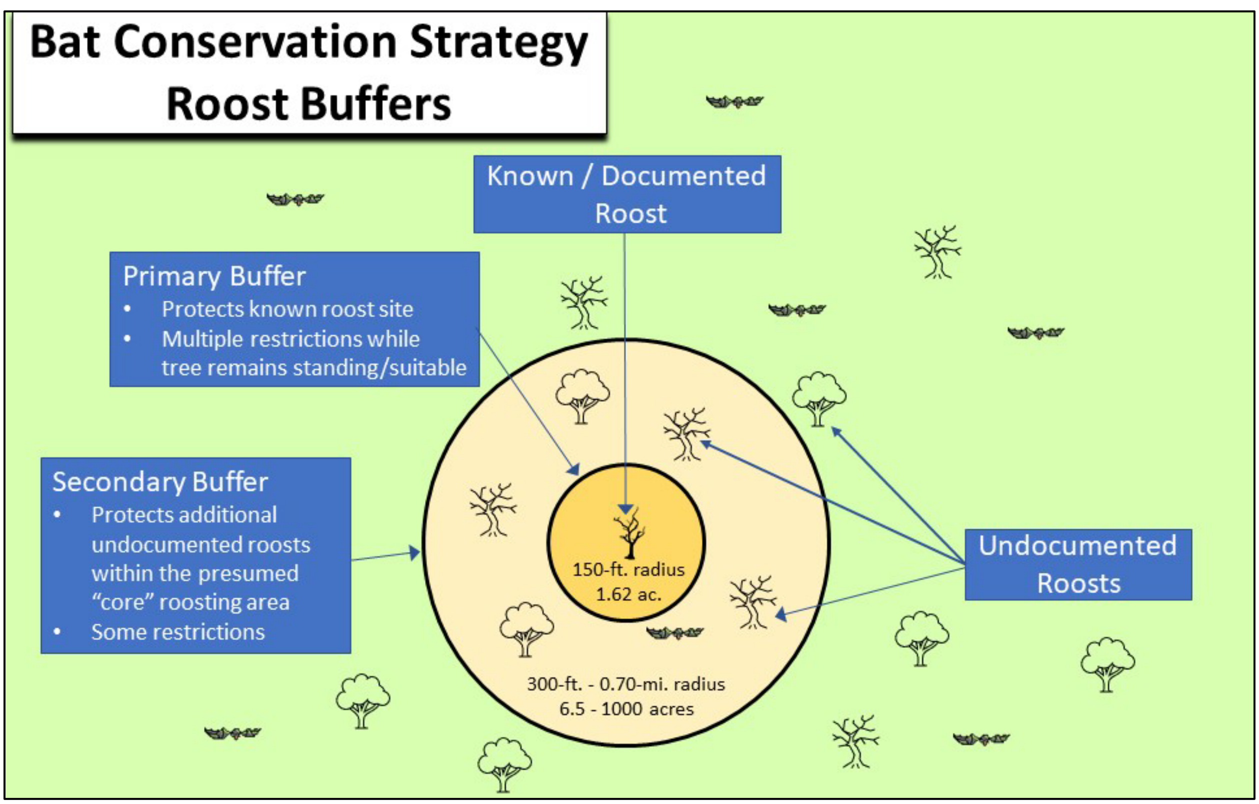
Secondary Roost and Maternity Capture Buffers

Secondary Roost Buffer

Maternity colonies return to suitable forested habitat patches within and between years showing site fidelity (e.g., Thompson 2006, Perry 2011), but colony members often switch roost trees within those areas every 2 to 5 days during the breeding season (e.g., Sasse and Pekins 1996, Foster and Kurta 1999, Menzel et al. 2002a, Carter and Feldhamer 2005, Timpone et al. 2010). Collectively, a colony will typically roost within dozens of different trees over the course of a summer. Some trees are routinely used by larger numbers of bats (i.e., a “primary” roost site), but adult females and their pups will also use a relatively large number of nearby alternate tree roosts. This roost-switching behavior between a network of roost sites likely facilitates 1) thermoregulation of individuals under variable weather conditions (Bergeson et al. 2021a), 2) maintenance of long-term social relationships between individuals within a colony, and 3) social interactions among colony members that may be important in exchanging information about potential new roosts (Willis and Brigham 2004, Johnson et al. 2012, Silvis et al. 2014b). This is important for bats, including the BCS species, occupying more ephemeral roost features such as snags; these bats may exhibit lower fidelity to a specific roost site but have also shown high levels of fidelity to roost areas (Kunz and Fenton 2003). Bats often display fidelity to a group of roosts that are clumped in the environment within these roost areas. The clumping of roosts used by bark- or cavity-roosting species, as well as those that roost in foliage, may result in part because clumped trees tend to be similar in age, and they simultaneously become exposed to windstorms, disease vectors, or rotting agents (Lacki et al. 2007). Additionally, nearby trees of similar size often simultaneously develop cavities or die and may possess similar favorable microclimate conditions.

Due to time, costs, and logistical constraints, bat biologists typically are only able to successfully locate a small fraction of a given colony's total number of roost sites while tracking a relatively small number of radio-tagged bats. For every maternal roost that is documented (i.e., "known"), there are often multiple others that are occupied or used, and may be for multiple years, but remain undocumented (i.e., "unknown"). To protect these additional undocumented roost trees that collectively comprise the core maternal roosting area, a secondary roost buffer will be created around known maternity roosts (Figure 4-1) where specific conservation measures will be applied.

Figure 4-1. Conceptual application of Primary and Secondary Roost Buffers.



There are considerable differences in the roosting and foraging ecology and areal extent of core roosting and foraging areas of the different BCS species. Thus, species-specific secondary roost buffers around known maternal roosts are needed. The sizes of species-specific secondary roost buffers are described in Table 4-1. These distances may be revisited and subject to change as new information becomes available in the future.

Table 4-1. BCS species-specific secondary roost buffers for known maternal roosts.

BCS Species	Secondary Roost Buffer Distance for Known Maternity Roosts	Secondary Roost Buffer Area for Known Maternity Roosts
Indiana Bat	0.7 mile	1,000 acres
Little Brown Bat	0.7 mile	1,000 acres
Northern Long-Eared Bat	0.25 mile	126 acres
Tricolored Bat	300 feet	6.5 acres

This secondary roost buffer, once established, will remain in place even if the associated primary roost buffer is removed. The secondary roost buffer will continue to apply to this area, including the area formerly covered by the primary roost buffer, until such time that defined removal criteria are met. The Criteria for Removing Roost or Capture Buffers are outlined below.

In addition to the scientific information documented in Table 4-2, we relied on professional judgement and experience to develop the species-specific secondary roost buffers. The secondary buffer is designed to minimize impacts to maternity colonies. Successful management of BCS habitat around known roosts includes balancing the need to protect BCS bats using these unique sites during vulnerable time periods—primarily when pregnant females and nonvolant pups are in maternity colonies. Thus, the goal for developing buffers and management considerations for the BCS is to minimize potential adverse impacts where and when management may pose the greatest risks where BCS species are known to occur on the landscape.

Table 4-2. Rationale of the primary and secondary roost buffer sizes.

Species	Buffer Category	Roost Buffer Distance	Rationale for Buffer Size
All BCS Species	Primary	150 feet (1.6 acres)	The Lakes States Forest Management Bat Habitat Conservation Plan – Michigan, Minnesota, and Wisconsin Departments of Natural Resources minimizes impacts on roosting bats by implementing a 150-foot buffer around all known occupied maternity roost trees for covered species (Indiana bat, northern long-eared bat, little brown bat, and tricolored bat) (ICF 2023). In addition to the final listing rule designating northern long-eared bat as a

Species	Buffer Category	Roost Buffer Distance	Rationale for Buffer Size
			threatened species on April 2, 2015, the FWS finalized a Section 4(d) rule exempting take that would occur as a result of certain activities, including most forest management activities, from the ESA's Section 9 take prohibition (FWS 2016a). Under the 4(d) rule, incidental take resulting from tree removal is only prohibited if it (1) occurs within 0.25-mile (0.4 kilometer) of known northern long-eared bat hibernacula entrance; or (2) cuts or destroys known, occupied maternity roost trees or any other trees within a 150-foot (45-meter) radius around the known, occupied maternity tree during the pup season (June 1 to July 31). A 39-foot buffer around a northern long-eared bat maternity roost tree during harvest in May allowed the roost to be successfully used through late July (O'Keefe 2009).
Indiana Bat or Little Brown Bat	Secondary	0.7 mile (1,000 acres)	Studies using radio telemetry tagging and various analysis methods have estimated average individual Indiana bat summer home range sizes of 205–917 acres (Jachowski et al. 2014; Kniowski and Gehrt 2014; Menzel et al. 2005, Sparks et al. 2005, Watrous et al. 2006) (TNFO 2018). Studies reported mean summer home ranges and foraging areas of female little brown bats of between 30 and 994 ha (74–2,456 acres) in an agricultural landscape (Henry et al 2002; Broders et al 2006; Bergeson et al 2013; Coleman et al 2014). Limited research suggests that optimal habitat patch size can range up to 30.1+/- 15 ha (74.4 +/- 37.1 acres) (Henry et al 2002). Bergeson and Carter (2012) found that movements of little brown and Indiana bats among roosts were somewhat different between the two species with Indiana bats switching roosts more often than little brown bats. Indiana bats had a mean movement distance of 1,079 m (0.7 mile) and a maximum distance of 1,574 m (1.0 mile) while little brown bats had a mean distance of 815 meters (0.5 mile) and a maximum distance of 1,100 meters (0.7 miles). Both species covered approximately the same maximum distance between roosts, Indiana bat with 1,468 m (0.9 mile) and little brown with 2,964 m (1.8 miles).
Northern Long-Eared Bat	Secondary	0.25 mile (126 acres)	Broders et al. (2006) found the maternity roosting area and foraging area of female northern long-eared bats (mean of 8.6 ha (21.3 acres) and 46.2 ha (114.2 acres), respectively) was larger than males (mean of 1.4 ha (3.5

Species	Buffer Category	Roost Buffer Distance	Rationale for Buffer Size
			acres) and 13.5 ha (33.4 acres), but Lereculeur (2013) found no difference between sexes at a study site in Tennessee. Broders et al. (2006) and Henderson and Broders (2008) found the foraging areas of either sex were six or more times larger than roosting areas. At sites in the Red River Gorge area of the Daniel Boone National Forest, Lacki et al. (2009b) found female home range size to range from 19 to 172 ha (47 to 425 acres). Owen et al. (2003) estimated average maternal home range size at 65 ha (161 acres). Silvis et al. (2015a) found that the maternity colony roosting area sizes at Fort Knox, a heavily forested landscape, ranged from 1.3 ha to 58 ha (3.2 acres to 143.3 acres, respectively). In Missouri, Timpone et al. (2010) radio-tracked 13 northern long-eared bats to 39 roosts and found the mean distance traveled between roost trees was 0.67 km (0.42 mile) (range 0.05–3.9 km (0.03–2.4 miles)). In Michigan, the longest distance moved by the same bat between roosts was 2 km (1.2 miles), and the shortest was 6 m (20 feet) (Foster and Kurta 1999). In the Ouachita Mountains of Arkansas, Perry and Thill (2007a) found that individuals moved among snags distributed in an area of about 2 ha (5 acres).
Tricolored Bat	Secondary	300 feet (6.5 acres)	Veilleux et al. (2003) showed tricolored bats traveling an average of 60 meters (range of 19 and 139 meters) between roost trees. Quinn and Broders 2007 found the distance from capture point to roosts ranged from 300 to 5,000 meters (0.19 to 3.1 miles). Veilleux et al. (2003) additionally documented that the mean distance from the site of capture to the roost area was 720 meters (0.44 mile) (range = 50–2,610 meters, or up to 1.6 miles). The roost area for female tricolored bats, that used equal to or greater than 3 roost trees, was 0.23 ha (0.57 acres) (range = 0.03 and 0.42 ha; or, 0.07 and 1.0 acre) (Veilleux et al 2003). Veilleux and Veilleux (2004) found that the minimum and maximum distances between two roost trees, based on observations of three reproductively active females, was 13 m and 857 m with the minimum roost area ranged between 0.1 ha and 2.2 ha (0.25 acre and 5.4 acres).

Maternity Capture Buffers

Mist net captures of reproductive females and juveniles (aka "maternity captures") provide evidence of nearby maternity colonies. Maternity captures are defined as pregnant, lactating, and post-lactating females as well as juvenile captures between April 15 and August 15 and are considered indicative of the presence of nearby maternity roosts.

For the purposes of the BCS, where a roost tree near a maternity capture has not been identified, a maternity capture buffer will be established around capture sites and will be treated the same as a secondary roost buffer for known maternal roosts areas (see the Conservation Measures for Secondary Roost and Maternity Capture Buffers section below). Providing buffers around these maternity capture sites will provide for conservation of these individuals until the specific roosts are discovered or it has been determined that the bats are no longer present. Other captures, such as juveniles after August 15th, males, and non-reproductive females will not receive any maternity capture buffers.

While the CMs and CRs for maternity capture buffers are the same as for secondary roost buffers around known maternity roosts, the buffer size would be larger around maternity capture sites than for known roosts to accommodate for the uncertainty of the roost location (see Table 4-3). The observations and rationale provided for secondary roost buffers (see Table 4-2) were considered to identify a maternity capture buffer distance that would provide reasonable protections to the unknown maternity colony that is likely occupying the area. Until we have more evidence as to where bats are (e.g. until at least one maternity roost trees in the immediate area is identified), maternity capture buffers are expected to provide protections for a larger area that hopefully includes unknown maternity roosts. Because BCS species use of an area can be highly variable, and specific roosts are unknown, the larger buffers are intended to provide protections across the majority of the area that an individual bat may be using to forage or for nightly travel around those unknown roosts.

Table 4-3. BCS species-specific maternity capture buffers.

BCS Species	Maternity Capture Buffer Distance	Maternity Capture Buffer Area
Indiana Bat	1.8 miles	6,514 acres
Little Brown Bat	1.8 miles	6,514 acres
Northern Long-eared Bat	0.75 mile	1,131 acres
Tricolored Bat	0.75 mile	1,131 acres

Known non-reproductive capture sites are indicative of potential use of an area by a BCS species during the active season; however, the capture buffers and corresponding CMs and CRs would not apply for these types of sites. Instead, these types of sites should be used in future efforts to improve our knowledge of the bat's use of the landscape. This location and species information may be used to develop and validate occupancy models, monitor bat response to management activities, determine the effectiveness of conservation efforts, etc.

Criteria for Applying a Maternity Capture Buffer

For the purposes of the BCS, in areas where WNS declines have occurred, only maternity captures documented after the local post-WNS year will be buffered (see Appendix D). For areas not impacted by WNS, all maternity captures shall be buffered. Where white-nose syndrome (WNS) has been detected, buffers will only be placed around maternity capture sites documented after the local post-WNS[9] year. For those areas not yet impacted by WNS, all maternity capture sites will be buffered. The timeframe for applying post-WNS capture buffers would be determined as follows. See Appendix D for WNS detection and post-WNS dates by administrative unit:

- If there is local data based on when local population crashes occurred, that date would be used to determine the post-WNS baseline year (typically 2 to 4 years after WNS is discovered, dependent on location and species, see Appendix D). Captures from that point on would be buffered.
- If data is available for when WNS was detected locally but site-specific data[10] are not available to determine when the local population crash occurred, then the post-WNS baseline would be calculated as 2 years after WNS was first confirmed locally for northern long-eared, little brown, tricolored, and Indiana bats in the Northeast and Appalachian Recovery Units.
- If no information is available for when WNS was first detected locally, then FS units will rely on the national WNS map (available on https://www.whitenosesyndrome.org) to determine when WNS was confirmed in their geographic area (i.e., county or state). The post-WNS baseline would then be calculated as 2 years after the provided date.
- Indiana bat captures in the Ozark-Central and Midwest Recovery Units would not have a cut-off date (i.e., all maternity captures will be buffered) as those bats have not seen the same degree of population declines observed in other parts of the species' range (i.e., Northeast and Appalachian Recovery Units). This may also include areas where the *Pseudogymnoascus destructans* (Pd) fungus has been detected but where bat populations have not yet been affected (e.g., coastal zones).
- Where WNS has not been detected, such as the far South, there would be no cut-off date for applying maternity capture buffers of these cohorts.

[9] Post-white-nose syndrome is in reference to when the Pd fungus was first detected locally. It is assumed that Pd continues to be present in the areas it has been detected. See Appendix D for white-nose syndrome detection date by National Forest Unit.

[10] Evidence of population declines may come from data collected by mist netting, winter hibernacula count, etc.

The CMs and CRs established for secondary roost buffers will apply within maternity capture buffers. The maternity capture buffer distances are larger than known roost buffer distances and are based on literature indicating how far each BCS species typically forages from its roost areas.

RMC-O-20A: Implement a species-specific secondary roost buffer centered on each known *maternity* roost in trees or bat boxes to reduce potential adverse impacts to roosting BCS species and manage habitat within the core maternal roosting area. See Table 4-1 for BCS species-specific secondary roost buffer distances.

- In circumstances where the sex and reproductive status of the occupying BCS species are unknown, or the probability of it being a maternity roost is high, a secondary roost buffer will be delineated around the known roost.
- For those rare situations when a maternity roost is located but the BCS species using the roost is unknown, the local FS biologist, in coordination with FWS, will adopt the established secondary roost buffer distance for the species determined most likely to use the roost until such time that species confirmation can occur.

RMC-O-20B: Implement a species-specific maternity capture buffer centered on each capture site where reproductive female and juvenile BCS species are captured between April 15 and August 15 to conserve individuals until specific roosts are discovered or bats are documented as no longer present. See Table 4-3 for BCS species-specific maternity capture buffer distances.

Conservation Measures for Secondary Roost and Maternity Capture Buffers

RMC-CM-20.1: Prohibit management activities that are not consistent with the intent of the secondary roost buffer or maternity capture buffer during the **entire year**:

- Firewood cutting of any standing snags or trees.
- Commercial or personal use collection/harvest activities of special forest products that have negative effects to BCS species or their habitats, such as any item(s) deemed to be a component of or contribute to the characteristics of potential roost sites will be prohibited from harvest (e.g., shagbark hickory bark, Spanish moss, etc.). Such activities must be evaluated and approved on a case-by-case basis in coordination with a FS biologist.

- Construction of new, or expansion, modification, or realignment of maintenance level 4-5 roads outside of existing, cleared rights-of-way (i.e. trees are already cleared).

- Coordinate with a FS Biologist for any other activity that may impact the integrity of the roosting area or undocumented roosts that is not specified in the conservation measures and recommendations for the secondary roost buffer below.

RMC-CM-20.2: Prohibit permanent tree removal and permanent land use conversion (includes living and standing dead suitable roost trees) during the **summer occupancy period*** (see Appendix B for local dates) within a secondary roost buffer or maternity capture buffer.

*Coastal Zone Units Only: Where bats are active year-round, these timing restrictions will also be in place when temperatures are below 40°F when bats may enter a brief torpor.

RMC-CM-20.3: During the **summer occupancy period** (see Appendix B for local dates) cutting of high-priority hazard trees within the secondary roost buffer or maternity capture buffer is prohibited unless the following conditions are met:

- Prior to removal, conduct an emergence survey (see Appendix C protocol) when air temperatures are above 50°F.

- If bats are not observed during the survey, cut tree within 24 hours of survey.

- If bats are observed during the survey, coordinate with FWS prior to cutting.

When emergence surveys are planned within a roost buffer, coordination with the local FWS field office is required prior to conducting the survey. Modification to the protocol could be appropriate depending on the BCS species that may be present.

RMC-CM-20.4: Within the secondary roost buffer or maternity capture buffer, prohibit all tree cutting (includes living and standing dead suitable roost trees) during the **pup season*** (see Appendix B for local dates) unless there is an imminent threat to human safety.

Additional considerations for tree cutting within the secondary roost or maternity capture buffer include:

- If a high-priority hazard tree must be cut, see RMC-CM-20.3.

- Timber harvest conducted during timeframes outside of the pup season is allowable but must be designed to improve bat roosting and foraging habitat or respond to forest health issues (i.e., salvage). Activities must retain live trees ≥12” DBH and all snags, where safety allows.

- Management for insect and disease outbreaks and other forest health issues (such as oak decline) conducted outside of the pup season is allowable. Only the minimum number of trees required to prevent or contain the spread should be cut. If it is critical to remove trees during the seasonally restricted period, coordinate with FS biologist and FWS; stand-alone consultation may be necessary.

- Maintenance to existing roads or trails is allowable but only the minimum number of trees necessary should be cut.

* Coastal Zone Units Only: Where bats are active year-round, prohibitions also apply when temperatures are below 40°F (when bats may enter a brief torpor).

RMC-CR-20.5: Avoid direct disturbance to trees (e.g., sounding, girdling, coring, tagging, etc.) during the **summer occupancy period** (see Appendix B for local dates) that could result in the mortality, injury, or roost abandonment by bats in undocumented roost trees within the secondary roost buffer or maternity capture buffer.

RMC-CM-20.6: Even-aged regeneration harvest units shall not exceed 40 acres in size within a secondary roost buffer.

RMC-CM-20.7: Prescribed fire to achieve specific restoration objectives during the **pup season** in a secondary roost buffer or maternity capture buffer will be conducted with low intensity burning conditions and minimize smoke impacts around roost trees.

BCS Species’ Roosts and Maternity Capture Sites Occurring Outside National Forest System Lands

Situations may exist where BCS species’ roosts and maternity capture sites occur outside, but near National Forest System lands. While these “off-forest” roost, maternity capture site, and associated features are not managed by the Forest Service, occupying bats are using the surrounding landscape that may include adjacent National Forest System lands. Where Forest Service managers are aware of BCS bat occupied roosts and maternity capture sites occurring within 0.7 miles (roost) or 1.8 miles (capture buffer) of National Forest System lands, evaluate these sites and apply BCS roost and maternity buffers as described above as appropriate. If a BCS buffer(s) applied to an off-forest roost or maternity capture site extends into and overlaps with National Forest System lands, then all CMs and CRs will be applied as appropriate to the overlapping portions that are within the authority of the Forest Service to manage. See Figure E-1 for an example of a conceptual application of BCS buffers for off-Forest BCS features.

Off-forest roost and maternity capture site locations themselves and portions of the associated buffers that are off National Forest System lands would not typically be managed by the FS—the BCS does not apply to private lands or other ownerships that are outside the management authority of the Forest Service. However, if the FS has other management authority regarding these off-forest roost and maternity capture sites (such as an agreement, funding, or another mechanism or authority), then the buffers and associated CMs and CRs should be implemented within the entire buffer area where possible and as allowed. The applicability of this management authority would only extend for the space and duration in which the FS has responsibility for the feature or has management responsibility for actions that occur within the buffered areas. At such time the FS management authority and responsibility ceases, the provisions of the BCS would no longer apply to those areas outside National Forest System managed lands.

Roosts in Transportation Structures and Other Anthropogenic Structures

RMC-O-21: Reduce negative impacts to bats roosting within transportation and other anthropogenic structures (e.g., bridges, culverts, tunnels, homes, offices, outbuildings, etc.) or conduct humane exclusion in tandem with suitable alternative accommodation in coordination with FWS.

The 150-foot primary roost buffer will be applied to known bat roosts present in transportation structures (including but not limited to bridges, culverts, tunnels, etc.), buildings, recreational shelters, and other anthropogenic structures (such as hydropower dams). The secondary roost buffer for any known maternity roosts in these structures will also be applied; however, not all associated conservation measures and recommendations may be applicable given the circumstance and particulars of the structure in question. The structural condition of the building, current human occupancy and use of the structure, the biological importance of the structure as a roost, potential human health and safety concerns, and the physical location of the structure itself (i.e., is the structure in a forested or urban setting, is the surrounding area in FS ownership or management, etc.) are some examples of items to consider. FS biologist input, and coordination with FWS, is required if a secondary roost buffer cannot be applied or there are questions about whether the secondary roost buffer is appropriate for the given situation and what additional protection makes sense.

In some circumstances, as mentioned above, it may not be practical or possible to fully apply one or both roost buffers in terms of transportation and other anthropogenic structures. When possible, the minimum application of the primary roost buffer for these structures will help to maintain the integrity (i.e., microclimate) of the roost during critical periods and minimize directly impacting or disturbing bats when they are present. Additional protections in the vicinity of occupied structures may be needed to ensure the continued suitability of the site, or perhaps the best option is to provide alternate suitable roosting space and humanely exclude bats from the structure. The following conservation measures and recommendations will help to avoid and minimize effects to BCS species roosting in anthropogenic structures.

Please Note: Not every scenario where bats are found roosting in a human-made structure will be the same and each must be taken as their own unique situation. The following information and recommendations are meant to be a starting point and to provide foundational guidance for the conservation of the BCS species. FS biologist input, in coordination with FWS, is needed to address any issues or circumstances not covered here. Additionally, in situations where roosting BCS species need to be humanely excluded from a structure, coordinate with FWS *before* undertaking any exclusion activities. For additional information and general recommendations and mitigations for BCS species roosting in structures, see Appendix G.

If a building or other structure is used as a hibernaculum, see HMC-CM-9.1.

Conservation Measures and Conservation Recommendations for Anthropogenic Structures Used as Roosts:

RMC-CM-21.1: If BCS species are occupying a building or other anthropogenic structure, apply the 150-foot primary roost buffer, and the species-specific secondary roost buffer, as appropriate, to the roost site. All applicable primary and secondary roost buffer conservation measures and recommendations apply. Where artificial roosts are present in administrative areas, routine administrative activities, such as grass mowing, garbage collection, restroom cleaning, campsite maintenance, fee collection, camping, etc., can proceed. Coordinate with a FS biologist if there are questions whether an administrative activity can be considered routine as it relates to BCS species. If valid human health and safety concerns or other extenuating reasons exist that make the application of the roost buffer(s) impossible or the buffer(s) itself would severely impact or alter the maintenance, use, and function of the building or structure in question, evaluation of protection measures may be necessary on a case-by-case basis with FS biologist input and in coordination with FWS.

RMC-CM-21.2: For structures used as a roost, occupancy surveys shall be conducted by a qualified individual prior to maintenance, repair, or replacement of existing anthropogenic structures (e.g., bridges, culverts, buildings, etc.) when BCS species may be present (as described in LTH-CM-8.1 and 8.2):

- Conduct the work at a time of year when bats are not using the structure.
- If planned maintenance, repair, replacement, or demolition activities must occur when BCS species are present, coordinate with FWS prior to

activities taking place to identify appropriate steps to avoid or minimize adverse impacts; the project may require consultation outside the BCS.

RMC-CM-21.3: When bats are occupying buildings and similar structures, coordinate with FWS to develop measures to encourage the bats to move by using appropriately-timed humane exclusion methods or other humane options such as acoustic deterrents (see Appendix G) when the presence of BCS or unidentified bat species may impact human health or safety within a man-made structure. Suitable alternative roost(s) shall be provided in conjunction with these activities.

RMC-CM-21.4: If planned required maintenance, repair, or another expected bat-disturbing activity must occur in a confirmed BCS or unidentified bat species-occupied structure, activities will be scheduled when bats are not present. In situations where the building or similar structure is being removed or otherwise made unsuitable for roosting and the occupying bat colony has 100 or more bats, provide a suitable roost alternative capable of supporting the colony size (e.g. bat condo, clusters of modular bat boxes, etc.).

Note: If planned required maintenance, repair, or another activity expected to disturb BCS or unidentified bat species must occur when bats are present, coordinate with FWS prior to activities taking place to identify appropriate steps to avoid or minimize adverse impacts (e.g. using appropriately-timed exclusion methods or installing suitable alternative roosts). The project may require consultation outside the BCS.

RMC-CM-21.5: For construction, maintenance, repair, or replacement of transportation structures where there is evidence of bat use of the structure (see LTH-CM-8.1):

- Conduct the work at a time of year when bats are not using the transportation structure.
- If planned maintenance, repair, or replacement of transportation structures must occur when BCS species are present, coordinate with FWS prior to activities taking place to identify appropriate steps to avoid or minimize adverse impacts. If there is potential for a maternity colony or more than 5 bats may be affected, the project may require consultation outside the BCS.

RMC-CR-21.6: Conduct periodic inspections of human occupied structures, especially those with documented past bat use, and prioritize efforts to prevent individual BCS bats or colonies from becoming established within.

RMC-CR-21.7: In those situations where bats are present within a public access structure, such as a picnic shelter, and humane exclusion efforts cannot be completed or are unsuccessful, consider a closure order to administratively close the site to protect bats during critical periods (e.g., summer occupancy period).

RMC-CR-21.8: If anthropogenic structures (e.g. bridges, culverts, buildings, etc.) with documented bat use are no longer needed, consider leaving them on site to continue providing bat habitat if there are no overriding concerns, like public safety, administrative, maintenance, policy, or ordinance. If they must be replaced or demolished, strive to incorporate similar roosting opportunities into the new structure (or provide an alternate structure) to the extent practicable.

Criteria for Removing or Modifying Roost or Capture Buffers

Bats have evolved to use a variety of roosts, and bat species differ considerably in their selection, use, and fidelity to roosts and roost areas. Roost type, selection, and use can be dependent on the location within the animal's range, distance to and from foraging habitats and water, roost condition (e.g., solar exposure, microclimate, cavity volume), surrounding landscape (or stand) condition and weather conditions. Criteria for removing buffers (changing status from active to historic) on roosts will typically depend on the location within the animal's range, type of roosts (hardwood vs. pine), age and condition of roosts, and changes in the condition of the surrounding landscape and stands (i.e., local forest conditions).

The primary roost buffer associated with a BCS species roost that becomes unsuitable or unusable may be removed following the criteria outlined below. This secondary roost buffer, once established, will remain in place even if the associated primary roost buffer is removed. All associated secondary roost buffer conservations measures and recommendations will apply to this area, including the area formerly covered by the primary roost buffer, until such time that defined removal criteria are met.

Though removal of a primary or secondary roost buffer after the associated roost becomes unsuitable is not required under the BCS, it is recognized that it may be necessary in certain circumstances or to meet management objectives, including bat habitat objectives. To provide management flexibility, the primary and/or secondary buffer may be removed following the criteria outlined below.

NOTE: If a primary and secondary roost buffer have been destroyed and made unsuitable due to factors such as hurricanes, tornados, wind events, floods, or catastrophic fire, a primary roost buffer may be removed in coordination with FWS.

Removing the Primary Roost Buffer

The primary 150-foot buffer can be removed from known roosts that have fallen down, are no longer accessible to bats, or no longer possess the characteristics of a suitable roost. When determining roost suitability, refer to Appendix A for general and species-specific roost characteristics. For example, the availability of exfoliating bark, suitable cavities, cracks, and crevices are important roost characteristics for Indiana, northern long-eared and little brown bats. For tricolored bats, availability of live or dead leaf clusters (or Spanish moss) in either live or dead trees is important.

When a known roost is determined to be unsuitable, the primary roost buffer and all associated restrictions can be removed.

NOTE: A known roost is considered occupied or "active" while the roost and surrounding habitat remain suitable for covered BCS species or until such time as surveys reveal the roost is unoccupied. Snag roosts over 10 years past documentation are also considered "historic," see RMC-CM-18.1.

Removing the Secondary Roost Buffer

The secondary roost buffer, established around known suitable maternity roosts, will continue to be applied (centered on the former maternal roost location) and considered "active" until:

- There are no remaining known maternity roosts within the buffer; and
- Presence/absence surveys have been conducted according to the appropriate protocols within the FWS' most recent range-wide survey guidelines for BCS species (e.g., US Fish and Wildlife Service, 2023) and produce negative results that are ap proved by the FWS. FWS range-wide survey guidelines are currently unavailable for all BCS species. Once these survey guidelines become available, presence/absence surveys would then be conducted following the respective guidance for the species present. Until then, surveys for all BCS species will meet the survey guidelines for the Indiana bat and northern long-eared bat.

NOTE: BCS species show varying levels of site fidelity and roost switching behavior over the course of a season and between years. It can be reasonably assumed that if bats once occupied a maternity roost that is no longer suitable, they could still be using other potential roosts within the surrounding area. For this reason, the location of the former maternity roost will be included into any presence/absence surveys required to remove the secondary roost buffer.

Modifying the Secondary Roost Buffer

RMC-O-22: Apply buffers as appropriate to the most site-specific information available.

Bat data collected over time in some locations have identified maternity colonies and delineated home ranges using radio telemetry. These areas generally include the primary roost, alternate roosts, and foraging areas. These buffers or known areas of use should remain in place until it is determined that they are no longer occupied.

RMC-CM-22.1: If a Forest has more site-specific information (i.e, data from telemetry efforts) to delineate a maternity area more specific than a circular buffer prescribed in the BCS, they may coordinate with FWS to determine if adjustments to the size and shape of the secondary roost buffer should be made based on either telemetry information or habitat suitability. If a buffer is already in place for a maternity area, coordinate with the local FWS field office to determine the appropriate size and shape of the secondary roost buffer for that circumstance.

Removing Maternity Capture Buffers

We propose two circumstances in which a maternity capture buffer may be removed. The ability for the FS to remove the larger maternity capture buffer would provide incentive for additional survey efforts to improve our understanding of the bats that remain on the landscape:

- Mist-netting would be targeted to capture and radio-tag reproductive females or juveniles to locate current maternal roosts and roost areas. When these subsequent surveys within the maternity capture buffer of an eligible capture site successfully redocuments reproductive females or juveniles, and telemetry successfully locates one or more maternity roost(s) of the same species, then the associated maternity capture buffer would be replaced with more species-specific primary and secondary roost buffers in accordance with Table 4-1.
- For sites where it is suspected that reproductive females and juveniles no longer occur, the FS and FWS will jointly develop a survey approach that outlines an appropriate level of subsequent monitoring needed to determine that a maternity colony is no longer in the vicinity of a capture site. When this level of effort is reached and no BCS bats are captured or detected, the maternity capture buffer would be removed in coordination with FWS. FS and FWS will develop a survey approach within three to five years of adopting the final BCS.

APPENDIX A. LIFE HISTORY, HABITAT USE, AND ROOST CHARATERISTICS OF BCS SPECIES

Appendix A provides general characteristics of roosts that can assist individuals in understanding what bats are using on the landscape and potentially selecting for in terms of roosting sites. Bat roosts can include general day roosts, maternity roosts, night roosts, and winter roosts. Roost sites can be defined as any location (e.g. trees, bat box, structure, bridge, rock outcrop, talus slope, etc.) where bats roost singly or in colonies. This information will provide a foundation from which to create a clear search image for assessing and protecting existing roosts as well as assessing the need for recruiting and protecting potential future roosts. For this discussion and the overall BCS, bat boxes and similar bat-specific constructed roost structures will be considered in the same context as natural tree roosts. Though an artificial roost, their placement and general function on the landscape most closely matches that provided by tree roosts than other human-made structures.

Species status assessment for the northern long-eared bat includes additional information for that species: https://www.fws.gov/media/species-status-assessment-report-northern-long-eared-bat.

Tricolored Bat: https://www.fws.gov/species/tricolored-bat-perimyotis-subflavus

It is recommended that a FS biologist coordinate with FWS to define suitable habitat more clearly for their region when needed as some differences in state and regional suitability criteria may be warranted. It is important to understand how BCS bats use and interact with the landscape and the information in this appendix is meant to provide a starting point for understanding general roosting information.

Table A-1. Summary of general bat roosting requirements and characteristics (Adapted from the Lake States Forest Management Bat Habitat Conservation Plan (ICF 2023)

Characteristics	Description
Solar Exposure	Trees with roosts that are exposed to the sun are able to heat quickly providing suitable roosts. This is often tied to the following factors: The tree height relative to the rest of the canopy, with tall trees getting more sun The location of the tree in the forest, with edge trees receiving more sun
Wind and Rain	Exposure to wind and rain weathers trees, which helps to create favorable bat roost characteristics. However, these potential roosting sites must also provide shelter and protection from the elements to be suitable as bat roosts.
Topographic Position	Trees near the top of a high point receive greater exposure to both sun and weather. This helps to create bat suitable roosting characteristics and potentially improve roost condition with increased solar exposure. In addition, areas prone to natural disturbance events (i.e., fire, storms, periodic flooding) are likely to contain suitable roosts because these events accelerate snag creation and promote structural complexity of the forest. Proximity to bottomlands, riparian areas, and other water features also improve roost suitability for foraging bats. It should be noted that topographic influence is likely less important in areas with less variation in topography. Elevational constraints may also exist in some regions (e.g., high-elevation areas may not be suitable habitat).
Size and Condition	Trees with cavities, cracks, crevices, large areas of loose bark, leaf clusters and hanging dead foliage provide prime habitat for bats. In general, larger trees are more beneficial to bats than smaller trees because larger trees are more likely to have these preferred habitat structures. Also, the water contained in living trees acts as a thermal mass so larger trees heat and cool more slowly than smaller trees.
Attributes of Trees Contributing to Suitable Roosting Habitat	Tree species that provide multiple types of roosting features (e.g., loose/exfoliating bark, cavities, crevices, cracks, broken limbs, Spanish moss, and hanging dead foliage) and remain viable for multiple years. Tree species that remain on the landscape long after developing cavities. Tree species that, following death, provide sheets of bark under which bats roost. Tree species that provide cavities but are heavily shaded until they die. Live tree species that provide bark habitat (curls or shags) used by individual bats.

Summary of species-specific roosting requirements for the four bats covered by the BCS

Indiana Bat

Suitable summer roosting habitat for Indiana bats include a variety of forested/wooded habitats and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent openings. This includes forests and woodlots, as well as linear features such as fencerows, riparian forests, and other wooded corridors, containing potential roosts (i.e., live trees and/or snags ≥5 inches DBH with exfoliating bark, cracks, crevices, and/or cavities). These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Individual trees may be considered suitable habitat when they exhibit the characteristics of a potential roost tree and are located within 1,000 feet of other forested/wooded habitat (FWS 2023).

Indiana bats can be found under the hanging, loose bark of live, dead, or partially dead trees. Preference seems to be for roosting under exfoliating bark. Larger trees (e.g., 18-inch or greater DBH) tend to be used by more bats (e.g., maternity colonies) and get several hours of direct sunlight per day, although there is variability in roost canopy cover depending on factors such as weather (Luensmann 2005). These larger trees, and others, may function as a node of a network of roosts (Silvis et al. 2014b). Indiana bats also roost in bat boxes that include features that resemble sloughing bark (Gumbert et al. 2013).

Examples of unsuitable habitat:

- Individual trees that are greater than 1,000 feet from forested/wooded areas;
- Trees found in highly developed urban areas (e.g., street trees, downtown areas); and
- A pure stand of less than 3-inch DBH trees that are not mixed with larger trees.

Northern Long-Eared Bat

Suitable summer roosting habitat for northern long-eared bats include a variety of forested/wooded habitats and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent openings. This includes forests and woodlots, as well as linear features such as fencerows, riparian forests, and other wooded corridors, containing potential roosts (i.e., live trees and/or snags ≥3 inches DBH with exfoliating bark, cracks, crevices, and/or cavities). These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Individual trees may be considered suitable habitat when they exhibit the characteristics of a potential roost tree and are located within 1,000 feet of other forested/wooded habitat (FWS 2023).

Northern long-eared bats can be found under the loose bark of live or dead trees. Cavity trees, typically 12-inch or greater DBH, or those with hollow limbs, can serve multiple bats over many years and may be the node of a network of roosts. NLEB also roost in anthropogenic structures, such as but not limited to buildings, barns, bridges, and bat boxes.

Examples of unsuitable habitat:

- Individual trees that are greater than 1,000 feet from forested/wooded areas;
- Trees found in highly developed urban areas (e.g., street trees, downtown areas); and
- A pure stand of less than 3-inch DBH trees that are not mixed with larger trees.

Little Brown Bat

Suitable summer roosting habitat for little brown bats include a variety of forested/wooded habitats and may include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent openings. This includes forests and woodlots, as well as linear features such as fencerows, riparian forests, and other wooded corridors, containing potential roosts (i.e., live trees and/or snags ≥5 inches DBH with exfoliating bark, cracks, crevices, and/or cavities). These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure.

Little brown bats can be found in a variety of natural sites that include trees, rock piles, boulder fields, etc. depending on reproductive status, gender, and daily needs (FWS 2016b). As with Indiana and northern long-eared bats, larger trees can be expected to harbor more bats and remain suitable longer. Bergeson and Carter (2012) showed an average size tree roost used by little brown bats to be approximately 22 inches DBH (56.9 cm). Crevices created by storm damaged trees (i.e., broken tops) also provide roosting opportunities. Little brown bats also roost in anthropogenic structures, such as but not limited to, attics of buildings, barns, expansion cracks of bridges, box culverts, bat boxes, under awnings, etc.

Maternity colonies, ranging in size from a few individuals to over a thousand, roost in natural sites and anthropogenic structures. Smaller maternity colonies have also, on rare occasion, been documented using tree cavities or caves. As with Indiana bats, maternity colonies tend to use large, dead trees with substantial solar exposure. Roosts in cracks and crevices seem to be the primary preference for maternity colonies, with exfoliating bark secondary. Males tend to be solitary in summer using secluded places in buildings, rock crevices, trees, caves, or mines, and are rarely found in groups (FWS 2016b).

Tricolored Bat

Suitable summer roosting habitat for tricolored bats predominately include the foliage of live deciduous hardwood trees. Roosts are often in clusters of live and dead foliage of live and recently dead trees or broken branches that retain dead leaves. Dead leaf roosts vary in size but are similar in shape: umbrella-like shelter, resulting in a protective roof of dead foliage and a hollow core into which bats retreat (Veilleux et al. 2003; Thames 2020). Single dead leaves may also serve as roosting sites for lone males (Perry and Thill 2007b). Oaks are selected more often than other tree species, followed by hickories and to a lesser extent, maples.

Tricolored bats commonly roost in the mid to upper canopy of tall, large diameter trees, although males will occasionally roost in dead leaves at lower heights (e.g., less than 16 feet from the ground; Perry and Thill 2007b) and females in Spanish moss of understory trees (Menzel et al. 1999). Preferred trees tend to be greater than 12 inches DBH for females, and around 8 inches DBH or greater for males. Tricolored bats generally select taller trees in relation to other available trees (Zirkle 2022) and select roosts with dense vegetation above and more open conditions below the roost (Yates and Muzika 2006; Perry and Thill 2007b; Thames 2020). Roosting tends to occur in mature stands much more often than in younger stands, presumably because old growth oak, and similar species, provide more roosting opportunities (in foliage) as the branches break and fold down (Veilleux et al. 2003, Perry and Thill 2007b).

Tricolored bats may also roost in Spanish moss (southern range) and beard lichen (northern range) in those portions of the bats range when present. Occasional roosts include clusters of dead pine needles of large live pines, live branches of Norway spruce, eastern red cedar, abandoned squirrel nests, and under the peeling bark of paper birch and river birch (Veilleux et al. 2003; Perry and Thill 2007b; Wisconsin DNR 2016; Wisconsin DNR 2017a; Wisconsin DNR 2017b; Wisconsin DNR 2018; Thames 2020). Anthropogenic structures (e.g. artificial roosts, barns, porch roofs, bridges, concrete bunkers, partially enclosed buildings such as under awnings, picnic shelters, and overhangs for covered porches) are used opportunistically and to a lesser extent than foliage, particularly in early spring prior to leaf-out (Allen 1921; Lane 1946; Cope et al 1961; Jones and Pagels 1968; Jones and Suttkus 1973; Hamilton and Whitaker 1979; Hoying and Kunz 1998; Whitaker 1998; Whitaker et al. 2014; Wisconsin DNR 2017b). Tricolored bats also use caves, mines, and rock shelters (e.g., bluff shelter, grotto habitat). Tree cavities (or hollows) and culverts are important during the winter in the southern range where they are active year-round (Newman et al. 2021).

APPENDIX B. BAT ACTIVITY PERIODS

Activity time periods for BCS species are separated by periods of activity and inactivity. These activity periods are defined in Table B-1 below, and in the glossary.

Table B-1. Bat Activity Periods and Definitions

Hibernation	Winter Torpor	Spring Staging	Summer Occupancy	Pup Season	Fall Swarming
Timeframe when most bats are hibernating (i.e., inactive season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor (coastal zones only)	Timeframe when most bats are emerging from hibernation, roosting near hibernacula, and preparing for migration to summer home range	Timeframe when bats are present on their summer home range and/or roosting in colonies[11]	Timeframe during late pregnancy and when most young are born until they can fly and forage independently	Period of increased activity near hibernacula (including foraging, roosting in trees, and mating) prior to hibernation

In most areas during winter months, all four BCS species enter an extended hibernation period. But in coastal zones, insect prey and other resources are generally available year-round and temperatures are warm enough that BCS species to not have to hibernate for extended periods to conserve energy. However, even with coastal zones there is variability during the winter season. In Coastal Zone 1, BCS species are generally active year-round, but may enter into a brief torpor when temperatures drop below 40°F. In Coastal Zone 2, weather tends to be very mild and temperatures rarely, if ever, drop below 40°F. Thus, in Coastal Zone 2, BCS species are unlikely to enter into torpor at any point.

- Hibernation Zone (all non-coastal areas): Bats generally occupy forested habitats during the summer and hibernate in caves and similar structures during winter.
- Coastal Zone 1 (Year-Round Active Range – Winter Torpor): Bats are generally active year-round but may enter brief torpor when temperatures drop below 40° F.

[11] IBAT (rangewide) and NLEB (hibernating range) often remain in colonies until the end of Summer Occupancy. TCB (rangewide) and NLEB (year-round active range) roost singly once young can fly and forage independently (i.e., the end of the pup season).

- Coastal Zone 2 (Year-Round Active Range): Bats are considered to be active year-round.

The date ranges for each bat activity period are variable depending on location. These date ranges were developed by the FWS after reviewing local information on BCS species behavior for each state. Table B-2 provides the activity dates for each FS unit included in the BCS according to the state-wide activity dates developed by the FWS. These dates may be updated in the future as more information on local bat activity is collected.

For Coastal Zone 1, the FWS identified a winter torpor period to denote the period of time that temperatures are most likely to drop below 40°F and bats may enter a temporary torpor. A torpor period was not identified for Coastal Zone 2 since temperatures in these areas rarely, if ever, drop below 40°F. For the purposes of the BCS, we utilized the 40°F threshold to develop CMs and CRs that provide additional protections (generally by way of activity restrictions) for bats within the coastal zones when bats may be in temporary torpor. The activity restrictions would apply for both coastal zones any time the temperature threshold is met and would not be limited to the winter torpor period.

Table B-2. Bat activity dates by Forest Service unit

Forest or District (State)	**Hibernation**	**Winter Torpor (Applies to Coastal Zones Only)**	**Spring Staging**	**Summer Occupancy**	**Pup Season**	**Fall Swarming**
Allegheny NF (PA)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15
Chattahoochee-Oconee NF; Blue Ridge, Chattooga River, Conasauga (GA Hibernating Range)	Nov 16–Mar 14	*does not apply*	Mar 15–Apr 30	Mar 15 – Sept 30	May 15–July 31	Sept 1–Nov 15
Chattahoochee-Oconee NF; Oconee (GA Year-round Active Range Zone 1)	*does not apply*	Below 40°F	*does not apply*	Mar 15 – July 15	May 1–July 15	*does not apply*

Forest or District (State)	Hibernation	Winter Torpor (Applies to Coastal Zones Only)	Spring Staging	Summer Occupancy	Pup Season	Fall Swarming
Cherokee NF (TN)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15
Chequamegon-Nicolet NF (WI)	Nov 1–Apr 14	*does not apply*	Apr 15–May 14	Apr 15–Sept 30	June 1–Aug 15	Aug 16–Oct 31
Chippewa NF (MN)	Nov 1–Apr 14	*does not apply*	Apr 15–May 14	Apr 15–Sept 30	June 1–Aug 15	Aug 16–Oct 31
Daniel Boone NF (KY)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Oct 15	May 15–July 31	Aug 16–Nov 15
Francis Marion NF and Sumter NF; Enoree and Long Cane RDs (SC Year-round Active Range Zone 1)	*does not apply*	Below 40°F	*does not apply*	Apr 1–July 15	May 1–July 15	*does not apply*
Sumter NF; Andrew Pickens RD (SC Hibernating Range)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Sept 1–Nov 15
George Washington and Jefferson NF (VA Hibernating Range)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15
Grey Towers National Historic Site (PA)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15
Green Mountain and Finger Lakes NF (NY/VT)	Nov 1–Apr 14	*does not apply*	Apr 15–May 14	Apr 15–Sept 30	June 1–Aug 15	Aug 16–Oct 31
Hiawatha NF (MI Outside Indiana Bat Range)	Nov 1–Apr 14	*does not apply*	Apr 15–May 14	Apr 15–Sept 30	June 1–Aug 15	Aug 16–Oct 31

Forest or District (State)	Hibernation	Winter Torpor (Applies to Coastal Zones Only)	Spring Staging	Summer Occupancy	Pup Season	Fall Swarming
Hoosier NF (IN)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15
Huron-Manistee NF (MI Within Indiana Bat Range	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15
Huron-Manistee NF (MI Outside Indiana Bat Range)	Nov 1–Apr 14	*does not apply*	Apr 15–May 14	Apr 15–Sept 30	June 1–Aug 15	Aug 16–Oct 31
Kisatchie NF; Caney, Catahoula, Kisatchie, Winn (LA Year-round Active Range Zone 1)	*does not apply*	Below 40°F	*does not apply*	Mar 15–Jul 15	May 1–July 15	*does not apply*
Kisatchie NF; Calcasieu, Catahoula, Kisatchie (LA Year-round Active Range Zone 2)	*does not apply*	Below 40°F	*does not apply*	Mar 15–Jul 15	May 1–July 15	*does not apply*
Land Between the Lakes NRA (KY)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Oct 15	May 15–July 31	Aug 16–Nov 15
Land Between the Lakes NRA (TN)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15
Mark Twain NF (MO)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Oct 15	May 15–July 31	Aug 16–Nov 15
Midewin NTGP (IL)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15
Monongahela NF (WV)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15

Forest or District (State)	Hibernation	Winter Torpor (Applies to Coastal Zones Only)	Spring Staging	Summer Occupancy	Pup Season	Fall Swarming
National Forests in Alabama; Bankhead, Oakmulgee, Shoal Creek, Talladega (AL Hibernating Range	Nov 16–Mar 14	*does not apply*	Mar 15–Apr 30	Mar 15–Sept 30	May 15–July 31	Sept 1–Nov 15
National Forests in Alabama; Conecuh, Oakmulgee, Talladega, Tuskegee (AL Year-round Active Range Zone 1)	*does not apply*	Below 40°F	*does not apply*	Mar 15–Jul 15	May 1–July 15	*does not apply*
National Forests in Alabama; Conecuh (AL Year-round Active Range Zone 2)	*does not apply*	Below 40°F	*does not apply*	Mar 15–Jul 15	May 1–Jul 15	*does not apply*
National Forests in Florida (FL Year-round Active Range Zone 2)	*does not apply*	Below 40°F	*does not apply*	Mar 15–Jul 15	May 1–July 15	*does not apply*
National Forests in Mississippi; Holly Springs, Tombigbee (MS Hibernating Range)	Nov 16–Mar 14	*does not apply*	Mar 15–Apr 30	Mar 15–Sept 30	May 15–July 31	Sept 1–Nov 15

Forest or District (State)	Hibernation	Winter Torpor (Applies to Coastal Zones Only)	Spring Staging	Summer Occupancy	Pup Season	Fall Swarming
National Forests in Mississippi; Bienville, Chickasawhay, Delta, De Soto, Homochitto (MS Year-round Active Range Zone 1)	*does not apply*	Below 40°F	*does not apply*	Mar 15–Jul 15	May 1–July 15	*does not apply*
National Forests in Mississippi; De Soto, Homochitto (MS Year-round Active Range Zone 2)	*does not apply*	Below 40°F	*does not apply*	Mar 15–Jul 15	May 1–July 15	*does not apply*
National Forests in North Carolina; Appalachian, Cheoah, Grandfather, Nantahala, Pisgah, Tusquittee (NC Hibernating Range)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15
National Forests in North Carolina; Croatan, Uwharrie (NC Year-round Active Range Zone 1)	*does not apply*	Below 40°F	*does not apply*	Apr 1–Jul 15	May 1–July 15	*does not apply*

Forest or District (State)	**Hibernation**	**Winter Torpor (Applies to Coastal Zones Only)**	**Spring Staging**	**Summer Occupancy**	**Pup Season**	**Fall Swarming**
National Forests and Grasslands in Texas; Caddo – Lyndon B Johnson NG (TX Hibernating Range)	Nov 16–Mar 14	*does not apply*	Mar 15–Apr 30	Mar 15–Sept 30	May 15–July 31	Sept 1–Nov 15
National Forests and Grasslands in Texas; Angelina, Davy Crockett, and Sabine (TX Year-round Active Range Zone 1)	*does not apply*	Below 40°F	*does not apply*	Mar 15–Jul 15	May 1–July 15	*does not apply*
National Forests and Grasslands in Texas; Angelina, Davy Crockett, Sabine, and Sam Houston (TX Year-round Active Range Zone 2)	*does not apply*	Below 40°F	*does not apply*	Mar 15–Jul 15	May 1–July 15	*does not apply*
Ottawa NF (MI Outside Indiana Bat Range)	Nov 1–Apr 14	*does not apply*	Apr 15–May 14	Apr 15–Sept 30	June 1–Aug 15	Aug 16–Oct 31
Savannah River Site (SC Year-round Active Range Zone 1)	*does not apply*	Below 40°F	*does not apply*	Apr 1–July 15	May 1–July 15	*does not apply*
Shawnee NF (IL)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15
Superior NF (MN)	Nov 1–Apr 14	*does not apply*	Apr 15–May 14	Apr 15–Sept 30	June 1–Aug 15	Aug 16–Oct 31
Wayne NF (OH)	Nov 16–Mar 31	*does not apply*	Apr 1–May 14	Apr 1–Sept 30	May 15–July 31	Aug 16–Nov 15

Forest or District (State)	Hibernation	Winter Torpor (Applies to Coastal Zones Only)	Spring Staging	Summer Occupancy	Pup Season	Fall Swarming
White Mountain NF (ME, NH)	Nov 1–Apr 14	*does not apply*	Apr 15–May 14	Apr 15–Sept 30	June 1–Aug 15	Aug 16–Oct 31

APPENDIX C. EMERGENCE SURVEY PROTOCOL

Emergence surveys[12] will be used to document the absence of bats prior to removing high-priority hazard trees with potential bat-roosting suitability that occur within primary or secondary roost buffers during the summer occupancy period (see **RMC-CM-19.4** and **RMC-CM-20.3**). When emergence surveys are planned within a roost buffer, coordination with the local FWS field office is required prior to conducting the survey. Modification to the protocol could be appropriate depending on the BCS species that may be present.

Emergence surveys may also be deemed prudent in other circumstances, especially when routine hazard trees with potential bat-suitability must be removed during the maternity or pup seasons (see LTH-CR-5.1). If emergence surveys indicate bat use, hazard trees will not be cut until a FWS biologist can re-assess the situation and needs. Emergence surveys are intended for limited use when other solutions cannot meet the need, as they are time-intensive and not foolproof. When emergence surveys are planned outside of a roost buffer, coordination with the local field office is recommended prior to conducting the survey.

PERSONNEL

FS biologists, biological technicians, and any other individuals who have received training from a knowledgeable individual on how to properly conduct bat emergence surveys may perform them.

EMERGENCE SURVEYS FOR HAZARD REMOVAL OF POTENTIALLY SUITABLE ROOST TREES

1. There must be at least one surveyor per potential roost, if more than one tree is surveyed on a given night.

2. Bat emergence surveys should begin at least one-half hour before sunset[13] and continue until at least one hour after sunset or until it is otherwise too dark to see emerging bats. The surveyor(s) must be positioned so that emerging bats will be silhouetted against the sky as they exit the roost. Tallies of emerging bats should be recorded every few minutes or as natural breaks in bat activity allow. Surveyors must be close enough to the roost to observe all exiting bats but not close enough to influence emergence. That is, do not stand directly beneath the roost, do not make noise or carry on a conversation, and

[12] This protocol is adapted from Appendix E of FWS's March 2023 Range-wide Indiana Bat and Northern Long-eared Bat Survey Guidelines. Changes to the FWS protocol have been made for clarity and specific needs for implementation of the BCS.

[13] Surveys may need to start a little earlier or later than one half hour before official sunset times (i.e., before "dusk") in some settings such as deep/dark forested valleys or ridge tops, respectively. Sunset tables for the location of survey can be found online (e.g., *https://sunrise-sunset.org*).

minimize use of lights (use a small light to record data, if necessary). Do not shine a light on the roost as this may prevent or delay bats from emerging. Use of an infra-red, night vision, or thermal-imaging video camera or spotting scope is encouraged but not required. Use of an ultrasonic bat detector is strongly recommended, as they may aid in noticing exiting bats and help to differentiate between low- and high-frequency bat species. (Caution: acoustic calls around roost features cannot be considered species-diagnostic.)

3. Bat activity is affected by weather; therefore, emergence surveys should not be conducted when the following conditions exist: (a) temperatures that fall below 50°F (10°C); (b) precipitation, including rain and/or fog, that exceeds 30 minutes or continues intermittently during the survey period; or (c) sustained wind speeds greater than 9 miles/hour (4 meters/second; 3 on Beaufort scale).

4. Surveyors will use the "Example Bat Emergence Survey Datasheet" (or similar) to record results and submit the form to the local FWS field office.

5. At the conclusion of the emergence survey:

    a) If **no** bats were observed emerging from the potential roost(s), then it maybe felled immediately. If safety concerns dictate that a tree cannot be felled immediately (i.e., in the dark), then the tree(s) should be felled as soon as possible after sunrise on the following day. If a tree is not felled during the daytime immediately following an emergence survey, then the survey must be repeated, because bats may switch roosts on a nightly basis. Immediately after the tree is felled, a visual inspection of the downed tree must be completed to ensure no bats were present, injured, or killed. The USFWS FO(s) should be contacted immediately, if bats are discovered during this inspection.

    b) If **1 or more** bats, regardless of species, are observed emerging from the roost, then it should **not** be felled until coordination occurs with a FWS biologist to reassess the situation and consider options.

EXAMPLE BAT EMERGENCE SURVEY DATASHEET

Project Name: ____

Date:	Surveyor(s) Full Name:	
State:	County:	
Site Name/#:		
Lat/Long or UTM of Hazard Tree:		
Description of Roost/Habitat Feature Surveyed:		
Bat Species Known to be using this Roost/Feature (if not known, leave blank):		
Other Suspected Bat Species (explain):		
Weather Conditions during Survey (temperature, precipitation, wind speed):		
Survey Start Time:	Time of Sunset:	Survey End Time:

NOTE: Emergence surveys should begin 0.5-hour before sunset and continue until at least one hour after sunset or until it is otherwise too dark to see emerging bats. The surveyor(s) should position him or herself so that emerging bats will be silhouetted against the sky as they exit the roost. Tallies of emerging bats should be recorded every few minutes or as natural breaks in bat activity allow. Ensure that surveyor(s) are close enough to the roost to observe all exiting/returning bats, but not close enough to influence emergence (i.e., do not stand directly beneath the roost and do not make unnecessary noise and/or conversation, and minimize use of lights other than a small flashlight to record data, if necessary). Do not shine a light on the roost tree crevice/cave/mine entrance itself as this may prevent or delay bats from emerging. If available, use of an infra-red, night vision, or thermal-imaging video camera or spotting scope and an ultrasonic bat detector are strongly recommended but not required.

Time	**Number of Bats Leaving Roost**	**Comments / Notes**
Total:		

Note: If any bats return to the roost during the survey, then they should be subtracted from the tally.

Describe Emergence: Did bats emerge simultaneously, fly off in the same direction, loiter, circle, disperse, etc.

APPENDIX D. WHITE-NOSE SYNDROME DETECTION DATES

Table D-1 depicts the year when white-nose syndrome was detected for each Forest Service unit and the post-white-nose syndrome year when Forest Service biologists recorded an associated steep decline in BCS species populations.

Table D-1. Year of white-nose syndrome detections and BCS species declines for Forest Service units in the Eastern and Southern regions

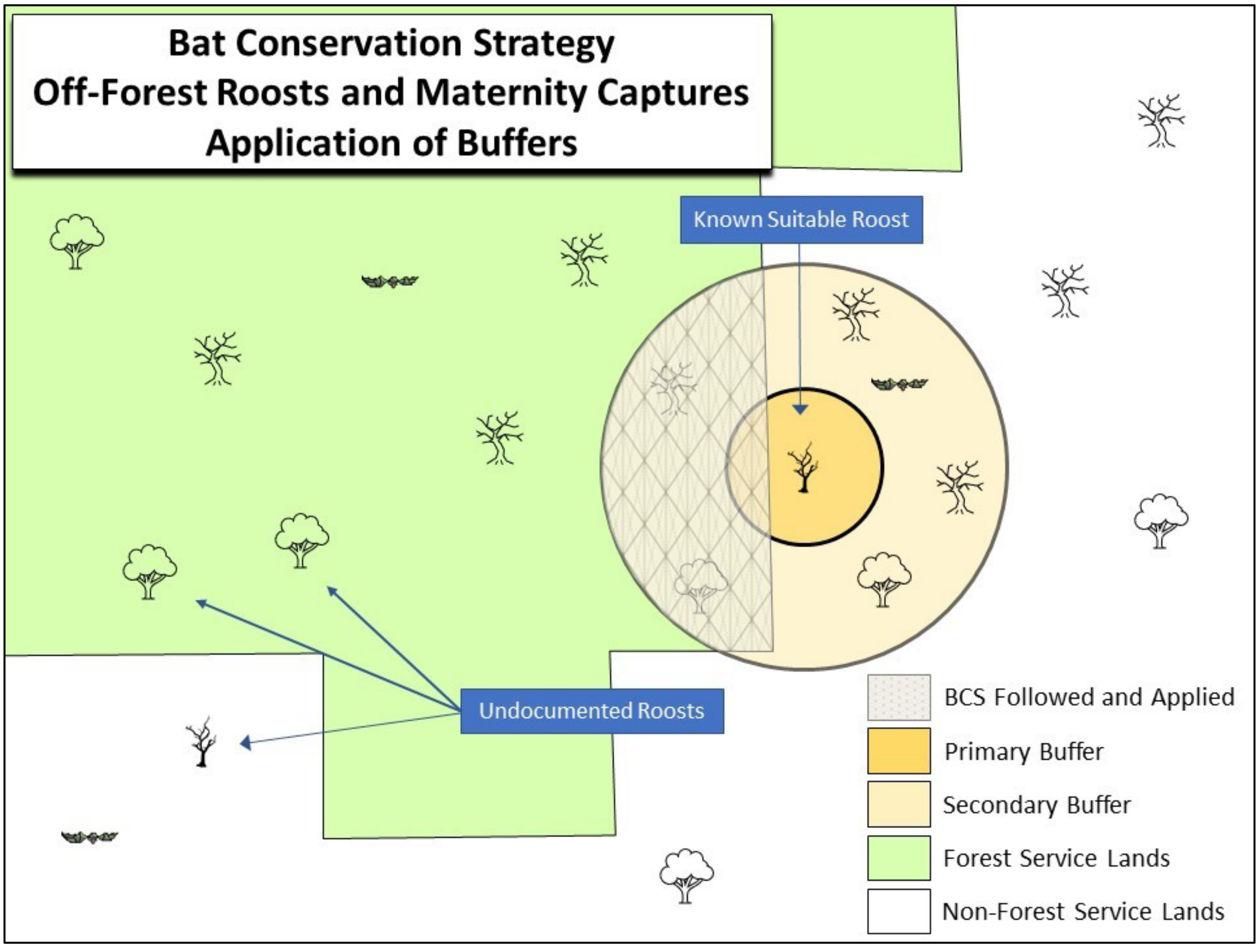
Forest Service Unit (Region)	WNS Detection Date	Post-WNS Date
Chattahoochee-Oconee National Forest (8)	2013	2015
Cherokee National Forest (8)	2010	2013
Croatan National Forest (8)	Has not been detected	Not applicable
Daniel Boone National Forest (8)	2011	2014
Francis Marion National Forest (8)	Has not been detected	Not applicable
George Washington and Jefferson National Forest (8)	2008	2013
Kisatchie National Forest (8)	Has not been detected	Not applicable
Land Between the Lakes National Forest (8)	2010	2013
National Forests in Alabama (8)	2014	2016
National Forests in Florida (8)	Has not been detected	Not applicable
National Forests in Mississippi (8)	Has not been detected	Not applicable
National Forests in North Carolina (8)	2011	2013
National Forests and Grasslands in Texas (8)	Has not been detected	Not applicable
Sumter National Forest (8)	2015	2017
Allegheny National Forest (9)	2012	2014
Chequamegon/Nicolet National Forest (9)	2016	2018
Chippewa National Forest (9)	2012	2015
Green Mountain/Finger Lakes National Forest (9)	2006	2011
Hiawatha National Forest (9)	2014	2016
Hoosier National Forest (9)	2011	2014
Huron-Manistee National Forest (9)	2014	2016
Mark Twain National Forest (9)	2012	2016
Midewin Tallgrass Prairie (9)	2013	2016

Forest Service Unit (Region)	WNS Detection Date	Post-WNS Date
Monongahela National Forest (including the Fernow Experimental Forest) (9)	2009	2011
Ottawa National Forest (9)	2015	2017
Shawnee National Forest (9)	2013	2016
Superior National Forest (9)	2012	2016
Wayne National Forest (9)	2011	2015
White Mountain National Forest (9)	2010	2014

APPENDIX E. APPLICATION OF OFF-FOREST AND OVERLAPPING BCS BUFFERS

Off-Forest Buffers

Figure E-1. Conceptual application of a BCS roost buffers applied to a known off-forest roost[14]



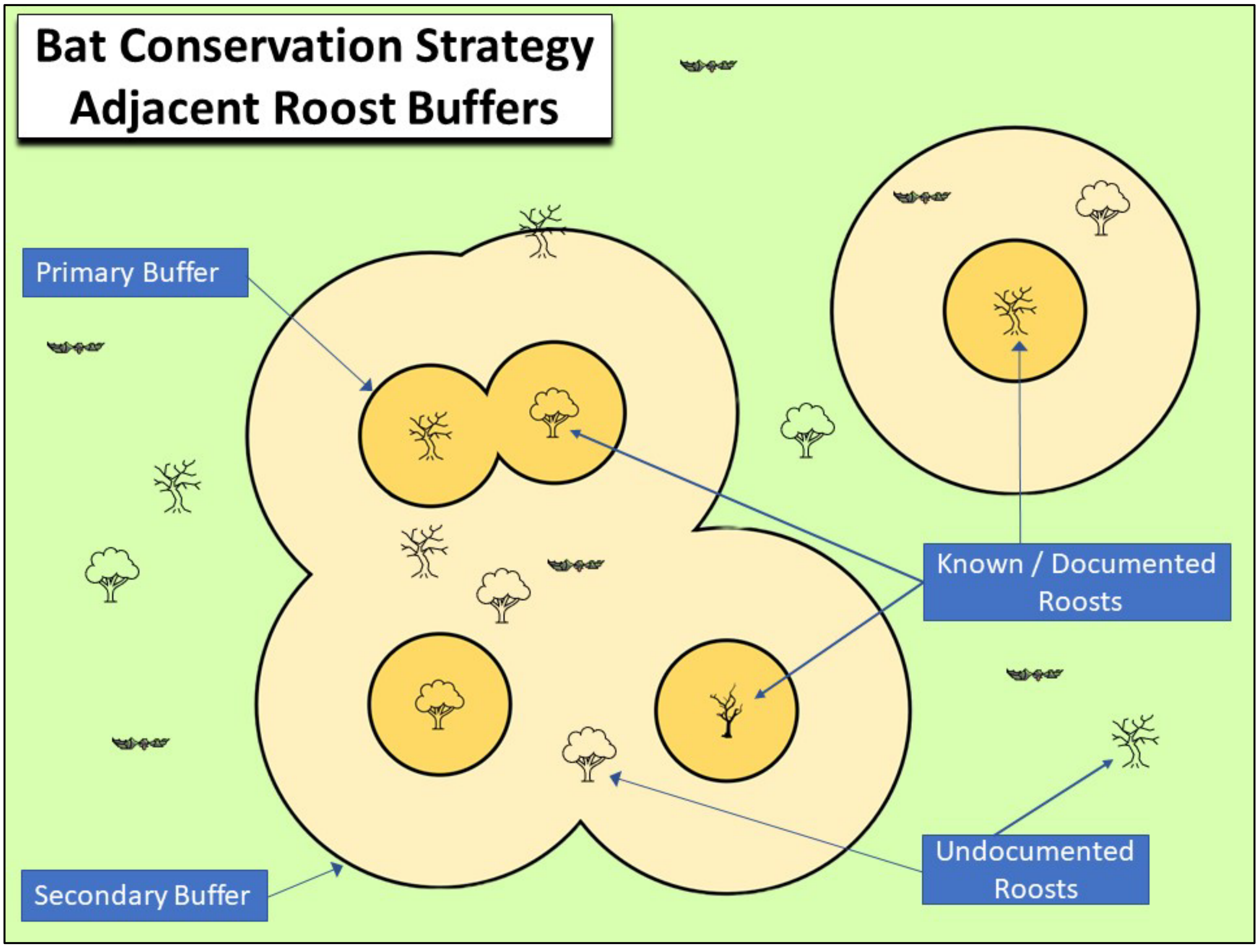
Adjacent or Overlapping Buffers

As BCS buffers are applied, there will be situations when multiple known roosts, maternity captures, and/or hibernacula are close enough to each other for their respective buffers to overlap. When similar types of buffers partially or fully overlap (such as for the conceptual

[14] Note: BCS Conservation Measures and Recommendations will only be applied to the shaded portion of the buffer(s) that extend onto National Forest System lands.

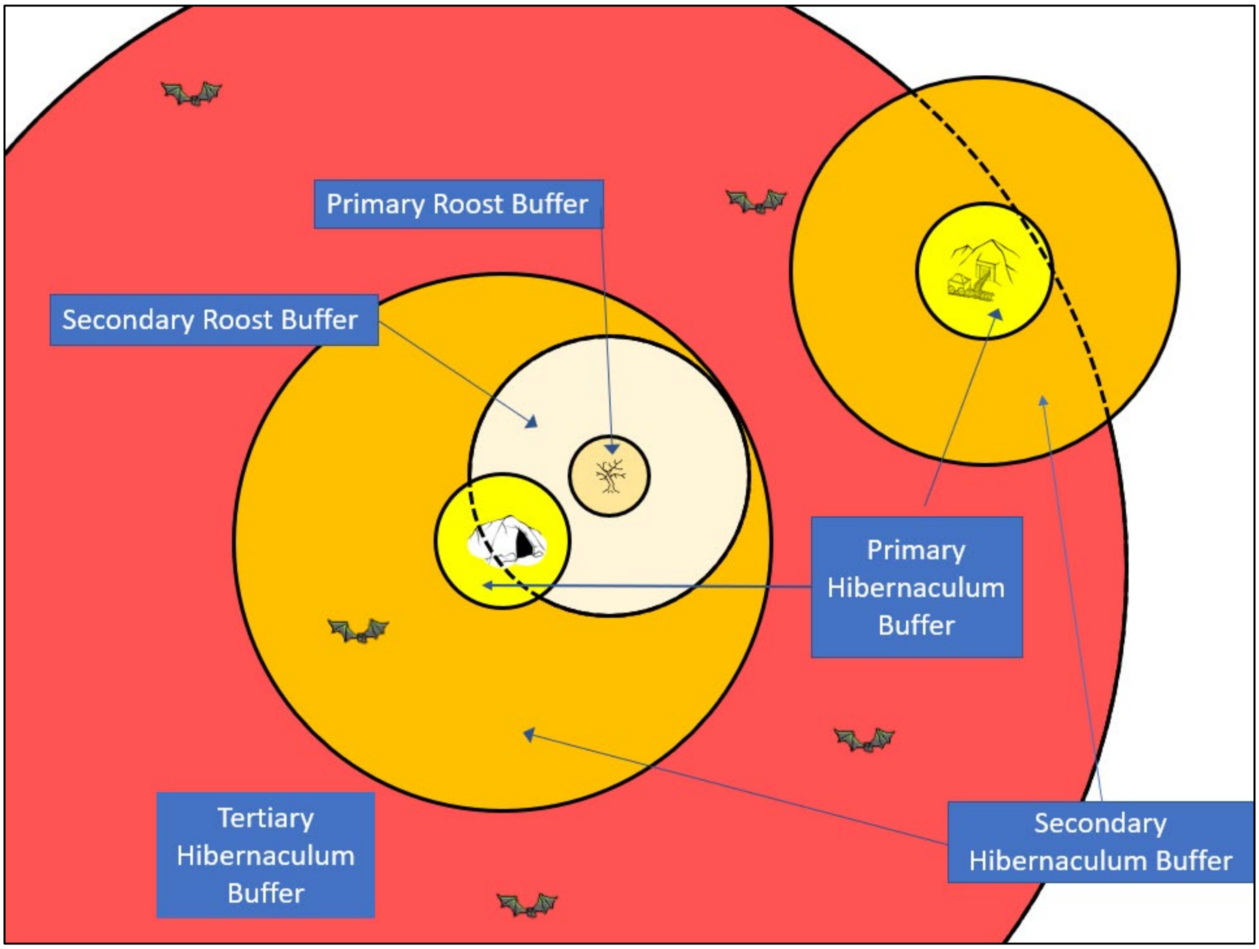
example of overlapping primary and secondary roost buffers in Figure E-2), they essentially merge to create the larger buffered area.

Figure E-2. Conceptual application of adjacent primary and secondary roost buffers



Where different types of buffers partially or fully overlap (such as shown in the conceptual example in Figure E-3), the buffers will not merge. Instead, this will create a scenario where different seasonal restrictions can overlap, depending on the management activity and conservation measures and recommendations applied. In the example shown in Figure E-3, a primary roost buffer overlaps with a secondary hibernaculum buffer and secondary roost buffer overlaps with a primary and secondary hibernaculum buffer. Where the roost buffers overlap with the hibernaculum buffers, the conservation measures and recommendations (including seasonal any restrictions) for both types of buffers would apply as appropriate to the management activities occurring in the area.

Figure E-3. Conceptual application of overlapping roost and hibernaculum buffers



APPENDIX F. CONSIDERATIONS WHEN PREPARING A HIBERNACULUM MANAGEMENT PLAN

Following publication of the BCS, the FS, in coordination with the FWS and other partners, will develop Hibernaculum Management Plans (HMPs) for historic and occupied high priority hibernacula occurring on or adjacent to National Forest System lands. The purpose of an HMP is to identify/diagnose site-specific threats to hibernacula, assess the severity of threats, and develop an integrated, site-specific, management prescription that can subsequently be implemented to reduce threats. For example, management prescriptions within HMPs may include, erecting/modifying a bat-friendly gate(s), posting new or additional signage, obliterating and/or rerouting trails, installing an alarm system, acquiring land containing hibernacula entrance(s) and/or important parcels of surrounding swarming habitat, improving forest connectivity, and other site-specific actions needed to remedy unique threats. An HMP can be prepared for an individual site or for "complexes" of caves/mines within a discrete geographic region. HMPs may be complex for large, complex sites or very streamlined (e.g., a few pages of text and a map) depending on the site-specific and unique conditions that present themselves at each site. A single HMP may also cover multiple hibernacula that will be managed similarly.

In general, an HMP will:

- Provide a brief overview of past threats and management activities and summarize responses of bats to these actions,
- Identify ongoing and likely future threats,
- Assess the magnitude and immediacy of identified threats,
- Prescribe a prioritized list of site-specific management activities that need to be implemented to mitigate threats to hibernaculum-associated bat species,
- Identify appropriate collaborators and potential conservation partners, and
- Outline a tentative implementation schedule.

Each HMP should contain a concise summary of information regarding the topics (as applicable) outlined below.

EXAMPLE HIBERNACULUM MANAGEMENT PLAN OUTLINE

Note: not all items will be applicable to all sites

Introduction

- Purpose and Need of HMP

Background and History of Hibernaculum and Surrounding Area

- Discovery of Cave or Creation of Mine
- Historic Bat Population
- Ownership, Site History, Historic Maps, Property Legal Description
- Geologic and Hydrologic History
- Mineralogy History (particularly for mines)
- Tribal, Paleontological and Archaeological Significance and Considerations (if any)
- History of Human Modifications and Use (Including Tribal Use)
- Historic and Current Threats
    - Ecological issues (e.g., prone to freezing, flooding, collapse, white-nose syndrome)
    - Anthropogenic issues (e.g., history of local actions, vandalism, etc.)
- Bat/Cave Conservation History
    - Bat conservation measures previously implemented
    - Past research and monitoring
- Associated Caves or Mines
    - Spatial relationship in context to other nearby hibernacula complexes
- History of Surrounding Land-use / Landcover Change
    - Percentage of forest cover
    - Ownership (public vs. private)
- Associated Cave/Karst-dependent Species

Current Status and Management

- Current bat population status
- Current Ownership Information
- Points-of-Contact for landowner, FS, FWS, and other agencies/partners involved
- Description of current signs or interpretive materials (including the incorporation of tribal perspectives)
- Current accessibility
    - Restrictions on when public can visit the hibernacula?
    - If gated, how is access managed?
- Hibernaculum maps
    - GPS coordinates of hibernaculum entrance
    - Accurate map of cave passages, if available

- Current Geology / Seismic Activity Risk
    - Structural Integrity of Hibernaculum
    - Recharge area: has this been mapped?
    - Current water sources and water quality
- Contaminants / Herbicides / Pesticides: Are there any known contaminants issues or concerns within the vicinity of the hibernaculum?
- Erosion/Siltation: If a problem, provide guidance.
- Current Microclimate Dynamics: Overview of known air flow patterns and temperature and humidity profiles
- Current activities / disturbances (temporal, seasonal)
- Current Roost Conditions / Suitability
    - Microclimate Suitability: Are temps and humidity levels currently suitable?
    - Freezing/Flooding: Is the hibernaculum prone to freezing or flooding? Can these issues be remedied?
    - Current Entrance Vegetation Conditions / Issues (if any)
    - Restoration Actions: Is any restoration work warranted? Why? Has previous restoration work been proposed, attempted or completed?
    - Protective Actions / Law Enforcement / On-site Management
    - Gates: If gates are not present, are they warranted? If gates are present, are they bat-friendly? When were they installed? Do they allow unrestricted airflow and bat flight? Are they vandal proof? If one or more gates are needed, then a careful study (including pre-and post-installation bat flight path analyses) should be considered.
- Other Biota: Special considerations due to presence of other biota?
- Current Threats to Site and Biota
    - Roadways: Are there busy roadways near hibernaculum entrances? Any evidence of road-killed bats? Can low-use roadways be gated or closed? Any current /planned road construction?
    - Predators: Is there current evidence of high predation by natural predators or feral/domestic cats?
    - Other Natural Threats: Flooding, Freezing, Subsidence, Collapse? Are these issues?
- Currently Planned Conservation Measures
- Current Research

BCS Conservation Measures and Recommendations

- Map of BCS hibernaculum buffers
- Timber Management
    - What level and manner of timber harvest is consistent with BCS?
    - What time of year may timber harvest occur?

- Prescribed Fire
    - Where and what time of year is prescribed fire consistent with BCS?
    - Avoidance of smoke impacts on hibernacula.

- Other allowable and prohibited activities
    - Activities prohibited year-round, by buffer zone.
    - Activities seasonally restricted, by buffer zone

- Roost Tree Management
    - Are there document roost trees in the vicinity of the hibernaculum? Are there additional roost-specific conservation measures that apply?

Planned Future Management

- Prospects for future land acquisition
- Future Management / Conservation
    - Future timber management
    - Future prescribed fire
    - Future water sources and water quality

- Bat Monitoring Plan
    - Bat Surveys: Who is responsible for conducting biennial (or otherwise scheduled) winter bat surveys at the site? With whom must they coordinate?
    - White-Nose Syndrome Surveillance and/or Mitigation Plans

- Research Plan: Will there be any continuing/sporadic research?
- Outlook / Threats / Needed Conservation Actions
    - Future Vandalism: Is it anticipated to be a problem? Potential Solutions?
    - Future Roadways: Are new roadways planned near hibernacula entrances? Plan to reduce incidence of roadkill?
    - Other Future Natural Threats: Flooding, Freezing, Subsidence, Collapse, Predators?
    - Other Future man-made Threats?

List of HMP Preparers

APPENDIX G. GENERAL RECOMMENDATIONS AND MITIGATIONS FOR BCS SPECIES ROOSTING IN STRUCTURES

Appendix G provides useful information for individuals with concerns or confirmed presence of bats roosting in buildings and other human-made structures. The information provided here is to further support implementation of RMC-O-21 and associated conservation measures and recommendations. Items covered below are not exhaustive and should be used with FS biologist input and current available science in mind, as variations in the use of structures by bats do occur along the geographic range of BCS species. As FWS guidance around bats and human structures becomes available for one or more of the BCS species, this BCS will adopt the respective guidance provided. Coordinate with FWS as appropriate.

Characteristics of human-built structures potentially suitable for bat roosting

Buildings shrink, warp, or move over time, or are constructed in a way that provides opportunities for bats to access gaps and structures suitable for roosting. Good areas to search human-built structures for bats include:

- On southerly or westerly facing walls (increased solar exposure).
- On northerly or easterly facing walls (reduced solar exposure, particularly in southern tier);
- In attic space, rafters, and dormers;
- Under covered porches and overhangs;
- Between cavities on interior or exterior walls;
- Beneath siding;
- In open garages or outbuildings;
- In basements;
- Under damaged cedar or similar shingles; and
- In cisterns or wells.

In addition to buildings, all BCS species have been documented using transportation-related structures, with roosting observed in some areas of the U.S. during every season of the year, including during winter hibernation periods.

Characteristics of transportation structures potentially suitable for bat roosting

Bats are known to utilize transportation structures for roosting. Structures and features used vary geographically and by BCS species. The following includes examples of common structures and features that may be used. However, this is not a comprehensive list. Coordinate with the local FWS field office for guidance.

- Areas with best chances of full sun exposure and protected from element;
- Crevices in concrete bridge railings, concrete bridge parapets, concrete retaining walls and other types of crib walls;
- Crevices on bridges, especially within expansion joints on bridges, and areas where the bridge decking (superstructure) meets the bridge support substructure (pylons, piers, etc.);
- Cavern-like areas under bridge decks, especially areas with reduced air flow near the bridge abutments. These areas are often observed where tall, pre-stressed concrete girders approach fill areas;
- The underside of bridge decks, especially over water;
- Box beam bridges or pre-stressed concrete girder bridges;
- Culverts three feet or greater in diameter and at least 25 feet long (especially culverts that have high complexity, such as weep holes, seams, bends, side and drop inlets); and
- Additional characteristics of culverts considered suitable to bats, regardless of constructed material: located in areas not susceptible to flooding, inner areas that are relatively dark, have roughened walls or ceilings, crevices, imperfections, or other features such as swallow nests present (Keeley and Tuttle 1999).

Lower quality roosting conditions within human-built structures

Some potential roost sites for bats can be assigned a lower priority for evaluation and reduce the need for intensive surveying methods due to reduced suitability. Bats typically avoid areas prone to flooding. Any transportation structure 3 feet or less above the ground or water surface during low water flow is not likely to be used by bats. Smaller culverts (less than 3 feet in diameter)) that tend to flood more often are generally less conducive for roosting suitability. Flat slab bridges may be less suitable for bats. If there are signs that water is leaking into crevices or that the top of the structure is not sealed properly, it is likely not a good structure for bats.

Methods for locating bats in human-built structures

- The following is a short summary of methods that can be used to evaluate a variety of structures for BCS species presence and use in the field. Other information that may be useful for locating bats in structures are also available from the FWS range-wide survey guidelines, Federal Highway Administration, Indiana State University Bat Center, and other sources.

When visually looking for bats note things like the type of structure, where the bats are located within the structure, number of bats, and information on dead or injured bats. In some cases, bat squeaking, and chirping may also be an indicator of bat use, but these sounds may not always be picked up by humans so using a bat detector is recommended. Another visual indicator is guano deposits which are like mouse feces but are less regular and always contain insect parts. When crushed between your fingers, guano easily crumbles into tiny pieces, while rodent droppings do not. The important aspects of guano to note include color of droppings and the amount of guano found. Other visual indicators include brown or gray staining, crystalized urine, and bare scratched areas. Also, a musty odor may accompany these visual elements. To get good observational data, structures may need to be observed at dusk during the summer occupancy period (see Appendix B for local dates) for bat emergence (INDOT 2020).

When looking in transportation structures (such as but not limited to culverts and bridges), inspect unobstructed expansion joints with a spotlight. Sometimes there is a presence of guano under the joints to indicate bat use. Look for structures that mimic caves and have features like enclosed sides or that are protected on both sides by landscape features like embankments or hillsides. Pay special attention to bridges that span large rivers as these are often good areas for bats (INDOT 2020).

Humane Bat Exclusions – Considerations and Installation

BCS species may need to be excluded from structures for human health or safety reasons. In these cases, bats should be encouraged to move by using appropriately timed humane exclusion methods or other humane options such as acoustic deterrents. Avoid removing bats or "bat-proofing" during the pup season (see Appendix B*)* when flightless young might be present. Install one-way exits after finding all possible openings that bats are using in the structure. Make sure to leave these exclusion measures in place for 5 to 7 days. Once bats are no longer in the structure, seal openings larger than 0.5×0.5 inch, or long thin slots larger than 0.25×2 inches. Use materials such as expanding spray-on foam, caulk, wire mesh, wood that fits tightly, backer rod, etc., to seal gaps and holes. Make sure all windows have screens, chimneys are capped, and electrical and plumbing openings are plugged before monitoring the area to ensure success and effectiveness of exclusions (Keeley and Tuttle 1999).

In conjunction with all humane exclusion efforts, a suitable replacement (similar type roost of sufficient size to contain the whole colony) should be constructed or purchased and placed nearby prior to the exclusion to provide displaced bats with an alternative shelter. Due to the differences in the roosting ecology between the BCS species, and the number of different artificial roosting structure options available, input from a FS biologist and coordination with FWS as appropriate is highly recommended to ensure appropriate selection and placement of the alternate roost(s).

Recommended Mitigations for Removal or Manipulation of Confirmed Bat-Occupied Structures

Sometimes structures need to be removed. If so, removal shall occur outside of the summer occupancy period (Appendix B) to protect bats from direct effects and a suitable replacement (similar type roost of sufficient size to contain the whole colony) should be constructed/purchased and placed in the vicinity before bats return the following summer occupancy period. If removal of a known roosting structure must occur during the summer occupancy period for human health or safety, a humane exclusion must first be performed (see above), and a suitable replacement (similar type roost of sufficient size to contain the whole colony) should be placed nearby prior to removal to provide the displaced bats with an alternative shelter. As discussed in the humane bat exclusion section above, input from a FS biologist and coordination with FWS as appropriate is highly recommended to ensure appropriate selection and placement of the alternate roost(s).

GLOSSARY

A

Acoustic Monitoring: A tool that detects and often records bat echolocation calls. It is not adequate for determining presence of maternity colonies, sex, numbers of individuals, or hibernaculum use in the fall. Acoustic monitoring in the winter can be used to determine hibernaculum use.

Mobile Route: A pre-determined route driven with an ultrasonic recording device affixed to the vehicle to record echolocation calls of bats to identify species by their unique calls. Routes are driven at a speed that would typically ensure only a single encounter per bat. Specific protocols for mobile acoustic deployment are available in A Plan for North American Bat Monitoring Program (NABat).

Stationary: Deployment of an ultrasonic recording device to record echolocation calls to identify different bat species by their unique calls at a fixed location over multiple nights. Specific protocols for stationary acoustic deployment are available in A Plan for North American Bat Monitoring Program (NABat).

Active Season: Non-hibernation period when bats are active on the landscape -- collectively refers to the spring staging, summer occupancy, and fall swarming periods.

Adaptive management: This BCS uses as a tool to deal with uncertainty and changing conditions; new information from research and monitoring will be incorporated as available to guide the conservation of bats and their habitat.

Anthropogenic structures: Man-made features including but not limited to transportation structures (bridges, culverts, tunnels, etc.), buildings, homes, offices, outbuildings, picnic shelters, sheds, etc.

B

Bat blitz: A coordinated effort of bat biologists from across the region to focus on a specific intensive survey in extensive area in a matter of days.

Bat Conservation Team: The FS organizes local teams, each consisting of Forest Service, Fish and Wildlife Service, State wildlife agencies, and other key partners who coordinate and prioritize Survey and Monitoring activities for local implementation of the BCS.

Bat-disturbing activities: Any activity that can disrupt bats' regular behavioral patterns such as noise, vibrations, physical disturbance, smoke, etc. These disturbances may occur during structure renovations, conversions, or demolitions; tree felling, snag cutting, and other tree alterations of known or suitable roost trees; prescribed fire, or other forest management.

Bat box: A constructed structure (commonly from wood) designed as an artificial roosting location for crevice and cavity roosting bats. These structures can vary in size and construction, but all are made to simulate the structural and functional properties found in important natural roosts such as cliffs, caves, or trees. Note: A bat condo is just a very large bat box/house (4 feet cubed) mounted on stilts at least 10 feet above ground. See also "Roost: Artificial."

Bat-friendly gates: Usually horizontally barred gates, with an about 5.75-inch bar-spacing to allow bats to fly in and out without slowing their pace and potentially being predated.

Bat Resources Map: A map showing important features for bats (hibernacula and roost trees) across the BCS area. Many of the Conservation Measures and Conservation Recommendations rely on the location of these bat resources.

BCS Oversight Board: An advisory and review committee comprised of Forest Service and Fish and Wildlife Service staff. The purpose of the committee is to review the survey and monitoring plans, make recommendations, and provide clarification on implementation issues and questions. (see Chapter 1 for more information)

BCS Species: The four species of forest-dwelling bats covered in this conservation strategy are: Indiana bat (*Myotis sodalis*), northern long-eared bat *(M. septentrionalis),* little brown bat *(M. lucifugus*), and tricolored bat (*Perimyotis subflavus).*

BCS Survey and Monitoring Fund: Forest Service funding allocated to National Forest and Grassland units for implementation of the Survey and Monitoring strategy for the BCS. Project proposals from the Bat Conservation Teams and funding priorities determined by the BCS Oversite Board.

C

Cavernicolous: Inhabiting caves.

Clutter, forest: Amount of horizontal and vertical structure and vegetative growth that can vary from dense and highly stocked, to low and open conditions. Dense clutter can be characteristic where invasive plants or native weedy species dominate the under- or midstory, in stands regenerating post-harvest with high stem density, or in more mature stands not recently subjected to natural disturbance or management. In terms of bat ecology, clutter is any type of physical or acoustic structure in the environment (e.g., vegetation, buildings, the ground, other bats, insect prey, etc.) that affects bats' use of and navigation through it. Bat species tolerate and respond to various levels of clutter based on how they echolocate, the shape of their wings, their foraging strategies, and possibly other factors. The various species are often generally categorized as clutter-adapted, clutter-tolerant, or open-adapted (see Table 2-1).

- **Clutter-adapted:** (or "forest interior") Bat species that will generally use densely vegetated environments but may also tolerate somewhat open or edge habitats.

- **Clutter-tolerant:** Bat species that are better able to interface with a wider range of vegetative conditions (e.g., forest gaps, forest trails, edges).
- **Open-adapted:** Bat species that prefer spaces with overall little or no clutter (e.g., forest openings, above tree canopy, edges or over water).

Conservation Measure: Actions that are intended to promote the conservation and/or potentially support long-term recovery of BCS species that are included as an integral part of the overall BCS. These actions serve to benefit, minimize, or avoid potential project effects on BCS species.

Conservation Recommendation: Discretionary actions to benefit, minimize, or avoid adverse effects of a proposed action on BCS species or their habitat. Also include suggestions to assist in BCS species conservation as part of proposed actions.

Consultation: The regulatory process codified (50 CFR 402) that establishes the requirements of a federal action agency to ensure that their actions do not jeopardize a species' continued existence.

Coordination: For the purpose of the BCS, an informal process of communication between FS and FWS staff. It may be used to discuss situations that arise and need a case-by-case approach or in instances where additional guidance is desired.

Core Maternal Roosting Area: The extent of forest and intervening habitats that contain the trees and other roosts used by a maternity colony of BCS species. It includes both known and unknown maternity roosts. The core maternal roosting area is the basis for the establishment of BCS Secondary Roost Buffers (See also Secondary Roost Buffer).

D

E

Emergence Survey: An unobtrusive survey methodology to determine bat use of a roost or hibernaculum by observing bats as they fly out near sunset. Emergence surveys cannot determine species, sex, or reproductive condition but can indicate immediate bat use and approximate numbers.

Exit Count (or Survey): see Emergence Survey

F

Fall swarming: In temperate zones where bats hibernate; the period in autumn (see Appendix B for local dates) when bats engage in social behaviors, such as mating and flying in and out of hibernacula. The final active stage before hibernation.

Foraging area: Habitats actively used by bats for sustenance. This varies depending on the season, geographical forest-type, and species of bat.

Forest opening: areas within forested landscapes with little to no overstory canopy that often support early successional habitats and are usually created that are typically either created or maintained as part of the natural ecosystem through natural events (such as wildfire, ice storms, or wind events) or through active vegetation management, and that generally retain some characteristics and vegetation that may provide for prey, water, or other life needs for BCS species, even when trees and snags are removed.

G

Guano: Excrement of bats.

GRTS Cell: Generalized random-tessellation stratified survey design algorithm used in NABat. https://www.nabatmonitoring.org/methods-and-sample-design

H

Harp trap: A device used to capture bats without exposing them to entanglement as with mist nets and hand nets. Most frequently used in constricted areas, such as openings of caves and where many bats may be encountered in a short period of time.

Hazard tree: Individual trees that need to be cut down to address human health and safety concerns, including to protect property and infrastructure.

High-priority: Unforeseen and requiring immediate or urgent attention to address human health and safety concerns, including to protect property and infrastructure (e.g., workers at a project site in the woods or forest users in and around roads, trails, campsites, or other improvements). Such hazard trees may be cut down when and where needed with a few exceptions within roost buffers (see Chapter 4).

Routine: Identified during routine hazard tree management (typically in high-use areas such as campgrounds, trail intersections, trail corridors around facilities, and in rights-of-way) that likely allow for advanced planning to cut at times when least (or less) likely to directly affect roosting bats (i.e., during hibernation season or outside of the maternity and pup seasons).

Hibernaculum (*plural:* Hibernacula): Cave, or cave-like site(s) used during extended periods of winter torpor by one or more bats. For the covered bat species, these are subterranean, thermally stable sites most typically associated with caves and karst landforms, but also include sites that function in a similar manner (e.g., mines, railroad tunnels, culverts, hollow concrete dams).

Historically Important: High abundance hibernacula sites containing large numbers of the four bat species covered in this BCS; abundance guidelines listed in Table 3-1.

Potential: A habitat feature, such as a cave or mine, that has appropriate characteristics for bat hibernation, but hibernation activity has not been confirmed.

Priority: Winter roost site(s) identified by the local FWS field office, local National Forest, or State agency that: (1) supports a diverse or abundant bat colony and likely contributes substantially toward species recovery; (2) a historic bat roost that meets criteria for contributing substantially toward bat conservation but may be suffering from human alteration through behavior and/or physical modification; (3) may have low abundance but regionally contributes toward bat conservation where the bat colony is persisting in stable numbers despite declines due to WNS.

Hibernaculum Buffer

- **Primary**: A 500-foot buffer zone surrounding any entrance or other air passage leading to a hibernaculum.
- **Secondary**: Designated area in a buffer of variable size (see Figure 3-1. Staging and swarming habitat buffers based on winter colony abundance (from Table 3-1). Distances shown below are distance from hibernaculum entrance(s) for species specific secondary hibernaculum buffer sizes) surrounding hibernacula. This area typically has a high density of bats, often roosting in trees, during spring staging and fall swarming periods.
- **Tertiary:** Designated area in a buffer of variable size (see Figure 3-1 for species specific tertiary hibernaculum buffer sizes) corresponding to or surrounding hibernacula. Bats may be in moderate to low densities due to a small colony size at a hibernaculum or due to an extended distance from the hibernaculum.

Hibernaculum Management Plan (HMP): A written plan that outlines relevant information for a hibernaculum, including conservation measures and maps of hibernacula buffers to further refine local prescriptions and management needs based upon site-specific conditions. Hibernacula Management Plans may cover an individual hibernaculum or multiple hibernacula that are located in close proximity or have similar conditions.

Hibernation period: A physiological and behavioral response characterized by a non-active time when bats are in an extended period of torpor. These periods are typically associated with locations where food and water resources are not available during winter, and during other extended periods of unfavorable weather conditions or food shortages.

I

IPaC: Information for Planning and Consultation. An online, web-interface project planning tool created and hosted by the U.S. Fish and Wildlife Service to aid federal and non-federal entities in determining how their activities may affect federal trust species at a particular location. IPaC: Home (fws.gov)

J

K

Karst: A type of landscape where the dissolving of the bedrock has created sinkholes, sinking streams, caves, springs, and other characteristic features.

L

Leave tree: A tree left standing for wildlife, seed production, or other purposes, in an area where it might otherwise be felled.

M

Maternity colony: A group of reproductively active female bats and their young that occupy the same summer habitat, share communal roost sites, and interact to varying degrees.

Maternity habitat: Includes a variety of roost trees and suitable foraging summer habitat used by juveniles and reproductive (pregnant, lactating, or post-lactating) females during the maternity season.

Maternity season (summer): time of year when reproductively active female bats and their young are present on the landscape (ranges from approximately April to August and varies by species of bat and geographic location).

Mist-net survey: An active survey technique using low-visibility nets to capture bats in typical bat travel corridors or foraging spaces. Such surveys may be used to inventory species in a given area or to determine presence or probable absence of the species; does not provide enough data to determine population size or structure.

N

NABat: North American Bat Monitoring Program https://sciencebase.usgs.gov/nabat/#/home

National Speleological Society: An organization founded in 1941 to aid in the conservation, study, exploration, and understanding of caves in the United States.

Non-volant: Flightless or lacking the ability to fly. Bat pups are non-volant for approximately the first 3-6 weeks after they are born, known as non-volant season or pup season.

O

Overwintering: Process by which some organisms pass through or wait out (by means of hibernation and torpor) the period of the year where cold and dry conditions make it difficult or nearly impossible for survival.

P

Permanent land use conversion: refers to areas that are managed for purposes other than ecosystem or vegetation management. These areas are often, but not always, associated with development and are not likely to provide suitable bat habitat and are likely to be avoided by

BCS species as they do not provide favorable opportunities for roosting, foraging, drinking, or traveling.

Pup season: When mothers are still nursing their offspring ("pups"), which are dependent and not yet able to fly (i.e., non-volant). A time when bats are most vulnerable.

Pseudogymnoascus destructans **(Pd):** A psychrophilic (cold-loving) fungus that causes white-nose syndrome (WNS) in bats, devastating bat populations in parts of the United States and Canada.

Q

R

Road maintenance levels: The Forest Service classifies maintenance of National Forest System roads by five levels:

- **Maintenance level 1:** roads are closed to motor vehicle use and have been placed in storage between intermittent uses.
- **Maintenance level 2:** roads are maintained for high-clearance vehicles and are not suitable for passenger cars. They have low traffic volume and low speed.
- **Maintenance level 3:** roads are maintained for travel by a prudent driver in a standard passenger car during the normal season of use. Roads in this level are typically low speed with single lanes and turnouts.
- **Maintenance level 4:** roads are maintained to provide a moderate degree of user comfort and convenience at moderate travel speeds. Most roads are double laned and aggregate surfaced.
- **Maintenance level 5:** roads are maintained to provide a high degree of user comfort and convenience. These roads are normally double laned, paved roads.

Roost: Any location, (tree, bat box, structure, bridge, rock outcrop, talus slope, etc.), including hibernacula, used by bats, singly or in colonies, for rest, sleep, torpor, food digestion, shelter, etc. Roosts may be further defined as "day" or "night" roosts. Day roosts are typically used on a more permanent basis and night roosts are sites used temporarily at night between foraging bouts. For the purposes of the BCS, this term refers to roosts used during the non-hibernation or summer occupancy period.

- **Active:** Once identified, roosts (maternity and non-maternity) are presumed to be occupied unless surveys reveal otherwise or the roost is no longer present (e.g., roost tree falls down or is determined to be unsuitable by covered bats).
- **Alternate:** see "Secondary."
- **Artificial:** A human-made structure created for bats to roost within created from wood, concrete, or other materials varying in size and shape. Other variables are considered to attract bats like aspect, substrate, and mount location.

- **Historic:** BCS species roost that was documented prior to the issuance of the BCS that no longer remains suitable and has been verified by a Forest Service biologist following the process outlined in Chapter 4. Roost buffers are not required for roosts classified as historic.
- **Long-term:** A bat roost that provides and maintains suitable roosting conditions over a long period of time, typically over multiple seasons and years. They may be natural or artificial. Examples can include caves, mines, large transportation structures, and buildings.
- **Maternity:** A summer roost, usually a tree but sometimes a human-made structure or bat box, used by reproductively active (pregnant, lactating, or post-lactating) female bats and their young.
- **Non-maternity:** A roost location in which bats have been observed roosting singly or in colonies where the occupying bats do not include reproductively active females and their young. Bats present may include non-reproductive females, males, and/or bats of unknown sex.
- **Potential roost tree:** A live or dead standing tree exhibiting characteristics that make it potentially suitable for bat roosting, such as presence of cavities, cracks, crevices, or exfoliating bark.
- **Primary:** A roost location occupied by bats, potentially large groups or maternity colonies, consistently and repeatedly used through a season.
- **Secondary:** A roost location, sometimes also referred to as an alternate roost, occupied by individual or small groups of bats for only one or a few days. The secondary roost may be associated with a primary roost and numerous secondary roosts may be present within the surrounding area.
- **Winter:** A roosting location used by bats in more moderate winter climates that may be trees or manmade structures. Shallow to extended bouts of torpor are typically used during this period.

Roost Area: An area comprised of multiple known and undocumented roosts collectively used by bats. Bats require and use different roosting conditions at different times of the year and often move around to find the conditions that best meet their needs. Roost areas can be occupied by single bats, groups of non-reproductive bats, and maternity colonies (see also Core Maternal Roosting Area and Secondary Roost Buffer).

Roost Buffer

- **Primary:** A 150-foot buffer zone surrounding a known active roost (maternity or non-maternity) to safeguard the roost's current condition, characteristics, and associated microclimate.
- **Secondary:** Designated species-specific buffer of variable size (see Table 4-1) surrounding a known active maternity roost or documented post-WNS maternity capture site. This area will typically include multiple known and undocumented primary and alternate roost trees used by the maternity colony. These known and unknown roosts

collectively comprise the core maternal roosting area. (See also Core Maternal Roosting Area)

Roosting strategy: The behavior and perceived roost selection preferences exhibited by bats that can be influenced by several factors including the abundance and availability of roosts, predation risk, proximity and distribution of food, social structure (i.e., solitary or colonial), and conservation of energy as influenced by the environment and body size.

S

Seasonal periods: The timeframes representative of when bats in an area are considered to be in a particular life history stage: e.g., maternity period; pup season; spring emergence period, fall swarming period, hibernation period.

Seasonal restriction: A time-of-year restriction, based on the species' biology, on a given activity to avoid or minimize adverse effects.

Smoke sensitive receptor: A designation made in prescribed fire burn plans for entities (e.g., bat hibernacula) that are susceptible to the adverse effects of smoke exposure.

Snag: A standing dead (or dying) tree. Snags may provide important roosting habitat (i.e., potential roost trees) for bats under loose bark and in cavities, crevices, and cracks.

Spring staging habitat: Includes roost and foraging habitat in the area surrounding hibernacula that bats use after emerging from hibernation, prior to beginning migration to summer habitat.

Summer habitat: Consists of a wide variety of forested/wooded habitats where bats roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This may include anthropogenic structures such as but not limited to bat boxes, bridges and buildings.

Summer occupancy period: Time when bats can reasonably arrive on summer home range until most begin migration back to hibernacula. Also see Appendix B.

T

Torpor (adjective: Torpid): An inactive, energy-saving state in which a bat lowers its metabolic rate and body temperature.

U

V

Volant: Ability to fly.

W

White-nose syndrome (WNS): a disease in hibernating bats caused by the nonnative fungal pathogen *Pseudogymnoascus destructans* (Pd) that causes premature winter arousal of many bat species in North America, leading to complex infection that may result in mortality or effects to reproduction.

Winter habitat: roosting and foraging habitat used by bats during the winter. Although BCS species typically hibernate through much of the winter, some tricolored bats and northern long-eared bats remain active through the winter in the southern part of the ranges where prey is available year-round.

X

Y

Z

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