BAT HABITAT CONSERVATION PLAN

PREPARED FOR:

Missouri Department of Conservation
PO Box 180
Jefferson City, MO 65102
Contact: Kelly Rezac
(573) 522-4115

PREPARED BY:

ICF
10 South Broadway, Suite 570
St. Louis, MO 63102 USA
Contact: Paola Bernazzani
(440) 708-4787

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Contents

Tables

Figures

Page

ES.1 Overview

The Missouri Department of Conservation (MDC) has developed this Bat Habitat Conservation Plan (MDC Bat HCP, or HCP) to address the potential for covered forest management activities to cause incidental take of five listed or otherwise at-risk bat species over a period of 50 years. The following bat species are covered in this HCP:

- **Indiana bat (*Myotis sodalis*).** Federally listed as endangered.
- **Gray bat *(Myotis grisescens).*** Federally listed as endangered.
- **Northern long-eared bat (*Myotis septentrionalis*).**[1] Federally listed as threatened.
- **Little brown bat (*Myotis lucifugus*).**[1] Under status review by the U.S. Fish and Wildlife Service (USFWS) with the potential to become federally listed.
- **Tricolored bat (*Perimyotis subflavus).***[1] Petitioned for listing with the potential to become federally listed.

MDC manages land for the purpose of promoting fish and wildlife habitat, enhancing and maintaining forest health, and providing recreational opportunities for all Missourians. While enhancing and maintaining forest health has the potential to adversely affect listed bats at the site level (e.g., habitat management and restoration could result in the removal of trees containing roosting bats), overall, MDC forest management activities result in long-term habitat maintenance and the creation of forest conditions that are beneficial to bats. As a result, MDC seeks to avoid, minimize, and mitigate for potential site-level effects on bats while continuing to manage forests to provide long-term habitat benefits for bats and other wildlife and enjoyable natural resource experiences for citizens. The USFWS has advised that, under certain circumstances, forest management practices and other related MDC activities have the potential to incidentally take the covered species. To provide for the continuance of these activities while minimizing the potential for take of the covered species, MDC has developed the MDC Bat HCP.

ES.2 Covered Lands and Activities

Lands within the plan area are defined broadly as the State of Missouri, and covered lands include those lands owned and managed by MDC as well as those lands where MDC conducts operations in support of its mission to promote fish and wildlife habitat, enhance and maintain forest health, and provide recreational opportunities. There are approximately 1 million acres of MDC-owned and/or managed lands within the approximately 42 million acres of public and private land potentially covered under the MDC Bat HCP. Although MDC-owned lands represent a relatively small proportion of the potentially covered lands, most of the covered activities will occur on MDC lands.

[1] The USFWS announced on March 12, 2020, the initiation of Species Status Assessments for northern long-eared bat, little brown bat, and tricolored bat. The status of these three species is evolving rapidly, in part due to litigation. The MDC Bat HCP will incorporate applicable revisions to the status of these species in the final HCP.

Approximately 41.4 million acres of land addressed under the MDC Bat HCP are non-MDC, nonfederal lands, of which 14.7 million acres are forested. Actions on both forested and nonforested lands are covered, but most covered activities involve actions on forested land cover where there is potential foraging, roosting, maternity colony, and swarming habitat for the covered bat species. The non-MDC, nonfederal lands covered by this HCP must meet certain criteria, such as existing landowner support programs including cost share with landowner agreements and state forestry programs.

The primary goal of the MDC Bat HCP is to obtain authorization for incidental take of the five covered species for specific activities, called *covered activities*, as administered by MDC. Covered activities have been grouped into three major categories: habitat management, public access and asset management, and HCP implementation. Habitat management activities include prescribed fire and tree removal. Prescribed fire is an important forest management practice conducted for the purpose of enhancing and maintaining wildlife habitat and improving recreational and hunting opportunities. Prescribed fire also creates roost trees and foraging habitat for bats. Tree removal ultimately accomplishes two major management objectives: namely, opening the canopy to allow new trees to grow and managing existing habitat to improve the quality of the timber and/or wildlife habitat within the stand. Public access and asset management activities are necessary to maintain infrastructure (e.g., buildings, roads) needed to administer MDC lands and to allow for public access. Take can occur as a result of tree removal during construction, maintenance, and repair of facilities, vehicle operation, and demolition of structures. Implementation of the HCP conservation strategy may result in incidental take during monitoring (e.g., result of direct handling of bats).

Additional MDC activities conducted on covered lands that are not covered or permitted under the MDC Bat HCP may be regulated under their own environmental compliance processes, including ESA compliance. These activities not addressed by the HCP include MDC technical assistance without a nexus to funding (i.e., a cost share), application of approved pesticides/herbicides, utilities accesses, recreational activities, collection of down and dead firewood, and research by individuals or organizations not affiliated with MDC.

ES.3 Environmental Setting

The environmental setting provides an overview of the existing physical and ecological conditions of the plan area (State of Missouri). These environmental baseline conditions are influenced by broader external factors that could affect the status of bats in Missouri. The collective information, obtained through analysis of state and federal data sources (e.g., MDC Geographic Information System datasets, National Land Cover Database) will be used to assess the distribution of the five covered species, to help quantify impacts, and to develop a conservation strategy for the MDC Bat HCP.

The primary external factor affecting the environmental baseline for bats is white-nose syndrome (WNS). WNS was discovered in Missouri in 2012. Since that time, significant population declines of the little brown, northern long-eared, and tricolored bats have occurred. These declines are linked to the migratory patterns of bats between the covered lands and surrounding, WNS-infected states, compounded further by Missouri's extensive cave system and presence of abandoned mines. A secondary external factor in Missouri is wind turbine technology, which has become more

sophisticated with added commercial wind energy facilities and use by farmers or landowners. Wind development results in the accidental mortality of all species covered by the MDC Bat HCP.

The legal status, life history, habitat, distribution, and reasons for decline of the Indiana bat, gray bat, northern long-eared bat, little brown bat, and tricolored bat across the landscape of the plan area are influenced not only by external factors, but also by the physical and ecological attributes of Missouri. The environmental setting components provide a context for evaluating impacts and developing conservation actions for the MDC Bat HCP. These physical and ecological components include location of Missouri within the greater United States, topography, geology, ecological classifications, soils, climate, hydrology, land cover, and forest type distribution. The unique Missouri topography and geology are tied closely to vegetation, climate, soil types, and hydrology that influence bat distribution. The covered bat species are found throughout Missouri, but predominantly inhabit the Missouri Ozarks, which encompass approximately the southern half of the state. The Missouri Ozarks are characterized by heavily forested hills and low mountains, woodlands, karst topography (i.e., caves, sinkholes, springs), and abandoned limestone and iron ore mines, all of which provide preferred roosting, foraging, commuting, and hibernating habitat for the covered bat species.

Table ES-1. HCP Land Cover on MDC and Other Nonfederal Lands Grouped by Preferred Use by Bats (Acres)

HCP Land Covers	MDC Owned and/or Managed Lands (Acres)	Other Nonfederal Lands (Acres)[a]
Preferred by Bats		
Forests and Woodlands	743,113	14,758,443
Glades	2,443	59,863
Total	*745,556*	*14,818,306*
Other Land Covers		
Open Lands	211,190	23,158,199
Open Water	42,704	437,976
Developed	25,220	3,002,418
Total	*279,114*	*26,598,593*

Source: U. S. Geological Survey 2014National Land Cover Database 2011

[a] All lands in Missouri that are not owned by the federal government or by MDC

ES.4 Effects Analysis

Quantification of the potential effects of covered activities on the covered species and a description of the methods to fully offset the effects of the potential taking are requirements in the HCP process. *Take* can be quantified by identifying the number of affected individuals or breeding groups, or by using acres of habitat as a surrogate. Incidental take in terms of numbers of individuals of covered species is often difficult to detect for many types of projects, not just the forestry activities, because of population dynamics, small body size, seasonal fluctuations in populations, habitat type (i.e., tree cavities), and the elusive nature of many species. In the forestry industry, directly estimating the number of individuals that may be taken is difficult to predict, not only for the general reasons noted above, but also because of the expansive landscape included in the covered activities and the timing of those forestry activities caused by site-specific conditions. Also, the presence of WNS in the bat populations presents uncertainty and varying effects from year to year. Based on these limitations, the MDC Bat HCP quantifies take by using the amount of habitat affected by covered activities as a surrogate for the number of bats taken within that habitat.

In the long term, forest management activities improve bat habitat as a result of the covered activities by creating and maintaining preferred roosting and foraging habitat. Covered activities also have the potential to negatively affect bats in roosting trees. The effects analysis evaluates impacts on covered bat species during forest management and public access and asset management activities. The analysis uses a habitat-based approach to quantify the potential for take of bats during these activities. For context and to allow for USFWS to evaluate the impact of the taking, an analysis of effects on individual bats and the populations is also provided.

The methods used to predict and monitor the extent of effects of each covered activity on the covered species quantifies the amount of take in acres. The analysis assesses the effects on HCP land cover categories and at various times of year when bats have the potential to be present. Land cover categories are grouped based on preferential use by bats (i.e., forests and woodlands/glades) versus those land covers less likely to be preferred by bats (i.e., open land, developed land). Seasonal effects are based on the time of year during which the covered activities are completed relative to the times of year when bats are present or absent.

Results of the annual effects of habitat management, public access and asset management (i.e., prescribed fire, tree removal, other tree removal, vehicle operation, demolition of structures) are presented for each of the covered bat species according to season and type of land cover. The results are grouped by the acres affected during the times of year when bats are present (spring/fall and summer) annually and over the 50-year permit term.

Table ES-2. Acres of Habitat Manipulated When Bats Are Present

	Available Fall/Spring (Total Acres)[a]	Available Summer Habitat (Total Acres)	Amount of Potential Fall/Spring/Summer Habitat Impacted When Occupied (Acres/Year)		
			Habitat Management	Public Access and Management	Total
MDC Activities on MDC Lands					
Preferred Land Covers (Forest, Woodlands, Glades)					
Indiana Bat	114,198	745,556	8,197	55	8,252
Little Brown Bat	154,392	745,556	9,831	65	9,896
Northern Long-Eared Bat	160,637	745,556	9,949	66	10,015
Tricolored Bat	178,174	745,556	10,281	67	10,348
Open Lands					
Indiana Bat	32,348	211,190	8,186	0	8,186
Little Brown Bat	43,734	211,190	9,817	0	9,817
Northern Long-Eared Bat	45,503	211,190	9,935	0	9,935
Tricolored Bat	50,470	211,190	10,266	0	10,266
MDC Activities on Other Nonfederal Lands					
Preferred Land Covers (Forest, Woodlands, Glades)					
Indiana Bat	874,208	14,818,306	7,330	< 1	7,330
Little Brown Bat	1,759,340	14,818,306	8,469	< 1	8,469
Northern Long-Eared Bat	1,563,762	14,818,306	8,400	< 1	8,400
Tricolored Bat	1,669,340	14,818,306	8,437	< 1	8,437
Open Lands					
Indiana Bat	1,366,221	23,158,199	1,876	0	1,876
Little Brown Bat	2,749,515	23,158,199	2,168	0	2,168
Northern Long-Eared Bat	2,443,864	23,158,199	2,150	0	2,150
Tricolored Bat	2,608,861	23,158,199	2,159	0	2,159
Statewide Preferred Habitats (Forests, Woodlands, Glades)					
Indiana Bat	988,406	15,563,862	15,527	55	15,581
Little Brown Bat	1,913,732	15,563,862	18,300	65	18,365
Northern Long-Eared Bat	1,724,399	15,563,862	18,349	66	18,415
Tricolored Bat	1,847,514	15,563,862	18,718	68	18,785

[a] Fall/Spring Habitat is a subset of Summer Habitat.

Table ES-3. Conservative Estimate[a] of Bats Taken by Covered Activities

	State Population (Adult Bats)	Estimated Annual total Mortality (Bats)[b]
Indiana Bat	195,157	20.38
Little Brown Bat	748	0.11
Northern Long-Eared Bat	125	0.02
Tricolored Bat	11,147	1.81

[a] Values presented in table have been rounded.

[b] Accounts for protective buffer around Sodalis Nature Preserve in fall, but not for other avoidance measures that are difficult to quantify

HCPs are required to describe the effect of covered activities on the long-term survival and recovery of the each of the covered species, also known as the impact of the taking. A description is provided of the combined adverse effects of covered activities on the long-term survival and recovery of each covered species in the plan area, using the best available information regarding stressors on the species. For each covered species, the impact of the taking assesses the indirect (long-term) and direct (short-term) habitat impacts and an evaluation of populations at multiple scales.

ES.5 Conservation Strategy

The conservation strategy for the MDC Bat HCP is designed to avoid, minimize, and mitigate effects on the covered species such that the take described in Chapter 4, *Effects Analysis*, is fully offset. The conservation strategy is based on a set of biological goals and objectives described in Chapter 5, *Conservation Strategy*, developed specifically for this HCP. Conservation measures were identified to achieve these goals and objectives. Beneficial and net effects of the conservation strategy include the successful management of working forests, which protect potential habitat for bats; the permanent removal of lands from the development stream, thus preventing habitat fragmentation and land conversion; site-level maintenance and promotion of roost trees and foraging habitat; the protection of priority bat management zones (PBMZs) targeted at tree-roosting covered species, the protection and enhancement of caves; and other specific measures that minimize or avoid effects.

The conservation strategy also incorporates an adaptive management program. Adaptive management is a decision-making process promoting flexible management that can be adjusted as uncertainties become better understood or as conditions change. Monitoring the outcomes of management actions is the foundation of an adaptive approach. Adaptive management combines monitoring results with advances in conservation science, potential changing environmental conditions (e.g., shifts in conditions driven by climate change), habitat features (e.g., addition or subtraction of subterranean habitat), changes to covered activity regulations (e.g., prescribed fire), changes to PBMZs/buffers, and unexpected changes to the covered species status (e.g., WNS) to improve management over the permit term. The MDC Bat HCP includes two principal types of monitoring: compliance monitoring and effectiveness monitoring. Compliance monitoring tracks the status of HCP implementation and documents that the requirements of the HCP are being met. Effectiveness monitoring assesses the biological success of the MDC Bat HCP by measuring the fulfillment of the biological goals and objectives.

Table ES-4. Summary Table of Conservation Benefits for the Covered Bat Species

	Protection of Forests and Open Habitat (1.1 million acres)[a]	Management Activities in Habitat Modeled for Bats [a, b]	Species-specific Creation of 7,000-acre PBMZs [a]	Cross-species Use of 21,000 Acres of PBMZs [a]	1.6-acre Buffer around Known Roosts [a, b]	5-mile Seasonal Buffer around Priority 1 & 2 Indiana Bat Hibernacula [a]	10-mile Buffer around SNP [b]	20-acre Buffer around All Caves and Protection of Cave Entrances[a,]	Outreach, Extension and Research on WNS
Indiana Bat	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gray Bat	✓	✓		✓		✓	✓	✓	✓
Northern Long-Eared Bat	✓	✓	✓	✓	✓	✓	✓	✓	✓
Little Brown Bat	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tricolored Bat	✓	✓	✓	✓	✓	✓	✓	✓	✓

[a] = Forest management actions that occur on MDC lands

[b] = Forest management actions that occur on private lands where landowners are participating in the HCP

PBMZ = priority bat management zone

SNP = Sodalis Nature Preserve

WNS = white-nose syndrome

ES.6 HCP Implementation and Assurances

The MDC Bat HCP will be implemented by MDC. The Section 10(a)(1)(B) incidental take permit issued to MDC by USFWS will address incidental take resulting from covered activities on lands throughout Missouri that are owned and managed by MDC, non-MDC lands that participate in qualifying MDC programs (i.e., cost-sharing, habitat management, or grant programs) and other lands that are managed by MDC (e.g., lands leased to the MDC by the U.S. Army Corps of Engineers). Decisions regarding HCP implementation will be made by the MDC director and the Missouri Conservation Commission. The MDC director will serve as the final decision-maker regarding the implementation of the MDC Bat HCP and will ensure MDC is in compliance with the Section 10(a)(1)(B) permit terms and conditions. The Missouri Conservation Commission will provide input on key HCP decisions, particularly regarding amendments, negotiations with USFWS, or extending incidental take coverage to third parties.

To carry out HCP implementation, MDC will assign responsibilities to specific MDC staff members, including an HCP administrator, Geographic Information System technician, and community liaison. The HCP administrator will be responsible for managing the implementation of the MDC Bat HCP and will be in charge of general oversight, calling and leading meetings, communicating directly with USFWS, and maintaining a schedule. MDC staff also includes biologists, foresters, administrators, and other natural resource specialists who will carry out planning and design, monitoring, adaptive management, and periodic coordination with and reporting to USFWS.

The USFWS is the regulatory agency that issues the federal permit for incidental take and that will oversee implementation and enforcement of the MDC Bat HCP. MDC will continue to engage USFWS as specified in the HCP and will provide annual reports concerning its implementation.

While no formal scientific review committee will be established, MDC will consult with outside scientists to get advice on issues related to conservation actions, monitoring, and adaptive management, as needed. MDC will also solicit input from stakeholders with an interest in the MDC Bat HCP and will present an annual update to all interested parties on the status of HCP implementation. The MDC will also maintain an HCP website to provide key program information, reports, and contact information to the public.

ES.7 Cost and Funding

The direct cost to implement the MDC Bat HCP is estimated at approximately $5.3-7.8 million over the 50-year permit term, or approximately $106,024-155,319 annually (Chapter 7, *Cost and Funding*). Direct costs include program administration, conservation program implementation, monitoring, adaptive management, and changed circumstances.

MDC is solvent and committed to funding the implementation of the MDC Bat HCP, including program administration and implementation of the conservation program.

ES.8 Alternatives to Take

The ESA requires that the applicant (MDC) for an incidental take permit specify what alternative actions to the take of the covered species were considered and why those alternatives were not selected. The alternatives discussed further in Chapter 8, *Alternatives to Take*, focus on significant differences in project approach that would avoid or reduce the take. The three alternatives considered but not selected for analysis in the MDC Bat HCP are: (1) no take; (2) retaining current Indiana and northern long-eared bat buffer zones; and (3) reduced covered activities.

Under the no take alternative, MDC would not engage in forest management activities that result in the take of covered species, thereby removing the need for an incidental take permit from the USFWS. Forest management activities are necessary for MDC to meet its required mandates, and because covered activities are necessary, take of the covered species can be minimized but not entirely avoided. Therefore, the no take alternative was rejected. Under the retaining current Indiana bat and northern long-eared bat buffer zones alternative, MDC would avoid the take of Indiana and northern long-eared bats by precluding or minimizing forest management activities (e.g., timber harvest) around known roost locations during the active season. The conservation strategy, as proposed, provides landscape-level protection for all covered species through the development of PBMZs in areas of high conservation value. The alternative that maintains the avoidance buffer zone for Indiana bat and northern long-eared bat buffer zones was rejected. Under the reduced covered activities alternative, take would be reduced by discontinuing the prescribed burning practice. Removal of prescribed fire as a covered activity would force MDC to rely only on tree cutting to manage forest ecosystems. Covering the full suite of MDC habitat management activities at the preferred extent and frequency will allow managers the ability to better enhance forest conditions for bats and other wildlife species. Because prescribed fire benefits forest ecosystems including bats and because addressing fire as a covered activity provides MDC with needed flexibility, the alternative to reduce take of covered by bats by eliminating fire as a covered activity was rejected.

Chapter 1
Introduction

The Missouri Department of Conservation (MDC) is developing a Bat Habitat Conservation Plan (MDC Bat HCP, or HCP) under Section 10(a)(1)(B) of the federal Endangered Species Act (ESA). The MDC Bat HCP protects five listed or otherwise at-risk bat species while allowing specific, covered activities to occur. These activities consist mainly of MDC sustainable forestry and habitat management actions.

MDC manages land for the purpose of promoting fish and wildlife habitat, enhancing, and maintaining forest health, and providing recreational opportunities. Lands covered by this HCP are those owned and administered by MDC. Limited additional forest lands may be covered by this HCP if they meet certain criteria and work with MDC under existing landowners support programs including cost share with landowner agreements and state forestry programs. Of the 42 million acres of MDC-owned and nonfederal land within Missouri, 15.7 million acres are forested land that provides potential habitat to the following federally listed and unlisted species covered in this HCP:

- **Indiana bat (*Myotis sodalis*).** Federally listed as endangered.
- **Gray bat *(Myotis grisescens).*** Federally listed as endangered.
- **Northern long-eared bat (*Myotis septentrionalis*).** Federally listed as threatened.
- **Little brown bat (*Myotis lucifugus*).** Under status review by the U.S. Fish and Wildlife Service (USFWS) with the potential to become federally listed.
- **Tricolored bat (*Perimyotis subflavus).*** Petitioned for listing with the potential to become federally listed.

1.1 Purpose

MDC's mission is "to protect and manage the fish, forest, and wildlife resources of the state; to facilitate and provide opportunity for all citizens to use, enjoy, and learn about these resources" (Missouri Department of Conservation 2018). At times, the implementation of this mission may be limited by federal statutes, regulations, and guidelines for bats, which have the potential to restrict management practices and other MDC activities, particularly during the summer months.

The following strategic goals have been prioritized by MDC for the next 5 years (fiscal years 2019–2023; Missouri Department of Conservation 2018).

1. Sustain and Improve Fish, Forest, and Wildlife Resources
2. Enhance the Relevance of Conservation
3. Connect Missourians with Fish, Forest, and Wildlife Resources
4. Strengthen Operational Excellence to Deliver Superior Customer Service

Fulfilling these goals requires the implementation of land management activities for multiple resources that may impact foraging, swarming, and staging habitat; maternity colonies; and roost

trees for bats. Although potential take involves death, harassment, or harm, including significant habitat modification, forest management activities also have positive effects on bats and bat habitat. MDC, through this HCP, will minimize negative effects and promote positive outcomes for bats, while balancing the needs of other species and objectives.

The overall goal of the MDC Bat HCP is to develop and implement a conservation plan that will accomplish the following objectives:

- Avoid, minimize, and mitigate for incidental take of covered species resulting from habitat management, including forestry, public access, and asset management on covered lands.
- Identify and discuss existing forest management practices occurring on covered lands that benefit bats and their habitats.
- Accommodate current and future habitat management activities on covered lands.
- Provide the basis for take authorization pursuant to the federal ESA for impacts that will occur as a result of covered activities.
- Identify conservation efforts that can improve the value of covered lands for covered species and thus help stabilize and aid in their recovery.

In addition to allowing MDC to fulfill its mission, the MDC Bat HCP will streamline ESA compliance. The HCP will consider the impacts of habitat management, including forestry, and public access and asset management on covered species at a landscape scale rather than on a project-by-project basis (e.g., at the stand level). This approach will allow MDC to meet its mission efficiently, while incorporating a program of comprehensive, large-scale planning and conservation.

1.2 Scope

This section introduces key elements of the MDC Bat HCP: covered activities, plan area, permit term, permittees, and covered species.

1.2.1 Covered Activities

A primary goal of the MDC Bat HCP is to obtain incidental take permits for ESA-listed and at-risk species resulting from specific activities, called *covered activities*. This HCP will cover three major categories: habitat management, public access and asset management, and HCP implementation. Chapter 2, *Covered Lands and Activities*, provides detailed descriptions of these covered activities and the selection process used to evaluate activities for coverage.

1.2.1.1 Habitat Management

The term *habitat* refers to the various types of foods, cover, and other environmental factors needed by a species to survive and reproduce. Approximately 191 native species of vertebrates (80 breeding birds, 42 mammals, 69 reptiles) use Missouri's forests, woodlands, and savannas as key habitat for part or all of their life cycle. Climate, soils, topography, geology, and hydrology as well as land use and natural disturbances determine the types of wildlife habitats found across the state. Several of MDC's divisions (i.e., Forestry, Wildlife, Fisheries, Private Land Services) manage forest and other natural land cover types to fulfill habitat objectives and to maintain natural landscapes in the plan area (see Section 1.2.2, *Plan Area and Covered Lands*, for a description of the plan area).

Habitat management has been grouped into two major categories: prescribed fire and tree removal for habitat management and restoration. While these activities may have short-term effects on bats (e.g., disturbance) and bat habitat (e.g., removal of roost trees), most activities have a long-term positive influence on bats by enhancing foraging and roosting habitat (Boyles and Aubrey 2006; Pauli et al. 2015; Sheets et al. 2013).

1. **Prescribed Fire.** Fire is used to manage and restore a wide variety of wildlife habitats. Prescribed fire can be applied to regenerate and improve habitats, increase biological diversity, control invasive or pest species and diseases, and improve recreational and hunting opportunities.
2. **Tree Removal for Habitat Management and Restoration.** While fire is one tool for managing natural land cover types, tree removal is another. Tree removal includes a range of activities from the targeted removal of single trees to the broad practice of silviculture where new age classes are created by opening the canopy to allow tree growth. Additional detail can be found in Chapter 2, *Covered Lands and Activities*.

1.2.1.2 Public Access and Asset Management

Activities associated with public access and asset management are necessary to maintain the infrastructure (e.g., buildings, roads) needed to administer MDC lands and to allow for public access.

1. **Other Tree Removal.** This activity is necessary to maintain and repair existing infrastructure, including the improvement of public access areas and the construction and maintenance of assets (e.g., constructing buildings, roads, and parking lots; clearing levees and pond dams).
2. **Vehicle Operation.** These activities are associated with MDC's use of vehicles both on- and off-road and potential take from collision.
3. **Demolition of Structures**. This activity is required when older buildings or other structures are demolished. Covered bats roosting in or near the structure being demolished could be affected.

1.2.1.3 HCP Implementation

Implementation of the HCP conservation strategy may require activities (e.g., monitoring and other mitigation activities) that affect covered species. The MDC is seeking coverage for these activities under the incidental take permit for the HCP.

1.2.2 Plan Area and Covered Lands

The plan area for the HCP is defined broadly as the State of Missouri and includes areas where conservation activities occur and MDC is directly involved. The covered lands are those areas where all impacts occur and consist of approximately 42 million acres in two categories: MDC lands (those owned and/or managed by MDC) and other nonfederal lands (Table 1-1 and Figure 1-1). MDC lands, including Conservation Areas, account for approximately 1.02 million acres (2.4%) of the covered lands. MDC activities may also occur on federal lands owned by the U.S. Army Corps of Engineers and leased to MDC. Through these leases, MDC has authority to manage the lands, including obtaining any necessary state and federal permits to conduct the management. Activities on these MDC-managed lands are covered as MDC activities and are grouped with MDC lands for the purposes of this HCP. Although MDC-owned lands represent a relatively small proportion of the

covered lands, the vast majority of the covered activities will occur on forested MDC lands, although nonforested MDC lands are also covered.

Other nonfederal lands represent most of the covered lands (approximately 41.4 million acres or 97.6%) and consist of all land not owned by the federal government or MDC. Other nonfederal lands are typically owned by corporations, private individuals, nonprofit conservation groups, local government, and private clubs. It is important to note that MDC does not anticipate conducting activities on all, or even most, of the 41.4 million acres of nonfederal land in Missouri but seeks to cover all nonfederal lands in this HCP to facilitate current and future opportunities to provide landowner assistance, including cost sharing and technical assistance, to any interested landowner anywhere in Missouri for the duration of the permit. Of the 41.4 million acres of nonfederal lands, 14.7 million acres are forestlands. Covered activities are most likely to occur on forestlands. Chapter 2, *Covered Lands and Activities*, and Chapter 3, *Environmental Setting*, provide more information on covered lands.

Table 1-1. Covered Lands by Ownership

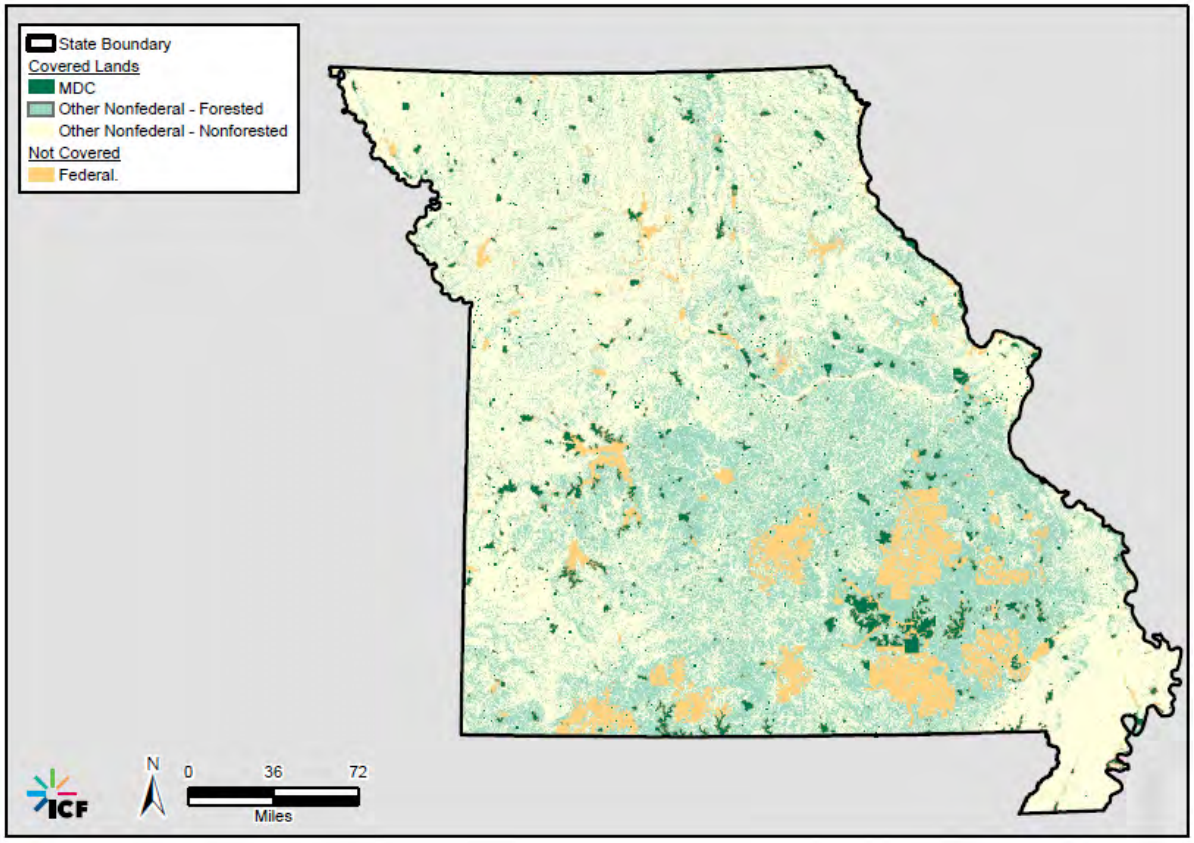
Ownership Type	Acres[a]	% of All Covered Lands
All covered lands	42,444,570	—
MDC-owned and managed lands[b]	1,024,792	2.4
Other nonfederal lands	41,419,778	97.6
Other nonfederal lands—forested	14,715,955	34.7
Other nonfederal lands—nonforested	26,703,823	62.9

Sources: State Boundary—Missouri Department of Conservation 2014; MDC Lands—Missouri Department of Conservation 2017; Public Lands—U.S. Geological Survey Protected Areas Database 2016; Land Cover—National Land Cover Database 2014; Private Lands—Forested—analytical GIS step.

[a] Numbers may not sum exactly due to rounding.

[b] Includes U.S. Army Corps of Engineer lands that are managed by MDC.

Figure 1-1. Map of Covered Lands (MDC and Other Nonfederal Lands)



Sources: State Boundary—Missouri Department of Conservation 2014; MDC Lands—Missouri Department of Conservation 2017; Public Lands—U.S. Geological Survey Protected Areas Database 2016; Land Cover—National Land Cover Database 2014; Private Lands—Forested—analytical GIS step.

1.2.3 Permit Term

The MDC is seeking a 50-year incidental take permit from USFWS. All assessments in the MDC Bat HCP are therefore based on a 50-year period. This permit term was selected because it provides a foreseeable planning horizon of the effects of forest management activities on species listing, covered activities, and for the full implementation and evaluation of the conservation strategy (Chapter 5, *Conservation Strategy*), including monitoring and adaptive management. The permit term will also allow for a sufficient assessment of many of the effects of the proposed forest management activities on covered bat species, for tracking the implementation of conservation actions, and for tracking the responses of resources to climate change and the uncertainties associated with the spread of white-nose syndrome (WNS) and its effects on bats. Upon expiration of the initial permit or to incorporate major revisions during the permit term, MDC may apply to renew or amend the permit and the associated MDC Bat HCP. The MDC may also relinquish the permit prior to its expiration in the event of the extirpation, extinction, or federal delisting of the listed bat species covered by the HCP.

1.2.4 Permittee

The permittee for the incidental take permit is MDC. This HCP and associated permits will allow for implementation of the covered activities and conservation and monitoring measures. HCP implementation is described in Chapter 6, *Implementation and Assurances*. As mentioned previously, actions undertaken on private land under the authority of MDC are also covered. For a project on private land to be covered by this HCP, there must be an MDC nexus with the project, and MDC must have direct authority over the landowner for the covered activity.

1.2.5 Covered Species

The MDC is requesting incidental take coverage for four bat species that typically hibernate in caves and mines and inhabit forests from spring to fall: Indiana bat, northern long-eared bat, little brown bat, and tricolored bat, as well as one bat species, gray bat, which typically inhabits caves, mines, or other subterranean structures throughout the year. A complete description of each species is included in Appendix A, *Species Accounts*.

Indiana bat (*Myotis sodalis*). The Indiana bat is a medium-sized, insectivorous bat that ranges from New Hampshire south to Alabama and west to the Great Plains. Factors such as habitat loss and degradation, disturbance during hibernation, and environmental contamination have contributed to the species' decline, and USFWS listed the species as endangered on March 11, 1967 (32 *Federal Register* [FR] 4001). In addition to these factors, WNS has emerged as a significant threat to Indiana bat populations, causing the loss of approximately 20% of the population since 2007 (U.S. Fish and Wildlife Service 2017). In Missouri, the species is potentially present in most counties except the south-central, southwest, and west-central parts of the state (Boyles et al. 2009).

Gray bat *(Myotis grisescens).* The gray bat is a relatively large bat native to the caves of the south-central United States. Unlike many similar species, the gray bat relies on caves throughout the year. The species was listed as endangered on April 28, 1976 (41 FR 17736–17740) chiefly due to population declines associated with human disturbance at caves. Since the gray bat's listing, most important caves have been protected, leading to dramatic population increases such that concerns over WNS are now the largest obstacle to delisting the species (U.S. Fish and Wildlife Service 2009).

The species remains common in southern Missouri where decades of effort by MDC and its partners have resulted in the protection of many important sites (Boyles et al. 2009).

Northern long-eared bat (*Myotis septentrionalis*). The northern long-eared bat is a medium-sized, insectivorous bat distinguished from other eastern species of *Myotis* by its long ears. The species ranges from easternmost Quebec to Saskatchewan in Canada and south to the Florida Panhandle. The predominant threat to northern long-eared bats is WNS; studies of northern long-eared bat populations in the northeastern United States have shown a 98–99% decline in the number of hibernating individuals since the arrival of this syndrome in 2006. Since then, the syndrome has spread steadily throughout the species' range (see https://www.whitenosesyndrome.org/). The USFWS published a proposed rule to list northern long-eared bats as endangered under the ESA on October 2, 2013 (78 FR 61046), but subsequently revised this on January 15, 2015, to propose its listing as threatened. The USFWS published a final listing rule designating northern long-eared bats as threatened on April 2, 2015 (80 FR 17974). In addition to the listing rule, USFWS 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 (U.S. Fish and Wildlife Service 2016). 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 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). While the 4(d) rule effectively exempts most take associated with forest management activities in the state, the species' continued decline may result in its uplisting (from threatened to endangered) over the course of the permit term. Special 4(d) rules do not apply to species listed as endangered. Therefore, should the species be uplisted, the associated exemptions for forestry will no longer exist. In Missouri, the species likely occurred across most of the state, although it was more common in areas with more trees (Boyles et al. 2009) prior to WNS.

Little brown bat (*Myotis lucifugus*). The little brown bat is a medium-sized, insectivorous bat that ranges from Alaska south to central Mexico and from the Atlantic to the Pacific, although the species is less abundant in the Deep South. The little brown bat, once among the most common and widespread species of bats in North America characterized by conspicuous maternity colonies and relatively stable populations, is now in rapid decline due to WNS (Kunz and Reichard 2010). The little brown bat is not currently listed under the ESA, but a recently completed status review found evidence of dramatic and widespread declines throughout the eastern United States (Tinsley 2016). In 2023, USFWS plans to conclude a formal review of the species to determine whether its listing under the ESA as endangered or threatened is warranted. In Missouri, the species likely occurred in every county in the state (Boyles et al. 2009) prior to WNS.

Tricolored bat (*Perimyotis subflavus*). The tricolored bat, previously known as the eastern pipistrelle, is wide-ranging over most of the eastern United States and southern Canada. Although the tricolored bat is not currently listed under the ESA, USFWS (82 FR 60362) found that a June 2016 petition to list this species as threatened (Center for Biological Diversity and Defenders of Wildlife 2016) presented substantial scientific or commercial information indicating that listing may be warranted and is now completing a formal status review. The tricolored bat may therefore become listed during term of this HCP. In Missouri, the species likely occurred in every county in the state (Boyles et al. 2009) prior to WNS.

There are a number of other federally listed species in the plan area (Appendix B, *Species Evaluation*). The MDC Bat HCP will not cover these species based on the following considerations: the proposed covered activities do not affect the species, the species is highly localized in the plan area and effects will be avoided or permitted separately, or insufficient data exist to cover the species. In all cases, either covered activities will avoid other listed species or these species will be addressed in separate compliance processes, such as through Section 7 consultation. Appendix B, *Species Evaluation,* displays federally listed species with the potential to occur in Missouri.

1.3 Regulatory Setting

The USFWS issuance of an incidental take permit under the ESA is subject to all the applicable federal regulatory requirements associated with any federal action. In addition, applicable state laws, guidelines, and mandates must also be addressed for wildlife species, including the five covered bat species.

1.3.1 Applicable Federal Environmental Laws

1.3.1.1 Federal Endangered Species Act

In 1973, the federal government enacted the ESA (16 United States Code [USC] § 1531 et seq.). Congress increased protections relative to previous environmental regulations by creating a more comprehensive approach focused not only on individual species, but also their habitats. For the first time, the ESA enunciated the intention of conserving the ecosystems on which endangered and threatened species depend, with a goal of restoring listed species to a condition that would render the protections of the ESA unnecessary. The USFWS and the National Marine Fisheries Service (NMFS) jointly administer the ESA. The ESA requires USFWS and NMFS to maintain lists of threatened and endangered species and provides substantial protections for these listed species. The NMFS jurisdiction under the ESA is limited to marine mammals, marine fish, and anadromous fish; because none of these species are proposed to be covered under this HCP, NMFS will not be involved in permit issuance. The USFWS will be the permitting agency for the HCP and the lead agency for the National Environmental Policy Act (NEPA) compliance.

Some of the most relevant sections of the ESA are summarized below.

Section 4(d)

Section 4(d) of the ESA allows the USFWS to establish special rules for threatened (but not endangered) species of wildlife, subspecies, and distinct population segments. These rules may either increase or decrease the normal take prohibitions established under Section 9 of the ESA for endangered species but must be "necessary and advisable to provide for the conservation" of threatened species. Typically, 4(d) rules are aimed at reducing ESA conflicts by allowing some activities to continue even if they will result in take of a threatened species.

For the northern long-eared bat, a 4(d) rule exists that exempts certain actions from the prohibition of take and minimizes regulatory requirements for landowners, land managers, government agencies, and others within the species' range. A description of the 4(d) rule compliance process for northern long-eared bat can be found on the USFWS website: https://www.fws.gov/Midwest/endangered/mammals/nleb/KeyFinal4dNLEB.html.

Section 7

Section 7(a)(2) of the ESA requires all federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat. To ensure that its actions do not violate these provisions, each federal agency must consult with USFWS, NMFS, or both (collectively referred to as "the Services") when they determine that an action may affect listed species or designated critical habitat. If, after consultation, the Services conclude that the proposed action would jeopardize the continued existence of a listed species or adversely modify its critical habitat, the biological opinion may suggest *reasonable and prudent alternatives* to the proposed action. If the USFWS concludes that the proposed action is not likely to jeopardize the species, the action is granted exemption from the provisions of Section 9 of the ESA through an incidental take statement. To qualify for this exemption, the federal agency must implement the terms and conditions of the incidental take statement. The incidental take statement does not provide an incidental take exemption for nonlisted species.

Before a Section 10 permit is issued, USFWS is required to undertake an internal Section 7(a)(2) consultation because the issuance of the permit is a federal action. This process, whereby USFWS consults with itself, is also known as *intra-Service consultation*. In addition to the requirements of the Section 10 permit regulations, species and habitat information are needed for the Section 7 review. All covered species (listed and nonlisted) will need to be assessed under Section 7 with respect to the likelihood of jeopardizing the species and with respect to adverse modification of any critical habitat. For species covered by an incidental take permit, the biological opinion addresses Section 7 criteria—specifically that the permitting of incidental take and implementation of the HCP will "not appreciably reduce the likelihood of the survival and recovery of the species in the wild."

Section 9

Section 9 of the ESA prohibits the take of any fish or wildlife species listed under the ESA as endangered. For threatened species only, Section 4(d) allows USFWS (or NMFS) to design and implement special rules that may exempt certain activities from the prohibition of take as described above. Although Section 9 of the ESA includes prohibitions that apply to listed plants, the take prohibitions in Section 9 are applied only to listed wildlife (animals), not to listed plants.

Section 10

Under Section 10(a)(1)(B), private landowners, Native American Tribes, corporations, state agencies, local agencies, and other nonfederal entities without a federal nexus may, at their discretion, seek to obtain an incidental take permit for take of federally listed fish and wildlife species "that is incidental to, but not the purpose of, otherwise lawful activities" (50 Code of Federal Regulations [CFR] § 402.02).

In order to receive an incidental take permit, the nonfederal entity is required under Section 10(a) to prepare an HCP. HCPs are voluntary agreements under the ESA. An HCP analyzes the anticipated impacts of the proposed taking and provides a conservation strategy that describes how those impacts will be minimized and mitigated to the maximum extent practicable. The HCP will also demonstrate that funding will be available to implement such measures (16 USC § 1539(a)).

1.3.1.2 National Environmental Policy Act

The NEPA (42 USC § 4332 et seq.) requires all federal agencies to evaluate the environmental effects of proposed agency actions as part of their decision-making process. This environmental impact analysis is documented in either an environmental assessment or an environmental impact statement. In addition, these documents and a description of the efforts to avoid or minimize the adverse effects of proposed actions must be made available for public notice and reviewed as part of the NEPA process.

The USFWS issuance of an incidental take permit is a federal action subject to NEPA review. To comply with NEPA, USFWS will prepare an environmental review document (either an environmental assessment or an environmental impact statement) to disclose the effects on the natural and human environment of issuing the incidental take permit.

1.3.1.3 National Historic Preservation Act

The National Historic Preservation Act (16 USC §§ 470–470x-6) is the principal federal statute protecting historical, architectural, archaeological, and cultural resources. The act establishes an independent agency, the Advisory Council on Historic Preservation as well as the National Register of Historic Places within the National Park Service. In particular, Section 106 of the act requires federal agencies to consider the effects of their undertaking (or action) and consult with specific parties on properties listed in or eligible for inclusion in the National Register of Historic Places. Eligible for listing in the register are all properties that meet the specifications laid out in the Department of the Interior regulations at 36 CFR Section 60.4.

The USFWS issuance of an incidental take permit is a federal action subject to Section 106 of the National Historic Preservation Act. To comply with Section 106, USFWS will have to consider the effects of permit issuance on properties listed in or eligible for inclusion in the National Register of Historic Places.

1.3.2 Applicable State Endangered Species Laws and Guidance

This section describes Missouri laws, regulations, and guidance that pertain to endangered species or to wildlife protections for bats.

1.3.2.1 Missouri Statutes

In 1937, Missouri Constitutional Amendment 4 took effect; it created the Missouri Conservation Commission and MDC, an apolitical, science-based conservation agency with authority over fish, forests, and wildlife. The Missouri General Assembly passed an act (Section 252.240 Missouri Revised Statutes [RSMo]) in 1972 charging MDC with establishing a list of endangered species and providing protection for them. The Missouri Code of State Regulations (CSR) (Title 3, Department of Conservation, Division 10, Conservation Commission, Chapter 4—Wildlife Code: General Provisions) provides Missouri's guidelines for the designation and protection of threatened and endangered species. Title 3 CSR 10-4.110 (3) states "Except as otherwise provided in this Code, wildlife may be taken only by holders of the prescribed permits and in accordance with prescribed methods."

The Wildlife Code of Missouri (Title 3 CSR 10-4.111) prohibits the following:

> *Importation, transportation, sale, purchase, taking, or possession of any endangered species of wildlife, or hides or other parts thereof, or the sale or possession with intent to sell of any article made in whole or in part from the skin, hide, or other parts of any endangered species of wildlife.*

For the purposes of this rule, endangered species of bats designated as native to and endangered in Missouri include the Indiana bat, gray bat, and northern long-eared bat. There is no incidental take permitting process for listed species under the Wildlife Code of Missouri.

1.3.2.2 Best Management Practices

MDC provides a public website that provides general guidance and best management practices (BMPs) on MDC lands and private lands (https://mdc.mo.gov/property/responsible-construction). Note that BMPs are recommended practices and are not enforceable. The website provides the following information for the public.

- Species Impact: Best Practices—provides BMPs for building near streams. This section lists BMPs for certain species, including the gray bat.
- Building on Karst Best Practices—provides BMPs when building on karst topography.
- Missouri Natural Heritage Program (MONHP)—identifies species and natural communities of conservation concern in each Missouri county. This database provides current information for conservation planning, environmental review, scientific research, land acquisition, and planning for economic development. Developers are encouraged to complete a MONHP review prior to construction; however, there are no state enforcement guidelines to ensure that these reviews occur.
- Constructing with Care—provides BMPs for managing the building area to protect trees.
- Grow Native!—provides information for Missouri native plants.
- Conservation and Habitat Contractors—provides information for improving private land for conservation and wildlife.

1.4 Development of the MDC Bat HCP

The MDC Bat HCP was developed in coordination with a steering committee that provided technical advice and guidance. The members of the steering committee who participated in the development of the MDC Bat HCP are identified in Table 1-2.

Table 1-2. Participants in the Steering Committee

HCP Steering Committee				
Division	**Primary**	**Title**	**Backup**	**Title**
HCP Coordination	Ryan Houf	HCP Development Coordinator	Kelly Rezac	Wildlife Diversity Coordinator
Design and Development	Barbara Li	Project Engineer	Ronnie Thurston	Construction and Maintenance Superintendent
Fisheries	Laura Ruman	Fisheries Programs Supervisor	Mike Mitchell	Fisheries Administrative Manager
Forestry	Rich Blatz	Forestry Field Programs Supervisor	Justine Gartner	Forest Management Chief
Policy Coordination Unit	Lin Kuhn	Environmental Compliance Specialist	Theresa Hyland	Environmental Compliance Specialist
Private Land Services	Lisa Potter	Private Land Services Programs Supervisor	Jason Jensen	Private Land Services Unit Chief
Protection	Randy Doman	Protection Field Chief	N/A	Protection Field Chief
Resource Science	Anthony Elliott	Field Station Supervisor	Kathryn Womack Bulliner	Wildlife Bat Ecologist
Wildlife	Lee Hughes/Chris Newbold*	Public Lands Coordinator	Norman Murray	Species and Habitat Chief
Administration	Doyle Brown	Federal Aid Coordinator	N/A	
Administration	Jennifer Frazier	General Counsel	N/A	

* Geographical Information Systems Coordinator for HCP
N/A = not applicable

1.5 Document Organization

This MDC Bat HCP document contains the following chapters and appendices.

- Chapter 1, *Introduction*
- Chapter 2, *Covered Lands and Activities*
- Chapter 3, *Environmental Setting*
- Chapter 4, *Effects Analysis*
- Chapter 5, *Conservation Strategy*
- Chapter 6, *Implementation and Assurances*
- Chapter 7, *Cost and Funding*
- Chapter 8, *Alternatives to Take*
- Chapter 9, *References*
- Appendix A, *Species Accounts*
- Appendix B, *Species Evaluation*
- Appendix C, *Covered Activity Impact Breakdown*
- Appendix D, *Literature Review for the Benefits of Forestry on Bats*
- Appendix E, *Priority Bat Management Zones*
- Appendix F, *Desired Future Conditions Within Priority Bat Management Zones (PBMZs)*
- Appendix G, *Template Landowner Agreement*

Chapter 2
Covered Lands and Activities

2.1 Overview

This chapter provides an overview of covered lands and activities that will be used to request take authorization under the Missouri Department of Conservation (MDC) Bat Habitat Conservation Plan (MDC Bat HCP or HCP). This HCP will cover three categories of activities: habitat management, public access and asset management, and HCP implementation.

2.2 Covered Lands

Lands covered by this HCP include those owned and managed by MDC as well as those lands where MDC conducts operations in support of its mission to manage the fish, forest, and wildlife resources of the state. Table 1-1 in Chapter 1, *Introduction*, provides the acres of all covered lands.

2.2.1 MDC-Owned and/or Managed Lands

The MDC owns and manages approximately 1 million acres of lands (MDC lands) within the approximately 42 million acres of public and nonfederal land covered under the MDC Bat HCP (see Figure 1-1 in Chapter 1, *Introduction*). This total includes approximately 178,000 acres of land leased to and managed by MDC on behalf of the U.S. Army Corps of Engineers (USACE) (as described in Section 6.2.2, *Coverage to MDC Managing U.S. Army Corps of Engineers Property)*. Fish, forest, and wildlife resources on these lands are managed to assure health and diversity that will give citizens the opportunity to use, enjoy, and learn about these resources.

The MDC manages land owned by the USACE under three programs (Table 2-1). In all of these cases, USACE has delegated authority to MDC to obtain any necessary state or federal permits to conduct the management of these lands. For MDC to continue to manage these lands successfully and consistent with the agreements with USACE, limited take authorization is needed. Each of the USACE programs under which MDC manages land is described below, along with an accounting of the specific sites and the general activities it conducts.

The MDC manages 20,842 acres of land owned by or under easement to the USACE under the Bank Stabilization and Navigation Project. MDC is also contracted with the USACE to develop and maintain features of the Missouri River Fish and Wildlife Mitigation Project (Missouri River FWMP) in accordance with the Missouri River Recovery Program (MRRP); the primary activities under this program include site operations and maintenance and law enforcement. MDC manages these USACE lands as conservation lands the same as conservation lands that are owned and managed by MDC.

The MDC also manages 144,292 acres of USACE land surrounding reservoirs owned by the USACE. These areas, referred to as “Management Lands,” are managed like other MDC conservation lands under a separate 25-year license for each reservoir site (Table 2-2).

The MDC manages 13,086 acres of the Upper Mississippi Conservation Area, a collection of 38 parcels in or along the Mississippi River, under a cooperative agreement between the USACE and the

USFWS referred to as the "General Plan." This agreement restricts MDC's management of these lands to prescribed fire only.

Table 2-1. USACE Programs for Which MDC Manages Land Owned by USACE

USACE Program	MDC Activities	Land Managed by MDC (acres)	Notes
Missouri River Fish and Wildlife Mitigation Project	Habitat management, site operations and maintenance, law enforcement	20,482	Managed by MDC under contract with the USACE as described in the Performance Work Statement to Develop and Maintain Features of the Missouri River Fish and Wildlife Mitigation Project.
License for Fish and Wildlife Activities Around USACE Reservoirs	Habitat management, agricultural leases	144, 292	Called "Management Lands" by MDC. Managed under 25-year licenses with USACE.
Upper Missouri Conservation Area	Prescribed burning only	13,086	Managed by MDC under a Cooperative Agreement with USACE called the "General Plan."
Total		**177,860**	

Table 2-2. USACE-Owned Sites Managed by MDC

Site Name	County	USACE Program	Land Managed by MDC (acres)
Aspinwall Bend	Atchison	MRRP	689
Thurnau (H. F.) Conservation Area	Holt	MRRP	2,271
Monkey Mountain Conservation Area	Holt	MRRP	664
Eagle Bluffs Conservation Area (Sapp tract & McBaine)	Boone	MRRP	874
Deroin Bend Conservation Area	Holt	MRRP	1,213
Rocheport Cave Conservation Area	Boone	MRRP	44
Columbia Bottom Conservation Area	St. Louis	MRRP	4,256
Tate Island Conservation Area	Callaway	MRRP	422
Lower Hamburg Bend Conservation Area	Atchison	MRRP	2,395
Nishnabotna Conservation Area	Atchison	MRRP	2,832
Rush Bottoms Conservation Area	Holt	MRRP	1,095
Corning Conservation Area	Atchison, Holt	MRRP	1,999
Wolf Creek Bend Conservation Area	Holt	MRRP	982
Bull Shoals Lake Management Lands	Ozark, Taney	ML License	37,351
Wappapello Lake Management Lands	Wayne	ML License	1,909
Stockton Lake Management Lands	Cedar, Dade, Polk	ML License	16,883
Long Branch Lake Management Lands	Macon	ML License	2,504
Clearwater Lake Management Lands	Reynolds, Wayne	ML License	17,063
Norfork Lake Management Lands	Ozark	ML License	5,125
Pomme de Terre Management Lands	Hickory, Polk	ML License	4,951
Truman Reservoir Management Lands	Benton, Henry, Hickory, Polk, Saint Clair	ML License	58,506
Upper Mississippi Conservation Area	Lewis, Lincoln, Saint Charles, Pike	General Plan	13,086

MRRP = Missouri River Recovery Program

2.2.2 Other Nonfederal Lands

Of the 42 million acres of land covered under this HCP, 41,416,899 acres are nonfederal lands, of which 14,712,655 acres are forested. Actions on both forested and nonforested lands are covered, but most covered activities involve actions on forested land.

The MDC works with nonfederal landowners (e.g., private and county lands) to extend sustainable management practices to these lands to meet specific goals such as the creation of wildlife habitat and the promotion of healthy forests. These non-MDC, nonfederal lands are covered by this HCP through participation in various cost share, habitat management, and grant programs under the direct authority of MDC. Coverage under the HCP for these programs is based on a Template Landowner Agreement and is premised on MDC's ability to extend direct control over participants. These programs are described in more detail in Section 2.2.2.1, *Missouri Cost-Share Program* and

Section 2.2.2.2, *State Forestry Programs. .* A description of the agreements, monitoring, and enforcement associated with coverage of non-MDC lands and the Template Landowner Agreement are found in Chapter 6, *Implementation.*

The HCP specifically does not cover management recommendations provided to the public, regardless of whether such advice is delivered informally, as it is a nearly daily occurrence when members of the public approach an MDC employee in a public space; via a scheduled meeting between MDC staff and a landowner; or obtained from an MDC publication. In such cases, MDC will continue to work to identify potential issues with protected species and encourage the landowner to consult the U.S. Fish and Wildlife Service (USFWS).

2.2.2.1 Missouri Cost-Share Programs

The MDC facilitates the sharing of technical information and provides cost-share assistance to private landowners seeking to conduct conservation practices on their land. The cooperative effort between private or county landowners and MDC improves the quality and quantity of wildlife habitat on nonfederal land through a variety of projects, such as prescribed fires, restoration, and management of multiple habitat types, including both forest/woodlands and open habitat types.

Missouri Cost-Share Program participants enter into a landowner agreement with MDC and receive funds from MDC for actions undertaken at the direction of MDC staff. Because the landowner agreement is binding, and these funds can be revoked if actions are not carried out, these activities are under the direct authority of MDC and can therefore receive coverage under the take permit associated with the HCP, as long as all conservation strategy measures are implemented. Currently, over 18,000 acres of habitat are restored on private land on average each year under the Missouri Cost-Share Program.

2.2.2.2 State Forestry Programs

With support and funding from the U.S. Forest Service, MDC administers three programs whose aim is to encourage the long-term protection, management, and productivity of privately owned forests and woodlands. These programs are voluntary, require a Forest Stewardship Plan, and will receive coverage under the MDC Bat HCP, so long as they follow HCP guidelines for conducting covered activities on their lands. A description of the agreements, monitoring, and enforcement associated with coverage of state forestry programs is found in Chapter 6, *Implementation*

Timber Sale Assistance Program

The Timber Sale Assistance Program provides private landowners with the tools and guidance to manage natural resources on forested lands under their control. This is accomplished through the development of management plans that promote sustainable natural resource use and healthy ecosystem function, through the incorporation of resource and wildlife management goals. These plans often include a variety of habitat management activities.

Missouri Tree Farm Program

The Missouri Tree Farm Program is part of the American Tree Farm System, which was developed to encourage protection of forested habitat on privately owned land, including native forest, native woodland, and plantations. This program oversees the growth and management of forest habitat for sustainable natural resource use, improved water quality, recreational opportunities, and wildlife

habitat. A parcel of land qualifies if it is at least 10 acres of forested land, undergoes approved management activities, and has a detailed long-term management plan.

Missouri Managed Woods Program

The Missouri Managed Woods Program encourages long-term habitat management on larger tracts of private lands. It applies to property with over 20 acres of undeveloped, continuous forest habitat and requires a 15-year commitment. Participants receive assistance in developing and applying a forest management plan and conducting sustainable timber sales. This program can use Forest Stewardship Plans as a management plan.

2.3 Covered Activities

2.3.1 Covered Activities Summary

Activities covered by this HCP can be broken into three major categories: habitat management, public access and asset management, and HCP implementation. Habitat management activities include prescribed fire and tree removal for habitat restoration and management. These activities remove trees and therefore have the potential to affect bats. However, all habitat management activities retain natural lands as such—conversion to nonnatural land cover (e.g., urban, agriculture) is inconsistent with these activities. Further, many of the habitat management activities have the potential to negatively affect covered bats over the short term but to create or improve habitat for covered bats over the long term.

2.3.2 Methods for Quantifying Covered Activities

The MDC identified five divisions (Forestry, Wildlife, Fisheries, Design and Development, and Private Land Services) responsible for coordinating activities that are reasonably certain to take one or more of the covered species. Each of these divisions completed an analysis identifying activities likely to result in take. The results of the breakdown (or deconstruction) analysis are found in Appendix C, *Covered Activity Impact Mechanism Breakdown by MDC Division*. During this process, it became clear that the primary potential impact mechanism on covered bats is tree removal (i.e., mechanized or hand felling), followed by prescribed burning. Other impact mechanisms identified through this process are collision with motorized vehicle, demolition of a structure, and noise. Each of these impact mechanisms is associated with at least one of the covered activities described below.

When feasible, data were collected over multiple years to inform estimates of future take. These estimates will function as caps across all of MDC for the purpose of permitting (note that limits on take will not be associated with specific divisions as these may change over time). The number of years and the date ranges for data varied by activity and included estimates for multiple years (up to 9 years) or estimates covering a single year of data. Information on the areas and locations of MDC covered lands and the location and extent of roads and trails were provided as geographic information system (GIS) data. Impacts on smaller-diameter trees are covered but not quantified because tracking and monitoring these effects is not feasible and the potential impact is small or negligible relative to effects on larger-diameter trees (9 inches or greater). Conservation measures are intended to fully offset both quantified and unquantified take.

2.3.3 Habitat Management

A key part of MDC's mission statement is to "protect and manage the fish, forest, and wildlife resources of the state." MDC undertakes a wide range of habitat management activities in support of this mission on MDC lands, including many that benefit other species but have the potential to result in the incidental take of the covered bats. These activities are described below.

2.3.3.1 Prescribed Fire

Prescribed fire is used as a habitat and wildlife management tool. It can be applied to regenerate and improve habitats, increase biological diversity, control invasive or pest species and diseases, improve watershed quality, and improve recreational and hunting opportunities.

In Missouri, prescribed fire is often used to manage and restore a wide variety of wildlife habitat including oak forests, glades, prairies, woodland, and savanna habitats. Prescribed fire is an important management tool in grassland habitats, and smoke from prescribed fire may affect adjacent woodland and savanna habitat used by bats. These land cover types and their use by bats are described in more detail in Chapter 3, *Environmental Setting,* and Chapter 4, *Effects Analysis*.

MDC requires that prescribed fire activities be based on a predetermined burn plan, which is described in the MDC Resource Policy Manual (Missouri Department of Conservation 2014).

Estimated acres of prescribed fire on MDC-owned and managed lands are provided in Table 2-3. Estimated acres of prescribed fire on other nonfederal lands are provided in Tables 2-5 and 2-6.

Table 2-3. Acres of Prescribed Fire on MDC-Owned and Managed Lands

	Acres Burned[a]	
Land Cover	**Annual Average**	**5-Year Average**
Forest and Woodland	19,448	97,240
Glades	1,155	5,775
Open Lands	28,009	140,045
Total	**48,612**	**243,060**

[a] Annual acreage based on recorded past activities provided by MDC. Average estimates of acreage used when multiple years of data were provided.

2.3.3.2 Tree Removal for Habitat Restoration and Management

Activities on MDC Lands (Owned and/or Managed)

Tree removal for the purposes of habitat restoration and management is used to carry out specific management objectives. By removing trees in both forested and open lands, managers can create habitat for a variety of wildlife and plant species, promote a mosaic of forest types on the landscape, and/or facilitate recreational opportunities. In some cases, the trees have commercial value and are sold. In other cases, non-merchantable trees are removed or killed and left in the stand as part of habitat restoration and management activities. With the exception of trees removed to facilitate public access and asset management (see Section 2.3.4, *Public Access and Asset Management*), tree removals on MDC lands have a designated goal of managing or restoring habitat.

These tree removals can be described based on both the intensity (i.e., limited removal versus extensive removal) of the activity and on its intended management objective. Ecologically, these tree removals can be used to mimic natural disturbances at various levels, and provide a mechanism to direct the growth, development, health, composition, and quality of forest stands so the stands meet an identified set of needs and values and maintain a sustainable forest ecosystem. At its simplest, MDC removes trees to accomplish two major management objectives within a stand. The first is to open the canopy to allow new trees to grow and the second is to manage existing habitat.

Encouraging New Trees to Grow

The purpose of the first category of tree removal associated with habitat restoration and management is to open the canopy to allow new tree growth. Such harvests promote regrowth by creating openings that range in size from a small gap created by removing an individual tree to larger open areas created by removing most of the trees from a stand. Foresters adjust the number and location of the trees being removed depending on the management objective for the stand. When all large trees are removed at one time, the resulting gap is filled by trees of the same age (i.e., an even-aged stand is created). Conversely, by completing multiple harvests over many years, a forester can establish a variety of age classes. MDC recognizes three subcategories of activities aimed at stimulating the growth of new trees. These subcategories are distinguished primarily by the proportion of the canopy trees that are removed from a management unit (i.e., stand).

- **Regeneration harvest.** These harvests remove all or most of the canopy trees in the stand, leaving 30 square feet or less of the basal area of the stand still forested. They are often restricted to 40 acres or less.
- **Shelterwood harvest.** These harvests remove the overstory in a series of harvests. They are designed to regenerate the stand while providing shelter to the newly established seedlings from environmental extremes. These rarely leave less than 30 square feet of basal area per acre per removal and most often leave more. Most of the time the remaining overstory is left in place, creating a stand of trees of two ages.
- **Uneven-aged harvest.** These harvests are designed to create three distinct age classes of trees by removing trees within a stand over several time periods. Trees are removed by either single tree selection, group selection, or a combination of both. Single tree selection may reduce the stand down to approximately 40 to 60 square feet of basal area per acre. Group selection creates gaps ranging anywhere from 0.5 to 5 acres in size.

Areas harvested using shelterwood harvests are likely to be subjected to a subsequent harvest effort in approximately 15 years that would be classified as a regeneration or uneven-aged harvest, depending on MDC's long-term management goals.

Managing Existing Trees

The purpose of the second major category of tree removal is to manage existing habitat (usually forests or woodlands) within a particular unit. Most such removals are completed to improve the quality of timber and/or wildlife habitat within the stand. For example, mast trees such as oaks and hickories are a critical food resource for wildlife. By removing competing trees from the stand, biologists and foresters can encourage more rapid growth of mast trees that provide greater food availability for wildlife.

In other cases, trees are removed to restore a habitat such as glades, savannas, or prairies where fire suppression has allowed trees to invade. Tree removal is integral to restoring these habitats that often support uncommon species.

Finally, trees are also removed as part of the process of creating shallow water sources for wildlife, including bats.

For the MDC Bat HCP, these harvests are termed *stand improvements* and combine the activities below, which are tracked separately by MDC.

- **Intermediate harvest.** In MDC, an intermediate harvest (also sometimes referred to as a commercial thinning) is completed when the trees being removed have enough commercial value to be sold and there is still opportunity to increase the diameter growth on the remaining trees. Not only can intermediate harvests be used for increasing diameter growth, but they may also be used to change the composition of the stand (for example, moving a stand from a maple stand to a more oak-dominated stand). Intermediate harvests can also create significant crown expansion on the remaining trees, thus providing more mast and an increase in insect populations. In a few cases, the wood product has limited commercial value, but is sold to a private individual as a firewood sale.
- **Tree thinning.** These are treatments designed to improve the quality of the residual stand. Thinning improves the residual stand quality by removing poorly formed, defective trees, and species with lower wildlife or timber values. Thinning is often performed in younger stands to release slower-growing, desirable species before they are overtopped or outcompeted. In most cases, the wood product cannot be sold and is tracked as thinning, or simply tree removal.

The goal of combining intermediate harvests with firewood sales, thinning, and tree removals is to group together a series of similar activities that are currently differentiated primarily by market forces that are outside the control of MDC.

With the exception of the regeneration harvests (described above), most of these activities remove only a few trees at a time and thus are termed **limited** tree removal (i.e., removes less than 75% from a woodland or remove trees from other habitat types). Regeneration harvests remove all but a few canopy trees from a stand and thus are termed an **extensive** removal (i.e., removes more than 75% of canopy trees from a forested or woodland landscape while leaving a small residual).

Timber Harvests

Timber harvests on MDC lands are carried out by third-party contractors that implement timber sale contract requirements in a designated area in accordance with MDC instructions (Appendix D, *Timber Process*). Before a forester can bid out a timber sale, they must first receive an authorization to sell the timber. The authorization to sell can be obtained in one of the following ways: Conservation Commission approved sales, regional approved sales, or special/salvage sales.

Regardless of the process used, before any tree is removed, a rigorous, highly detailed, scientific evaluation, often referred to as a forest inventory, is conducted by resource foresters. Except in salvage situations, forestry does not conduct management without first conducting a forest inventory. Salvage events are triggered in response to events that threaten forest health or human safety such ice storms, tornadoes, wildfires, severe thunderstorms, or insect and disease outbreaks. Prior to salvage the (salvage) area is mapped out using aerial reconnaissance and then the area is ground verified. Once the extent of the damage is verified, salvage is undertaken to clean up the

debris. Salvage events follow all snag retention guidelines as detailed in Objective 3.1, which is described in Section 5.2.2.1, *Biological Goal 3: Enhance, maintain, and restore roosting and foraging habitat for covered bats*. However, in some instances, the damage is so severe that no trees are left standing.

The forest inventory entails identifying the silvicultural methods needed to achieve the desired future condition of the stand, conducting a review of the heritage data, conducting a review of the soils data, evaluating harvesting intensities to meet the silvicultural prescriptions, identifying the species to be harvested, identifying infrastructure improvements (e.g., road construction or reconstruction) for the area, and estimating the volume or tonnage of logs of each species that will be harvested. Then, MDC provides specific instructions on all aspects of the timber harvest, from which trees are cut (and reserved) to how the felled trees are handled and stored prior to shipment off-site.

During a timber harvest, trees are not only felled and processed, but potentially removed from the site. Felling is done using either chainsaws or mechanized fellers. Larger trees are usually processed into logs for transport to roadside landings by skidders or forwarders, where they are loaded onto trucks. Skidders drag logs or entire trees along skid trails, limiting the area on which logs are moved and potentially affected by soil compaction from heavy equipment use. Forwarders, which are used in combination with mechanized fellers, are vehicles with beds that carry logs completely off the ground, further reducing the potential for soil compaction. Motorized equipment is used to cut, move, chip, and haul trees during forest management, and the MDC Bat HCP covers the operation of that equipment for forest management activities.

Table 2-4 summarizes the amount of tree removal that is expected to occur annually and every 5 years. These covered activities will be monitored annually to ensure that the take allowance is sufficient for the 50-year permit term.

Table 2-4. Acres of Trees Removed for Habitat Restoration and Management on Lands Owned or Managed by MDC[a]

Habitat Type	Activity Purpose	Extent of Removal[b]	Annual Average	5-Year Average[c]
Forests and Woodlands	Allow New Trees to Grow			
	Regeneration	Extensive	1,800	9,000
	Shelterwood	Limited	2,000	10,000
	Uneven-Age	Limited	4,000	20,000
	Manage Existing Habitat			
	Stand Improvement	Limited	13,998	69,990
Glades	Remove Woody Ingression	Limited	79	395
Open Lands	Remove Woody Ingression	Limited	8,143	40,715

[a] Acreage estimates based on recorded past activities provided by MDC.

[b] "Extensive" tree removal removes more than 75% of canopy trees from a forested or wooded landscape while leaving a small residual; "limited" tree removal removes less than 75% from a forest or woodland or removes trees from other habitat types.

[c] The 5-year average was estimated by comparing current harvest levels (based on years 2005–2017) to projected future needs to obtain a future estimate of activity and then multiplying annual average by 5.

Activities on Other Nonfederal Lands

Missouri Cost-Share Program

Table 2-5 summarizes activities completed under the Missouri Cost-Share Program. When completed in woodland and forest habitat, activities under the Missouri Cost-Share Program are considered limited removal. Summary data for prescribed fires on private lands are only tracked at the level of annual acres burned. Lacking other data, we assumed the ratios of fires in open lands versus forests, woodlands, and glades was similar to those conducted by MDC staff on MDC lands.

Table 2-5. Acres of Trees Removed for Habitat Restoration and Management on Other Nonfederal Lands under Missouri Cost-Share Program[a]

Type of Activity	Land Cover		Annual Average	5-Year Average
Prescribed Fire[b]	Forest/Woodland and Glades		3,437	**17,185**
	Open Lands		4,672	**23,362**
		Subtotal	**8,109**	**40,547**
Tree Removal (Limited)[c]	Forest/Woodland and Glades		9,579	47,895
	Open Lands		553	2,765
		Subtotal	**10,132**	**50,660**
All Activities Total			**18,241**	**91,207**

[a] Acreage estimates based on number of acres restored/managed in a year provided by MDC.

[b] Prescribed fire total acreage provided and acres in each habitat type was estimated based on proportion of activity conducted on MDC lands.

[c] Tree removal total and land-cover-specific data are based on recorded past activities.

State Forestry Programs

Activities completed under the three state forestry programs are administered by MDC as specified above (Section 2.2.2, *Other Nonfederal Lands*) and thus are eligible to receive take coverage under the HCP (Table 2-6).

Table 2-6. Acres of Trees Removed for Habitat Restoration and Management on Other Nonfederal Lands under State Forestry Programs (Acres)[a]

Type of Harvest	Extent of Removal	Annual Average (Acres)	5-Year Average
Regeneration	Extensive	200	1,000
Shelterwood	Limited	800	4,000
Uneven-Age	Limited	3,200	16,000
Stand Improvement	Limited	3,200	16,000
	Total Harvest	**7,400**	**37,000**

[a] Harvest data are provided by MDC and are based on recorded past activities and adjusted based on changes to expected amount of future activities.

2.3.4 Public Access and Asset Management

2.3.4.1 Other Tree Removal

In addition to trees removed for habitat management (see Section 2.3.3, *Habitat Management*), MDC also removes trees for construction, maintenance, and repair of facilities. As shown in Table 2-7, relatively little of this activity consists of converting potential bat habitat into developed lands. Trees may be permanently removed (i.e., habitat conversion) to allow construction of buildings (e.g., offices or interpretive centers); development of restrooms, boat ramps, roads, and trails; and bank management associated with streams, engineered wetlands, and lakes. In most cases the impact is temporary and trees are allowed to regrow. For example, trees may be removed to allow access for repairs such as roof or HVAC replacement, levee and dam maintenance, or culvert replacement; however, maintenance activities typically remove young, tight-barked trees from areas where the trees have grown since construction. Hazard trees (those trees that threaten people or their property) are potentially roost trees, and are only removed when there is a threat to people or property.

Table 2-7. Acres of Trees removed for Other Tree Removal (> 9 inches dbh) for Public Access and Asset Management[a]

	Acres	
Impact Type	**Annual Average**	**5-Year Average**
Habitat Converted[b]	10.5	52.5
Habitat Affected (No Conversion)	140.5	702.5
Total	**151**	**755**

[a] Harvest data are provided by MDC and are based on recorded past activities and adjusted based on changes to expected amount of future activities.

[b] Habitat conversion occurs when natural landcovers (such as trees) are replaced with anthropogenic landcovers (such as a building)

dbh = diameter at breast height

2.3.4.2 Vehicle Operation

MDC manages 872 miles of roads and 804 miles of trails, which are used year-round by both MDC staff and the general public to access parts of the conservation lands. Roads (both paved and gravel) are used by the public and people with disabilities to access areas and levees. Trails are used by pedestrians, bicycles, and horseback riders. Users with mobility-related disabilities are allowed access to MDC trails and field roads using motorized vehicles, which may include all-terrain vehicles, with a special use permit. MDC maintains a 45 mile-per-hour speed limit on all MDC lands. During vehicle operation, bats may be harmed or killed if they are struck by vehicles. While this is extremely unlikely, it may occur over the course of the permit term.

2.3.4.3 Demolition of Structures

Based on MDC data, an average of six structures per year are demolished. This is commonly the result of MDC acquiring a new parcel of land with existing structures. Demolition eliminates maintenance and liability concerns while returning a developed area back to a natural area. During

demolition of structures, there is the potential for covered species to be taken if bats are roosting in or near the structure. Chapter 5, *Conservation Strategy*, includes avoidance measures to reduce potential impacts.

2.3.5 HCP Implementation

The conservation measures applied as part of the MDC Bat HCP (Chapter 5, *Conservation Strategy*), and their associated monitoring, are carried out with the goal to promote and protect the covered species. However, some activities implemented for the HCP have the potential for incidental take of covered species. Therefore, the conservation measures are also included under covered activities.

Habitat management activities that may provide benefits for the covered species are already considered covered activities. This includes tree removal performed under forestry and wildlife habitat restoration and management activities, which encourages forested habitats utilized by the covered bat species. The conservation strategy may include the creation of snags by either girdling or through the use of an approved herbicide in areas where roosting habitat is limited.

In addition, surveying covered bat species on covered lands will be implemented as part of the HCP. Surveys may include the direct handling of bats and such activities may result in incidental take. These surveys are used to identify bat species and mark individuals to monitor populations. Biologists participating in the monitoring program will obtain handling permits from USFWS and/or MDC for covered species. MDC staff conducting bat surveys are covered under an existing Section 6 Cooperative Agreement with the USFWS and per the regulations at 50 CFR Sections 17.21 and 17.31. Research on covered lands by individuals or organizations not affiliated with MDC, such as academic scientists, would need to obtain a separate ESA Section 10(a)(1)(A) permit. The issuance of collection permits for such individuals will be granted by MDC and USFWS on a case-by-case basis. The actions of such an individual must not interfere with the conditions and/or limitations covered by the HCP.

2.3.6 Activities Not Covered by This Habitat Conservation Plan

This section discusses additional activities conducted by MDC on covered lands that are not permitted under this MDC Bat HCP, but that may be regulated under their own compliance processes, including ESA compliance (Table 2-8). These activities include those conducted by other entities, such as for utilities access and third-party research. Other activities that are not covered under this HCP are those that have no or very low likelihood of affecting covered species and therefore do not require coverage. These activities include recreation activities, such as the collection and use of wood for camp fires. MDC employees are frequently approached to provide advice on a wide variety of issues related to natural resource management. The implementation of that advice (whether provided via formal or informal means) is not covered by the HCP unless it is part of a formal agreement, as discussed in Section 2.2.2, *Other Nonfederal Lands*. MDC will continue to advise the public to comply with the ESA. This HCP also does not cover activities that are conducted by those who lease MDC lands for agricultural or other purposes. MDC will advise lessees to comply with laws and regulations and will utilize lease terms that comply with this HCP.

Table 2-8. Activities Not Covered by This Habitat Conservation Plan

Activities	Description	Reason for Exclusion
Technical assistance without nexus	MDC's role requires constant interactions with the public on nearly any task related to natural resources management. This HCP does not cover advice provided by MDC employees unless the activity is completed with funding (i.e., a cost share) from MDC or by MDC staff by persons acting under the direct control of MDC.	MDC lacks a mechanism to enforce compliance. MDC will continue to advise landowners of the need to comply with all laws including the ESA.
Application of approved pesticides	Herbicides, pesticides, and biological controls are commonly implemented in association with habitat management efforts, such as control of undesirable species.	USFWS is unable to provide take authorization for herbicide or pesticide use.[a]
Lessee activities	Farming and other activities conducted by third parties who lease MDC lands.	MDC will incorporate lease terms consistent with their incidental take permit for activities covered by the MDC Bat HCP only.
Gas and power line access	Use of rights-of-way and other routes to access gas and power lines on MDC lands.	Right-of-way owner is responsible for ESA compliance for their activities.
Recreational activities	Activities include hunting, fishing, hiking, biking and camping. Recreational activities occur on MDC lands throughout the year.	Recreational activities such as walking, horseback riding, and riding bicycles are unlikely to take bats. MDC does not assume responsibility for any individual's take (incidental or otherwise) of covered species. MDC Conservation Agents do, however, take enforcement action when they encounter wildlife-related violations.
Collection of down and dead firewood	MDC allows the removal of down and dead trees for firewood in some capacity, or on some lands. This activity is distinct from the removal of standing live or dead trees, which is a covered activity.	Although bats may occasionally use down and dead material as a temporary roost, removal of such material is unlikely to result in take of covered species.
Research by external parties	Research on covered lands by individuals or organizations not affiliated with or working for MDC (e.g., academic studies), even in the case of projects funded by MDC.	The nature and impacts of future research projects cannot be predicted. Researchers would obtain a separate ESA Section 10(a)(1)(A) permit.

[a] Most herbicides and pesticides cannot be covered in an HCP due to the challenge in reconciling multiple federal laws implemented by the EPA with the USFWS's mandates in the ESA.

MDC = Missouri Department of Conservation; HCP = Habitat Conservation Plan; USFWS = U.S. Fish and Wildlife Service; ESA = Endangered Species Act; EPA = U.S. Environmental Protection Agency

Chapter 3
Environmental Setting

3.1 Overview

This chapter describes the physical and biological setting of the plan area (the state of Missouri) for the Missouri Department of Conservation (MDC) Bat Habitat Conservation Plan (MDC Bat HCP). The information in this chapter will be used to assess the distribution of the five covered species, to help quantify impacts, and to develop a conservation strategy for the MDC Bat HCP. This chapter describes methods and data sources, provides background information on major factors affecting the environmental baseline, describes the environmental setting, and summarizes information on the covered species.

3.2 Methods and Data

This section describes the data sources used to formulate the physical and ecological aspects of the plan area.

- MDC Geographic Information System datasets
- National Land Cover Database (NLCD) 2011
- Missouri Natural Heritage Database (2018)
- Missouri Ecological Classification System (2002)
- Tabular data provided by the MDC
- Professional knowledge of the region

The applications and limitations of these datasets are also discussed.

3.3 External Factors Affecting Environmental Baseline for Bats

This section discusses external factors that frame the environmental baseline for covered species in Missouri. Specifically, the section addresses broad issues that could affect the status of bats in Missouri that are external to MDC management and covered activities.

3.3.1 White-Nose Syndrome

The discovery of white fungus on the noses of bats hibernating in a cave near Albany, New York, in 2006 was the first sign of an emerging infectious disease. The white-nose syndrome (WNS) fungus, *Pseudogymnoascus destructans*, thrives in cold and humid conditions characteristic of the caves and mines used by hibernating bats, including the covered species (Gargas et al. 2009), and readily invades the tissue of hibernating bats. When bats are using the caves and mines during hibernation,

they have a reduced immune response, making them susceptible to infection (Carey et al. 2003). The disease now occupies a range from the Atlantic Coast to the Great Plains with a series of isolated records in Washington State (whitenosesyndrome.org 2018).

Following the arrival of WNS at a hibernaculum, populations of most cave-hibernating bats decline rapidly, but the level of mortality varies with physical conditions at the site and species-specific responses to infection (Langwig et al. 2012, 2016). Emerging data (Frick et al. 2017) provide evidence that in the decade since WNS first arrived in the Northeast, Indiana bat has suffered significant population declines, but those declines are less severe than other similar species, and populations are no longer declining. Similarly, populations of little brown and tricolored bats were severely affected but now are no longer rapidly declining. Unfortunately, populations of northern-long-eared bat continue declining without signs of slowing.

Federal, state, local, and private entities are investing significant time and funding into research aimed at reducing effects from WNS, but efforts at treatment or prevention remain experimental (whitenosesyndrome.org 2018). The fungus is initially transmitted primarily through bat-to-bat contact, but once it is present in a hibernaculum it can persist for long periods within the cave system (Lorch et al. 2013; Zukal et al. 2014). Decontamination protocols are available from the U.S. Fish and Wildlife Service (USFWS) to prevent spread of the disease by researchers (whitenosesyndrome.org 2018). Cave management and preservation organizations are limiting or not allowing access to caves and are requiring that clothing and equipment be disinfected in an effort to prevent the spread of the WNS fungus.

The arrival of WNS in Missouri prompted various stakeholders, including MDC and federal biologists, to initiate a collaborative effort to biannually survey winter hibernacula (i.e., cool, stable, underground cavern used for hibernation) focusing on biannual surveys of 183 hibernacula (Colatskie 2017). Since WNS was first discovered in Missouri in 2012, survey efforts indicate species-specific responses; however, once-common species including little brown, northern long-eared, and tricolored bats all have suffered substantial population declines (Colatskie 2017). Finally, bats migrate to and from the covered lands from surrounding states, including Arkansas, Illinois, Iowa, Kansas, Kentucky, Nebraska, Oklahoma, and Tennessee, all of which are known to be infected with WNS (whitenosesyndrome.org 2018).

3.3.2 Wind Development

A decade ago, wind speeds throughout most of Missouri were not suitable for commercial wind-energy developments with contemporary technology (Missouri Division of Energy 2005). Thus, most wind-energy development in the state is currently restricted to four counties (Atchison, Nodaway, Gentry, and Dekalb) in the state's northwest corner. However, as available technology changes to facilitate energy generation at lower wind speeds, additional areas of the state are becoming more available to commercial wind energy development. Alternatively, smaller wind turbines (such as those used by farmers or homeowners) can be located throughout much of the state. The operation of commercial wind energy facilities results in the accidental mortality of both birds and bats, including all species covered by the MDC Bat HCP. On behalf of the industry, the American Wind Energy Association worked with USFWS and other partners to develop a draft conservation plan called the *Midwest Wind Energy Habitat Multi-Species Conservation Plan* (Wind Energy Plan) and its supporting *Midwest Wind Energy Habitat Multi-Species Conservation Plan Draft Environmental Impact Statement* (Draft EIS) (U.S. Fish and Wildlife Service 2016a) to address the potential effects of this industry on the Indiana, northern long-eared, and little9 brown bats.

To calculate effects, the Wind Energy Plan made use of a proportional mortality model. This model works by combining data obtained when biologists survey operating wind turbines for dead birds and bats (i.e., carcass searches). To obtain an accurate estimate of mortality, biologists must not only count the number of carcasses they find but also account for those carcasses that are taken by scavengers before they are found, overlooked by biologists, or fall outside of designated search areas. When these mortality estimates are combined across multiple studies, it is possible to estimate the number of bats killed per tower (standardized to the size of the towers in megawatts [MW]), and the proportion of those mortalities that are assignable to a particular species. The Wind Energy Plan projects the eventual construction of 33,000 MW in the region including 971 MW (3% of the total) in Missouri. The two largest planned wind turbine projects in Missouri include the Liberty Utilities-Empire District wind farm, with a projected 600 MW of wind generation in southwest Missouri (Barton, Jasper, Dade, and Lawrence counties), and the Ameren project, a projected 400 MW windfarm located in northeast Missouri (Adair and Schuyler counties).

Based on studies throughout the Midwest (defined as Ohio, Indiana, Illinois, Iowa, Michigan, Minnesota, Missouri, and Wisconsin), the number and size of operating turbines, and the number and size of turbines expected to be built in the region during the next 45 years, it was possible to estimate the number of bats that will be killed at these sites. Thus, the Wind Energy Plan estimates that over the next 45 years, wind energy in the Midwest will take 16,822 Indiana bats (Missouri's portion would be 505 bats), 9,753 northern long-eared bats (293 in Missouri), and 440,830 little brown bats (13,225 in Missouri).

As part of the associated Draft EIS, the model used to estimate mortality of Indiana bats was re-created for a variety of other species, including tricolored bat, in order to estimate the impacts of the Wind Energy Plan on these nontarget species. That model predicted the mortality of 51,389 tricolored bats (1,542 in Missouri). No dead gray bats have been recorded under wind turbines; however, there currently is minimal wind energy development in the range of gray bat. The Draft EIS indicates such mortality is likely to be documented in the future as wind development continues to intersect with the gray bat range.

These numbers are based on summer 2016 population estimates and are expected to decline proportionally as WNS reduces the population of bats throughout the region. These numbers also do not reflect conservation measures included in the Wind Energy Plan. At this time, the Wind Energy Plan appears unlikely to be completed, but many of the conservation measures outlined in it are likely to be applied to facilities as they are built in Missouri. These conservation measures were expected to reduce bat mortality by at least 50%.

3.4 Environmental Setting

The physical and ecological components of Missouri's environmental setting influence the distribution of the five covered species of bats and provide a context for evaluating impacts and developing conservation actions for the MDC Bat HCP. The following sections describe the physical and ecological attributes of the plan area.

3.4.1 Location

The plan area for the MDC Bat HCP (refer to Chapter 1, *Introduction*, Figure 1-1) is defined broadly as the state of Missouri. Missouri is located on the eastern fringes of the Great Plains of North America, bounded on the north by Iowa; across the Mississippi River to the east, by Illinois, Kentucky, and Tennessee; to the south, by Arkansas; and to the west, by Oklahoma, Kansas, and Nebraska.

3.4.2 Topography

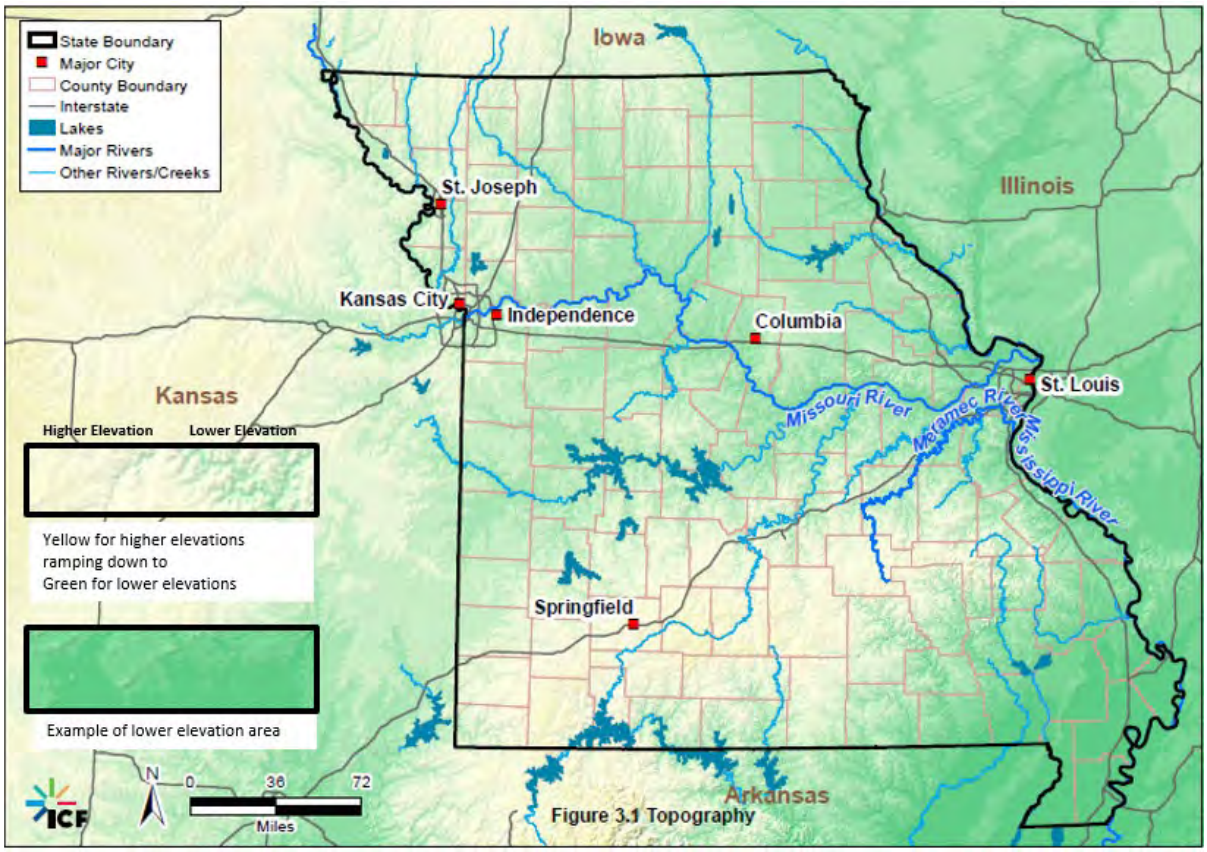
Topography influences vegetation and climate, both of which may affect covered species in the plan area. Missouri has a diverse topography, ranging in low relief areas within the alluvial plains of the Missouri River and the Mississippi River, to high relief areas of the St. Francois Mountains located in southeastern Missouri (Figure 3-1). The alluvial plains and limestone bluffs of the Missouri River bisect the central portion of the state, flowing from Kansas City in the west to St. Louis in the east, where it joins the Mississippi River. The Mississippi River forms the majority of the eastern border of Missouri.

The area north of the Missouri River is known as the Northern Plains, with rolling hills that remain from the glaciation that once extended from the Canadian Shield to the Missouri River. The Dissected Till Plains portion of the Northern Plains region lies in the portion of the state north of the Missouri River, while the Osage Plains portion extends into the southwestern portion of the state bordering the Ozark Plateau. The Osage Plains, located in the west and south of the Missouri River, are mostly flat, stretching west to Missouri's border with Kansas.

Approximately 75% of the land in Missouri located south of the Missouri River, and parts of northern Arkansas, northeastern Oklahoma, and southern Illinois are known as the Ozark Plateau, or "the Ozarks." The portion of the Ozarks within Missouri (Missouri Ozarks) is a dissected plateau with heavily forested hills and low mountains with deep, narrow valleys. The Missouri Ozarks are further characterized by karst topography with the formation of caves, sinkholes, and spring systems. The Missouri Ozarks surround the St. Francois Mountains, including Taum Sauk Mountain, which registers the highest point in Missouri with an elevation of 1,772 feet above sea level.

The far southeastern area of Missouri is part of the Mississippi Alluvial Plain and is commonly known as the Missouri Bootheel region. The lowest elevation is located on the southwestern edge of this region at an elevation of 230 feet above sea level, where the St. Francis River flows from the Missouri Bootheel into Arkansas.

Figure 3-1. Plan Area Topography Map



3.4.3 Geology

Bat distributions are tied closely to physiography. First, geology influences vegetation, which influences bat distribution. In addition, bats use specific geological features in the landscape. A karst landscape, with its caves and cliffs, provides potential sites that may serve as bat hibernacula. Similarly, past volcanic activity deposited minerals that are removed by mining, which in turn, created hibernacula for bats. The following discussion provides an overview of the geology and physiography in the plan area and a description of features that are relevant for the covered species.

Generally, the Precambrian-aged St. Francois Mountains in the northeastern Missouri Ozarks exhibit the oldest rocks in the state, characterized by igneous granite and rhyolite outcroppings, while the rest of the state is underlain by sedimentary rocks, mainly limestone, dolomite, sandstone, and shale (Figure 3-2).

The approximate southern half of Missouri is located on the northeast end of a regional upwarping[2] of the Earth's crust known as the Ozark Uplift (also known as the Ozark Plateau or Missouri Ozarks). Beginning in the Paleozoic Era, and continuing through much of its geological history, Missouri was covered by extensive ancient seas. Reefs of carbonate were points of concentration for later ore-bearing fluids that formed the rich lead-zinc ores that have been and continue to be mined in the

[2] An upwarping is a geological structure, usually of relatively large dimensions, whose flanks slope gradually away from the center.

area. Mining for these high-grade iron ores has produced a large number of abandoned mines that are now used for hibernating bats.

The Missouri Ozarks consist of the Springfield Plateau of southwest Missouri (Mississippian-aged rocks), the Salem Plateau (Ordovician- and Cambrian-aged rocks), which includes a broad band across south central Missouri, and the St. Francois Mountains (Cambrian- and Precambrian-aged rocks). The Ozark Uplift exposed the carbonate bedrock that is most evident in the karst-dominated area of the Missouri Ozarks (Figure 3-2). Karst features such as caves, springs, and sinkholes are common in the limestones of the Springfield Plateau and abundant in the dolomite, limestone, and sandstone bedrock of the Salem Plateau (Figure 3-3). The weathered limestone and dolomite bedrock of the karst dominated Missouri Ozarks has resulted in approximately 7,300 recorded caves in Missouri (Missouri Department of Natural Resources 2017); the majority of these are found in the Ozarks. Many of these caves provide habitat for hibernating bats.

Figure 3-2. Plan Area Generalized Geology Map

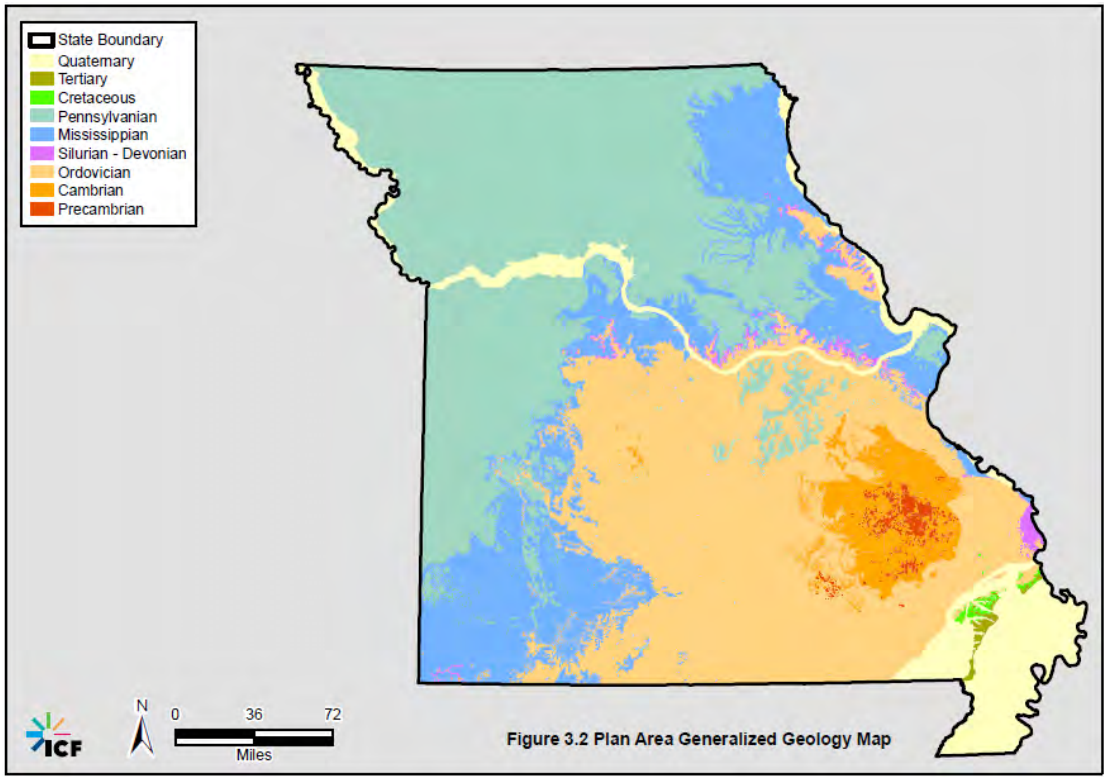
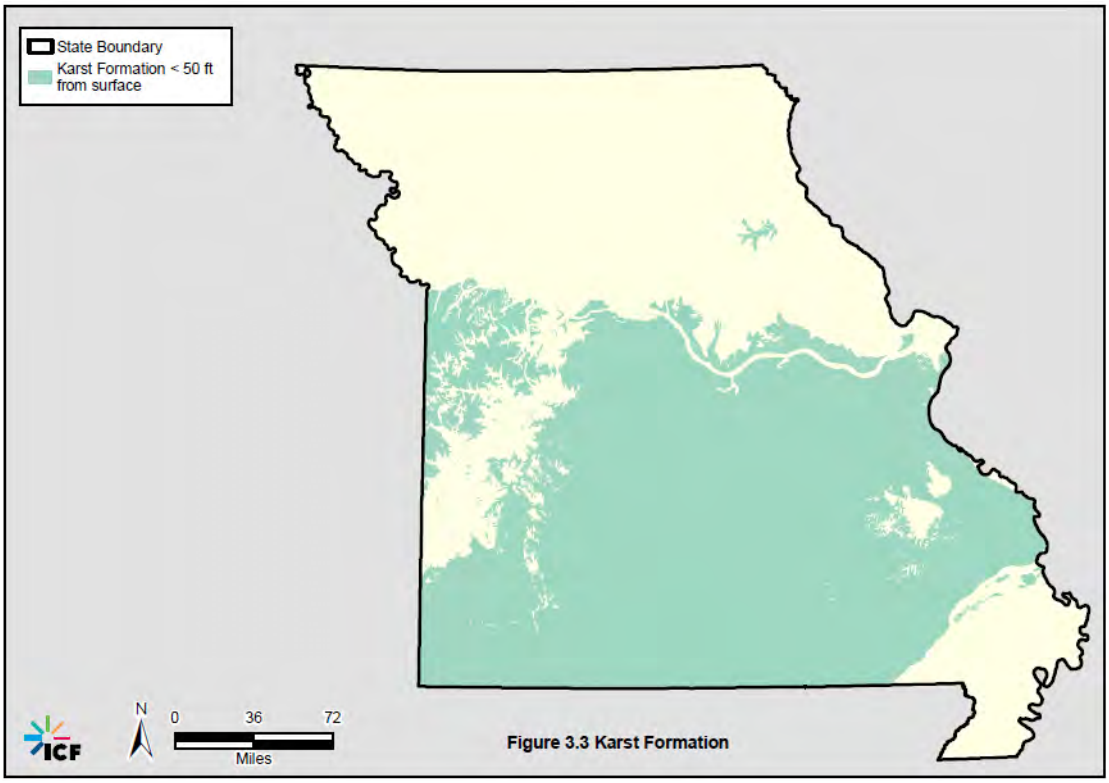


Figure 3-3. Plan Area Karst Formation Map



In addition to the karst topography referenced above, limestone crops out over large areas of eastern Missouri. Anthropogenic activities (e.g., limestone mining) within areas dominated by sedimentary rocks (limestone and dolomite) have expanded hibernating opportunities for bats.

The weathered limestone, shale, and sandstone of the upper Pennsylvanian System, along with loess deposits, glacial sediments, and alluvial sediments dominate the geology in the northern portion of the state (Figure 3-2). Much of this landscape does not contain the caves (and mines) that allow the covered species to hibernate through winter.

3.4.4 Ecological Classifications

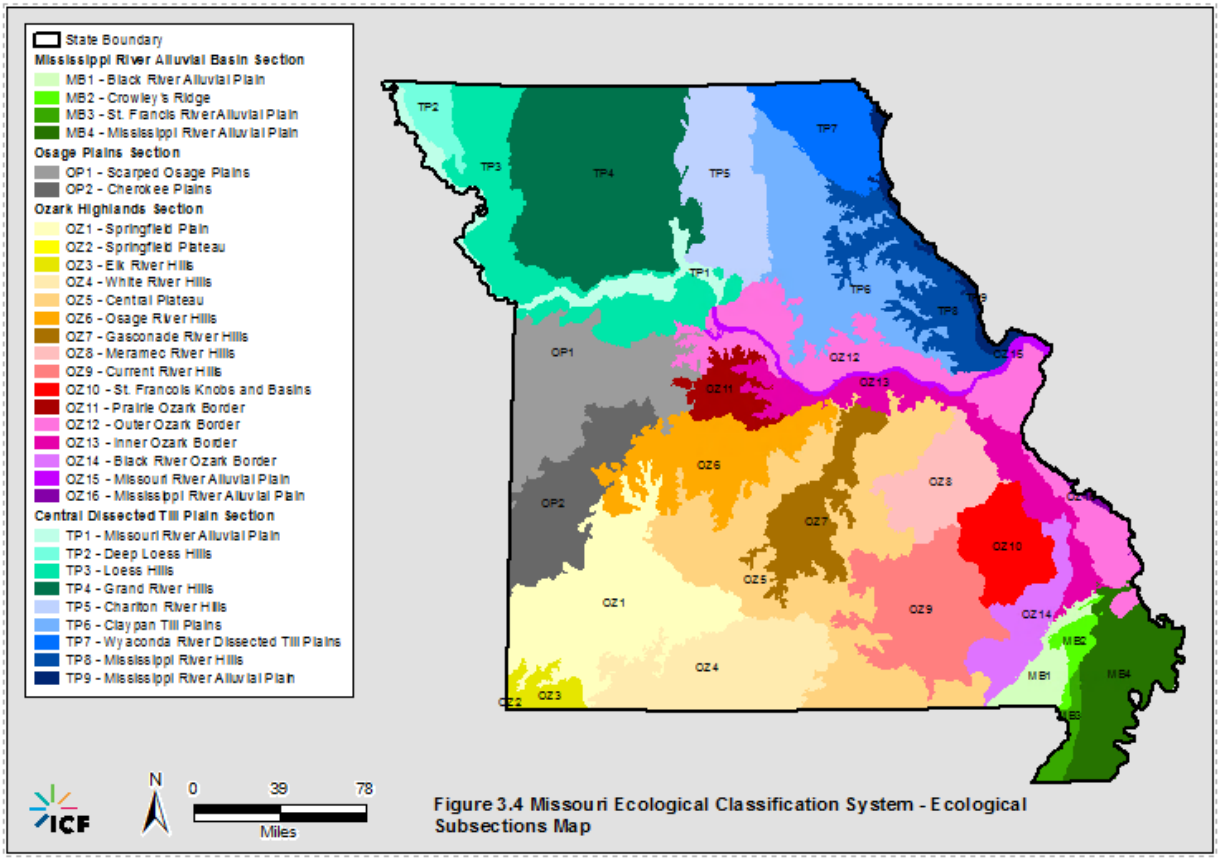
This section describes the four ecological classification sections and subsections as described in the Missouri Ecological Classification System (Nigh and Schroeder 2002; Figure 3-4). Because the distribution of vegetation types, bedrock, and other habitat elements is important for bats, an ecological classification framework provides a consistent approach for visualizing the distribution of those habitat factors over large areas. Ecological classification is the process of dividing the landscape into repeatable, unique, and discrete units (Struckhoff et al. n.d.). Sections within this framework are classified considering discrete physical and biotic factors. Physical factors are soils, climate, hydrology, geology, and physiographic features. Major biotic factors are plant species occurrence, plant community compositions, annual biomass production, and wildlife and vegetation interactions. The Missouri Ecological Classification System framework allows users to identify, map, and describe land with similar physical and biological characteristics, known as *ecological sites*. Information and data pertaining to a particular ecological site is organized into a reference document known as an Ecological Site Description, which can be accessed through the U.S.

Department of Agriculture (USDA) Web Soil Survey, USDA Ecological Site Information System website, and the Missouri Field Office Technical Guide.

The four Ecological Classification sections within the plan area include the following general descriptions.

- Mississippi Alluvial Basin Section—formerly a forested swamp filled with bald cypress, sweet gum, and associated wetland plants. The major natural habitats are swamp, bottomland forest, upland sand prairie, and woodland.
- Osage Plains Section—unglaciated prairie historically a tallgrass prairie. The major natural habitats are grassland, broken prairie/woodland landscape, and floodplain forest/wetland.
- Ozark Highlands Section—western extension of a large deciduous forest. The major natural habitats include forest, woodland, caves and karst, rivers, and streams.
- Central Till Plains Section—moderately dissected glaciated plains that slope toward the Missouri River and Mississippi River. This area is covered with Pleistocene loess over glacial till. The major natural habitats are primarily grassland and woodland, but also contains floodplain wetland and forest, as well as prairie streams.

Figure 3-4. Plan Area Ecological Sections and Subsections Map (Missouri Ecological Classification System)



3.4.5 Soils

Soils exert a strong influence on the land cover and forest types of the plan area and consequently affect bat habitat distribution. This section describes the USDA soil types in the plan area, their origins, and their influence on land cover and forest types.

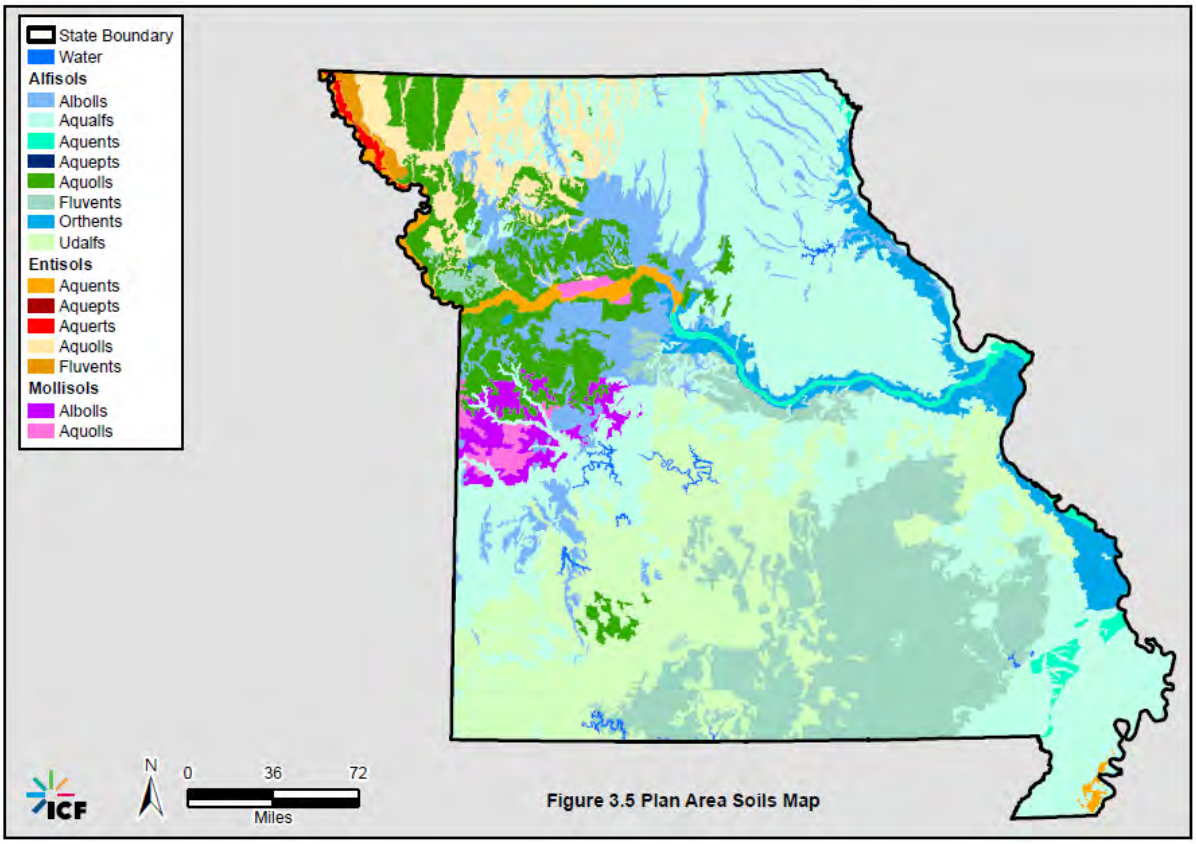
Northern Missouri is covered by rich glacial and loessial[3] soils. The bottomlands along the rivers and streams are covered by silts, sands, clays, gravels, and organic matter typical of alluvial soils. The dominant parent material of soils over the plan area is composed of residuum from primarily weathered sedimentary bedrock, and to a lesser degree, igneous bedrock.

The plan area comprises three USDA soil orders classified by several parameters, including parent material, prevalent vegetation, climate variables, and weathering processes (Plant & Soil Sciences eLibrary 2018). These are mapped as *alfisols*, *entisols*, and *mollisols* (Figure 3-5). Missouri soils are dominated by *alfisols*, which occur throughout the state. These nutrient-rich soils were typically formed under broadleaf deciduous forests as a result of weathering processes that leach minerals form the surface layer into the subsoil. In the plan area, these soils supported forest vegetation in the past. *Entisols* are young soils that lack horizon development. These soils are commonly found at

[3] Loess is a very fine-grained silt or clay thought to be deposited as dust blown by the wind. Most loess is believed to have originated during the Pleistocene epoch from areas of land covered by glaciers and from desert surfaces.

the site of recently deposited materials (e.g., alluvium) where deposition is faster than the rate of soil development, or in parent materials resistant to weathering (e.g., sand). *Entisols* are found in the northwestern portion of the state, adjacent to the Missouri River, and also emanating east from the Missouri River in a contiguous area south of the Iowa border that was part of the Pre-Wisconsin glaciations and subsequent loess deposition. A small patch of *entisols* also occur adjacent to the Mississippi River in the Missouri Bootheel region. *Mollisols* are formed where organic matter accumulates beneath prairie grasses and most of the native grassland that produces them has been converted to highly fertile agricultural land. These soils are found in the far west-central portion of Missouri where tallgrass prairie exists and adjacent to the Missouri River in the northwestern portion of the state.

Figure 3-5. Plan Area Soils Map



3.4.6 Climate

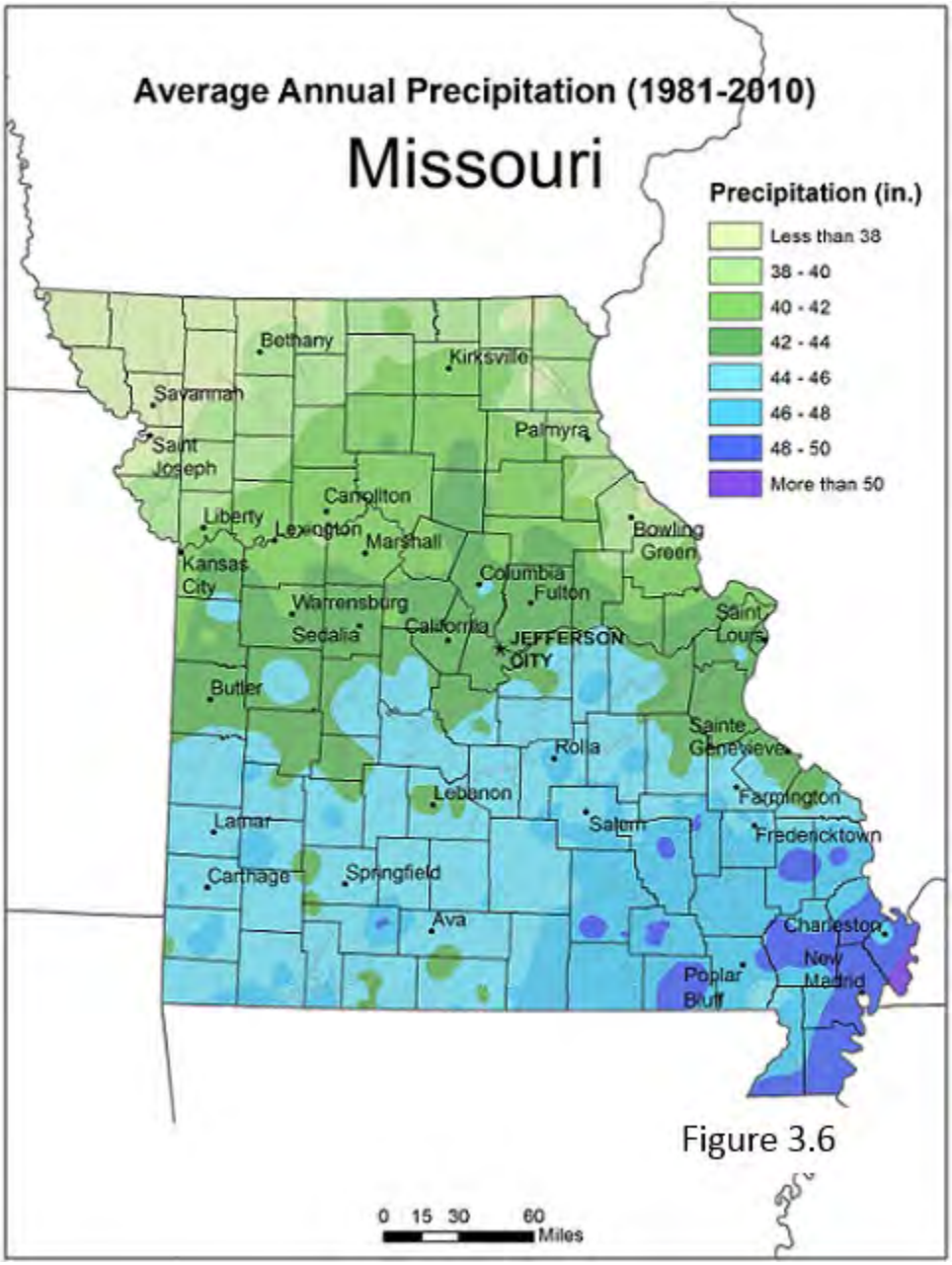
Climate influences the biogeography of bats, their access to food, timing of hibernation, and reproduction and development. As the climate changes, habitat types and insect prey types available to bats for foraging may indirectly affect bat populations.

The climate of Missouri can generally be considered a continental type of climate marked by strong seasonality. Missouri generally has a variety of seasonal humid subtropical climates, with cool winters and long, hot summers. The climate varies by region; a diagonal line can be thought to divide the northwest and southeast, as the two regions have noticeably different climates (Decker 2015). As the state is unchallenged by any topographical barriers, the climate is alternately

influenced by air from the cold Arctic and the hot, humid Gulf of Mexico. Summertime high temperatures in the day have averaged 87 degrees Fahrenheit (°F) statewide. Summer temperatures rise to 90°F or higher an average of 40 to 50 days in the north and 50 to 60 days in the south. Wintertime averages are closer to the middle 20°F range. The northern half of Missouri and the Ozarks average around 100 to 110 days of below freezing temperatures. Winter nights can dip into subzero temperatures up to five times per year in northern counties and around two times in southern counties. Autumn and spring are generally more temperate; mean temperatures are typically in the middle 50°F range.

Precipitation is higher in the southeast, with a mean of 50 inches (Figure 3-6), and lower in the northwest, with a mean of 34 inches (Decker 2015). Generally, spring is the wettest season of the year, with the mean precipitation for this period approximately 12 inches. The mean precipitation in fall is 10 inches. Winter is typically the driest season, with snowfall averages of 20 inches occurring in the northern region and 10 inches of precipitation in the southeast.

Figure 3-6. Plan Area Precipitation Map



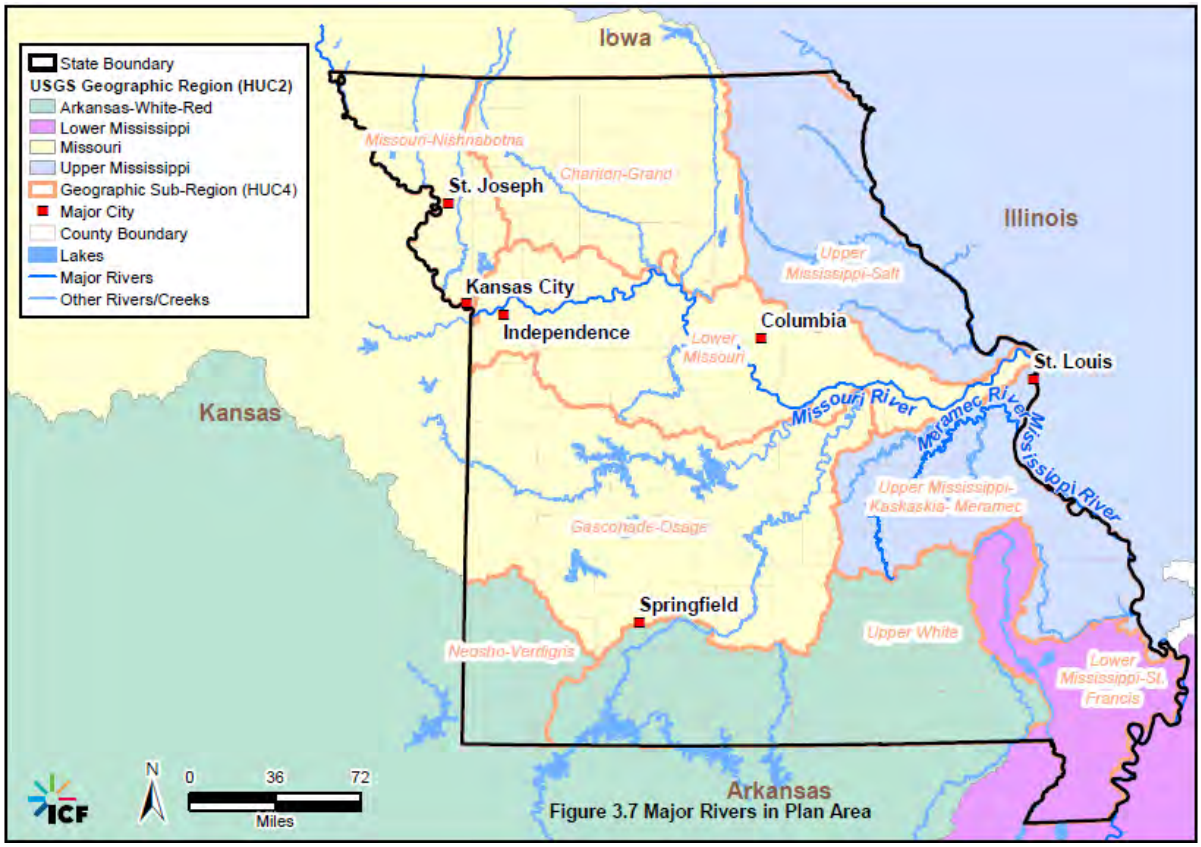
Source: Oregon State University PRISM Climate Group 2014

Climate change is affecting Missouri's temperature and precipitation patterns (Environmental Protection Agency 2016). Habitat destruction, and effects of flooding and prolonged exposure to freezing temperatures in caves will affect bat survival (National Park Service 2017).

3.4.7 Hydrology

Missouri has an estimated 66 hydrologic subbasins (Hydrologic Unit Code [HUC] 8) that contain 115,000 miles of rivers and streams and 3,080 lakes and reservoirs (Missouri Department of Natural Resources 2018a, 2018b). The four major hydrology geographic regions (HUC 2) in Missouri are the Upper Mississippi Region, Lower Mississippi Region, Arkansas-White-Red Region, and the Missouri Region (Figure 3-7). Hydrology is important to the ecology of all species of bats because it influences and shapes habitats of wetlands, floodplains, and waterways used by roosting, foraging, and traveling bats (Carter 2006).

Figure 3-7. Major Rivers in Plan Area (National Hydrology Dataset)



3.4.7.1 Upper Mississippi Region

The Upper Mississippi River flows roughly 1,300 miles, from northern Minnesota to the confluence with the Ohio River at the southern tip of Illinois near Thebes, Illinois, over half of the length of the entire Mississippi River. The region is approximately 189,000 square miles spread over five states, with 14,812 square miles in Missouri. The three subregions (HUC 4) found in Missouri are Des Moines, Upper Mississippi-Kaskaskia-Meramec, and Upper Mississippi-Salt. The Mississippi River is the state boundary between Missouri and Illinois along 361 miles of the Upper Mississippi River. One of the two largest tributaries to the Mississippi, the Missouri River, enters the Upper Mississippi River north of St. Louis, Missouri.

3.4.7.2 Lower Mississippi Region

The Lower Mississippi River free-flows roughly 1,000 miles from the confluence with the Ohio River near Thebes, Illinois, and discharges into the Gulf of Mexico south of New Orleans, Louisiana. The region is approximately 105,000 square miles spread over six states, with 4,883 square miles in Missouri. The two subregions found in Missouri are Lower Mississippi-Hatchie and Lower Mississippi-St. Francis. For 126 miles, the Lower Mississippi River separates Missouri from Kentucky and Tennessee. The region receives streamflow from four other major river basins that make up the Mississippi River drainage system, of which three are in Missouri: the Upper Mississippi River Basin, the Missouri River Basin, and the Arkansas-White-Red Basin.

3.4.7.3 Missouri Region

The Missouri River is the longest river in North America, with a total length of 2,565 miles. Rising in the Rocky Mountains of Montana, the Missouri flows east and south before entering the Mississippi River north of St. Louis, Missouri. The region is approximately 529,400 square miles spread over seven states, with 36,478 square miles in Missouri. The Missouri River flows through Missouri approximately 553 miles, entering the state at the Nebraska-Missouri boundary, where it flows south and follows the boundary between Kansas and Missouri until it reaches Kansas City, Kansas. At this point, it flows east through Kansas City, Missouri, and meanders generally eastward through the central portion of the state until it reaches St. Louis. The five subregions found in Missouri are Chariton-Grand, Gasconade-Osage, Kansas, Lower Missouri, and Missouri-Nishnabotna. Approximately 14 rivers (not including smaller tributaries) flow into the Missouri River.

3.4.7.4 Arkansas-White-Red Region

The Arkansas-White-Red River Region comprises three rivers, including the Arkansas River, White River, and Red River. This region is approximately 280,000 square miles spread over eight states, with 13,514 square miles in Missouri. The Arkansas River does not flow through Missouri; the river's Neosho-Verdigris River Subregion is located in southwest Missouri. The White River is a 722-mile long river that flows through Arkansas and Missouri. Originating in the Boston Mountains of Arkansas, it flows northward into southern Missouri, and then turns back into Arkansas. Four major tributaries to the White River's Upper White Subregion are located in Missouri. Although the Red River is part of the Arkansas-White-Red Basin hydrology geographical basin, no Red River subregions are found in Missouri.

3.4.8 Land Cover

Land cover provides context on where covered bats are typically found. This MDC Bat HCP uses the NLCD (2011) to define and map land cover type (Homer et al. 2015). The NLCD was aggregated into high-level groupings for the purposes of this Plan as follows: forest and woodland, glades, open lands, open water, and developed. These broad categories function at the landscape scale and will allow broad mapping of bat distribution for the purposes of a state-level HCP. It is important to note that while bats utilize sub-components of these groupings (such as riparian forest), these finer-scale land cover types are not relevant to mapping the broader distribution of bats and are therefore not described in detail. Table 3-1 shows how the NLCD land cover types relate to the HCP categories in Missouri.

Table 3-1. Crosswalk of HCP Categories to NLCD Land Cover and Acreages for MDC Lands and Other Nonfederal Covered Lands

HCP Categories	NLCD Land Cover	Acres on MDC Lands	Acres on Other Nonfederal Lands	Description
Forest and Woodland	Deciduous Forest	599,131	13,040,781	Forest with greater than 75% cover of deciduous trees.
	Evergreen Forest	25,005	451,617	Forest with greater than 75% cover of evergreen trees.
	Mixed Forest	27,620	432,185	Forest with neither deciduous nor evergreen species accounting for greater than 75% of total tree cover.
	Woody Wetlands	84,495	644,202	Forest or shrubland with greater than 20% cover of vegetative cover with semipermanent or permanent floodwaters.
	Shrub/Scrub	6,862	189,658	Dominated by shrubs with shrub canopy greater than 20% of total vegetation. Includes true shrubs and young or stunted trees.
Glades	Barren Land (Rock/Sand/Clay)	2,443	59,863	Barren areas of bedrock, scarps, strip mines, talus, slides, glacial debris, volcanic material, gravel pits, and other accumulation of earthen material. Vegetation accounts for less than 15% of land cover.
Open Lands	Cultivated Crops	97,428	9,301,198	Predominantly cropland including row, close-grown, forage, and perennial woody crops. Crop vegetation accounts for greater than 20% of total vegetation.
	Grasslands/ Herbaceous	23,094	628,647	Predominantly graminoid or herbaceous vegetation, generally greater than 80% of total vegetation.
	Pasture/Hay	58,785	13,140,272	Grasses, legumes, or grass-legume mixtures planted for livestock grazing or production of seed/hay crops. Pasture vegetation accounts for greater than 20% of total vegetation.
	Emergent Herbaceous Wetland	31,883	88,082	Perennial herbaceous vegetation accounts for greater than 80% of vegetative cover with semi-permanent or permanent floodwaters.

HCP Categories	NLCD Land Cover	Acres on MDC Lands	Acres on Other Nonfederal Lands	Description
Open Water	Open Water	42,704	437,976	All areas of open water, generally with less than 25% cover or vegetation or soil.
Developed	Developed, High Intensity	46	101,492	Nonvegetated, impervious surfaces dominated by streets, parking lots, buildings. Impervious surfaces account for 80–100% of total cover.
	Developed, Medium Intensity	276	255,267	Mixture of vegetated urban environments and constructed materials. Impervious surfaces account for 50–79% of total cover.
	Developed, Low Intensity	2,529	822,788	Mixture of vegetated urban environments and constructed materials. Impervious surfaces account for 20–49% of total cover.
	Developed, Open Space	22,369	1,822,871	Predominantly vegetated urban environments with some constructed materials. Impervious surfaces account for less than 20% of total cover.

Source: National Land Cover Database 2011
HCP = habitat conservation plan; MDC = Missouri Department of Conservation; NLCD = National Land Cover Database

3.4.8.1 Forest and Woodland

This category comprises the NLCD land cover types characterized (for purposes of bat distribution modeling) as forest and woodland (Figure 3-8 illustrates the NLCD land cover categories within the HCP categories; Figure 3-9 illustrates the aggregated HCP categories).

The forest and woodland land cover type includes bat habitats that range from low quality (e.g., shrub/scrub, evergreen forest) to high quality (e.g., deciduous forest, woody wetland). As described in previous sections, ecological factors (i.e., topography, geomorphology, soils, hydrology, and climate) have led to large forested areas in the Ozark Highlands, and to a lesser extent, riparian forest corridors in the Osage Plains, Northern Plains, and the Mississippi Alluvial Basin. The heavily wooded/forested areas of the Ozark Highlands are underlain by cavernous limestone (karst terrain), which provides preferred habitat for the covered species. The following are NLCD land cover types within the forest and woodland category.

- Deciduous Forest—characterized by areas dominated by trees generally greater than 16.4 feet (5 meters) tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
- Evergreen Forest—characterized by areas dominated by trees generally greater than 16.4 feet (5 meters) tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.

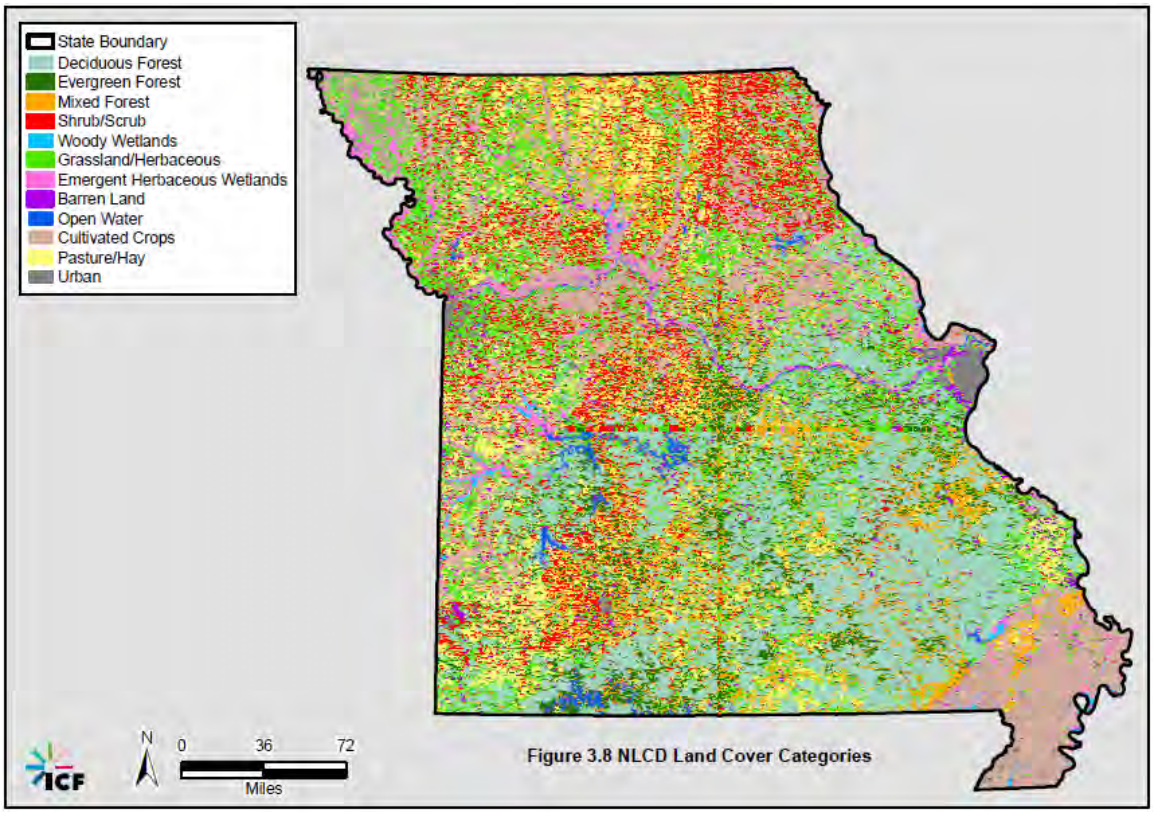
- Mixed Forest—characterized by areas dominated by trees generally greater than 16.4 feet (5 meters) tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
- Woody Wetlands—characterized by areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated or inundated.
- Shrub/Scrub—characterized by areas dominated by shrubs less than 16.4 feet (5 meters) tall with shrub canopy typically greater than 20% of total vegetation. This class comprises true shrubs, young trees in an early successional stage, and trees stunted from environmental conditions.

3.4.8.2 Glades

This category comprises the NLCD land cover type characterized as barren land, which includes glade features. Barren land (e.g., rock, sand, clay) is characterized by barren areas of bedrock, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

This land cover type is found mainly in southern Missouri (Ozark Highlands) in small, patchy areas where the surficial limestone and/or igneous rocks outcrops are highly weathered (Figure 3-8). Barren land is less widespread in Missouri relative to forests and woodlands (Table 3-1). This land cover type is characterized by areas of exposed bedrock and other earthen material, and as a result, is important for the covered species that utilize rock crevices for roosting and barren land for movement and foraging. Although the NLCD categories do not map glades, these habitat features are present within this land cover type. Glades (also known as *balds*) are open, rocky barren areas dominated by drought-adapted forbs, warm-season grasses, and a specialized fauna. They appear as small or large essentially treeless openings within landscapes primarily dominated by woodlands. (Rock outcrops characterize glades with bedrock near the surface, shallow soils, and the absence of a developed canopy or subcanopy layer.) Glades are characterized by rock outcrops, bedrock near the surface, shallow soils, and the absence of a developed canopy or subcanopy layer. Lichens and mosses occur on exposed rock surfaces, especially on sandstone, chert, and granite. Trees and shrubs occur on glades but are not dominant unless overgrazing and/or disruption of natural fire regimes have resulted in invasion by wood species such as the eastern red cedar.

Figure 3-8. Plan Area National Land Cover Database Land Cover



Source: National Land Cover Database 2011

3.4.8.3 Open Lands

This category comprises the NLCD land cover types characterized as open lands. This land cover type is found predominantly in the Osage and Dissected Till Plains of northern and west-central Missouri and the Mississippi Alluvial Basin of the Bootheel Region of southeastern Missouri (Figure 3-9). Open lands are less suitable for covered bats relative to forests and woodlands and barren lands. However, covered species may utilize open land for movement and foraging. The following NLCD land cover types are found in open lands.

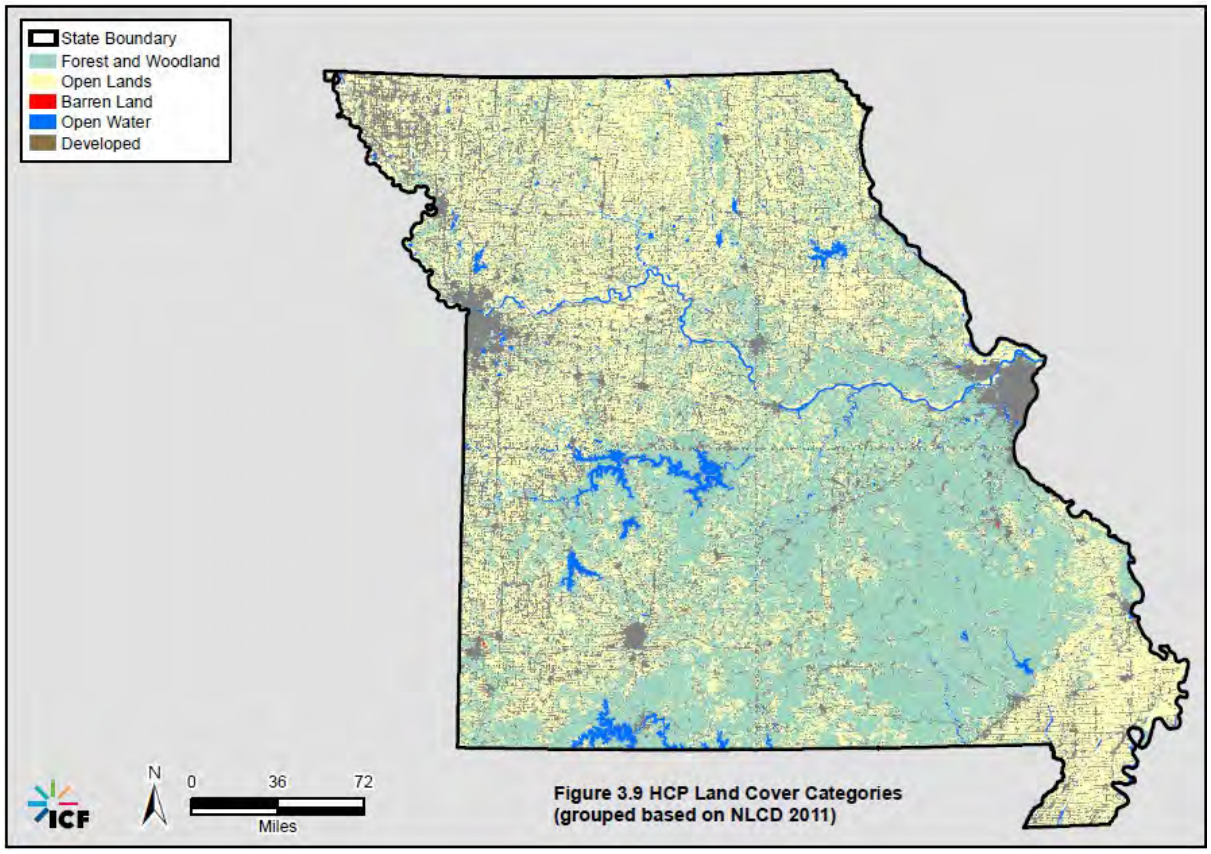
- Cultivated Crops—characterized by areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
- Grasslands/Herbaceous—characterized by areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.

Although the NLCD categories do not identify savannas, this vegetation type is present within grasslands/herbaceous. Savannas are grasslands interspersed with open-grown scattered trees, groupings of trees of various age, and shrubs. Abundant sunlight reaches the ground layer. They are distinguished from woodlands in that savannas are strongly associated with large prairies nearly level to dissected plains and are generally dominated by prairie grasses and forbs. Savannas are species-rich natural communities, with most diversity found in the understory layer. Although oak

savanna possesses a distinct herbaceous community characterized by species adapted to frequent large-scale disturbances, no endemics presently occur in savannas.

- Pasture/Hay—characterized by areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
- Emergent Herbaceous Wetland—characterized by areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Figure 3-9. Plan Area Habitat Conservation Plan Categories



Note: Categories grouped based on National Land Cover Database 2011

3.4.8.4 Open Water

This category comprises the NLCD land cover type characterized as open water. As described in Section 3.4.7, *Hydrology*, Missouri contains thousands of miles of streams, rivers, and lake shorelines. Not only do these water bodies provide movement corridors for the covered bat species, but the adjoining riparian forests and wetlands also allow for movement and provide habitat for foraging. In the NLCD, open water is characterized by all areas of open water, generally with less than 25% cover of vegetation or soil.

3.4.8.5 Developed

This category comprises the NLCD land cover types characterized as developed. Developed areas where covered bat species roost include attics and buildings in residential, commercial, and industrial areas (Figure 3-9). During the summer, the bat species that are common to urban areas utilize the city landscapes for foraging.

- Developed, High Intensity—characterized by highly developed areas where people reside or work in high numbers. Examples are apartment complexes, row houses, and commercial/industrial areas. Impervious surfaces account for 80–100% of the total cover.
- Developed, Medium Intensity—characterized by areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50–79% of the total cover. These areas most commonly contain single-family housing units.
- Developed, Low Intensity—characterized by areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20–49% of total cover. These areas most commonly contain single-family housing units.
- Developed, Open Space—characterized by areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly contain large-lot, single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

3.4.9 Forest Type Distribution

This section describes forests in the plan area with respect to land cover and vegetation, special resources, forest types, and the distribution of ownership. When first settled by Europeans in the early to mid-1800s, about 31 million acres in Missouri (approximately 70% of the state's land) were forested, with the rest being prairie (King et al. 1949). Later in the nineteenth century, the extensive pine forests in the Ozark region attracted large-scale logging and processing operations. As a result, from about 1880 to 1920, Missouri was one of the leading lumber-producing states in the United States (Benac and Flader 2004). By the time of the first forest inventory in 1947, forestland area had declined by about 50%. The low point in Missouri's forestland area was recorded in 1972 at 12.9 million acres. Since 1972, forestland area has rebounded and has consistently been approximately 15 million acres. In spite of periodic fluctuations over the past 70 years, essentially one-third of Missouri has remained forested. In 2017, the forestland area of Missouri was estimated at 15.35 million acres (Goff 2018; Table 3-2). The most heavily forested areas are located in the southeastern and south-central parts of the state. Approximately 80% of the forestland is found in the Ozark region (Benac and Flader 2004). The northern and western areas of Missouri are primarily agricultural and prairie, with forestland limited to wood lots and riparian areas.

Table 3-2. Forest-Type Groups and Types in Missouri

Forest-Type Group	Forest Type		Thousands of Acres
White/red/jack pine	Eastern white pine		3.9
White/red/jack pine		**Total**	**3.9**
Loblolly/shortleaf pine	Shortleaf pine		269.8
Loblolly/shortleaf pine		**Total**	**269.8**
Other eastern softwoods	Eastern red cedar		365.8
Other eastern softwoods		**Total**	**365.8**
Exotic softwoods	Scotch pine		0.7
Exotic softwoods		**Total**	**0.7**
Oak/pine	Eastern white pine/northern red oak/white ash		1.6
Oak/pine	Eastern red cedar/hardwood		587.9
Oak/pine	Shortleaf pine/oak		318.0
Oak/pine		**Total**	**907.6**
Oak/hickory	Post oak/blackjack oak		1,519.2
Oak/hickory	White oak/red oak/hickory		6,714.3
Oak/hickory	White oak		1,890.6
Oak/hickory	Northern red oak		94.3
Oak/hickory	Sassafras/persimmon		68.4
Oak/hickory	Bur oak		35.8
Oak/hickory	Scarlet oak		103.7
Oak/hickory	Yellow-poplar		2.5
Oak/hickory	Black walnut		154.6
Oak/hickory	Black locust		37.5
Oak/hickory	Chestnut oak/black oak/scarlet oak		229.3
Oak/hickory	Cherry/white ash/yellow-poplar		62.3
Oak/hickory	Elm/ash/black locust		311.4
Oak/hickory	Red maple/oak		2.3
Oak/hickory	Mixed upland hardwoods		1,081.6
Oak/hickory		**Total**	**12,307.6**
Oak/gum/cypress	Swamp chestnut oak/cherrybark oak		64.6
Oak/gum/cypress	Sweetgum/Nuttall oak/willow oak		11.9
Oak/gum/cypress	Overcup oak/water hickory		67.3
Oak/gum/cypress	Baldcypress/water tupelo		10.1
Oak/gum/cypress		**Total**	**153.9**
Elm/ash/cottonwood	Black ash/American elm/red maple		47.1
Elm/ash/cottonwood	River birch/sycamore		211.2
Elm/ash/cottonwood	Cottonwood		99.9
Elm/ash/cottonwood	Willow		44.7
Elm/ash/cottonwood	Sycamore/pecan/American elm		117.6
Elm/ash/cottonwood	Sugarberry/hackberry/elm/green ash		453.2
Elm/ash/cottonwood	Silver maple/American elm		145.1

Forest-Type Group	Forest Type		Thousands of Acres
Elm/ash/cottonwood	Red maple/lowland		0.6
Elm/ash/cottonwood	Cottonwood/willow		14.5
Elm/ash/cottonwood		**Total**	**1,134.0**
Maple/beech/birch	Sugar maple/beech/yellow birch		61.4
Maple/beech/birch	Hard maple/basswood		35.8
Maple/beech/birch		**Total**	**97.2**
Other hardwoods	Other hardwoods		42.1
Other hardwoods		**Total**	**42.1**
Exotic hardwoods	Other exotic hardwoods[a]		3.0
Exotic hardwoods		**Total**	**3.0**
Nonstocked	Nonstocked[b]		60.8
Nonstocked		**Total**	**60.8**
Grand Total		**Total**	**15,346.3**

Source: U.S. Forest Service 2017

[a] Includes any of the following species: Norway maple, ailanthus, mimosa, European alder, Chinese chestnut, ginkgo, Lombardy poplar, European mountain-ash, West Indian mahogany, Siberian elm, saltcedar spp., chinaberry, Chinese tallowtree, tung-oil-tree, Russian- olive, and avocado.

[b] Timberland less than 10% stocked with all live trees

The oak/hickory forest-type group occupies 80% of the total area in the state (Table 3-2). The elm/ash/cottonwood forest-type group is the second largest group (7% of the total forestland area in the state) followed by oak/pine, other eastern softwoods (eastern red cedar [*Juniperus virginiana*]), and loblolly/shortleaf pine. The most commonly occurring tree species in Missouri is eastern red cedar (Goff 2018; Piva and Treiman 2017). The number of red cedar trees increased by 4% from 2012 to 2017. The number of white oak (*Quercus alba*) trees has decreased by 3% since 2012; however, it continues to be the most dominant species based on volume (increased by 1% since 2012). According to Goff (2018), over half of Missouri's 21.4 billion cubic feet of live tree volume on forestland constituted white oak and four other species: black oak (*Q. velutina*), post oak (*Q. stellata*), shortleaf pine (*Pinus echinata*), and northern red oak (*Q. rubra*). Net volume increased on both forestland (2.8%) and timberland[4] (2.7%) from 2012 to 2017. Annual net growth of growing stock exceeded removals on timberland for all of the major species groups in Missouri for this same period while mortality for several dominant oak species was particularly high. As a consequence of higher mortality rates, average annual removals decreased for white oak (17%) and black oak (43%) during this timeframe (Goff 2018).

About 85% of the forestland in Missouri is privately owned (National Land Cover Database 2011) (Table 3-3). In 2013, family forests (212,000 owners) accounted for 76% of the private forestland (Butler et al. 2016). Corporate forests accounted for 5% of the private forestland and other private (nongovernmental conservation agencies, unincorporated partnerships, clubs,) ownerships accounted for 1% of the private forestland (Butler et al. 2016). The remaining 18% of the forestland in Missouri is owned by government entities. A total of 12% is federally owned (most of this area is

[4] Timberland is defined as forestland that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation.

accounted for by the Mark Twain National Forest) and state/local governments comprise the remaining 6%.

Table 3-3. Missouri Forestland Status by Ownership Class

	Missouri Forestland Status (thousands of acres)				
Ownership Class	**Timberland**	**Unreserved other Forestland**	**All Unreserved Forestland**	**Reserved Forestland**	**All Forestland**
National Forest System	1,373.2	12.8	1,386.0	97.1	1,483.1
National Park Service	—	—	—	57.6	57.6
Fish and Wildlife Service	—	—	—	23.8	23.8
Department of Defense[a]	257.9	5.8	263.7	5.1	268.9
Other Federal	10.5	—	10.5	—	10.5
State[b]	644.4	4.1	648.5	151.1	799.6
County and Municipal	76.2	—	76.2	14.1	90.3
Private	12,429.2	183.2	12,612.4	—	12,612.4
Total	**14,791.4**	**205.9**	**14,997.3**	**348.9**	**15,346.3**

Source: U.S. Forest Service 2017

[a] Includes Army Corps of Engineers lands.

[b] Includes MDC lands.

3.5 Covered Species

This section introduces the covered species and describes their distribution generally across the landscape of the plan area. Additional information on species will be addressed in Appendix A, *Species Accounts*.

3.5.1.1 Indiana Bat (*Myotis sodalis*)

Legal Status

The federally endangered (U.S. Fish and Wildlife Service 1967) Indiana bat (*Myotis sodalis*) is a small bat with brown to gray fur (Mumford and Whitaker 1982; Thomson 1982; U.S. Fish and Wildlife Service 2007) that resembles little brown bat (*M. lucifugus*) and northern long-eared bat (*M. septentrionalis*). These species are distinguished based on differences in the foot morphology, fur color, and ear length (Thomson 1982; U.S. Fish and Wildlife Service 2007).

Federal Register (FR) Documents

72 FR 19015–19016; 16 April 2007: Draft Indiana Bat Recovery Plan, First Revision

42 FR 47840–47845; 22 September 1977: Final Correction and Augmentation of Critical Habitat

41FR 41914; 24 September 1976: Determination of Critical Habitat

40 FR 58308–58312; 16 December 1975: Proposed Determination of Critical Habitat

32 FR 4001; 11 March 1967: Endangered Species List - 1967

Life History

In spring, Indiana bats emerge from hibernation in caves and mines. Most males stay near the hibernacula, and frequently change home ranges (Brack 1983, Whitaker and Brack Jr. 2002). Females (and some males) migrate up to 357 miles from winter habitat (Rockey et al. 2013), where

they join with other pregnant females to form groups known as maternity colonies. Within these maternity colonies, females give birth to a single pup per year in early June and the pup begins flying by early July (Thomson 1982; Hayssen et al. 1993). Once pups begin to fly, members of maternity colonies become more widely dispersed. Migration back to the hibernacula begins in August and continues through early October with weather conditions such as high winds, rain, and cold temperatures serving as cues to "pulses" of migrants (Pettit and O'Keefe 2017).

During mid-August to late-October, large numbers of bats fly in and out and around the entrances to caves and mines, engaging in a behavior known as swarming (Humphrey and Cope 1976; Cope and Humphrey 1977). Most mating occurs during swarming at night (Thomson 1982). The same individuals are rarely captured on concurrent nights at the same caves, indicating at least some are using the caves as stopover sites, although some are eventually found hibernating at the site (Humphrey and Cope 1976; Cope and Humphrey 1977). Females often enter hibernation shortly after arriving at the hibernacula, whereas males may travel some distance out onto the surrounding landscape and even leave the entrance for a time, presumably to rest (Chenger et al. 2007).

Indiana bats enter hibernation by November (or mid-October in northern latitudes) (U.S. Fish and Wildlife Service 2007). Indiana bats often hibernate in large clusters. Caves and mines with cool and stable temperatures and noticeable airflow are used for hibernation. During hibernation, 250 or more Indiana bats cluster together in areas of caves that reach approximately 41–50˚F (5–10 degrees Celsius [˚C]) (Thomson 1982). Indiana bats periodically arouse from hibernation, and the duration of hibernation bouts between each arousal decreases as temperature of the hibernacula increases (Brack and Twente 1985; Park et al. 2000). Typical time between arousals is 12 to 15 days (U.S. Fish and Wildlife Service 2007).

Indiana bats emerge from hibernation from mid-March to mid-May, depending on latitude (U.S. Fish and Wildlife Service 2007), and may linger near the hibernacula or fly around the entrance for a few days before migrating in a behavior known as spring staging (Thomson 1982; U.S. Fish and Wildlife Service 2007). Pulses of spring migration are associated with spring storms and increased temperatures (Pettit and O'Keefe 2017).

Habitat

During the active season, when Indiana bats are outside of caves and mines, the typical roost for this species is a dead or dying tree with loose bark, although bats are occasionally found in cracks, crevices, and anthropogenic structures such as bat boxes (Kurta 2004). The species of tree is not as important as its form, as Indiana bats require loose, sloughing bark as roost structures, and a variety of tree species are used across the Indiana bat's distribution area (Kurta 2004). Summer roosting habitat for Indiana bats may be in forested upland or riparian areas, and maternity colonies can be found in a variety of tree species (Britzke et al. 2003). Maternity roosts are typically very large (16 inches [>40 centimeters] diameter at breast height) trees with substantial solar exposure in areas with 20–80% canopy closure (Humphrey et al. 1977; Gardner et al. 1991b; Kurta et al. 1993). Trees used by Indiana bats not associated with a maternity colony are typically smaller and less shaded than maternity roosts (Brack et al. 2004; Kurta 2004). Individuals and colonies show strong fidelity to roosting and foraging areas over many years (Kurta and Murray 2002; Kurta et al. 2002; Whitaker and Sparks 2008).

At a landscape scale, Indiana bats make preferential use of forested habitat for foraging and commuting (Murray and Kurta 2004; Menzel et al. 2005a; Sparks et al. 2005; Bergeson et al. 2013; Womack et al. 2013). However, within forested habitat there is preference for openings and edges

that allow Indiana bats to fly around foliage surfaces, including over and below the tree canopy in upland and riparian forested areas and along edges of forests (Humphrey et al. 1977; Gardner et al. 1991a; Brown and Brack 2003; Sparks et al. 2004). In these habitats, Indiana bats feed on many insect types, although moths (*Lepidoptera*), beetles (*Coleoptera*), true flies (*Diptera*), wasps and flying ants (*Hymenoptera*), and caddisflies (*Trichoptera*) (Tuttle et al. 2006) are typically the most important food sources. Diet varies by age, gender, habitat type, prey availability, time of year, lunar cycle, and geographic location (Brack 1983; Brack and LaVal 1985; Murray and Kurta 2002; Tuttle et al. 2006).

Hibernacula are typically caves and abandoned mines (Thomson 1982), although a few individuals use a hydroelectric dam in Michigan (Kurta et al. 1997). Large, complex hibernacula offer hibernating Indiana bats a variety of thermal conditions and a buffer against sudden temperature changes (Tuttle and Kennedy 2002; Brack 2007). Indiana bat hibernacula are typified by mid-winter temperatures between 41° and 50°F (5° and 10°C).

Indiana bat hibernacula are assigned priority numbers based on the number of individuals contained within (U.S. Fish and Wildlife Service 2007). Priority 1 hibernacula have suitable and stable microclimates with a current or historical population of greater than 10,000 individual Indiana bats (U.S. Fish and Wildlife Service 2007). Priority 2 hibernacula contain between 1,000 and 10,000 bats and have a suitable microclimate (U.S. Fish and Wildlife Service 2007). Priority 3 hibernacula are associated with current or historical observations of 50 to 1,000 individuals (U.S. Fish and Wildlife Service 2007). Priority 4 hibernacula are the least important to recovery and conservation of Indiana bats and have current or historical observations of fewer than 50 individuals (U.S. Fish and Wildlife Service 2007). The largest known hibernacula of the species is located in an abandoned limestone mine in Sodalis Nature Preserve in Hannibal, Missouri.

Critical habitat for the Indiana bat includes 11 caves and 2 abandoned mines in Illinois, Indiana, Kentucky, Missouri, Tennessee, and West Virginia (U.S. Fish and Wildlife Service 1976a). In Missouri, critical habitat consists of five caves and one mine in Crawford, Franklin, Iron, Shannon, and Washington Counties. While the Sodalis Nature Preserve is the largest known hibernaculum for the Indiana bat, it has not officially been designated as critical habitat as it was discovered after critical habitat for the species was already designated. Critical habitat designations have not been updated since the Sodalis Nature Preserve was discovered to be a major hibernaculum.

Distribution

Indiana bats are distributed throughout cavernous limestone areas and areas just to the north in the midwestern and eastern United States (Thomson 1982). The species can be found from Alabama and Georgia north to New Hampshire and west through Michigan to Iowa, Missouri, and Oklahoma (Thomson 1982). Observations in Florida and Wisconsin are considered accidental, and the species is likely absent from these states (Thomson 1982).

Data provided by MDC indicate that Indiana bats have been observed in 62 Missouri counties with 4 counties designated as historic: Barry, Christian, McDonald, and Stone counties. Boyles et al. (2009), predicted the species was likely to occur throughout the state with the exception of the counties in west-central Missouri, chiefly located in the Osage and Dissected Till Plains regions.

Reasons for Decline

WNS is the primary threat now facing Indiana bats, as populations in hibernacula throughout the range have suffered dramatic declines since the arrival of WNS (U.S. Fish and Wildlife Service 2017). Models based on these declines predict that WNS will cause the Indiana bat to become extirpated over a large portion of its distribution (Thogmartin et al. 2013). Large-scale declines have not been documented in Missouri (Colatskie 2017), however, based on data from surrounding states, they are expected.

Indiana bats were suffering marked declines in winter populations (where the bats could be counted) well before the arrival of WNS. Historically, the most significant cause of decline for Indiana bat was disturbance of winter hibernacula, but loss of summer habitat was also an issue (Johnson et al. 1998; U.S. Fish and Wildlife Service 2007).

3.5.1.2 Gray Bat (*Myotis grisescens*)

Legal Status

Federal Register (FR) Documents
40 FR 17590–17591; 21 April 1975: Lists of Endangered and Threatened Fauna (10)
41 FR 17736–17740; 28 April 1976: Determination of Endangered Species Status
71 FR 16176–16177; 30 March 2006: 5-Year Review of Five Midwestern Species

Gray bat (*Myotis grisescens*) is a federally endangered bat native to the caves of the south-central United States. These are large members of the genus *Myotis,* with a typical weight of 0.35 ounce (10 grams) at maturity with a right forearm measurement of 1.6–1.8 inches (40.5–45.5 millimeters) (U.S. Fish and Wildlife Service 1976b; Decher and Choate 1995). Gray bats are distinguished from other similar species by their large size, unique ankle morphology, and monochromatic fur (Decher and Choate 1995).

Life History

Bats begin to arrive at hibernacula in late August. When females arrive, they mate and begin hibernating. Adult males and juveniles remain active for several weeks later than mated females but usually enter hibernation by early November. Hibernation continues through April (U.S. Fish and Wildlife Service 1982), when bats migrate back to summer caves.

Females store sperm through hibernation and a single pup is born in late May or early June (U.S. Fish and Wildlife Service 1982). Colony members are loyal to their colony home range but tend to disperse in groups among several different caves within that area (U.S. Fish and Wildlife Service 1982). Adult males tend to concentrate in areas not used by maternity colonies, and these concentration of bats are termed *bachelor colonies*. Some adult males roost with females until the pups are born, and adult males begin to rejoin the maternity colonies once the pups are volant (i.e., flying or capable of flying) (U.S. Fish and Wildlife Service 1982).

Habitat

Gray bats use caves throughout the year (Decher and Choate 1995), and may migrate more than a hundred miles between summer and winter caves (Tuttle 1976a; Elder and Gunier 1978; LaVal and LaVal 1980; Decher and Choate 1995). During the migration, a wide variety of caves may be used, but those used during summer and winter are often large and complex systems. Maternity colonies are typically formed in caves with domed ceilings that trap the body heat of bats to produce air

temperatures ranging from 57 to 79°F (14° to 26°C) (Tuttle 1976a). Maternity caves often contain underground streams and are usually located within 0.6–2.5 miles (1–4 kilometers) of rivers or other bodies of water (Tuttle 1976b; U.S. Fish and Wildlife Service 1997). A few colonies of gray bats summer in anthropogenic roosts including storm sewers (Decher and Choate 1995), mines (Brack et al. 1984), railroad tunnels, dams, buildings (Evans and Drilling 1992), and bridges (Cervone and Yeager 2016). Hibernacula used by gray bats typically have a strong vertical component which allows cold air to fall into the cave and become trapped in domed rooms in which typical mid-winter temperatures range from 43° to 52°F (6° to 11.6°C) (Tuttle 1976a).

Gray bat foraging habitat includes wooded riparian areas as well as waterways such as streams, rivers, and lakes (Tuttle 1976b; LaVal et al. 1977; Clawson and Titus 1992; Best and Hudson 1996; Moore et al. 2017). Adult gray bats typically eat aquatic flying insects while volant juveniles more commonly eat terrestrial insects, foraging more in woodlands (Brack and LaVal 2006).

Critical habitat has not been designated for gray bat.

Distribution

The southern extent of gray bat's distribution reaches the northern portions of Florida and continues north through the eastern United States in the western parts of North Carolina and Virginia. The distribution extends west through the southern portions of Indiana and Illinois and south to southeastern Kansas and Oklahoma (Decher and Choate 1995). Gray bat is a true cave-dwelling species, roosting in caves throughout the year, and is most abundant in the karst regions of Missouri, Arkansas, Kentucky, Tennessee, and Alabama (Decher and Choate 1995).

Data provided by MDC indicate that gray bats have been observed in 66 Missouri counties. Boyles et al. (2009) identified the potential range of gray bat as encompassing 67 counties, but noted the species is rare in areas without caves, such as the Till Plains of northern Missouri and the Bootheel Region.

Reasons for Decline

Declining population numbers due to habitat loss is the primary reason gray bat was listed as endangered (U.S. Fish and Wildlife Service 1975, 1976b). Factors contributing to the decline include human disturbance, including intentional destruction and commercialization of caves, and vandalism to caves, as well as pesticides, siltation of rivers, deforestation, and even research activities (U.S. Fish and Wildlife Service 1975; Choate and Decher 1996). Disturbance of hibernating gray bats causes individuals to rouse from hibernation and use energy (fat) resources (U.S. Fish and Wildlife Service 1982). A majority of the gray bat population hibernates in a small number of caves, and the loss of any of these important caves would devastate the species (U.S. Fish and Wildlife Service 1975). Maternity caves are most vulnerable when nonvolant juveniles are present, and thousands of individuals may be lost due to a single disturbance (U.S. Fish and Wildlife Service 1982).

At the time of listing, gray bat population was believed to be approximately 128,000 individuals, but increases over the past few decades, largely due to management activities, have brought the estimated potential total to over 3,000,000 individuals (U.S. Forest Service 2005). Available data (Colatskie 2017) indicate the wintering population of gray bats is approximately stable since WNS was detected in 2012.

3.5.1.3 Northern Long-Eared Bat (*Myotis septentrionalis*)

Legal Status

Northern long-eared bat (*Myotis septentrionalis*) was listed as threatened with an interim 4(d) rule on April 2, 2015; a final 4 (d) rule was approved on January 14, 2016 (U.S. Fish and Wildlife Service 2016b). Like Indiana bat and little brown bat, northern long-eared bat is a small brownish bat. While it differs from these other species slightly in terms of coloration and foot morphology, the most striking feature of northern long-eared bat are its long ears (0.7 inch [17 millimeters]), which extend past the muzzle when laid forward, and a long and thin tragus (0.4 inch [9 millimeters]) (Whitaker and Mumford 2009b).

Federal Register (FR) Documents

81 FR 24707–24714; 27 April 2016: Determination that Designation of Critical Habitat Is Not Prudent for the Northern Long-Eared Bat: Critical habitat determination

81 FR 1900–1922; 14 January 2016: 4(d) Rule for the Northern Long-Eared Bat; Final Rule

80 FR 17973–18033; 2 April 2015: Threatened Species Status for the Northern Long-Eared Bat with 4(d) Rule

78 FR 72058–72059; 2 December 2013: Listing the Northern Long-Eared Bat as an Endangered Species

78 FR 61045–61080; 2 October 2013: 12-Month Finding on a Petition to list the Eastern Small-Footed Bat and Northern Long-Eared Bat as Endangered or Threatened Species; Listing the Northern Long-Eared Bat as an Endangered Species Proposed Rule

Life History

There are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction (Caceres and Barclay 2000; U.S. Fish and Wildlife Service 2015).

The dates provided here are generalized from studies appropriate to the covered lands (Kunz 1971; Caire et al. 1979; Whitaker and Rissler 1992a; Sasse and Pekins 1996; Lacki and Schwierjohann 2001; Krochmal and Sparks 2007; Timpone et al. 2010; Sasse et al. 2014; U.S. Fish and Wildlife Service 2016b); hibernation lasts longer in areas with more extreme winters and is shorter in warmer climates (U.S. Fish and Wildlife Service 2015). Females begin to migrate from their hibernacula to their summer range in April and form maternity colonies with other pregnant females (U.S. Fish and Wildlife Service 2016b). The bats change roosts every few days. One pup per female is born in early June and pups begin to fly in July. Once the pups begin to fly, bats are less likely to be found in groups and switch roosts more often. Males also migrate to the summer range in April and are often found roosting in the same woodlands as maternity colonies. Males visit caves and mines en masse in July, and then return for the fall swarming season, which lasts from August through October. During this period, bats fly in and around the entrance to potential hibernacula and appear to both be preparing for hibernation and mating. Bats begin to emerge from hibernation in March and some may spend time near the hibernacula entrance in a behavior known as staging prior to migrating to the summer range.

Habitat

Critical habitat has not been designated for northern long-eared bat.

Northern long-eared bat is a “cave bat” in winter (Caceres and Barclay 2000), and a “tree bat” throughout the active season. Most active-season roosts are under loose bark and in cavities or cracks of both live and dead trees (Sasse and Pekins 1996; Lacki and Schwierjohann 2001; Carter and Feldhamer 2005; Garroway and Broders 2008; Krynak 2010; Timpone et al. 2010; U.S. Fish and Wildlife Service 2015), but the species also makes use of anthropogenic structures, including artificial roosts (Whitaker et al. 2006; Adams et al. 2015; Stein and White 2016). Northern long-

eared bats will return to the same areas and even the same trees during subsequent seasons (U.S. Fish and Wildlife Service 2015). Large groups of bats (especially maternity colonies) are most likely to be found in trees with diameters greater than 12 inches (30.5 centimeters) (Garroway and Broders 2008). Thus, maintenance of large-diameter trees with cavities is an important management opportunity for this species. However, single bats may be found in trees as small as 3 inches (7.6 centimeters) in diameter at breast height. During fall swarming, northern long-eared bats roost within 5 miles (8 kilometers) of their hibernacula and appear equally likely to roost anywhere within that buffer (Lowe 2012).

Northern long-eared bats forage extensively in forested habitats (Henderson and Broders 2008), and make use of forests with greater vertical habitat variation (clutter) than many sympatric species (Caceres and Barclay 2000; U.S. Fish and Wildlife Service 2015). While foraging in these habitats, northern long-eared bats capture insects both on the wing and by gleaning them off vegetation. True flies (*Diptera*), beetles, (*Coleoptera*), and moths (*Lepidoptera*) are the most common foods (Caceres and Barclay 2000; Brack and Whitaker 2001; Whitaker and Mumford 2009c; U.S. Fish and Wildlife Service 2015).

Northern long-eared bats are most typically found hibernating in caves or abandoned mines, and often selects roosts in cracks and crevices (Caceres and Barclay 2000), thus leading to substantial underestimates during intra-cave survyes (Whitaker and Rissler 1992a, 1992b). Summer populations often occur in areas with few caves and mines, making it likely that this species also hibernates in rock crevices like several closely related species farther west (Sparks et al. 2011; Lemen et al. 2016).

Distribution

Northern long-eared bat ranges from the northwestern border of Florida north into Canada from Saskatchewan to Labrador and as far westward as Montana (Caceres and Barclay 2000).

Within the plan area, data provided by MDC indicate that northern long-eared bats have been observed in 82 Missouri counties. Boyles et al. (2009) predicted the species was likely to occur throughout the state with the exception of counties in west-central Missouri chiefly located in the Osage and Dissected Till Plains regions.

Reasons for Decline

The most significant cause of decline for northern long-eared bat is WNS (U.S. Fish and Wildlife Service 2015). Since its discovery in New York in 2006, WNS has spread rapidly throughout the eastern and midwestern United States and eastern Canada, and has caused unprecedented mortality in bats hibernating in caves and mines in the eastern United States (U.S. Fish and Wildlife Service 2015). Based on hibernacula studies, northern long-eared bat has suffered estimated losses of up to 93–98% in certain areas of the northeastern United States since 2005 (Turner et al. 2011). Available data (Colatskie 2017) indicate the population of northern long-eared bats in Missouri has declined by more than 95% since 2012.

Other challenges facing the species include the loss of winter and summer habitat and direct mortality at wind energy sites (U.S. Fish and Wildlife Service 2015).

3.5.1.4 Little Brown Bat (*Myotis lucifugus*)

Legal Status

Federal Register (FR) Documents
No listing FR documents exist for little brown bat

Little brown bat (*Myotis lucifugus*) is a small, insectivorous bat with variable fur coloration ranging from pale to dark brown, often described as "dark sooty brown through paler golden" on their backside and "pallid, to yellowish or olive brown" on their underside (Fenton and Barclay 1980; Kunz and Reichard 2010).

Little brown bat is not federally listed, however, a formal request to list the species was submitted to USFWS in 2010 (Kunz and Reichard 2010). USFWS completed a status review in 2016, focusing on the eastern subspecies and severe population declines attributed to WNS (Tinsley 2016). USFWS plans to evaluate listing status by 2023 (U.S. Fish and Wildlife Service 2019).

Life History

The four components of little brown bat annual life cycle are winter hibernation, spring staging/autumn swarming, spring/autumn migration, and summer reproduction.

During the spring (April to June, depending on latitude), bats migrate from winter habitat to summer. Summer habitat is occupied April through August. Pregnant females form maternity colonies that before WNS typically contained 300 to 1,200 bats (Humphrey and Cope 1976), and males (and nonreproductive females) roost singly or in small groups called bachelor colonies. Most young are born in early June and begin flying in early July.

Prior to entering hibernation (September to October), little brown bats "swarm" or fly repetitively around entrances of caves and mines (Fenton 1970). Most bats will mate during this time (Kurta 2008). In early spring (March to April), bats engage in a less intense version known as "staging," and some mating occurs during this staging (Whitaker and Rissler 1992a, 1992b).

Little brown bats hibernate September through April on the ceilings of caves and mines. They often form loose, irregular clusters that contain hundreds of bats.

Habitat

During the active season, when bats are not hibernating, little brown bats select different habitats for the following purposes: roosting, commuting, and foraging. Most known little brown bat roosts are in anthropogenic structures such as bat boxes, buildings, and bridges; although some bats roost in the cavities or under the bark of dead or dying trees (Humphrey and Cope 1976; Boyles et al. 2009). Trees used by maternity colonies tend to be very large and either dead or dying. Male roosts are much more varied and include virtually any place a bat can secret itself such as rock crevices, tree hollows, loose bark, bat boxes, and small openings in buildings (Humphrey and Cope 1976; Boyles et al. 2009). Although a few bats roost as far away as 10 kilometers (6.2 miles), most swarming little brown bats roost within the immediate vicinity of the hibernacula (Lowe 2012).

Little brown bats often commute within corridors in open flyways (streams, woodland trails, small infrequently used roads, and possibly utility corridors), away from foraging and roosting habitat (Brown and Brack 2003). Foraging habitat is primarily associated with aquatic resources and along

forest edge (Belwood and Fenton 1976; Anthony and Kunz 1977; Fenton and Bell 1979; Barclay 1991; Barclay and Brigham 1991; Kunz and Reichard 2010; Bergeson 2012; Bergeson et al. 2013).

Cool, stable, underground caverns are used for hibernation. As little brown bats hibernate, their body temperatures drop to near ambient. The average temperature at sites used by hibernating little brown bats is 45°F (7°C) with high humidity. (Barbour and Davis 1969; Humphrey and Cope 1976; Kurta 2008; Brack et al. 2010). Bats with low fat reserve select colder temperatures to maximize energy conservation, whereas bats in better condition select warmer temperatures to minimize other costs of hibernation (Boyles et al. 2007). WNS has forced bats to select colder, more variable sites (Johnson et al. 2016).

Distribution

Little brown bat is widely distributed across North America from central Alaska to central Mexico, and occurs in all continental U.S. states (Harvey et al. 1999). The eastern subspecies occurs east of the Rocky Mountains. Prior to the arrival of WNS the largest known colonies were located in the Midwest and the northeastern United States (Davis and Hitchcock 1965; Kunz and Reichard 2010). WNS has reduced the eastern population significantly (an average of 97%) (Tinsley 2016).

Within the plan area, data provided by MDC indicate that little brown bats have been observed in 86 Missouri counties. Prior to the arrival of WNS, Boyles et al. (2009) predicted the species was likely to occur in every county.

Reasons for Decline

The threat posed by WNS overshadows all other conservation issues for the little brown bat. In 2005, this species was abundant, but it is now all but extirpated across large areas of the Northeast (Dzal et al. 2010; Frick et al. 2010; Tinsley 2016). Available data (Colatskie 2017) indicate the population of little brown bats in Missouri has declined by more than 85% since 2012.

Other potential threats include mortality at wind turbines, poisoning from pesticides and contaminants, and habitat destruction and degradation from deforestation. Wind turbine strikes and barotrauma (internal injuries caused by decreased air pressure around turbine blades) are a significant secondary threat to little brown bats. Up to 107,000 little brown bats may have been killed at wind turbines between 2000 and 2011 (Arnett and Baerwald 2013). Pesticides are a lesser threat, but persistent organic pollutants have been found in lethal concentrations in little brown bats (Fenton and Barclay 1980; Kannan et al. 2010). Loss of important hibernacula can have regional effects, and removal of summer roosts (both trees and structures) can reduce local abundance (Whitaker et al. 2002).

3.5.1.5 Tricolored Bat (*Perimyotis subflavus*)

Legal Status

Federal Register (FR) Documents
82 FR 60362 60366; 20 December 2017: 90-Day Finding on a Petition to list the Tricolored Bat as Endangered or Threatened Species

The tricolored bat (*Perimyotis subflavus*) is not federally listed, but a petition to list the species as threatened or endangered was submitted to USFWS on June 14, 2016 (Center for Biological Diversity and Defenders of Wildlife 2016). On December 20, 2017, USFWS issued a 90-day finding that the petition presented credible evidence that listing may be warranted. Based on

this finding, USFWS has formally initiated the process to determine whether the tricolored bat should be protected under ESA.

The tricolored bat is a small insect-eating bat about 3 inches (7.6 centimeters) long with tricolored fur that appears golden to reddish brown from afar, a partially furred tail membrane, and brown colored ears. Most literature available for the tricolored bat is associated with an earlier name, eastern pipistrelle (*Pipistrellus subflavus*).

Life History

The four components of the tricolored bat annual life cycle are winter hibernation, spring staging/autumn swarming, spring/autumn migration, and summer reproduction.

During the spring (April to May), tricolored bats migrate from winter habitat to summer. Most bats are on the summer range from May through August. During summer, females and their pups live together in maternity colonies while males and nonreproductive bats roost singly. Young may be born mid-May through mid-July and are independent in about 5 weeks (Hoying and Kunz 1998).

Like most cave-hibernating bats, tricolored bats "swarm" or fly repetitively around entrances of caves and mines and mate (Fenton 1970). In early spring (March to April), bats engage in a less intense version of congregation around caves known as staging, during which some mating occurs (Whitaker and Rissler 1992a, 1992b). Tricolored bats can be found hibernating September through May.

Habitat

Three types of activities define tricolored bat summer habitat: roosting, commuting, and foraging. Tricolored bats locate their roosts within wooded habitats near water (Whitaker and Mumford 2009a), and will use natural and human-made structures as shelter. Maternity colonies form primarily within clusters of dead leaves hanging from the terminal ends of tree branches, but may also form in live leaf foliage, buildings, caves, and rock crevices (Humphrey 1975; Veilleux et al. 2003; Veilleux and Veilleux 2004a, 2004b; Veilleux et al. 2004; Perry and Thill 2007). Because dead leaf clusters easily decay, tricolored bats do not often return to the same roost tree in successive years, but they do frequent the same area (Veilleux and Veilleux 2004a, 2004b).

Tricolored bats have a low wing aspect ratio, making them highly maneuverable but less energy-efficient fliers (Norberg and Rayner 1987; Menzel et al. 2005b). Consequently, tricolored bats are considered clutter-adapted: Activity levels are higher in forests with greater clutter (Menzel et al. 2005b). Preferred habitats for foraging include forest, grasslands, and agriculture, but transportation corridors, low-density residential, high-density residential, commercial, industrial, and waterways are also used (Helms 2010).

Prior to the arrival of WNS, tricolored bats selected from a wide variety of hibernacula including caves, mines, storm sewers, and box culverts (Whitaker and Mumford 2009b), where they often are the only bat present. Inside hibernacula, they roost singly, avoid the ceiling, and are often located toward the back of the cave in areas that are warm and relatively stable (Brack 2007; Kurta 2008).

Distribution

Tricolored bat ranges from the Yucatan Peninsula to Nova Scotia, New Brunswick (Broders et al. 2001), and Quebec and east to the Atlantic Ocean. In recent years, the species has expanded its range across the High Plains (Damm and Geluso 2008) and subsequently has been captured in the Intermountain West including Texas and New Mexico (Sparks and Choate 2000; Geluso et al. 2005; White et al. 2006; Valdez et al. 2009). Rapid declines associated with WNS have negatively affected hibernating populations in northeastern states during the past decade (Turner et al. 2011).

Within the plan area, data provided by MDC indicate that tricolored bats have been observed in 88 Missouri counties. Prior to the arrival of WNS, Boyles et al. (2009) predicted the species was likely to occur in every county.

Reasons for Decline

The single greatest threat facing tricolored bat is WNS. In USFWS Region 5, tricolored bat population declined 75% from 1999 to 2011 (Turner et al. 2011), 98% in Ohio, and at least 45% in Indiana (Center for Biological Diversity and Defenders of Wildlife 2016). Available data (Colatskie 2017) indicate the population of tricolored bats in Missouri has declined by more than 50% since 2012.

Other potential threats include mortality at wind turbines, poisoning from pesticides and contaminants, and habitat destruction and degradation from deforestation. Researchers estimate that from 2000 to 2011 between 45,200 and 93,700 tricolored bats were killed at wind farms in the United States and Canada (Arnett and Baerwald 2013).

Chapter 4
Effects Analysis

This chapter of the Missouri Department of Conservation Bat Habitat Conservation Plan (MDC Bat HCP) addresses the potential effects of covered activities (Chapter 2, *Covered Lands and Activities*) on covered species. According to the *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (HCP Handbook) (U.S. Fish and Wildlife Service 2016a), "quantifying the amount of take provides a key basis for evaluating project impacts." *Take* can be quantified by identifying the number of affected individuals or breeding groups, or by using acres of habitat as a surrogate. In this HCP, bat habitat is used as a surrogate metric to quantify take. All HCPs must include a description of the "impact that will likely result from the take of covered species" (U.S. Fish and Wildlife Service 2016a). To receive an incidental take permit, Section 10(a)(2)(B) of the Federal Endangered Species Act (ESA) requires that the U.S. Fish and Wildlife Service (USFWS) find the following in relation to the level of take of each covered species.

- The taking will be incidental to otherwise lawful activities.
- The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking.
- The taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild.

These requirements, along with guidance from the HCP Handbook, inform the approach for the effects analysis. This chapter describes methods for quantifying effects and provides the results of the effects analysis.

4.1 Overview

Forest management and the activities permitted in this HCP maintain 700,000 acres of forest, woodland, and glades (preferred roosting and foraging habitat for covered bats) and improve 200,000 acres of open lands (foraging habitat for covered bats) over time. This HCP permanently affects only 11 acres of preferred habitat (forest, woodlands, and glades) per year. In terms of the conversion of natural habitat, there are no other impacts. As described in more detail below (Section 4.3.4, *Impacts of the Taking*), habitat for covered bats is improved as a result of the covered activities. In terms of roosting habitat, some roost trees may be lost, but the covered activities create roost trees on the landscape, resulting in a net increase in roost trees relative to areas under other ownership types (Guldin et al. 2007; Sheets et al. 2013b; Pauli et al. 2015a; Silvis et al. 2016).

Implementation of retention programs maintains many of the exiting snags and cavity trees, individual large (super-canopy) trees, and patches of forest. Over time, these become large trees that age as high-quality roosts. In fact, such management actions for bats are specifically identified as a goal in forestry guidelines used by MDC (Missouri Department of Conservation 2014, 2016).

Foraging habitat can be improved through forest management, and this is especially beneficial to bats in areas where open habitat is limited (Sheets 2010; Sheets et al. 2013a) or when the stands in question are highly cluttered, as is typical of younger stands (Blakey et al. 2016). Roads and trails

provide bats with access to corridors that are especially important to commuting and foraging (Brown and Brack 2003; Duchamp et al. 2004; Sparks et al. 2004; Menzel et al. 2005; Sparks et al. 2005; Sheets et al. 2013a; Sheets et al. 2013b; Weber and Sparks 2013).

While the covered activities improve habitat conditions over time, they do have the potential to affect bats roosting in trees. This effects analysis evaluates impacts on covered bat species during covered activities (forest management and public access and asset management activities). This analysis uses a habitat-based approach to quantify the potential for take from covered activities. For context, we also provide an analysis of effects on individual bats and the population. Because population numbers are highly unstable over time (due to white-nose syndrome [WNS]), acres rather than numbers of individuals are used to quantify impacts. The potential for take only exists when a bat is (or could be) present. For example, during the winter when bats are hibernating, covered activities will not disturb individuals directly because they are not present on the larger landscape. Hibernating bats are protected by winter buffers around their hibernacula (see Chapter 5, *Conservation Strategy*). During the spring, summer, and fall, when individuals are active across the landscape, there is potential for covered activities to result in harm or mortality.

Because bats are present on the landscape in different areas during different seasons, only a portion of the activities have potential to harm or kill bats. Section 4.2, *Methods*, describes how the seasonal habitat distribution models in Appendix A, *Species Accounts*, are used to quantify the potential for effects, in acres, on bats.

Because the long-term effects of covered activities create a net positive effect on habitat for covered bats, this effects analysis is primarily concerned with describing the potential for the direct effects of harm and mortality. In the sections that follow, the methods and results that quantify the potential for direct effect using acres of impacts when bats are present are described.

4.2 Methods

The HCP process requires an applicant to estimate the amount of take and to fully offset the effects of the taking (Chapter 5, *Conservation Strategy*). Many HCPs for bats (chiefly those completed for the wind industry) have directly estimated the number of bats that will be killed and then proposed measures to minimize and mitigate for impacts. The wind industry also monitors mortality of individual bats at turbines. In general, forest management activities benefit bats over the long term (Guldin et al. 2007; Sheets et al. 2013b; Pauli et al. 2015a; Silvis et al. 2016) and these positive effects are summarized in Chapter 5 (see specifics in Section 5.3, *Beneficial and Net Effects*).

Nonetheless bats have the potential to be affected during covered activities, and the effect analysis must quantify these effects. Estimating take of individual bats is challenging for forestry activities because activities occur across an expansive landscape and the timing of forestry activities is difficult to predict due to site-specific conditions. WNS, the main threat to bats, presents another challenge to estimating take of individual bats because of its uncertain and varying effects on their populations. For these reasons, the MDC Bat HCP quantifies the effects on bats using the amount of habitat affected by covered activities as a surrogate for the number of bats taken within that habitat. The next sections provide a description of the methods used to predict and monitor the extent of effects on the habitat of the covered species.

4.2.1 Effects on Land Cover

The HCP land cover categories (Table 3-1 in Chapter 3, *Environmental Setting*) are grouped based on preferred use by bats (Table 4-1). Forests and woodlands provide important summer roosting habitat for the tree-dwelling bat species (Indiana, little brown, northern long-eared, and tricolored bats), while glades include open areas with exposed rock. Exposed rock includes crevices and caves, habitat used by all covered bat species for winter hibernacula and by the gray bat year-round. Open lands have primarily small, isolated trees, but some of the covered species (e.g., northern long-eared and tricolored bats) are generalists and may use smaller trees as roosts. In northern Missouri, wooded landscapes are very fragmented and generally mapped as open lands and may support roosting Indiana bats in small clusters of trees within an open/agricultural matrix.

Effects on these land cover groupings are provided in the results section. Since effects differ by land cover, take was estimated separately for habitat preferred by bats and other land cover types.

Table 4-1. HCP Land Cover on MDC and Other Nonfederal Lands Grouped by Preferred Use by Bats (Acres)

HCP Land Covers	MDC Owned and/or Managed Lands (Acres)	Other Nonfederal Lands (Acres)[a]
Preferred by Bats		
Forests and Woodlands	743,113	14,758,443
Glades	2,443	59,863
Total	*745,556*	*14,818,306*
Other Land Covers		
Open Lands	211,190	23,158,199
Open Water	42,704	437,976
Developed	25,220	3,002,418
Total	*279,114*	*26,598,593*

Source: U.S. Geological Survey 2014

[a] All lands in Missouri that are not owned by the federal government or by MDC

The sections that follow describe the methods used to quantify take in acres of seasonal bat habitat affected by each covered activity over the course of the permit term.

4.2.1.1 Habitat Management

The estimates of bat habitat likely to be affected by covered activities are based on data from Chapter 2, *Covered Lands and Activities*, Chapter 3, *Environmental Setting*, and Appendix A, *Species Accounts*.

To estimate the likely extent of prescribed fire and tree removal, we used the results from Chapter 2 (Tables 2-2 through 2-5). Trees removed to create a fire line or fire break during prescribed burn activities are considered under the tree removal covered activity. Tree removal is classified as either limited or extensive. Extensive removal applies when 75% or more of canopy trees are removed, leaving a small residual; limited removal removes less than 75%.

This HCP uses the seasonal habitat distribution models from Appendix A, *Species Accounts*, to help predict the extent of overlap between occupied bat habitat and covered activities. Bats are not

distributed evenly across the state. With these models, areas of relative occupancy (high, medium, and low) are delineated across the state for each species; areas are also delineated where take of the species is not anticipated (e.g., Appendix A, Figure 3). The proportion of lands within each ownership type (Table 1-1) and occupancy category are then estimated. For example, MDC lands[5] are divided among the occupancy categories in the summer range of the Indiana bat as follows:

- 19.08% high occupancy
- 45.63% medium occupancy
- 22.65% low occupancy
- 12.64% areas where take is not anticipated

For each land cover, the acres that would be affected by management actions (Table 2-2 and Table 2-3) are then prorated based on the proportions of each occupancy category. For example, if MDC were to burn 100 acres in the preferred land covers for bats (i.e., forests, woodlands, and glades), then the annual take (as measured in acres) would be as follows:

- 19.08 acres affected in high-occupancy habitat
- 45.63 acres affected in medium-occupancy habitat
- 22.65 acres affected in low-occupancy habitat
- 12.64 acres affected in areas where take is not anticipated

The approach allows a careful accounting of effects across all covered activities and habitat types. Where management activities overlap on the same acre of land, the impacts are additive; that is, an acre of impact is accrued each time a management action occurs.

4.2.1.2 Public Access and Asset Management

4.2.1.3 Other Tree Removal

The approach to quantifying take associated with other tree removal for public access and asset management is similar to that described for habitat management, except that these impacts are also separated into permanent (i.e., land conversion) and nonpermanent (e.g., maintenance activities).

4.2.1.4 Vehicle Operation and Demolition of Structures

Two covered activities (vehicle operation and building removal) have the potential for take even when no trees are removed. While the length of roads and the number of buildings demolished are provided, these expected impacts are described qualitatively. Relative to other covered activities, these effects are expected to be low, and the proposed conservation measures will avoid and minimize take. The expected take from these negligible sources is accounted for in a conservative take estimate for other activities, including timber harvest.

4.2.1.5 HCP Implementation

HCP implementation including associated conservation measures and monitoring actions are covered by the Plan. Monitoring through capture, for example, has the potential to harm covered

[5] MDC lands in this analysis refer to lands owned or managed by MDC.

bats. However, these actions are necessary to achieve desired outcomes such as understanding the status and location of covered bats. As such, the net effects of HCP implementation are positive and so minor as to be discountable, and thus these activities are not quantified as part of the effects analysis.

4.2.2 Effects of Seasonality

The time of year during which covered activities are completed is important because bats make predictable movements between seasonal habitats. USFWS uses this seasonality to identify periods when bats are present or absent from select parts of the range (e.g., U.S. Fish and Wildlife Service 1982, 1999, 2005, 2009, 2016b, 2016c, 2017b). Conducting activities when bats are absent is thus termed *seasonal avoidance*. Activities completed when the bats are absent do not result in take unless habitat modification causes harm (i.e., injury or mortality) (U.S. Fish and Wildlife Service 2018). Habitat modification can cause harm to covered bats, even though bats are not present during the disturbance, if the habitat is limited and the loss of this habitat precludes an individual bat, or a group of bats, from survival. This situation is rare and would have the greatest potential to occur at the edges of development where small pockets of isolated habitat remain (e.g., St. Louis suburbs). The practice of retaining roost trees will avoid the potential for this rare circumstance.

During winter (i.e., the 5-month inactive season from November to March), all covered bats hibernate underground in caves and mines. Thus, in practice, activities outside the hibernacula are unlikely to kill or harm individual bats at this time of year (U.S. Fish and Wildlife Service 2017b).

Further, MDC implements a 20-acre management zone (usually created using a circle with a radius of 527 feet) around all caves wherein any management activities must minimize potential impacts from noise, vibration, and smoke. Because of the management zone, the possibility of taking wintering bats from activities that occur outside the hibernacula is not reasonably foreseeable.

Similarly, bats in fall and spring are assumed to occur near occupied hibernacula. The fall/spring habitat buffer extends 10 miles from Sodalis Nature Preserve and within 5 miles of all other hibernacula. Activities occurring outside of these buffers or in habitats unsuitable for roosting are unlikely to result in take. As outlined in Appendix A, *Species Accounts*, most of the covered bats are restricted to fall/spring habitat during fall swarming (September and October) and spring staging (April). In some cases, such as hibernacula containing exceptionally large populations of bats; hibernacula surrounded by limited foraging habitat, or hibernacula found in close proximity to summer colonies, bats may be found roosting at much greater distances (ESI 2005; Chenger et al. 2007). As such, the area of fall/spring habitat for the Sodalis Nature Preserve in Hannibal, in Marion County, is assumed to extend out to 10 miles. For the purposes of quantifying take in this HCP, covered activities that occur during fall and spring outside of these buffer zones are not included in the take estimate.

The implementation of covered activities is not always equally distributed across a year. Timing is dependent upon the type of covered activity. For instance, only 4% of prescribed fire takes place on MDC lands during summer (May through August), and most of that occurs in grasslands. Therefore, the prorated acres (i.e., the take estimate) for each covered activity across the state are adjusted for the time of year during which activities occur.

To continue the example of Indiana bat on MDC lands in summer, if 100 acres of prescribed fire were implemented in a year and 4% of prescribed fire on MDC lands takes place during summer (the other 96% taking place during other seasons), only 4 acres would be burned during the

summer season. Therefore, to adjust for the seasonality of prescribed fire on MDC lands in the preferred land covers for bats (i.e., forests, woodlands, and glades), take during summer would be as follows:

- 0.76 acre (19.08 acres x 0.04) affected in high-occupancy habitat
- 1.83 acres (45.63 acres x 0.04) affected in medium-occupancy habitat
- 0.91 acre (22.65 acres x 0.04) affected in low-occupancy habitat
- 0.51 acre (12.64 acres x 0.04) affected in areas where take is not anticipated

4.3 Results

4.3.1 Effects of Habitat Management

Impacts from habitat management are detailed in Tables 4-2 through 4-6. As noted, MDC will avoid take during winter (November to March) through implementation of a buffer that protects 20 acres of habitat around each cave or mine (i.e., hibernaculum) used by bats, and a 10-mile buffer around Sodalis Nature Preserve. An additional buffer of 0.25 mile around the hibernaculum entrance will preclude actions that may be especially intense, such as blasting and pile driving. Less intense activities such as road maintenance (e.g., grading, snow plowing, and minor repairs), building repair or facility maintenance that does not alter known roost sites, and removal of snow and ice can be completed within the 0.25-mile buffer during the winter, as these activities are not anticipated to cause take of bats that are in caves and mines (U.S. Fish and Wildlife Service 2016c). See Chapter 2, *Covered Lands and Activities,* for a complete list of covered activities.

Table 4-2 shows impacts for all of the covered species in fall and spring and Tables 4-3 through 4-6 show impacts for each of the covered species in the summer.

Table 4-2. Effects of Habitat Management on All Covered Bats in Fall and Spring[a]

	Available Fall/Spring Habitat (Total Acres)	Proportion of All Land That Is Fall/Spring Habitat[b]	Effects on Fall/Spring Habitat (Acres/Year)				Proportion of Habitat Management during Fall/Spring[d]	Fall/Spring Acres Affected during the Fall and Spring Each Year	Fall/Spring Acres Affected during the Fall and Spring over 50 Years
			Prescribed Fire	Tree Removal[c]					
				Extensive	Limited	Total			
MDC Activities on MDC Lands									
Preferred Land Covers (Forest, Woodlands, Glades)									
Indiana Bat	114,198	15%	3,156	276	3,363	6,794	32%	2,160	107,976
Little Brown Bat	154,392	21%	4,267	373	4,546	9,186	32%	2,920	145,979
Northern Long-Eared Bat	160,637	22%	4,439	388	4,730	9,557	32%	3,038	151,884
Tricolored Bat	178,174	24%	4,924	430	5,247	10,600	32%	3,369	168,466
Open Lands									
Indiana Bat	32,348	15%	4,290	0	2,495	6,785	32%	2,157	107,825
Little Brown Bat	43,734	21%	5,800	0	3,373	9,173	32%	2,916	145,775
Northern Long-Eared Bat	45,503	22%	6,035	0	3,509	9,544	32%	3,033	151,672
Tricolored Bat	50,470	24%	6,694	0	3,892	10,586	32%	3,365	168,230
MDC Activities on Other Nonfederal Lands									
Preferred Land Covers (Forest, Woodlands, Glades)									
Indiana Bat	874,208	6%	203	12	990	1,204	26%	309	15,429
Little Brown Bat	1,759,340	12%	408	24	1,992	2,424	26%	621	31,052
Northern Long-Eared Bat	1,563,762	11%	363	21	1,771	2,154	26%	552	27,600
Tricolored Bat	1,669,340	11%	387	23	1,890	2,300	26%	589	29,463
Open Lands									
Indiana Bat	1,366,221	6%	276	0	33	308	26%	79	3,949
Little Brown Bat	2,749,515	12%	555	0	66	620	26%	159	7,948
Northern Long-Eared Bat	2,443,864	11%	493	0	58	551	26%	141	7,064
Tricolored Bat	2,608,861	11%	526	0	62	589	26%	151	7,541

[a] Values presented in table have been rounded to nearest whole number.

[b] Modeled high-suitability fall and spring habitat occurs within 5 miles of known hibernacula (with the exception of the 10 mile buffer at Sodalis Nature Preserve) and, unlike modeled summer habitat, is not broken into high, medium, and low occupancy.

[c] Extensive tree removal removes more than 75% of canopy trees from a forested or wooded landscape while leaving a small residual; limited tree removal removes less than 75% from a forested or wooded landscape or removes trees from other habitat types.

[d] The proportion of covered activities conducted during fall (September/October) and spring (April) is based on the acres affected in those seasons relative to the total acres affected per year.

[e] Most effects occur on preferred land covers (forest, woodlands, and glades). Other potential effects on open lands are displayed for completeness. Effects on open lands include prescribed fire and occasional tree removal. Urban and open water land covers are not affected by MDC covered activities.

4.3.1.1 Indiana Bat

Table 4-2 summarizes the impacts from covered activities on occupied habitat of Indiana bat during fall and spring. Table 4-3 summarizes the impacts from MDC activities on Indiana bat during summer.

Table 4-3. Effects of Habitat Management on Indiana Bat in Summer[a]

	Available Summer Habitat (Total Acres)	Proportion of All Land That Is Summer Habitat	Effects on Summer Habitat (Acres/Year)				Proportion of Habitat Management during Summer[c]	Summer Acres Affected during the Summer each Year	Summer Acres Affected during the Summer over 50 Years
			Prescribed Fire	Tree Removal[b]		Total			
				Extensive	Limited				
MDC Activities on MDC Lands									
Preferred Land Cover									
(Forest, Woodlands, Glades)[d]	**745,556**		**20,603**	**1,800**	**21,954**	**44,357**	**16%**	**6,911**	**345,566**
High Occupancy	142,284	19%	3,932	344	4,190	8,465	16%	1,319	65,949
Medium Occupancy	340,171	46%	9,400	821	10,017	20,239	16%	3,153	157,670
Low Occupancy	168,838	23%	4,666	408	4,972	10,045	16%	1,565	78,257
Areas Where Take Is Not Anticipated	94,262	13%	2,605	228	2,776	5,608	16%	874	43,691
Open Lands	**211,190**	**–**	**28,009**	**0**	**16,286**	**44,295**	**16%**	**6,902**	**345,083**
High Occupancy	40,304	19%	5,345	0	3,108	8,453	16%	1,317	65,857
Medium Occupancy	96,359	46%	12,780	0	7,431	20,210	16%	3,149	157,449
Low Occupancy	47,826	23%	6,343	0	3,688	10,031	16%	1,563	78,147
Areas Where Take Is Not Anticipated	26,701	13%	3,541	0	2,059	5,600	16%	873	43,629
Total	**956,746**	**–**	**48,612**	**1,800**	**38,240**	**88,652**	**16%**	**13,813**	**690,648**
MDC Activities on Other Nonfederal Lands									
Preferred Land Cover									
(Forest, Woodlands, Glades)[d]	**14,818,306**		**3,437**	**200**	**16,779**	**20,416**	**38%**	**7,848**	**392,397**
High Occupancy	4,300,436	29%	997	58	4,869	5,925	38%	2,278	113,878
Medium Occupancy	4,932,806	33%	1,144	67	5,585	6,796	38%	2,612	130,624
Low Occupancy	4,023,646	27%	933	54	4,556	5,544	38%	2,131	106,548
Areas Where Take Is Not Anticipated	1,561,418	11%	362	21	1,768	2,151	38%	827	41,347
Open Lands	**23,158,199**	**–**	**4,672**	**0**	**553**	**5,225**	**38%**	**2,009**	**100,433**
High Occupancy	6,720,764	29%	1,356	0	160	1,516	38%	583	29,147
Medium Occupancy	7,709,040	33%	1,555	0	184	1,739	38%	669	33,433
Low Occupancy	6,288,194	27%	1,269	0	150	1,419	38%	545	27,271
Areas Where Take Is Not Anticipated	2,440,200	11%	492	0	58	551	38%	212	10,583
Total	**37,976,505**		**8,109**	**200**	**17,332**	**25,641**	**38%**	**9,857**	**492,831**

[a] Values presented in table have been rounded to nearest whole number.

[b] Extensive tree removal removes more than 75% of canopy trees from a forested or wooded landscape while leaving a small residual; limited tree removal removes less than 75% from a forested or wooded landscape or removes trees from other habitat types.

[c] The proportion of covered activities conducted May 1 through August 31 is based on the acres affected in the season relative to the acres affected per year.

[d] Most effects occur on preferred land covers (forest, woodlands, and glades). Other potential effects on open lands are displayed for completeness. Effects on open lands include prescribed fire and occasional tree removal. Urban and open water land covers are not affected by MDC management activities.

4.3.1.1 Gray Bat

Unlike the other covered species, gray bats rely on caves throughout the year for maternity roosts and hibernacula. Therefore, tree removal activities are not expected to affect roosting individuals. Gray bats are potentially exposed to take when individuals leave caves at night for foraging or traveling between different cave roosts, including transient caves (Myers 1964; Elder and Gunier 1978; LaVal and LaVal 1980; Elder and Gunier 1981; Missouri Department of Conservation 2000; Gerdes 2016). Safety considerations when conducting habitat management activities limit the covered activities to daytime, which means that gray bats are not occupying habitat when impacts would occur.

Prescribed fire activities close to caves may affect roosting or hibernating individuals through exposure to smoke, noxious gases, and alterations to airflow (Tuttle and Stevenson 1977; Carter et al. 2002; Dickinson et al. 2010; Perry 2012).

4.3.1.2 Northern Long-Eared Bat

Table 4-2 summarizes the impacts from covered activities on occupied habitat of northern long-eared bat during fall and spring. Table 4-4 summarizes the impacts from MDC activities on northern long-eared bat during summer.

Table 4-4. Effects of Habitat Management on Northern Long-Eared Bat in Summer[a]

	Available Summer Habitat (Total Acres)	Proportion of All Land That Is Summer Habitat	Effects of Summer Habitat (Acres/Year)				Proportion of Habitat Management during Summer[c]	Summer Acres Affected during the Summer Each Year	Summer Acres Affected during the Summer over 50 Years
			Prescribed Fire	Tree Removal[b]		Total			
				Extensive	Limited				
MDC Activities on MDC Lands									
Preferred Land Covers									
(Forest, Woodlands, Glades)[d]	**745,556**		**20,603**	**1,800**	**21,954**	**44,357**	**16%**	**6,911**	**345,566**
High Occupancy	627,343	84%	17,336	1,515	18,473	37,324	16%	5,815	290,774
Medium Occupancy	99,588	13%	2,752	240	2,933	5,925	16%	923	46,159
Low Occupancy	18,624	2%	515	45	548	1,108	16%	173	8,632
Open Lands	**211,190**		**28,009**	**0**	**16,286**	**44,295**	**16%**	**6,902**	**345,083**
High Occupancy	177,704	84%	23,568	0	13,704	37,272	16%	5,807	290,368
Medium Occupancy	28,210	13%	3,741	0	2,175	5,917	16%	922	46,095
Low Occupancy	5,276	2%	700	0	407	1,107	16%	172	8,620
Total	**956,746**		**48,612**	**1,800**	**38,240**	**88,652**	**16%**	**13,813**	**690,648**
MDC Activities on Other Nonfederal Lands									
Preferred Land Covers									
(Forest, Woodlands, Glades)[d]	**14,818,306**		**3,437**	**200**	**16,779**	**20,416**	**38%**	**7,848**	**392,397**
High Occupancy	12,336,490	83%	2,861	167	13,969	16,997	38%	6,534	326,677
Medium Occupancy	1,672,734	11%	388	23	1,894	2,305	38%	886	44,295
Low Occupancy	809,082	5%	188	11	916	1,115	38%	428	21,425
Open Lands	**23,158,199**		**4,672**	**0**	**553**	**5,225**	**38%**	**2,009**	**100,433**
High Occupancy	19,279,592	83%	3,890	0	460	4,350	38%	1,672	83,612
Medium Occupancy	2,614,166	11%	527	0	62	590	38%	227	11,337
Low Occupancy	1,264,441	5%	255	0	30	285	38%	110	5,484
Total	**37,976,505**		**8,109**	**200**	**17,332**	**25,641**	**38%**	**9,857**	**492,831**

[a] Values presented in table have been rounded to nearest whole number.

[b] Extensive tree removal removes more than 75% of canopy trees from a forested or wooded landscape while leaving a small residual; limited tree removal removes less than 75% from a forested or wooded landscape or removes trees from other habitat types.

[c] The proportion of covered activities conducted May 1 through August 31 is based on the acres affected in the season relative to the acres affected per year.

[d] Most effects occur on preferred land covers (forest, woodlands, and glades). Other potential effects on open lands are displayed for completeness. Effects on open lands include prescribed fire and occasional tree removal. Urban and open water land covers are not affected by MDC covered activities.

4.3.1.3 Little Brown Bat

Table 4-2 shows effects on little brown bat during fall and spring. Table 4-5 shows the effects on little brown bat during summer.

Table 4-5. Effects of Habitat Management on Little Brown Bat in Summer[a]

	Available Summer Habitat (Total Acres)	Proportion of All Land That Is Summer Habitat	Effects on Summer Habitat (Acres/Year)				Proportion of Habitat Management during Summer[c]	Summer Acres Affected during the Summer Each Year	Summer Acres Affected during the Summer over 50 Years
			Prescribed Fire	Tree Removal[b]		Total			
				Extensive	Limited				
MDC Activities on MDC Lands									
Preferred Land Covers									
(Forest, Woodlands, Glades)[d]	**745,556**		**20,603**	**1,800**	**21,954**	**44,357**	**16%**	**6,911**	**345,566**
High Occupancy	652,117	87%	18,021	1,574	19,203	38,798	16%	6,045	302,256
Medium Occupancy	76,234	10%	2,107	184	2,245	4,536	16%	707	35,334
Low Occupancy	17,206	2%	475	42	507	1,024	16%	159	7,975
Open Lands	**211,190**		**28,009**	**0**	**16,286**	**44,295**	**16%**	**6,902**	**345,083**
High Occupancy	184,722	87%	24,499	0	14,245	38,744	16%	6,037	301,834
Medium Occupancy	21,594	10%	2,864	0	1,665	4,529	16%	706	35,285
Low Occupancy	4,874	2%	646	0	376	1,022	16%	159	7,964
Total	**956,746**		**48,612**	**1,800**	**38,240**	**88,652**	**16%**	**13,813**	**690,648**
MDC Activities on Other Nonfederal Lands									
Preferred Land Covers									
(Forest, Woodlands, Glades)[d]	**14,818,306**		**3,437**	**200**	**16,779**	**20,416**	**38%**	**7,848**	**392,397**
High Occupancy	13,360,965	90%	3,099	180	15,129	18,408	38%	7,076	353,806
Medium Occupancy	752,560	5%	175	10	852	1,037	38%	399	19,928
Low Occupancy	704,781	5%	163	10	798	971	38%	373	18,663
Open Lands	**23,158,199**		**4,672**	**0**	**553**	**5,225**	**38%**	**2,009**	**100,433**
High Occupancy	20,880,652	90%	4,213	0	499	4,712	38%	1,811	90,556
Medium Occupancy	1,176,108	5%	237	0	28	265	38%	102	5,101
Low Occupancy	1,101,439	5%	222	0	26	249	38%	96	4,777
Total	**37,976,505**		**8,109**	**200**	**17,332**	**25,641**	**38%**	**9,857**	**492,831**

[a] Values presented in table have been rounded to nearest whole number.

[b] Extensive tree removal removes more than 75% of canopy trees from a forested or wooded landscape while leaving a small residual; limited tree removal removes less than 75% from a forested or wooded landscape or removes trees from other habitat types.

[c] The proportion of covered activities conducted May 1 through August 31 is based on the acres affected in the season relative to the acres affected per year.

[d] Most effects occur on preferred land covers (forest and woodlands and glades). Other potential effects on open lands are displayed for completeness. Effects on open lands include prescribed fire and occasional tree removal. Urban and open water land covers are not affected by MDC covered activities.

4.3.1.4 Tricolored Bat

Table 4-2 shows effects on tricolored bat during fall and spring. Table 4-6 shows the effects on tricolored bat during summer. As described in the species account, habitat for this species is broken into areas of high and medium occupancy.

Table 4-6. Effects of Habitat Management on Tricolored Bat in Summer[a]

	Available Summer Habitat (Total Acres)	Proportion of All Land That Is Summer Habitat	Effects on Summer Habitat (Acres/Year)				Proportion of Habitat Management during Summer[c]	Summer Acres Affected during Summer Each Year	Summer Acres Affected during Summer over 50 Years
			Prescribed Fire	Tree Removal[b]		Total			
				Extensive	Limited				
MDC Activities on MDC Lands									
Preferred Land Covers									
(Forest, Woodlands, Glades)[d]	**745,556**		**20,603**	**1,800**	**21,954**	**44,357**	**16%**	**6,911**	**345,566**
High Occupancy	728,345	98%	20,127	1,758	21,447	43,333	16%	6,752	337,588
Medium Occupancy	17,211	2%	476	42	507	1,024	16%	160	7,977
Open Lands	**211,190**		**28,009**	**0**	**16,286**	**44,295**	**16%**	**6,902**	**345,083**
High Occupancy	206,315	98%	27,362	0	15,910	43,272	16%	6,742	337,116
Medium Occupancy	4,875	2%	647	0	376	1,023	16%	159	7,966
Total	**956,746**		**48,612**	**1,800**	**38,240**	**88,652**	**16%**	**13,813**	**690,648**
MDC Activities on Other Nonfederal Lands									
Preferred Land Covers									
(Forest, Woodlands, Glades)[d]	**14,818,306**		**3,437**	**200**	**16,779**	**20,416**	**38%**	**7,848**	**392,397**
High Occupancy	14,113,363	95%	3,273	190	15,981	19,445	38%	7,475	373,730
Medium Occupancy	704,943	5%	164	10	798	971	38%	373	18,667
Open Lands	**23,158,199**		**4,672**	**0**	**553**	**5,225**	**38%**	**2,009**	**100,433**
High Occupancy	22,056,507	95%	4,450	0	527	4,977	38%	1,913	95,655
Medium Occupancy	1,101,692	5%	222	0	26	249	38%	96	4,778
Total	**37,976,505**		**8,109**	**200**	**17,332**	**25,641**	**38%**	**9,857**	**492,831**

[a] Values presented in table have been rounded to nearest whole number.

[b] Extensive tree removal removes more than 75% of canopy trees from a forested or wooded landscape while leaving a small residual; limited tree removal removes less than 75% from a forested or wooded landscape or removes trees from other habitat types.

[c] The proportion of covered activities conducted May 1 through August 31 is based on the acres affected in the season relative to the acres affected per year.

[d] Most effects occur on preferred land covers (forest and woodlands and glades). Other potential effects on open lands are displayed for completeness. Effects on open lands include prescribed fire and occasional tree removal. Urban and open water land covers are affected by MDC management activities.

4.3.2 Effects of Public Access and Asset Management

This section summarizes habitat effects from public access and asset management activities. It includes the effects of any additional tree removal as well as vehicle collision and demolition of structures on MDC-owned and managed lands.

4.3.2.1 Other Tree Removal

Impacts resulting from trees that are removed for construction, maintenance, safety and repair of facilities including roads and trails are provided for fall/spring (Table 4-7) and summer (Table 4-8) habitat for each of the covered bats.

Table 4-7. Effects of Other Tree Removal for Public Access and Asset Management on All Covered Bats in Fall and Spring[a]

	Available Fall/Spring Habitat (Total Acres)	Proportion of All Land That Is Fall/Spring Habitat[b]	Other Tree Removal (Acres/Year)			Proportion of Other Tree Removal during Fall/Spring[c]	Fall/Spring Acres Affected during Fall/Spring Each Year	Fall/Spring Acres Affected during Fall/Spring over 50 Years
			Permanent Removal	Maintenance	Total			
Covered Activities on MDC Lands								
Preferred Land Cover	**745,556**		**11**	**141**	**151**	**50%**	**75**	**3753**
Indiana Bat	114,198	15%	2	22	23	50%	11	575
Little Brown Bat	154,392	21%	2	29	31	50%	16	777
Northern Long-Eared Bat	160,637	22%	2	30	33	50%	16	809
Tricolored Bat	178,174	24%	3	34	36	50%	18	897
Covered Activities on Other Nonfederal Lands[d]								
Preferred Land Cover	**14,818,306**		**< 1**	**< 1**	**1**	**5%**	**< 1**	**3**
Indiana Bat	874,208	6%	< 1	< 1	< 1	5%	< 1	< 1
Little Brown Bat	1,759,340	12%	< 1	< 1	< 1	5%	< 1	< 1
Northern Long-Eared Bat	1,563,762	11%	< 1	< 1	< 1	5%	< 1	< 1
Tricolored Bat	1,669,340	11%	< 1	< 1	< 1	5%	< 1	< 1

[a] Values presented in table have been rounded to nearest whole number.

[b] Modeled high-suitability fall and spring habitat occurs within 5 miles of a known hibernaculum and, unlike modeled summer habitat, is not broken into high, medium, and low occupancy.

[c] The proportion of covered activities conducted during fall (September/October) and spring (April) is based on the acres affected in those seasons relative to the total acres affected/year

[d] Covered activities on Other Nonfederal Lands are addressed in Chapter 2, *Covered Lands and Activities*. They only include activities in cooperative agreements with MDC consistent with the goals and objectives of the MDC Bat HCP and that are incorporated in the template landowner agreement (Appendix G, *Template Landowner Agreement*)

Table 4-8. Effects of Other Tree Removal for Public Access and Asset Management on All Covered Bats in Summer[a]

	Available Summer Habitat (Total Acres)	Proportion of All Land That Is Summer Habitat	Other Tree Removal (Acres/Year)			Proportion of Other Tree Removal during Summer[b]	Summer Acres Affected during Summer Each Year	Summer Acres Affected during Summer over 50 Years
			Permanent Removal	Maintenance	Total			
MDC Activities on MDC Lands								
Preferred Land Cover	**745,556**		**11**	**141**	**151**	**33%**	**50**	**2,478**
Indiana Bat								
High Occupancy	142,284	19%	2	27	29	33%	9	473
Medium Occupancy	340,171	46%	5	64	69	33%	23	1,130
Low Occupancy	168,838	23%	2	32	34	33%	11	561
Areas Where Take Is Not Anticipated	94,262	13%	1	18	19	33%	6	313
Little Brown Bat								
High Occupancy	652,117	87%	9	123	132	33%	43	2,167
Medium Occupancy	76,234	10%	1	14	15	33%	5	253
Low Occupancy	17,206	2%	< 1	3	3	33%	1	57
Northern Long-Eared Bat								
High Occupancy	627,343	84%	9	118	127	33%	42	2,085
Medium Occupancy	99,588	13%	1	19	20	33%	7	331
Low Occupancy	18,624	2%	< 1	4	4	33%	1	62
Tricolored Bat								
High Occupancy	728,345	98%	10	137	148	33%	48	2,420
Medium Occupancy	17,211	2%	< 1	3	3	33%	1	57
Covered Activities on Other Nonfederal Lands[c]								
Preferred Land Cover	**14,818,306**		**< 1**	**< 1**	**1**	**5%**	**< 1**	**3**
Indiana Bat								
High Occupancy	216,369	29%	< 1	< 1	< 1	5%	< 1	< 1
Medium Occupancy	248,185	33%	< 1	< 1	< 1	5%	< 1	< 1
Low Occupancy	202,442	27%	< 1	< 1	< 1	5%	< 1	< 1
No Occupancy	78,560	11%	< 1	< 1	< 1	5%	< 1	< 1

	Available Summer Habitat (Total Acres)	Proportion of All Land That Is Summer Habitat	Other Tree Removal (Acres/Year)			Proportion of Other Tree Removal during Summer[b]	Summer Acres Affected during Summer Each Year	Summer Acres Affected during Summer over 50 Years
			Permanent Removal	Maintenance	Total			
Little Brown Bat								
High Occupancy	672,233	90%	< 1	< 1	< 1	5%	< 1	2
Medium Occupancy	37,864	5%	< 1	< 1	< 1	5%	< 1	< 1
Low Occupancy	35,460	5%	< 1	< 1	< 1	5%	< 1	< 1
Northern Long-Eared Bat								
High Occupancy	620,688	83%	< 1	< 1	< 1	5%	< 1	2
Medium Occupancy	84,161	11%	< 1	< 1	< 1	5%	< 1	< 1
Low Occupancy	40,707	5%	< 1	< 1	< 1	5%	< 1	< 1
Tricolored Bat								
High Occupancy	710,088	95%	< 1	< 1	< 1	5%	< 1	2
Medium Occupancy	35,468	5%	< 1	< 1	< 1	5%	< 1	< 1

[a] Values presented in table have been rounded to nearest whole number.

[b] The proportion of covered activities conducted May 1 through August 31 is based on the acres affected in the season relative to the acres affected per year

[c] Covered activities on Other Nonfederal Lands are addressed in Chapter 2, *Covered Lands and Activities*. They only include activities in cooperative agreements with MDC consistent with the goals and objectives of the MDC Bat HCP and that are incorporated in the template landowner agreement (see Section 6.1.1, *Coverage to Other Nonfederal Landowners*, and Appendix G, *Template Landowner Agreement*).

4.3.2.2 Vehicle Operation

Interactions between bats and roadways are complex. Relatively small, infrequently used roads and trails such as skid trails, haul roads, and footpaths often serve as travel corridors and foraging habitat for bats (Menzel et al. 2005). Where bat travel corridors and active roads intersect, there is a higher possibility of bat-vehicle collisions and fatalities (Russell et al. 2009; Bennett and Zurcher 2013). Generally, wider roads have more traffic, and the closer bat habitat is to either side of the road, the greater the likelihood the road will affect bat movements. Large roads (especially those with high volumes of nighttime traffic) can act as barriers to bat movements and increase mortality of bats. Other variables that contribute to road mortality for bats include location of the road (with bats being killed more frequently in forested habitats than open habitats), seasonality (young bats are more prone to collisions), and ecology of the bat species (bats that fly low to the ground and forage along the roadway are most at risk) (Lesinski 2007).

Most observations of bats being killed on roadways are associated with large, high-speed roads. The roads managed by MDC are one- or two-lane roads with relatively light traffic and have a speed limit of 45 miles per hour or lower if posted. Most visitation and traffic occur during daylight hours. Available data indicate that bats (including the covered species) are able to perceive and avoid occasional vehicles on small rural roads (Zurcher et al. 2010; Bennett and Zurcher 2013). The decision to avoid vehicles is based in part on the loudness of the approaching vehicle (Bennett and Zurcher 2013). Like birds (DeVault et al. 2015), bats may not be as capable of responding to faster-moving vehicles. However, the risk of mortality on MDC roads is low and can be further lowered or even eliminated.

The miles of MDC-managed roads within fall/spring and summer habitat of each of the tree-roosting covered bats are shown in Table 4-9 and Table 4-10. MDC seeks coverage for MDC staff who might strike a covered bat while driving on MDC lands. Occasional vehicle strikes also are possible for gray bats. There are no records of gray bats being killed by vehicles, but mortality among similar species has been documented (Sparks and Choate 2000; Russell et al. 2009). Most roads are driven during daylight hours, and almost all covered activities that involve driving take place during staff hours of 7 a.m. to 5 p.m. Thus, the probability of killing a bat from driving is very low.

Table 4-9. Miles of Roads and Trails on MDC Lands in Fall/Spring Habitat

	Miles in Fall/Spring Habitat[a]		
	Roads	**Trails**	**Total**
All MDC Lands	**872**	**804**	**1,676**
Species			
Indiana Bat	127	85	212
Little Brown Bat	57	155	212
Northern Long-Eared Bat	116	171	287
Tricolored Bat	147	180	327

[a] Fall/spring habitat is used by covered species during September/October and April.

Table 4-10. Miles of Roads and Trails on MDC Lands in Summer Habitat

	Miles in Summer Habitat[a]		
	Roads	**Trails**	**Total**
All MDC Lands	**872**	**804**	**1,676**
Indiana Bat			
High Occupancy	195	187	382
Medium Occupancy	444	327	771
Low Occupancy	153	230	383
Areas Where Take Is Not Anticipated	75	61	136
Little Brown Bat			
High Occupancy	800	747	1,547
Medium Occupancy	66	32	98
Low Occupancy	4	21	25
Northern Long-Eared Bat			
High Occupancy	731	703	1,434
Medium Occupancy	128	69	197
Low Occupancy	11	29	40
Tricolored Bat			
High Occupancy	866	779	1,645
Medium Occupancy	4	21	25

[a] Summer habitat is used by covered species from May 1 through August 31.

4.3.2.1 Demolition of Structures

All of the covered species make at least irregular use of buildings as roosts. As noted in Chapter 2, *Covered Lands and Activities*, MDC may demolish existing buildings after acquiring new parcels. Similarly, MDC may demolish damaged or obsolete buildings on existing lands. On average, MDC demolishes six such structures per year. There is the potential for take to occur when these buildings are demolished, as illustrated by Fagan et al. (2018), who surveyed 170 abandoned buildings in the Great Smoky Mountains National Park and found bats (including common species) using 44 (31.4%) of the buildings. In most cases, the bats using the structures were individual bats rather than colonies—only four buildings contained maternity colonies. Older buildings with dark

conditions were the most likely to be used and impacts on bats can often be avoided by checking such buildings prior to demolition. Therefore, while there is potential for take, impacts on covered species are expected to be low. If bats are present, the level of impact could vary from eliminating a maternity colony to the loss of individuals that are not part of a maternity colonies (male and nonreproductive females). By checking buildings ahead of time and scheduling the removal of buildings for a time when bats are absent, take should only consist of individuals using cryptic roosts. Such removals are unlikely to have population-level impacts.

4.3.3 Impacts on Critical Habitat

Missouri contains 6 of the 11 hibernacula designated as critical habitat for the Indiana bat (41 Federal Register 41914–41916). As noted above, the plan protects a buffer of 20 acres around these and all other hibernacula and caves. MDC will also protect and manage the hibernacula on MDC lands and maintain cave gates where needed. The project will have a positive effect on designated critical habitat. There is no critical habitat for other covered species within the plan area.

4.3.4 Impacts of the Taking

HCPs are required to describe the effect of covered activities on the long-term survival and recovery of the species, also known as the *impact of the taking* (Section 10(a)(2)(A)(i) of the federal ESA). This impact must be determined at the range-wide scale;[6] however, the impact assessment may analyze effects on a smaller population unit and then use the results of that analysis to predict effects associated with the entire range. This section describes the combined adverse effects of covered activities on the long-term survival and recovery of each covered species in the plan area, using the best available information regarding stressors on the species. Depending on the species, these may be at the scale of a recovery unit, regional population, or the global population.

Covered activities in the plan area are associated with (1) habitat management and (2) public access and asset management, as described in Chapter 2, *Covered Lands and Activities*. Habitat management includes prescribed fire and tree removal conducted to restore habitat. Public access and asset management activities are associated with the maintenance, construction, and repair of facilities and the use of roads that are maintained by MDC. Habitat management does not convert nonnatural habitat and generally does not remove habitat for covered bats. A small amount (11 acres) of forested habitat is converted annually as part of public access and asset management.

Tree removal associated with both habitat management and public access and asset management activities has the potential to harm or kill bats directly by crushing individuals or indirectly by exposing individuals to predation when they escape an area being disturbed. Prescribed burns could harm or kill individuals through burning or suffocation and through predation when they escape an area being disturbed. Both activities could result in the loss of roost trees, although these activities increase the quality and quantity of roosts on the landscape over the long term (see Section 4.1, *Overview*). Foraging habitat is generally improved after tree removal and prescribed fire.

Collectively, the covered activities improve environmental conditions for bats and have a positive net effect on bat habitat (see Section 5.3, *Beneficial and Net Effects*). Demolition of structures could crush individuals or expose individuals to predation when escaping a disturbed area. Vehicle

[6] If the entity listed is a geographic scale less than the entire range of the species (e.g., a Distinct Population Segment), then the listed entity is evaluated to determine the impact of the taking.

operation has the potential to result in collision that kills bats, though the probability of this occurring over the permit term is low.

4.3.4.1 Indiana Bat

This section describes the impact of the taking on Indiana bat. An overview of the Indiana bat population is provided. Indirect (long-term) and direct (short-term) habitat impacts are assessed. Effects on populations are evaluated at multiple scales.

Population Overview

The Indiana bat ranges from the northeast United States to the Midwest, reaching its western range limit in Iowa, Missouri, and Oklahoma. Populations of Indiana bats are monitored using a biennial census of hibernating populations, with the most recent detecting 537,297 bats across 16 states (U.S. Fish and Wildlife Service 2019). Recovery efforts for Indiana bats are focused on four recovery units, with Missouri being part of the Ozark/Central Recovery Unit (U.S. Fish and Wildlife Service 2007), which was estimated in 2019 to contain 276,317 bats (51.4% of the range wide population). Missouri is the most populous state for Indiana bats within the range, having an estimated 195,157 bats (36.3% of the range-wide population) across 92 hibernacula. The largest hibernaculum for the species is Sodalis Nature Preserve in Hannibal, Missouri, with an estimated population of 180,801 bats (34% of the range-wide population). In summer, Indiana bats may migrate hundreds of miles from their hibernacula. Thus, the take of Indiana bats in Missouri may also influence populations in other states.

Habitat Impacts

Effects on winter habitat are not anticipated due to avoidance measures described in Chapter 5, *Conservation Strategy*, including a 20-acre buffer around all known hibernacula and all naturally occurring caves on MDC lands, and a larger buffer around the Sodalis Nature Preserve. Within this buffer, habitat management is allowed only to improve or maintain habitat for bats and only when bats are absent.

The focus of this HCP is the management of habitat using tree removal and prescribed fire, which annually affects 64,773 acres of preferred habitat or 0.42% of the 15,563,862 acres of preferred habitat types on nonfederal lands in Missouri each year (Table 4-3). These activities could potentially remove roost trees and other important habitat features. However, these management activities also create roost trees (especially prescribed fire). Notably, the number of snags per unit area is higher on MDC-managed lands, indicating that MDC activities create habitat relative to other land ownerships, consistent with cited literature on the benefits of active management for bats (Silvis et al. 2012; Sheets et al. 2013b; Pauli et al. 2015a; Pauli et al. 2015b; Ford et al. 2016; Pauli et al. 2017). Habitat management can also create foraging habitat by creating edge habitat or by opening a stand where it is easier for Indiana bats to fly. The benefit of these forest-management activities that create open habitats is relative to the surrounding matrix. Forest-management activities have the highest value for bats in heavily forested regions where open habitat is limited. Forest-management activities (especially timber harvest) also play a key role in directing the growth of young forests, some of which will become highly suitable roosting and foraging habitat during the permit term. Over time, this would be expected to result in a net increase in fecundity and reproduction (Silvis et al. 2012; Pauli et al. 2015b). A more complete discussion of net effects can be found in Section 5.3, *Beneficial and Net Effects*. Although habitat manipulations have both positive

and negative impacts on the habitat of Indiana bats, the long-term effect of MDC's habitat management is that it provides Indiana bats and other wildlife with high-suitability habitat that will support long-term population recovery.

The HCP covers 141 acres of maintenance activities that annually affect <0.01% of the preferred habitats each year (Table 4-7). These activities do not result in the long-term loss of habitat. These activities may result in the loss of occasional roost trees (usually small trees of low quality).

However, they occur on managed landscapes where higher-quality roosts are relatively common. Areas that are maintained in an earlier successional state also provide value as foraging and commuting habitat. At the scale of the 114,198 acres of fall/spring (Table 4-2) and 651,294 acres (Table 4-3) summer habitat in preferred land covers that are managed by MDC where take is anticipated, the impacts of less than 150 acres per year of maintenance activities in Indiana bat habitat is negligible.

Impacts on Populations

Hibernating Bats

Bats are especially sensitive to disturbance during hibernation. Such disturbance was a key factor in the original decision to list Indiana bats (U.S. Fish and Wildlife Service 2007). Bats hibernating in Missouri in the winter are at risk of disturbance. If the disturbance substantially disrupts normal behavior patterns during hibernation, it could result in take. Because bats are relatively concentrated in 92 locations on the landscape during the winter, take of hibernating bats could result in substantial population effects. This HCP avoids take of hibernating bats by establishing a protective buffer of 20 acres around all hibernacula. These areas will be managed to protect individual bats and enhance bat habitat. Thus, the HCP not only avoids taking of individual Indiana bats during winter, it also provides long-term protections to the habitat on which the bats depend. Because there is no take of hibernating bats, there is no impact of the taking on hibernating bats.

Bats during the Active Season

Covered activities have the potential to directly and indirectly affect individual Indiana bats if the activity occurs in fall/spring and summer habitat when the bats are present on the landscape. In the absence of precise locational data and because numbers of individuals will vary year to year, acres of occupied habitat are used as a proxy for understanding impacts on individuals. Tables 4-11 and 4-12 provide details of the estimated combined effects of all covered activities on Indiana bat fall/spring and summer habitat when bats are present (i.e., occupied fall/spring and summer habitat), respectively.

Not all bats exposed to adverse effects experience take (mortality or harm). The biological assessment supporting the 4(d) rule for northern long-eared bats (U.S. Fish and Wildlife Service 2016b) relied on mortality estimates developed from observations on Indiana bats (Belwood 2002). This assessment indicated that approximately 3% of the volant bats present when trees were felled would suffer injury or death. An unknown number may also suffer injury while fleeing the roost.

Assuming all 195,157 bats that hibernated in Missouri in 2019 are present in fall/spring or summer habitat at the time impacts occur, we estimate up 490 bats could be exposed to covered activities in fall/spring, with up to 15 killed or injured per year (see Table 4-13 for calculations). Similarly, we estimate 184 adult and 92 juvenile Indiana bats would be exposed to covered activities in the

summer, with up to 20 Indiana bats killed or injured per year (Table 4-13). Table 4-13 calculates the number of Indiana bats potentially taken (using 2019 census numbers) resulting in impacts of less than 0.02% of the population in Missouri. This translates to approximately 0.01% of the Ozark/Central Recovery Unit, and 0.006% of the range-wide population each year.

Approximately 93% of the Indiana bat population in Missouri hibernates within the Sodalis Nature Preserve. As detailed in Chapter 5, *Conservation Strategy*, the HCP includes a conservation measure to protect occupied habitat within the area near Sodalis Nature Preserve. Therefore, the impacts of the taking described above and in Table 4-13 would only occur to Indiana bats distributed more widely and in smaller numbers across Missouri and outside of the most important population of Indiana bats in the state. For additional details, see Section 5.3, *Beneficial and Net Effects*.

In summary, the taking of Indiana bats and the impacts of the taking are as follows:

- No impacts to winter habitat or hibernating bats.
- Take of the largest and most important hibernating population of Indiana bat in Missouri (in Sodalis Nature Preserve) is avoided.
- Annual take of occupied fall/spring habitat (Table 4-11) and summer habitat (Table 4-12) for Indiana bat is minimized and represents a very small fraction (0.10%) of the preferred habitat available in the plan area.
- The impacts of the taking on Indiana bat populations is very low, even when estimated conservatively (annual estimates of approximately 0.01% of the Ozark/Central Recovery Unit population and 0.006% of the range-wide population; Table 4-13).

Table 4-11. Amount of Occupied Fall/Spring Habitat Affected by Covered Activities Annually[a]

	Available Fall/Spring Habitat (Total Acres)[b]	Amount of Occupied Fall/Spring Habitat Affected (Acres/Year)			Percent Occupied Habitat Affected
		Habitat Management	Public Access and Management	Total	
MDC Activities on MDC Lands					
Preferred Land Covers (Forest, Woodlands, Glades)					
Indiana Bat	114,198	2,160	11	2,171	1.90%
Little Brown Bat	154,392	2,920	16	2,935	1.90%
Northern Long-Eared Bat	160,637	3,038	16	3,054	1.90%
Tricolored Bat	178,174	3,369	18	3,387	1.90%
Open Lands[c]					
Indiana Bat	32,348	2,157	0	2,157	6.67%
Little Brown Bat	43,734	2,916	0	2,916	6.67%
Northern Long-Eared Bat	45,503	3,033	0	3,033	6.67%
Tricolored Bat	50,470	3,365	0	3,365	6.67%
MDC Activities on Other Nonfederal Lands					
Preferred Land Covers (Forest, Woodlands, Glades)					
Indiana Bat	874,208	309	< 1	309	0.04%
Little Brown Bat	1,759,340	621	< 1	621	0.04%
Northern Long-Eared Bat	1,563,762	552	< 1	552	0.04%
Tricolored Bat	1,669,340	589	< 1	589	0.04%
Open Lands[c]					
Indiana Bat	1,366,221	79	0	79	0.01%
Little Brown Bat	2,749,515	159	0	159	0.01%
Northern Long-Eared Bat	2,443,864	141	0	141	0.01%
Tricolored Bat	2,608,861	151	0	151	0.01%
All Activities Statewide					
Preferred Land Covers (Forest, Woodlands, Glades)					
Indiana Bat	988,406	2,468	11	2,480	0.25%
Little Brown Bat	1,913,732	3,541	16	3,556	0.19%
Northern Long-Eared Bat	1,724,399	3,590	16	3,606	0.21%
Tricolored Bat	1,847,514	3,959	18	3,977	0.22%

[a] Values presented in table have been rounded.

[b] Modeled high-suitability fall and spring habitat occurs within 5 miles of most known hibernacula (with the exception of the 10-mile buffer at Sodalis Nature Preserve) and, unlike modeled summer habitat, is not broken into high, medium and low occupancy.

[c] Most effects occur on preferred land covers (forest, woodlands, and glades). Other potential effects on open lands are displayed for completeness. Effects on open lands include prescribed fire and occasional tree removal. Urban and open water land covers are not impacted by MDC covered activities.

Table 4-12. Amount of Occupied Summer Habitat Affected by Covered Activities Annually[a]

	Available Summer Habitat When Occupied (Total Acres)[b]	Amount of Potential Summer Habitat Impacted When Occupied (Acres/Year)			Percent Occupied Habitat Affected
		Habitat Management	Public Access and Management	Total	
MDC Activities on MDC Lands					
Preferred Land Covers (Forest, Woodlands, Glades)					
Indiana Bat	651,294	6,038	43	6,081	0.93%
Little Brown Bat	745,556	6,911	50	6,961	0.93%
Northern Long-eared Bat	745,556	6,911	50	6,961	0.93%
Tricolored Bat	745,556	6,911	50	6,961	0.93%
Open Lands					
Indiana Bat	184,489	6,029	0	6,029	3.27%
Little Brown Bat	211,190	6,902	0	6,902	3.27%
Northern Long-eared Bat	211,190	6,902	0	6,902	3.27%
Tricolored Bat	211,190	6,902	0	6,902	3.27%
MDC Activities on Other Nonfederal Lands					
Preferred Land Covers (Forest, Woodlands, Glades)					
Indiana Bat	13,256,888	7,021	< 1	7,021	0.05%
Little Brown Bat	14,818,306	7,848	< 1	7,848	0.05%
Northern Long-eared Bat	14,818,306	7,848	< 1	7,848	0.05%
Tricolored Bat	14,818,306	7,848	< 1	7,848	0.05%
Open Lands					
Indiana Bat	20,717,999	1,797	0	1,797	0.01%
Little Brown Bat	23,158,199	2,009	0	2,009	0.01%
Northern Long-eared Bat	23,158,199	2,009	0	2,009	0.01%
Tricolored Bat	23,158,199	2,009	0	2,009	0.01%
Statewide Preferred Habitats (Forests, Woodlands, Glades)					
Indiana Bat	13,908,182	13,059	43	13,102	0.09%
Little Brown Bat	15,563,862	14,759	50	14,809	0.10%
Northern Long-eared Bat	15,563,862	14,759	50	14,809	0.10%
Tricolored Bat	15,563,862	14,759	50	14,809	0.10%

[a] Values presented in table have been rounded.

[b] Summer habitat is presumed to occur in all preferred habitats.

Table 4-13. Conservative Estimate of Bats Taken by Covered Activities Annually [a]

	State Population (Adult Bats)	Percent Habitat Affected When Bats Are Present	Adult Bats Exposed	Mortality Rate for Flying Bats[1]	Adult Mortality (Bats)	Juveniles Exposed	Mortality Rate for Juvenile Bats[1]	Juvenile Mortality (Bats)	Total Mortality (Bats)	% Annual Mortality
Indiana Bat										
Fall/Spring		0.25%	489.59	3%	14.69	0	15%	0	14.69	0.01%
Summer	195,157	0.09%	183.84	3%	5.52	91.92	15%	13.79	19.30	0.01%
Total			**673.43**	**3%**	**20.20**	**91.92**	**15%**	**13.79**	**33.99**	**0.02%**
Little Brown Bat										
Fall/Spring		0.19%	1.39	3%	0.04	0	15%	0	0.04	0.01%
Summer	748	0.10%	0.71	3%	0.02	0.36	15%	0.05	0.07	0.01%
Total			**2.10**	**3%**	**0.06**	**0.36**	**15%**	**0.05**	**0.12**	**0.02%**
Northern Long-eared Bat										
Fall/Spring		0.21%	0.26	3%	0.01	0	15%	0	< 0.01	0.01%
Summer	125	0.10%	0.12	3%	< 0.01	0.06	15%	< 0.01	0.01	0.01%
Total			**0.38**	**3%**	**0.01**	**0.06**	**15%**	**< 0.01**	**0.02**	**0.02%**
Tricolored Bat										
Fall/Spring		0.22%	23.99	3%	0.72	0	15%	0	0.72	0.01%
Summer	11,147	0.10%	10.61	3%	0.32	5.30	15%	0.80	1.11	0.01%
Total			**34.60**	**3%**	**1.04**	**5.30**	**15%**	**0.80**	**1.83**	**0.02%**

[a] Values presented in table have been rounded.

4.3.4.2 Gray Bat

This section describes the impact of the taking on gray bat. An overview of the gray bat population is provided. Habitat and population impacts are assessed within the context of the gray bats unique roosting preferences relative to other covered species and the absence of life-history and occurrence data generally.

Population Overview

The geographic range of the gray bat is primarily the limestone karst areas of the southeastern United States, with most populations occurring in Alabama, Arkansas, Kentucky, Missouri, and Tennessee. Populations of gray bats are regularly monitored, with counts of more than 700,000 individuals in the state of Missouri alone (Colatskie 2017). Recovery efforts for gray bats have been successful, and fortunately the species has not been strongly affected by WNS. Unlike other bats covered by this HCP, the gray bat is a year-round resident of caves; thus, protection of caves provides protection to gray bats.

Habitat Impacts

Effects on winter habitat are not anticipated due to avoidance measures described in Chapter 5, *Conservation Strategy*, including a 20-acre buffer around all known roosting sites and all naturally occurring caves on MDC lands. Within this buffer, habitat management is allowed only to improve or maintain habitat for bats and only when bats are absent.

Gray bats do not roost in trees, but they do use a wide variety of above-ground habitats for foraging. Most of the covered activities will provide and maintain suitable foraging habitat for this species, except for the 11 acres per year of tree removal for maintenance and access. These removals are permanent and reduce the amount of foraging habitat minimally, relative to 15,563,862 acres of forest and 23,369,389 acres of open habitat available for foraging available on areas with MDC activity.

Impacts on Populations

Potential impacts on individual gray bats have not been quantified because the species is a year-round user of caves. However, covered activities have a very small likelihood of affecting gray bats and of impacting the population at large. Tree-removal activities are unlikely to result in take of the gray bat. Similarly, the conservation measures outlined in Chapter 5, *Conservation Strategy*, should prevent smoke from entering caves in a quantity that would cause harm. Gray bats may occasionally be taken by vehicles on MDC lands, although that risk is ameliorated by the conservation measures outlined in Chapter 5. It is unlikely that covered activities will have a negative effect on the continued recovery of gray bats since gray bat populations in Missouri have nearly doubled since the 1980s, as MDC has undertaken many of these same conservation activities. In summary, the taking of gray bats are as follows:

- No impacts to hibernating bats.
- Annual take of bats during the active season is expected to be minimal and discountable as the species does not roost in trees.

4.3.4.3 Northern Long-Eared Bat

This section describes the potential take on the northern long-eared bat. An overview of the northern long-eared bat population demographics is provided, along with an assessment of the indirect (long-term) and direct (short-term) habitat impacts. Effects on populations are evaluated at multiple scales.

Population Overview

The range of the northern long-eared bat is large and includes much of the eastern deciduous forestlands from the northern border of Florida, north and west to Saskatchewan, and east to Labrador. Populations of northern long-eared bats are difficult to assess during hibernation because they often select roosts in cracks and crevices where they are difficult to count. The most recent hibernacula survey in Missouri only detected two individuals, a more than 99% decline from nearly 5,000 bats counted in winter 2012–2013 (Colatskie 2017). The USFWS estimated that Missouri contained a population of 285,948 northern long-eared bats in 2014 before the arrival of WNS (U.S. Fish and Wildlife Service 2016). Applying this decline to the summer estimate provided by USFWS yields a current population of 125 bats. This estimate may be as much as an order of magnitude low, but there can be little doubt that northern long-eared bats have been decimated by WNS. Declines in excess of 90% are also suspected in surrounding states. Historically, northern long-eared bats were found hibernating in caves and mines in 52 counties in the state. Maternity colonies were also widely dispersed, with the species being captured in woodland habitat throughout the state. Unfortunately, the location of surviving colonies is poorly understood, with fewer than 10 known roosts occurring on MDC lands.

Habitat Impacts

Effects on winter habitat are not anticipated because of the 20-acre buffer around all known hibernacula and all naturally occurring caves on MDC lands. Within this buffer, habitat management is allowed only when bats are absent with the intent of maintaining or improving habitat quality.

The focus of this HCP is the management of habitat using tree removal and prescribed fire, which annually affects 64,773 acres of preferred habitat or 0.42% of the 15,563,862 acres of preferred habitat types on nonfederal lands in Missouri each year (Table 4-4). These activities could potentially remove roost trees and other important habitat features. Benefits of these activities, specifically prescribed fire, could lead to the creation of suitable roost trees. Notably, the number of snags per unit area is higher on MDC-managed lands, indicating MDC activities create more habitat than other background activities (R. Blatz pers. comm.). Habitat management can also create foraging habitat by opening stands and creating edge habitat. Although the northern long-eared bat is adapted to fly in cluttered forest conditions, it is easier for bats to fly through cleared corridors than highly cluttered woodlands. These habitat manipulations play a key role in allowing and directing the growth of young forest, which will become highly suitable roosting and foraging habitat during the permitted term, resulting in a net increase in fecundity and reproduction. A more complete discussion of net effects can be found in Section 5.3, *Beneficial and Net Effects*. Although habitat manipulations have both positive and negative impacts on the habitat of northern long-eared bats, the long-term effect is that MDC's habitat management provides northern long-eared bats and other wildlife with high-suitability habitat that will support long-term population recovery.

The HCP covers 141 acres of maintenance activities that annually affect <0.01% of the preferred habitat each year. These activities do not result in the long-term loss of habitat. These activities may result in the loss of occasional roost trees (usually small trees of low quality); however, they occur on managed landscapes where higher-quality roosts are relatively common. These areas that are predictably maintained in an earlier successional state also provide value as foraging and commuting habitat. At the scale of 160, 637 acres of fall/spring (Table 4-11) and 745,556 of summer habitat (Table 4-12) provided by MDC lands, the impacts of less than 150 acres per year of maintenance is negligible.

This HCP permits the removal of 11 acres per year of forested habitat. Unlike the covered activities described above, these removals are permanent and have negative impacts associated with the loss of potential roosting and foraging habitat. Over the 50-year permit term, the loss of 550 acres of habitat is insignificant when compared to 160,637 acres of fall/spring and 745,556 of forested summer habitat provided by MDC lands (Tables 4-11 and 4-12). No critical habitat has been designated for northern long-eared bats and thus the HCP will have no impacts on critical habitat.

Impacts on Populations

Hibernating Bats

Bats are especially sensitive to disturbance during hibernation. Bats hibernating in Missouri in the winter are at risk of disturbance. If the disturbance substantially disrupts normal behavior patterns during hibernation, it could result in take. This HCP provides a protective buffer of 20 acres around all hibernacula, as well as caves that are not known to contain bats. The inclusion of caves not known to contain bats is an important precaution for the northern long-eared bat that often occupies cryptic roosts. Areas around caves and hibernacula are managed to protect individual bats and enhance bat habitat. Thus, the HCP not only avoids taking of individual northern long-eared bats during winter, but it also provides long-term legal protections to the habitat on which the bats depend. Because there is no take of hibernating bats, there is no impact of the taking on hibernating bats.

Bats During the Active Season

Covered activities have the potential to directly and indirectly affect individual northern long-eared bats if the activity occurs in fall/spring and summer habitat when the bats are present on the landscape. In the absence of precise locational data and because numbers of individuals will vary year to year, acres of occupied habitat are used as a proxy for understanding impacts on individuals.

Tables 4-11 and 4-12 provide details of the estimated combined effects of all covered activities on northern long-eared bat fall/spring and summer habitat when bats are present (i.e., occupied fall/spring and summer habitat), respectively. When we evaluate the effects on those habitats preferentially used by northern long-eared bats (forests, woodlands, and glades), the result is 0.2% of the population will be exposed to risk in the spring and fall and 0.1% in the summer.

Not all bats exposed to adverse effects experience take (mortality or harm). The biological assessment supporting the 4(d) rule for northern long-eared bats (U.S. Fish and Wildlife Service 2016b) indicated that only 3% of the volant bats and 15% of nonvolant juvenile bats would suffer injury or death when trees were felled. An unknown number may also suffer harm while fleeing the roost. Tree felling is the primary means of mortality expected under this HCP. Assuming all 125 northern long-eared bats that reside in Missouri in 2019 are present in fall/spring or summer

habitat at the time impacts occur, we estimate that less than one bat per year would be exposed to covered activities in fall/spring, with a low likelihood that one northern long-eared bat would be killed or injured per year (see Table 4-13 for calculations). Similarly, we estimate less than one adult and less than one juvenile northern long-eared bats would be exposed to covered activities in the summer, with less than one northern long-eared bat killed or injured per year (Table 4-13). Table 4-13 calculates the number of northern long-eared bats potentially taken, resulting in impacts on approximately 0.02% of the population in Missouri.

In summary, the taking of northern long-eared bats and the impact of the taking are as follows:

- No impacts to winter habitat or hibernating bats.
- Annual take of occupied fall/spring habitat (Table 4-11) and summer habitat (Table 4-12) for northern long-eared bat is minimized and represents a very small fraction— 0.11% of preferred habitat available in the plan area.
- The impacts of the taking on northern long-eared bat populations is very low, even when estimated conservatively (annual estimates of approximately 0.02% of the population in Missouri; Table 4-13).

4.3.4.4 Little Brown Bat

This section describes the impact of the taking on little brown bat. An overview of the little-brown bat population is provided. Indirect (long-term) and direct (short-term) habitat impacts are assessed. Effects on populations are evaluated at multiple scales.

Population Overview

The little brown bat range extends through much of North American from the edge of the arctic circle south to Central Mexico. Within this large range, little brown bats historically were most abundant in areas where caves and mines provide suitable winter habitat. MDC assesses populations of little brown bats as part of their regular hibernacula surveys. The most recent hibernacula survey in Missouri detected only 748 individuals, representing a decline of approximately 87% since winter 2012–2013 (Colatskie 2017). Like similar species, little brown bats have been decimated by WNS, with many states reporting declines of 85% to 95%. MDC staff report that their surveys likely underestimate the population of little brown bats because the species uses many hibernacula that are not surveyed. Historically, little brown bats were known to hibernate in caves and mines in 61 counties in the state. Maternity colonies were also widely dispersed, with the species being captured in woodland habitat and agricultural areas throughout most of the state. The species is heavily reliant on anthropogenic roosts, and no summer colonies in trees are known from Missouri. As with northern long-eared and tricolored bats, the location of surviving colonies is poorly understood. No known roosts occur on MDC lands.

Habitat Impacts

Effects on winter habitat are not anticipated due to avoidance measures described in Chapter 5, *Conservation Strategy*, including a 20-acre buffer around all known hibernacula and all naturally occurring caves on MDC lands. Removal of buildings is a minor part of this HCP, but one that may have substantial effects on little brown bats, which frequent these habitats. Notably, some structures removed by MDC are in imminent danger of collapse and would soon cease to be bat habitat even

without removal. In Chapter 5, MDC commits to implementing measures to reduce these impacts should an occupied building be found.

The focus of this HCP is the management of habitat using tree removal and prescribed fire, which annually affects 64,773 acres of preferred habitat or 0.42% of the 15,563,862 acres of preferred habitat types on nonfederal lands in Missouri each year (Table 4-5). These activities could potentially remove roost trees and other important habitat features. However, these management activities also create roost trees (especially prescribed fire). Notably, the number of snags per unit area is higher on MDC-managed lands, indicating that MDC activities create habitat relative to other land ownerships, consistent with cited literature on the benefits of active management for bats (Silvis et al. 2012; Sheets et al. 2013a; Pauli et al. 2015a; Pauli et al. 2015b; Ford et al. 2016; Pauli et al. 2017). Habitat management can also create foraging habitat by creating edge habitat and opening stands where it is easier to fly. This is an especially important issue for little brown bats, which frequent more open habitat than most of the other covered species. A more complete discussion of net effects can be found in Section 5.3, *Beneficial and Net Effects*. Although habitat manipulations have both positive and negative impacts on the habitat of little brown bats, the long-term effect is that MDC's habitat management provides little brown bats and other wildlife with high-suitability habitat that will support long-term population recovery.

The HCP covers 141 acres of maintenance activities that annually affect <0.01% of the preferred habitats each year (Table 4-7). These activities do not result in the long-term loss of habitat. These activities may result in the loss of occasional roost trees (usually small trees that are not maternity colonies). However, they occur on managed landscapes where higher-quality roosts are relatively common. These areas that are predictably maintained in an earlier successional state also provide value as foraging and commuting habitat. At the scale of 154,392 acres of fall/spring (Table 4-11) and more than 745,556 of summer habitat (Table 4-12) provided by MDC lands, the impacts of less than 150 acres per year of maintenance is negligible.

This HCP permits the removal of 11 acres per year of forested habitat. Unlike the covered activities described above, these removals are permanent and reduce the amount of roosting and foraging habitat. Over the 50-year permit term, the loss of 550 acres of habitat is minimal when compared to 154,392 acres of fall/spring and more than 745,556 of summer habitat provided by MDC lands (Tables 4-11 and 4-12).

Impacts on Populations

Hibernating Bats

Bats are especially sensitive to disturbance during hibernation. Bats hibernating in Missouri in the winter are at risk of disturbance. If the disturbance substantially disrupts normal behavior patterns during hibernation, it could result in take. This HCP avoids take of hibernating bats by establishing a protective buffer of 20 acres around all hibernacula. These areas will be managed to protect individual bats and enhance bat habitat. Thus, the HCP not only avoids taking of individual little brown bats during winter, it also provides long-term protections to the habitat on which the bats depend. Because there is no take of hibernating bats, there is no impact of the taking on hibernating bats.

Bats during the Active Season

Covered activities have the potential to directly and indirectly affect individual little brown bats if the activity occurs in fall/spring and summer habitat when the bats are most active. In the absence of precise locational data and because numbers of individuals will vary year to year, acres of occupied habitat are used as a proxy for understanding impacts on individuals. Tables 4-11 and 4-12 provide details of the combined effects of all covered activities on little brown bats in fall/spring and summer habitat when bats are present.

Not all bats exposed to adverse effects experience take. The biological assessment supporting the 4(d) rule for northern long-eared bats (U.S. Fish and Wildlife Service 2016b) relied on mortality estimates developed from observations on Indiana bats (Belwood 2002). This assessment indicated that approximately 3% of the volant bats present when trees were felled would suffer injury or death. An unknown number may also suffer injury while fleeing the roost. Assuming all 748 little brown bats that hibernated in Missouri in 2017 are present in fall/spring or summer habitat at the time impacts occur, we estimate approximately one bat could be exposed to covered activities in falls/spring, with less than one little brown bat killed or injured per year (see Table 4-13 for calculations). Similarly, we estimate less than one adult and less than one juvenile little brown bat would be exposed to covered activities in the summer, with little to no chance of little brown bats being killed or injured per year (Table 4-13). Table 4-13 calculates the number of little brown bats potentially taken (using 2017 census numbers), resulting in impacts 0.02% of the population in Missouri.

In summary, the taking of little brown bats and the impacts of the taking are as follows:

- No impacts to winter habitat or hibernating bats.
- Take associated with roost trees and removing building is avoided (Chapter 5, *Conservation Strategy*).
- Annual take of occupied fall/spring habitat (Table 4-11) and summer habitat (Table 4-12) for little brown bats is minimized and represents a very small fraction (0.11%) of preferred habitat available in the plan area.
- The impacts of the taking on little brown bat populations is very low, even when estimated conservatively (annual estimates of approximately 0.02% of the estimated state population; Table 4-13).

4.3.4.5 Tricolored Bat

This section describes the impact of the taking on tricolored bat. An overview of the tricolored bat population is provided. Indirect (long-term) and direct (short-term) habitat impacts are assessed. Effects on populations are evaluated at multiple scales.

Population Overview

The tricolored bat ranges from the Yucatan Peninsula to New Mexico north to Nova Scotia and east to the Atlantic Ocean. The MDC assesses populations of tricolored bats as part of their regular hibernacula surveys. The most recent hibernacula survey in Missouri only detected 11,147 individuals, representing a decline of approximately 54% since winter 2012–2013 (Colatskie 2017). Tricolored bats have been decimated by WNS, with many states reporting declines of 85% to 95%.

Historically, tricolored bats were found hibernating in caves and mines in 22 counties in the state. Maternity colonies were also widely dispersed with the species being captured in woodland habitat and agricultural areas throughout most of the state. The species makes occasional use of anthropogenic roosts,especially during spring; however, the location of surviving colonies is poorly understood. No known roosts occur on MDC lands.

Habitat Impacts

Effects on winter habitat are not anticipated because of the avoidance measures described in Chapter 5, *Conservation Strategy*, including a 20-acre buffer around all known hibernacula and all naturally occurring caves on MDC lands. Within this buffer, habitat management is allowed only to improve or maintain habitat for bats and only when bats are absent.

The focus of this HCP is the management of habitat using tree removal and prescribed fire, which annually affects 64,773 acres of preferred habitat or 0.42% of the 15,563,862 acres of preferred habitat types on nonfederal lands in Missouri each year (Table 4-6). These activities could potentially remove roost trees and other important habitat features; however, they may also allow new trees to grow. Tricolored bats make preferential use of oaks and hickories as roosts—a forest type that will decline without active management, especially forestry. Habitat management can also create foraging habitat by creating edge habitat and opening stands to allow for ease of passage through the forest. The 141 acres per year of maintenance activities would not result in the long-term loss of habitat. At the scale of 178,174 acres of fall/spring habitat (Table 4-11) and more than 745,556 of summer habitat (Table 4-12) provided by MDC lands, the impacts of less than 150 acres per year of maintenance is negligible. The value of these more open habitats likely depends on the surrounding matrix, with the value being highest in heavily forested regions where open habitat is limiting and lower in areas where open habitats are common. These habitat manipulations (especially timber harvest) also play a key role in allowing and directing the growth of young forest, much of which will become highly suitability roosting and foraging habitat during the permit term. These activities will result in a net increase in fecundity and reproduction of covered bat species.

Although habitat manipulations have both positive and negative impacts on the habitat of tricolored bats, the long-term effect is that MDC's habitat management provides tricolored bats and other wildlife with high-suitability habitat that will support long-term population recovery.

The HCP covers 141 acres of maintenance activities that annually affect <0.01% of the preferred habitats each year (Table 4-7). These activities do not result in the long-term loss of habitat. These activities may result in the loss of occasional roost trees (usually small trees of low quality).

However, they occur on managed landscapes where higher-quality roosts are relatively common. Areas that are maintained in an earlier successional state also provide value as foraging and commuting habitat. At the scale of 178,174 acres of fall/spring and 745,556 of summer habitat provided by MDC lands, the impacts on tricolored bat habitat from maintenance activities on less than 150 acres per year is negligible.

This HCP permits the removal of 11 acres per year of forested habitat. Unlike the covered activities described above, these removals are permanent and reduce the amount of potential roosting and foraging habitat. Over the 50-year permit term, the loss of 550 acres when compared to 178,174 acres of fall/spring and 745,556 acres of summer habitat provided by MDC lands is minimal.

Impacts on Populations

Hibernating Bats

Bats are especially sensitive to disturbance during hibernation. Bats hibernating in Missouri in the winter are at risk of disturbance. If the disturbance substantially disrupts normal behavior patterns during hibernation, it could result in take. This HCP provides a protective buffer of 20 acres around all hibernacula as well as caves that are not known to contain bats. The inclusion of caves not known to contain bats is an important precaution for tricolored bat because the species uses a wide variety of hibernacula. Areas around caves and hibernacula are managed to protect individual bats and enhance habitat. Thus, the HCP not only avoids taking of individual tricolored bats during winter, it also provides long-term legal protections to the habitat on which the bats depend.

Bats during the Active Season

Covered activities have the potential to directly and indirectly affect individual tricolored bats if the activity occurs in fall/spring habitat when the bats are present on the landscape and because numbers of individuals will vary year to year. In the absence of precise locational data, acres of occupied habitat are used as a proxy for understanding impacts on individuals. Tables 4-11 and 4-12 provide details of the estimated combined effects of all covered activities on tricolored bats in fall/spring and summer habitat when bats are present.

Not all bats exposed to adverse effects experience take (mortality or harm). The biological assessment supporting the 4(d) rule for northern long-eared bats (U.S. Fish and Wildlife Service 2016b) relied on mortality estimates developed from observations on Indiana bats (Belwood 2002). This assessment indicated that approximately 3% of the volant bats present when trees were felled would suffer injury or death. An unknown number may also suffer injury while fleeing the roost.

Assuming 11,147 tricolored bats are present in fall and spring, an estimate of the tricolored bat impact would be approximately 24 bats per year exposed to the activity with less than 1 bat per year being killed (Table 4-13). This would be 0.01% of the current population—a loss that would have no appreciable impact on the ability of the species to recover.

During summer, the covered activities have the potential to directly and indirectly affect individual tricolored bats. Table 4-13 provides details of the combined effects of all covered activities on tricolored bats in occupied summer habitat. When we evaluate the effects on those habitats preferentially used by bats (forests, woodlands, and glades), the result is 0.10% of the population will be exposed to risk. Tree felling is the primary means of mortality expected under this HCP. An unknown number may also suffer harm while fleeing the roost. If the population of tricolored bats in Missouri is 11,147 bats, then an average of less than one adult and less than one juvenile bat per year will be exposed to risk and will be taken (Table 4-13). Realistically, MDC will likely encounter occasional colonies of tricolored bats roosting in trees.

In summary, the taking of tricolored bats and the impacts of the taking are as follows:

- No impacts to winter habitat or hibernating bats.
- Annual take of occupied fall/spring habitat (Table 4-11) and summer habitat (Table 4-12) for tricolored bat is minimized and represents a very small fraction (0.11%) of available habitat in the plan area.

- The impacts of the taking on tricolored bat populations is very low, even when estimated conservatively (annual estimates of approximately 0.02% of the estimated state population; Table 4-13).

Chapter 5
Conservation Strategy

The conservation strategy for the Missouri Department of Conservation Bat Habitat Conservation Plan (MDC Bat HCP) is designed to fully offset impacts from covered activities on covered bats (Indiana bats, gray bats, northern long-eared bats, little brown bats, and tricolored bats) through avoidance, minimization, and mitigation. The program meets the requirements of the Endangered Species Act and streamlines compliance with other applicable environmental regulations (Chapter 1, *Introduction*). The conservation strategy was developed using the best science available at the time of plan preparation, including the following sources:

- *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016).
- Indiana bat, gray bat, northern long-eared bat, little brown bat, and tricolored bat species descriptions (Appendix A, *Species Accounts*).
- Data on ecosystems and vegetation data (Chapter 3, *Environmental Setting*).
- *Indiana Bat* (Myotis sodalis) *Draft Recovery Plan: First Revision* (U.S. Fish and Wildlife Service 2007).
- *Indiana Bat (*Myotis sodalis*) 5-Year Review: Summary and Evaluation* (U.S. Fish and Wildlife Service 2009b).
- *Gray bat recovery plan* (U.S. Fish and Wildlife Service 1982).
- *Gray bat* (Myotis grisescens): *5-year review* (U.S. Fish and Wildlife Service 2009a).
- *Northern Long-Eared Bat Interim Conference and Planning Guidelines* (U.S. Fish and Wildlife Service 2014).
- *Programmatic Biological Opinion on Final 4(D) Rule for the Northern Long-Eared Bat and Activities Expected from Take Prohibitions* (U.S. Fish and Wildlife Service 2016a).
- Information on using forestry to manage bat habitat contained in three recent reviews (Guldin et al. 2007; Sheets et al. 2013; Silvis et al. 2016).
- *National Plan for Assisting States, Federal Agencies, and Tribes in Managing White-Nose Syndrome in Bats* (U.S. Fish and Wildlife Service 2011).
- *Beneficial Forest Management Practices for WNS-Affected Bats: Voluntary Guidance for Land Managers and Woodland Owners in the Eastern United States* (Johnson and King 2018).
- Input from resource specialists, from both MDC and U.S. Fish and Wildlife Service (USFWS).

This chapter is organized into five sections. Section 5.1, *Conservation Strategy Overview,* provides general information about the program and defines key terms. Section 5.2, *Biological Goals and Objectives*, provides the biological goals and objectives and associated conservation measures that are the foundation of the conservation strategy. This section is organized into three topical areas: landscape conservation, site-level conservation, and addressing white-nose syndrome (WNS), the fatal fungal disease that is the greatest threat to these bats. The objectives and their associated

measures have enough detail and specificity to allow for implementation yet are flexible enough to allow for the state-wide scale of the MDC Bat HCP and the 50-year permit term.

The conservation strategy is based on the concept that forestry is different from other activities typically permitted under an HCP. Over time, forest management activities maintain a landscape that is suitable for use by covered bats and maintain and enhance habitat features used by bats. However, as outlined in Chapter 4, *Effects Analysis*, individual bats may incidentally be taken during these forestry operations, even as forest habitat is maintained and enhanced. Section 5.3, *Beneficial and Net Effects*, describes the conservation strategy relative to effects from covered activities. All objectives and their associated measures will be implemented using an adaptive management approach (Section 5.4, *Adaptive Management*) that is closely tied to long-term monitoring (Section 5.5, *Monitoring*).

5.1 Conservation Strategy Overview

Unlike many HCPs, the MDC Bat HCP permits activities that **maintain** and **enhance** a landscape suitable for use by covered bats.

The effects analysis (Chapter 4, *Effects Analysis*) quantifies take as the amount of habitat removed when bats are present, and the impacts of the take describes how individuals and populations will be affected. The conservation strategy focuses on minimizing negative effects on bats and bat habitat from forest management, proactively initiating beneficial actions, and mitigating for unavoidable impacts. The strategy is built on biological goals and objectives and their associated conservation measures. Collectively, avoidance, minimization, and mitigation measures outlined in the conservation strategy fully offset any impacts associated with the covered activities.

This section provides key terms and definitions for forestry and conservation. Conservation planning terms are based largely on the *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (HCP Handbook) (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016).

- **Avoidance and minimization measures:** Actions that reduce or eliminate the negative impacts of covered activities on bats.
- **Conservation measures:** Avoidance, minimization, and mitigation measures that implement the biological objectives of the MDC Bat HCP.
- **Den trees:** Live trees with cavities or broken limbs that provide roosting habitat.
- **Enhancement:** The improvement of an existing habitat condition for species.
- **Legacy trees:** Those trees that are retained because of their age and size (typically older and larger than average trees in the stand) and for the structural component they offer. These are trees that were typically left during a previous harvest and were not removed in a subsequent cut to provide a biological legacy. Such trees often provide roost structures that are favored by certain covered species.
- **Mitigation:** Actions meant to offset environmental impacts by compensating for adverse effects. These actions are based on the biological needs of the covered species and are designed to offset the impacts of the take from covered activities to the maximum extent possible.

- **Seasonal restriction:** A time-of-year restriction on a given covered activity to avoid or minimize direct or indirect impacts of the taking of covered species.
- **Fall/spring habitat:** Modeled habitat as described for each species in Appendix A. In most cases, this is habitat within 5 miles of known hibernacula.
- **Residual trees**: The crop trees or cull trees left standing after a cutting.
- **Summer habitat:** Modeled habitat as described for each species in Appendix A.

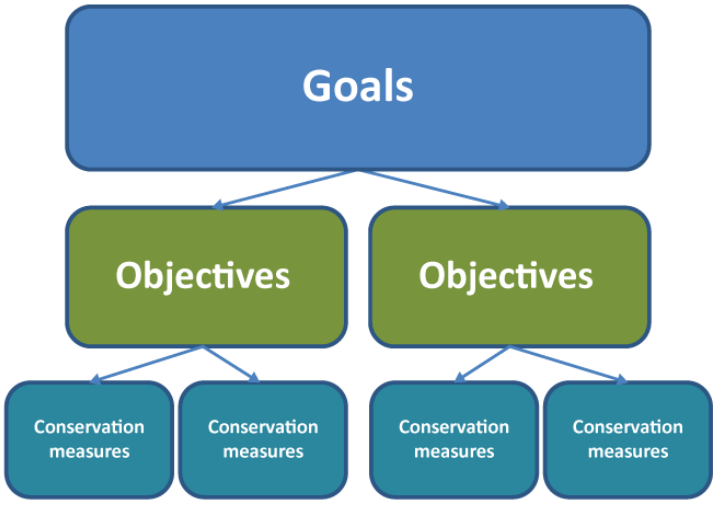
5.2 Biological Goals and Objectives

This section describes the purpose of setting biological goals and objectives for the MDC Bat HCP and the role that these elements play in the development of the conservation strategy. Figure 5-1 presents an overview of the plan's biological goals and objectives and how they relate to the plan's conservation measures.

Biological goals and objectives are the means by which the success of the plan is evaluated during implementation. Biological goals address the broad life-history needs of the species and should clearly support the species' overarching recovery and conservation goals. These goals may be expressed in terms of habitat (e.g., maintain and enhance functional forest and woodland communities that benefit covered species) or species (e.g., maintain or increase species distribution and promote species productivity).

The biological objectives for each goal describe the different elements needed to achieve the biological goal. Objectives should be SMART.

- **S**pecific
- **M**easurable
- **A**chievable
- **R**esult-Oriented
- **T**ime-Fixed



Source: U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016

Figure 5-1. Relationship between Biological Goals, Objectives, and Conservation Measures

Table 5-1. Biological Goals and Objectives

Goal	Objective	Conservation Measures
Biological Goal 1: Maintain a mosaic of contiguous or semi-contiguous natural lands to provide foundational habitat for covered bats.	Objective 1.1: Sustainably manage 700,000 acres of forest and woodlands across MDC lands beginning in year 1 and continuing throughout the permit term.	The conservation measures associated with this objective are the maintenance and acquisition of forested lands as part of the MDC system, the continued practice of sustainable forestry and habitat management on MDC lands, and the protection of MDC lands as managed forests that results in the removal of these lands from the development stream.
	Objective 1.2: Sustainably manage over 200,000 acres of ecologically appropriate open habitats across MDC lands beginning in year 1 and continuing throughout the permit term.	The conservation measures associated with this objective are the maintenance and acquisition of open habitats as part of the MDC system, the continued practice of habitat management on MDC lands, and the protection of MDC natural lands that results in the removal of these lands from the development stream.
	Objective 1.3: Conduct prescribed burning in forests and woodlands each year to increase native biological diversity and enhance forest regeneration, wildlife habitats, and ecological community types that benefit bats.	The conservation measure associated with this objective is the implementation of 10,000 acres of prescribed fire on MDC lands in areas that would benefit bats.
Biological Goal 2: Support land stewardship and bat conservation on lands not owned/managed by MDC.	Objective 2.1: Promote bat-friendly management practices on private and other nonfederal land in the plan area.	The conservation measures associated with this objective are the continued updating and promotion of the Missouri Forest Management Guidelines; the development and implementation of a communication plan (by year 5) and associated public outreach efforts related to bats, forestry, and WNS; implementation of the technical assistance and cost-share programs; and incorporation of the bat conservation measures described in this chapter into these programs.

Goal	Objective	Conservation Measures
Biological Goal 3: Enhance, maintain, and restore roosting and foraging habitat for covered bats.	Objective 3.1: Minimize impacts and improve habitat for covered bats by implementing roost tree retention guidelines in all forest habitat on covered lands.	The conservation measures associated with this objective are snag retention, maternity roost retention, patch retention, den-tree retention, super-canopy tree retention, snag creation, and additional measures as described in Table 5.2 for even- and uneven-aged stand management.
	Objective 3.2: Protect all known roost trees using 150-foot buffer.	Conservation measures associated with this objective include updating known roost data per natural heritage database, delineate buffer areas, and implement of forestry restrictions within the buffer between April 1 and August 31.
	Objective 3.3: Establish priority bat management zones (PBMZs) to protect bats and promote high-quality bat habitat in areas of known or potential bat activity.	Conservation measures associated with this objective include the establishment of 31 PBMZs for a total of 28,613 acres. These PBMZs will be targeted on concentration of maternity colonies and will be distributed as feasible throughout the state. Each species will have a minimum of 7,000 acres of PMBZs, each of which is a minimum of 100 acres in size. The PBMZs will be managed to benefit the target species by implementing forest management actions to achieve the species-specific habitat conditions described in Appendix F, PBMZ Future Desired Conditions. Within the PBMZs, removal of trees equal to or greater than 9 inches diameter at breast height will be avoided between April 1 to August 31 and prescribed fires will be avoided between May 1 and July 31.

Goal	Objective	Conservation Measures
Biological Goal 4: Protect and enhance subterranean habitat and bats using that habitat.	Objective 4.1: Assess and, if necessary, improve 10 entrances to known subterranean habitat on MDC lands annually beginning in year 1 and continuing for the duration of the permit term.	Conservation measures associated with this objective include determining the status of entrances around occupied caves and mines, trimming vegetation around entrances and removing other obstructions as needed, and maintaining entrances over time.
	Objective 4.2: Implement bat management zones around known entrances to subterranean habitat.	Conservation measures associated with this objective include the implementation of a 20-acre buffer around the 275 identified caves on MDC lands within which habitat will be managed to provide old-growth forest conditions, and activities associated with this management will be restricted between March 15 and April 30 and September 15 and October 31. In addition, activities within ¼ mile of all hibernacula will be limited to reduce the potential for noise or other disturbance during the winter season. At 1 and 2 priority hibernacula for covered species, harvest activities will be restricted in the spring and fall within five miles. Around the Sodalis Nature Preserve, within 10 miles, harvest activities will be limited to the winter.
	Objective 4.3: Maintain physical barriers at subterranean sites on MDC lands over the course of the permit term and gate additional sites as needed.	The conservation measures associated with this objective are the documentation of sites with existing physical barriers, prioritization of sites in need of physical barriers (including those on private lands where opportunity and feasibility allow), installation of physical barriers at sites without barriers where they are determined to be beneficial, and maintenance of existing and future physical barriers.

Goal	Objective	Conservation Measures
Biological Goal 5: Avoid and minimize other effects from covered activities on covered species.	Objective 5.1: Implement bat-friendly management measures within burn plans beginning year 1 of the plan.	The conservation measures associated with this objective are the development of burn plans and the implementation of these burn plans on modeled habitat during the spring and fall in areas where bats may be present.
	Objective 5.2: Implement bat-friendly construction and demolition measures throughout the permit area.	The conservation measures associated with this objective are the implementation of seasonal guidelines on tree removal associated with road and trail construction, the maintenance of speed limits, investigation into additional speed restrictions near hibernacula, and bat-friendly demolition practices.
	Objective 5.3: Provide training to new MDC staff to recognize and avoid potential roost trees.	The conservation measure for this objective is bat-specific training as part of the on-boarding process for new staff.
	Objective 5.4: Incorporate bat-friendly best management practices (BMPs) into the Professional Timber Harvester (PTH) training.	The conservation measures for this objective are the development of bat-friendly BMPs and their integration into the PTH training.
Biological Goal 6: Promote survival and recovery of bats affected by white-nose syndrome (WNS).	Objective 6.1: Update MDC's WNS action plan by year 5.	The conservation measure for this objective is the development of an updated action plan for MDC.
	Objective 6.2: Collaborate with researchers to identify ways to ameliorate the impacts of WNS through treatment or habitat management.	The conservation measure for this objective is the provision of technical assistance, permitting, and other collaborative efforts that could help treat WNS.

5.2.1 Landscape Conservation

Maintaining forest and other preferred habitats on the landscape is critical to the conservation of covered bat species. MDC promotes silvicultural practices that maintain forests regionally and enhance woodlands and other habitat. This section focuses on benefits provided by working forests and their contribution to the conservation of covered bats at the landscape level. MDC implements forest management and conservation on over 1 million acres of MDC lands (Missouri Department of Conservation 2016a).

State cost-share and technical assistance programs (e.g., Missouri Cost Share Program) directed toward habitat management extend MDC-approved conservation to other nonfederal lands. Outreach programs facilitated by MDC and their partners increase awareness of state and regional forest sustainability and conservation goals among various stakeholders, including private landowners and the forestry community throughout the state. In the context of this HCP, private landowners who participate in the Missouri cost share and similar technical assistance programs have the opportunity to participate in the HCP and apply conservation measures for bats- thereby achieving landscape conservation above and beyond state-owned lands (see Section 5.2.1.2, *Biological Goal 2*).

Working forests and woodlands maintain bat habitat on the landscape by reducing the chance for land conversion (i.e., natural to developed land) and provide opportunities for MDC and cooperating nonfederal landowners to apply conservation measures described in this HCP to avoid and minimize impacts and to enhance preferred habitats of covered bat species. Collectively, these programs help ensure that forested lands in Missouri remain forested.

5.2.1.1 Biological Goal 1: Maintain a mosaic of contiguous or semi-contiguous natural lands to provide foundational habitat for covered bats.

MDC owns, manages, or administers more than 1 million acres of natural lands across Missouri (Table 1-1). MDC is committed to protecting and maintaining vital ecosystem services supported by this significant area. This is accomplished through MDC's approach to sustainable forestry and habitat management. MDC's current management efforts are outlined in the *Missouri State Wildlife Action Plan* (Missouri Department of Conservation 2015) as implemented in coordination with a variety of other guidelines, including the *Missouri Forest Management Guidelines* (Missouri Department of Conservation 2014) and the *Guidelines for Avoiding and Minimizing Impacts to Federally Listed Bats on Missouri Department of Conservation Lands* (Missouri Department of Conservation 2016a). MDC is also currently enrolled (650,000 acres) in the Sustainable Forestry Initiative. The Sustainable Forestry Initiative is the largest forest certification body in North America, which makes it one of the only true measures of sustainability.

While millions of acres of forest are publicly and privately owned in Missouri, certain forest types (e.g., shortleaf pine [*Pinus echinata*]) and conditions (e.g., disturbance regimes), have been significantly altered or even lost since the state was settled by Europeans in the early to mid-1800s (Missouri Department of Conservation 2015). As a result, to achieve desired future conditions that are meaningful for species in the short term, it is often necessary to adjust successional pathways. Management actions will improve roosting and foraging habitat by targeting specific factors that would limit use by covered bats (e.g., overcrowding of available roost trees). Active forest

management (e.g., harvesting timber and selective tree removal) is a proven and objective-based way to accelerate or redirect forest successional development. By maintaining a diversity of seral stages, overstory species, stand ages, and harvest types, forest managers can create a shifting mosaic of conditions that is resilient to potential impacts associated with a variety of disturbances and environmental stressors. This shifting mosaic of habitat will ensure an ample supply of roosting and foraging habitat throughout the term of the HCP.

Objective 1.1: Sustainably manage 700,000 acres of forest and woodlands across MDC lands beginning in year 1 and continuing throughout the permit term.

Forests and woodlands provide important habitat elements for the covered bat species (Boyles et al. 2009; Sheets et al. 2013; Silvis et al. 2016), all of which make extensive use of forests and woodlands during commuting (traveling between roosts and foraging areas) and foraging (LaVal et al. 1977; Brack and Whitaker 2001; Owen et al. 2003; Sparks et al. 2004; Helms 2010; Bergeson et al. 2013; Womack et al. 2013a, 2013b). Indiana, northern long-eared, and tricolored bats rely on trees to provide the maternity roosts in which most pups are raised. During swarming, staging, and migration, these covered species also roost in trees (Gumbert et al. 2002; Britzke et al. 2006; Lowe 2012). MDC agrees to maintain at least 700,000 acres of forests and woodlands on MDC lands throughout the permit term. As outlined in the *Missouri State Wildlife Action Plan*, these habitats are also essential to managing other rare species in the state (Missouri Department of Conservation 2015).

Associated Conservation Measures: The conservation measures associated with this objective are the maintenance and acquisition of forested lands as part of the MDC system, the continued practice of sustainable forestry and habitat management on MDC lands, and the protection of MDC lands as managed forests that results in the removal of these lands from the development stream.

Objective 1.2: Sustainably manage over 200,000 acres of ecologically appropriate open habitats across MDC lands beginning in year 1 and continuing throughout the permit term.

Open lands and edge habitat are also valuable to the covered bats, especially during foraging (Tuttle 1976; Brack and Whitaker 2001; Owen et al. 2003; Sparks et al. 2004; Helms 2010; Bergeson et al. 2013; Moore et al. 2017). More importantly, highly developed landscapes can create a barrier to movement for the covered bats (Sparks et al. 2004, 2005; Helms 2010). This objective commits to managing open areas such as prairies, old fields, and emergent wetlands that compliment forested habitats for bats through various forest management techniques, including prescribed fire and tree removal. As outlined in the *Missouri State Wildlife Action Plan*, these habitats are also essential to managing other rare species in the state (Missouri Department of Conservation 2015).

Associated Conservation Measures: The conservation measures associated with this objective are the maintenance and acquisition of open habitats as part of the MDC system, the continued practice of habitat management on MDC lands, and the protection of MDC natural lands that results in the removal of these lands from the development stream.

Objective 1.3: Conduct prescribed burning in forests and woodlands each year to increase native biological diversity and enhance forest regeneration, wildlife habitats, and ecological community types that benefit bats.

Missouri is home to multiple natural communities including prairies, glades, savannas, and oak-hickory forests that are associated with periodic fire. MDC uses prescribed fire to maintain and manage these communities. Available literature suggests prescribed burning conducted under the plan provides a net benefit to bats by creating roost trees, reducing clutter, and increasing the insect prey base upon which bats feed (Boyles and Aubrey 2006; Dickinson et al. 2009; Lacki et al. 2009; Johnson et al. 2010; Johnson et al. 2012; Ford et al. 2016). Targeted, short-term burning can increase regeneration of oaks, hickories, and other species of trees that are often used as roosts.

Several studies have documented extensive use of burned areas by cavity- and bark-roosting bats, including Indiana bats (Boyles and Aubrey 2006; Dickinson et al. 2009; Lacki et al. 2009; Johnson et al. 2010; Johnson et al. 2012; Ford et al. 2016). In many cases, roosts are created when a fire-sensitive species is killed by the fire. However, available data also indicate that some trees are injured by fires and may die years later or continue to survive even with substantial damage that may subsequently lead to cavity formation. Of particular note, Ford et al. (2016) observed that prescribed fire in West Virginia removed some black locusts used by roosting northern long-eared bats but provided multiple replacements by killing fire-sensitive species, especially red maples. The Ford et al. example demonstrates that prescribed fires may remove some species of roost trees, but can have long-term benefits at a stand level by removing unfavorable tree species for bats, creating new roost trees, and positively influencing stand structure.

Although prescribed fires can result in an immediate decrease in prey (insect) abundance, fires can produce a rapid growth of the herbaceous community, which can lead to an increase in prey abundance (Dodd et al. 2012). For some time following a prescribed fire (ranging from months to years) insect abundance in the area increases (Jackson and Buckley 2004). While this effect depends on location and/or time of year, it can lead to higher quality and quantity of insect prey. In one of the studies (Lacki et al. 2009), bats switched roosts during a prescribed fire, and subsequently preferentially foraged in burned areas after the fire.

Prescribed burns are both a conservation action and a source of take. Objective 5.1 describes minimization measures associated with prescribed burning.

Associated Conservation Measures: The implementation of 10,000 acres of prescribed fire on MDC lands in areas that would benefit bats.

5.2.1.2 Biological Goal 2: Support land stewardship and bat conservation on lands not owned/managed by MDC.

MDC directly manages only a small portion (about 2.4% overall) of nonfederal forested lands in Missouri (Section 2.2.1, *MDC-Owned or Managed Lands*). The remaining covered lands are largely owned by private individuals or companies, some with little or no experience with land management. For these reasons, MDC provides technical support, forest management cost-share programs, public outreach, and education opportunities that aim to inform private landowners, foresters, and other interested stakeholders of bats and science-based forest management strategies.

This HCP represents a commitment on behalf of MDC to promote sustainable forests on nonfederal lands throughout the state. The MDC Bat HCP will accomplish this goal by extending conservation measures to private landowners, who receive direct and on-site technical support from MDC foresters and biologists, as well as by continuing to provide technical assistance, educational activities, and outreach. The following conservation measures will be required of private and other nonfederal landowners receiving coverage under the HCP: Objectives 3.1, 3.2, and 5.1.

Objective 2.1: Promote bat-friendly management practices on private and other nonfederal land in the plan area.

MDC will promote practices that support bats on lands not owned or administered by MDC, especially on nonfederal lands. By providing technical and financial support for forest management, MDC incentivizes maintaining forest habitat types on the landscape. This will be accomplished by (1) developing and implementing a communication plan, (2) providing technical assistance, (3) providing financial support, and (4) obtaining agreements from landowners who receive technical assistance and financial support to implement specified conservation measures (see Objectives 3.1, 3.2, and 5.1) for covered bat species.

The communication plan will educate the public about covered bat management practices and the availability of technical and financial assistance. The goal of the plan will be to influence nonfederal landowners across the state of Missouri to adopt bat-friendly management practices. Educational materials will communicate the benefit of science-based management practices to encourage the protection and enhancement of covered bat habitat on nonfederal lands. Materials will be consistent with the HCP and with MDC's *Missouri Forest Management Guideline*s (Missouri Department of Conservation 2014), which provide information on best management practices (BMPs) for foresters, landowners, and other land managers to retain and create snags and den trees with preferred roosting structures, such as cavities and exfoliating bark. The BMPs also promote retention of live and dead trees with roosting structures to protect and enhance wildlife habitat while considering and accommodating safety, long-term stand management, and overall forest health. The maintenance or addition of bat-friendly guidance has the potential to improve forestry practices for bats throughout the state. These guidelines will be disseminated and updated throughout the permit term.

The communication plan will provide information on how to take the following actions.

- Conduct sustainable habitat management on their lands.
- Recognize and protect covered bat hibernacula on nonfederal lands.
- Identify and avoid impacts on potential roost trees in areas where bats are known to occur.
- Provide high-quality summer habitat for covered bats.
- Avoid transmission of WNS.

The communication plan will include a strategy for press releases, web content development, social media outreach, and other methods of delivery, including public meetings and speaking engagements. MDC will also coordinate efforts with other outreach programs and existing media, such as MDC's monthly *Conservationist* magazine publication, to maximize program reach and effectiveness.

Educating members of the public (such as visitors, private landowners, cavers, biologists, and foresters) about covered bat species can promote conservation in Missouri. Informing the public about WNS can help reduce the transmission of the disease to new hibernacula. In addition, education and outreach efforts can help managers and private landowners implement practices on nonfederal lands that benefit covered bats, including slowing the conversion of forests to non-habitat land cover types. Given that most preferred bat habitat and therefore most covered bats are wholly or partly on other nonfederal lands, this objective provides an important benefit to covered bats in Missouri.

In addition, MDC will provide technical assistance and financial support to nonfederal landowners seeking to implement forest management activities. Other nonfederal lands make up the majority of covered lands (about 97.6% overall) in this HCP. Approximately 95% of family-owned forests in Missouri do not have a land management plan and have not previously enrolled in any management planning or assistance programs (Piva et al. 2016). The HCP presents an opportunity for MDC to encourage landowners via outreach initiatives to enroll in one or more MDC programs and adopt practices that support sustainable forest management, improve habitat for covered bats, and slow the conversion of forests to non-habitat types such as agricultural, suburban or urban land cover types. These programs provide landowners with financial compensation in return for implementing forest management practices promoted by MDC. MDC will maintain its current cost-share program that works provides assistance on an average of 15,000 acres of private, county, and other nonfederal lands each year. Program participants will implement the bat conservation measures associated with Objectives 3.1, 3.2, and 5.1 as described in this plan. This objective will provide bats with high-quality habitats by extending the expertise of MDC's professional staff beyond MDC-owned or administered lands. This is the most direct means of ensuring the maintenance and management of natural habitats on other nonfederal lands throughout Missouri.

Associated Conservation Measures: The conservation measures associated with this objective are the continued updating and promotion of the *Missouri Forest Management Guidelines*; the development and implementation of a communication plan (by year 5) and associated public outreach efforts related to bats, forestry, and WNS; implementation of the technical assistance and cost-share programs; and incorporation of the bat conservation measures described in this chapter into these programs.

5.2.2 Site-Level Conservation

While the maintenance of working forests across the landscape is a primary benefit of MDC forest management programs, site-specific management similarly protects and enhances habitat for covered bats and minimizes impacts on tree-roosting bats during the spring, summer, and fall.

It is standard practice to retain certain live and dead trees during the course of timber harvest for the wildlife and environmental benefits they provide. A retained tree, or *leave tree*, contributes to the next stand of trees and provides an element of structural complexity. At the site or stand level, snags, cavity, legacy, and mast-producing trees, as well as trees with loose bark or cracks or open seams all provide important roosting elements for covered bat species. The MDC tree-retention guidelines provide a mechanism for perpetuating these critical features within and across stands. Tree retention guidelines are applied to all MDC-administered lands., including private lands receiving coverage through this HCP under the authority of MDC. Collectively, tree-retention guidelines focus on retaining snags (dead standing trees), trees with cavities (could include snags), hollow trees, and healthy trees that are representative of the forest stand subject to harvest.

Depending upon current stand conditions and species composition, recruitment of live trees may be required to increase the pool of future snags and mast producers.

In addition, retention guidelines are aimed at fostering future roost trees. Forestry and wildlife professionals face a challenge when managing species such as Indiana, little brown, and northern long-eared bats that make extensive use of older trees associated with early to mid-successional tree species. If undisturbed, stands dominated by tree species such as oaks, hickories, cottonwoods, ashes, and elms will eventually succeed to more shade-tolerant species (such as maple). Growing a viable roost tree takes 50 to 100 years or more, and a viable snag may only remain on the landscape for a few years. The same principal applies to cavity trees, although they may remain viable for much longer periods of time since they may be used when alive. Potential roost trees have a short period of viability and take many years to replace. The only way to replace these aging trees is to begin growing new trees, and these are species that need substantial solar exposure to grow. As a result, providing future roost trees requires a decision to implement targeted retention guidelines and to manage existing forest (through harvest) to promote the growth of the new trees that will replace today's crop of viable roosts. As such, a key goal of this HCP is to allow the forestry and wildlife practices that will promote access to existing snags and ensure that new trees begin growing so that future generations of bats will continue to have access to viable roost trees. Additional detail on tree retention is provided in Objective 3.1.

5.2.2.1 Biological Goal 3: Enhance, maintain, and restore roosting and foraging habitat for covered bats.

All of the covered bats make extensive use of forested habitats for foraging, and all but the gray bat roost in trees during the active season. However, not all forests provide habitat of equal value for bats. For example, intermediate forests are dense—trees are close together, canopy coverage is high, and the diversity and abundance of understory are low. Because of these characteristics, intermediate-age forests are not as likely to be used by foraging or roosting bats. Newly harvested stands provide large open areas that have a greater abundance of understory plant species and thus a greater diversity and density of insect prey. Older stands are also more open as a result of competition; not all trees will survive to maturity and thus there are more snags that provide roosting habitat, less canopy coverage, greater light penetration, increased understory complexity, and more insects. With proper management, intermediate forests can become the high-quality roosting habitat bats require. The following objectives are aimed at ensuring Missouri's forests provide areas of high-quality habitat throughout the permit term.

Objective 3.1: Minimize impacts and improve habitat for covered bats by implementing roost tree retention guidelines in all forest habitat on covered lands.

MDC has given considerable attention to retention of snags and other trees that provide roost structures for wildlife, including bats, during timber harvests (Missouri Department of Conservation 2016a, 2014). All snags are retained unless they present a hazard. Additionally, Missouri aims to recruit new snags in areas where few snags exist (additional details provided below). The potential loss of roost trees is avoided or minimized through a variety of management practices, including, but not limited to, conserving riparian areas, retaining snags and live trees with known roost tree characteristics (e.g., exfoliating bark, large crevices, cracks, or cavities), and maintaining a minimum basal area of potential roost trees (Johnson and King 2018). As mentioned above, MDC's *Missouri Forest Management Guidelines* (Missouri Department of Conservation 2014) provide BMPs to retain and/or create trees with preferred roosting structures (e.g., cavities, exfoliating bark). These BMPs

are described as conservation measures in this HCP in the bullets below. As a result of these guidelines and aging forests, the estimated number of snags in Missouri forests have increased from 27 million in 2012 to 32 million in 2017 (U.S. Forest Service 2018).

The following conservation measures will be used to obtain Objective 3.1.

- **Retain all snags** except where public or worker safety concerns exist (e.g., prescribed fire line, catastrophic weather events) or disease/insect outbreaks in a stand constitute a threat to the health of the surrounding forest (Johnson and King 2018; Missouri Department of Conservation 2014).
- **Retain all known maternity roosts** for covered bats. Known maternity roosts are those within the Natural Heritage Database with documented use by multiple (>1) reproductive females over multiple nights (>1) (Missouri Department of Conservation 2016a).
- MDC and landowners who are participating in the HCP will **retain patches or aggregations of trees**, which are generally preferred over a scattered distribution of trees. The maintenance of both snags and live trees is important because snags are ephemeral (i.e., they fall down or lose their bark). Retaining snags and live trees with the potential to become roosts helps to provide a continuing supply of roost trees for covered bats. MDC will retain patches of varying size distributed in clumps throughout the harvest unit. All known roost trees will be buffered by a 1.62 acre patch. Additional information on patch sizes for even- versus uneven-aged stand management is provided below in Table 5-2.
- **Retain multiple den trees,** unless none are found. Although den trees can be long-lived, they are prone to developing additional roosting habitat, such as exfoliating bark, sooner than live trees without cavities. MDC and landowners participating in the HCP will use the following practices (Missouri Department of Conservation 2014).
    - Retain a minimum of three den trees (optimum of seven) per acre in heavily forested[7] areas.
    - Retain up to 25 den trees per acre in riparian forests.
    - Prioritize den trees with cavities higher than 20 feet above the ground.
    - When den trees are not present, retain a 0.2-acre (105-foot-diameter) group of trees around at least one large-diameter tree that may potentially serve as a den tree.

      Although den trees provide preferred roosting structures (e.g., cavities and foliage), for some species, such as the northern long-eared, little brown, and tricolored bats, they do not necessarily provide habitat for the bark-roosting Indiana bat. For this reason, when available, den trees with multiple types of roosting structures (e.g., cavities, crevices, exfoliating bark) will be used. Species such as shagbark and shellbark hickory (*Carya ovata* and *C. laciniosa*) can exhibit these characteristics.
- On average, **retain two to four super-canopy trees** (trees that are taller than the surrounding trees), or those with potential to become such trees, per acre in riparian areas and bottomland forests to promote structural diversity and provide large leafy surfaces for foraging activities. Sunlight reaching bark of trees is important for roosting bats. Often portions of boles or branches of these trees receive greater solar exposure than trees beneath the canopy. When super-canopy trees grow old or are exposed to storm damage, the tree can become damaged or

[7] A heavily forested area is defined as 70%–100% forested (Missouri Department of Conservation 1986).

die and develop suitable roosting structures. Some tree species, such as shagbark or shellbark hickory, develop and maintain suitable roost structures when alive. Such trees can provide long-term potential roosting habitat for covered bats (Missouri Department of Conservation 2014).

- If insufficient snags exist, **create snags** based on average per-acre targets. Concentrate on creating large diameter (greater than 16-inch) snags with exfoliating bark for bat maternity habitat. When creating snags, hickory will be used when it is present on the landscape. When selecting snags to retain, physical structures that provide roosting opportunities are considered more important than tree species. However, some tree species, such as shagbark and shellbark hickory, tend to develop preferred roosting structures more than others (Missouri Department of Conservation 2014). When creating snags, MDC and landowners participating in the HCP will leave, if present:
    - One existing, potential, or future snag greater than 20 inches diameter at breast height per acre.
    - Four existing, potential, or future snags between 10 and 20 inches diameter at breast height per acre.

Recommended snag/den tree creation and retention targets are greater for certain forest habitats (i.e., riparian corridors and bottomland hardwoods). When prioritizing snag creation, larger-diameter trees are preferred. In *Guidelines for Avoiding and Minimizing Impacts to Federally-Listed Bats on Missouri Department of Conservation Lands* (Missouri Department of Conservation 2016a).

Smaller-diameter snags are used as secondary roosts by Indiana and little brown bats but can be used as primary roosts by northern long-eared and tricolored bats. Secondary roost trees occur in greater numbers on the landscape than primary roosts and serve as important ancillary roost sites for bats.

Table 5-2. Even- and Uneven-Aged Stand Management Requirement in Forests and Woodlands

Even-Aged Stand Management Conservation Measures	Uneven-Aged Stand Management Conservation Measures
Snag Retention	
Retain all snags except where public or worker safety concerns exist or where catastrophic weather events or disease or insect outbreaks in a stand constitute a threat to the health of the surrounding forest.	Retain all snags except where public or worker safety concerns exist or where catastrophic weather events or disease or insect outbreaks in a stand constitute a threat to the health of the surrounding forest.
Retain Patches/Leave Trees	
In stands greater than or equal to 20 acres where harvest reduces basal area below 30 square feet per acre harvest reduces basal area below 30 square feet per acre, uncut patches totaling at least 5% of the harvested area will be retained.	Maintain a minimum basal area of 30 square feet and where possible retain at least 16 live trees greater than 9 inches in diameter at breast height per acre (with at least 6 trees per acre of the largest available trees of species favored by roosting bats, which will vary by bat species and geographic location).

Even-Aged Stand Management Conservation Measures	Uneven-Aged Stand Management Conservation Measures
In stands greater than or equal to 20 acres where harvest reduces basal area below 30 square feet per acre, create leave-tree patches that are variable in size (but a minimum of 0.25 acre) and located throughout the harvest unit.	Where insufficient large trees (9 inches in diameter or greater) are available to meet silvicultural management needs while providing the number and size of trees noted above, use the 16 largest trees available per acre, to provide adequate canopy cover and roost-tree availability.
When working in a riparian corridor, depending on stocking rate, always leave at least one-third of the typical-sized trees and 40 square feet of basal area or greater. One-half to two-thirds of typical-sized trees is recommended.	
In stands greater than or equal to 20 acres where harvest reduces basal area below 30 square feet per acre, leave one or more large live trees (retain hickory 16 inches or greater diameter at breast height if available), otherwise retain trees greater than 18 inches diameter at breast height, or as large as available) to provide for a continuous supply of future roost trees.	
In stands greater than or equal to 20 acres where harvest reduces basal area below 30 square feet per acre, locate leave-tree patches near or adjacent to riparian management zones, wetlands, or seasonal pools. Wildlife openings are encouraged; however, riparian buffers should not be used for all reserve islands because snag and leave-tree patches are also important in upland forest treatments.	When working in a riparian corridor, always leave *at least* one-third of the typical-sized trees.
Locate patches in draws and along protected slopes, near the edge of the stand on ridge-top locations, or just below the ridge, if possible, to reduce the potential for windthrow.	
Focus patches to coincide with such features as wetland inclusions, ponds, one or more active dens trees or cavity trees, or at least good candidates for potential cavities.	

Even-Aged Stand Management Conservation Measures	Uneven-Aged Stand Management Conservation Measures
Openings	
If openings are created for forest regeneration, those stands will be thinned and/or burned during appropriate seral stages to create and maintain high-quality foraging habitat in the future.	Create relatively small openings (less than 5 acres) where practicable because they may provide the best balance between maintaining foraging and roosting habitat across the landscape.
	Where practicable, maximize the amount of edge habitat (e.g., through the creation of long and narrow openings) to provide a greater amount of foraging habitat and additional predator protection.
	When creating openings, consider both the bat species and the amount of sunlight needed for forest regeneration. Larger openings provide more sunlight to regenerate future roost trees. However too large an opening (greater than 45 acres) may affect bat occupancy.

Objective 3.1 requires the continuation of tree retention guidelines that maintain suitable roost trees on the landscape and retain patches of forest throughout the permit term. Current retention guidelines apply to all individual sites that are harvested. However, for monitoring purposes, results should be assessed at the landscape level (e.g., 320 acres or more [Missouri Department of Conservation 2016b) because it's not always feasible to meet the specified requirements at each site. For example, certain sites may not contain snags, or the snags present may present hazards and thus require removal. Compliance for tree retention is described in Section 5.5, *Monitoring*.

Associated Conservation Measures: Conservation measures associated with this objective include snag retention, maternity roost retention, patch retention, den tree retention, super-canopy tree retention, snag creation, and additional measures as described in Table 5.2 for even- and uneven-aged stand management.

Objective 3.2: Protect all known roost trees using 150-foot buffer.

This objective builds off existing USFWS guidelines whereby timber harvests within 150 feet of a known northern long-eared bat maternity roost (i.e., 1.62 acres) are restricted to the bats' inactive season. These restrictions avoid direct mortality and will be extended to all known roosts of the covered bats. For all covered bats, a 1.62-acre buffer will be established around all known maternity roost trees, within which tree cutting and prescribed burning will be restricted to the non-maternity season (September 1 to March 31). For the remainder of the year, this area will be protectively managed and/or enhanced for the species of bat known to be present. If a known roost tree falls or is shown to be abandoned per USFWS survey guidelines, the protective buffer will be removed.

Associated Conservation Measures: Update known roost data per Natural Heritage Database, delineate buffer areas, and implement of forestry restrictions within the buffer between April 1 and August 31.

Objective 3.3: Establish priority bat management zones to protect bats and their pups and promote high-quality bat habitat in areas of known or potential bat activity.

During summer, all covered bats except the gray bat disperse across much of the state and can be found roosting in trees and/or human structures; these include female maternity roosts where pups are reared. The location of most maternity roosts is unknown, which makes avoidance difficult. The purpose of this objective is to manage habitat in a way that avoids impacts to bats and their pups in roosting colonies where high densities of summer maternity roosts are known or anticipated to occur (called priority bat management zones [PBMZs]). In addition, this objective will target management in PBMZs to benefit the target species for which the areas are protected.

A minimum of 28,000 acres of PBMZs will be established. Seven thousand acres will be delineated for each of the four covered bat species that have summer and maternity roosts in trees (i.e., Indiana bat, little brown bat, northern long-eared bat, tricolored bat). Although all known little brown bat colonies in Missouri are in structures (Boyles et al. 2009), the species regularly roosts in trees throughout its range (Barclay and Kurta 2007), and building colonies may have alternate roosts in trees (Buchler 1980). Initial PBMZ locations were selected based on existing survey data and habit quality.

Every 10 years, each PBMZ will be acoustically monitored per USFWS 2019 survey guidelines to determine presence of the target species. If the target species is not present, PBMZ locations or boundaries will be revised or relocated over time to increase the number of roosts protected, thus increasing the overall conservation value of MDC lands. For more details about PBMZ monitoring see Section 5.5, *Monitoring.*

The proposed PBMZs were identified using roost locations and water sources (such as second-order streams, lakes, and ponds). Recommendations found in *Indiana Bat Summer Maternity Distribution: Effects of Current and Future Climates* (Loeb and Winters 2013) are also incorporated into the PBMZs. The methods for creation of the PBMZs are described in Appendix E, *Priority Bat Management Zone Methods.*

The PBMZ concept was developed using guidance from the *Beneficial Forest Management Practices for WNS-Affected Bats*, hereafter called Beneficial Practices (Johnson and King 2018), which recommends creating "conservation zones." Beneficial Practices suggests that conservation zones vary by species and consider the species biology and life history. Beneficial Practices further suggests that conservation zones be irregular in size and account for flight paths, local topography, alternate roosts, foraging habitat, surface water sources, and hydrologically connected karst features/drainage basins. Management actions within these zones should be compatible with maintaining or restoring the structure, function, composition, and connectivity of forest ecosystems that support quality bat habitat.

One of the primary goals of PBMZs is protection of maternity colonies (and associated pups) during the nonvolant season. During the maternity season (April 1 to August 31), trees that are 9 inches or greater in diameter at breast height will be retained (not harvested); prescribed burns will occur between August 1 to April 30 consistent with *Guidelines for Avoiding and Minimizing Impacts to Federally-Listed Bats on Missouri Department of Conservation Lands* (Missouri Department of Conservation 2016a). Outside PBMZs, forest will continue to be maintained as a mosaic of high-quality summer rearing and foraging habitat on MDC lands where conservation measures will be incorporated for tree retention and protection (as described in Section 5.2.1.1, *Biological Goal 1*).

An additional goal of PBMZs is the enhancement of habitat for target covered species within each PBMZ. A management plan will be drafted by year 2 of plan implementation and will describe how the PBMZs will be managed to create conditions beneficial to each target species. Appendix F, *PBMZ Future Desired Conditions*, details the forest characteristics that will be the goal of PBMZ management.

Associated Conservation Measures: Conservation measures associated with this objective include the establishment of 31 PBMZs for a total of 28,613 acres. These PBMZs will be focused on maternity colonies and will be distributed as feasible throughout the state. Each species will have a minimum of 7,000 acres of PMBZs, each of which is a minimum of 100 acres in size. The PBMZs will be managed to benefit the target species by implementing forest management actions to achieve the species-specific habitat conditions described in Appendix F, *PBMZ Future Desired Conditions*. Within the PBMZs, removal of trees equal to or greater than 9 inches diameter at breast height will be avoided between April 1 to August 31 and prescribed fires will be avoided between May 1 and July 31.

5.2.2.2 Biological Goal 4: Protect and enhance subterranean habitat and bats using that habitat.

Each covered bat species spends winter in underground subterranean (i.e., caves and mines) habitat. One covered species, gray bat, uses subterranean habitat year-round. Caves and mines used as hibernacula also are the central point around which fall/spring habitat is modeled (0.25-mile buffer). During fall and spring, bats use habitat near the hibernacula to feed in preparation for and recovery from hibernation. Finally, some bats visit hibernacula throughout the summer (Mumford and Whitaker 1975; Caire et al. 1979; LaVal and LaVal 1980; Whitaker and Rissler 1992; Whitaker and Brack Jr. 2002). As such, subterranean habitats represent a crucial habitat element and are a focus of this biological goal.

Objective 4.1: Assess and, if necessary, improve 10 entrances to known subterranean habitat on MDC lands annually beginning in year 1 and continuing for the duration of the permit term.

Vegetation and other obstructions (such as dumped debris) can obscure or cause excessive clutter near hibernacula openings, altering airflow into the hibernaculum, affecting winter temperature regimes and humidity, and thereby affecting the suitability of the hibernaculum for over-wintering bats. In addition, altered entrances can divert water and debris into the hibernaculum, which can lead to flooding or make some areas of the hibernaculum inaccessible. Bats of many species (Sparks and Choate 2000) have been found impaled on thorny vegetation (e.g., burdock, multiflora rose, locusts, and hawthorns). Finally, in rare instances, predators can use this vegetation to ambush bats as they maneuver into the entrance of caves and mines (Sparks et al. 2000).

On-site assessments will be completed to ensure entrances to subterranean habitat harboring covered bats remain unobstructed and allow access to roosting and wintering habitat. This objective applies to the 90 entrances to subterranean habitat known or are thought to be used by bats on MDC lands (out of a total of 275 entrances total on MDC lands). Beginning in year 1 and lasting for the duration of the permit term, 10 entrances to occupied subterranean habitat will be checked annually for obstructions. Any detrimental obstructions will be subsequently removed. By the end of year 10, each known entrance is expected to have been checked at least once. Assessments will occur, at minimum, 5 times during the duration of the permit at each known entrance on MDC lands.

Currently (at the time of preparing the MDC Bat HCP), approximately 275 entrances to subterranean habitat occur on MDC lands. If other subterranean habitat is determined to harbor covered bats, those sites will be added to this list. It is anticipated that entrances to subterranean habitat containing large numbers of bats will be checked more regularly by MDC biologists who are counting bats at these sites.

Based on current assessments, there are approximately five hibernacula entrances with thick brush that should be removed to allow clearer flight access for bats using the site. In addition, there is at least one cave gate on MDC land that should be replaced because it does not meet current bat friendly standards and one gate that has been identified for repair. Improvements to these entrances would likely be prioritized in the first several years of HCP implementation. It is anticipated that additional assessments through time will reveal other priority opportunities for enhancement and maintenance.

Associated Conservation Measures: Conservation measures associated with this objective include determining the status of entrances around occupied caves and mines, trimming vegetation around entrances and removing other obstructions as needed, and maintaining entrances over time.

Objective 4.2: Implement bat management zones around known entrances to subterranean habitat.

As stated above, approximately 275 entrances to subterranean habitat occur on MDC lands, 90 of which are or are thought to be occupied by one or more covered bat species. Subterranean habitats are used by all five covered bats in winter, and regularly by one species, gray bat, year-round. Hibernating bats are sensitive to disturbance from a variety of sources. Hibernating bats are torpid and, even when aroused, must warm themselves sufficiently to flee. Thus, hibernating bats are particularly vulnerable to human disturbance (e.g., vandals, smoke, and entombment). When disturbed, bats arouse and become active. The arousal and subsequent period spent at normal body temperature is energetically expensive for the bats (Thomas et al. 1990; Boyles and Brack 2009). Repeated arousals can waste limited fat reserves and indirectly cause mortality and reduced reproduction (Thomas 1995). Such arousals are even more devastating when combined with arousals from WNS (Boyles and Brack 2009). Further, during fall and spring, bats often congregate near cave entrances and covered activities near hibernacula entrances must be timed to avoid these individuals.

MDC will implement a tiered approach to managing subterranean habitat.

- **All Caves:** MDC will continue to implement a 20-acre special management zone around the entrances of caves on MDC lands. MDC manages habitat within these buffers to provide old-growth forest conditions that provide high-quality potential roosts with a relatively open understory, allowing staging and swarming bats unfettered access to the cave entrance. Old-growth forests can vary widely in characteristics depending on site, species composition, and past management history; however, generally speaking, the most desirable old-growth forest condition includes the following major characteristics (Missouri Department of Conservation 1986).
    - 40% or more stocking of live trees greater than 14 inches diameter at breast height
    - Average age usually more than 120 years for dominant trees
    - Multilayered canopy (i.e., well defined overstory, midstory, and understory)

- Large snags, large fallen logs, and evidence of tree decadence

Management activities needed to maintain these conditions will be restricted during spring and fall swarming periods (March 15 to April 30 and September 15 to October 31, respectively).

- **All Known Hibernacula:** Hibernating bats may be disturbed by activities that cause loud sounds (85 decibels at distance of 50 feet) and vibrations such as pile driving and blasting (U.S. Fish and Wildlife Service 2016b). MDC will avoid activities that produce more than 85 decibels within 50 feet of known hibernacula on all MDC lands and lands covered by the MDC permit. MDC will also avoid blasting or pile driving within 0.25 mile at all times of year. When necessary, such activities will occur during summer, when most bats are away from the hibernacula and impacts on remaining bats would be temporary (i.e., not rise to the level of take). These restrictions do not apply to low-intensity management activities such as road grading, snow plowing, or short-term road maintenance activities.
- **High-Priority Hibernacula:** MDC already restricts and will continue to restrict forest management activities within 5 miles of Priority 1 and 2 hibernacula for Indiana bats in the spring and fall swarming period (March 15 to April 30 and September 15 to October 31, respectively). MDC and USFWS will identify any hibernacula for northern long-eared, little brown, tricolored bats that would benefit from the same restriction. The goal of this restriction is to avoid direct impacts on swarming/staging bats. Additional details on protection of the Sodalis Nature Preserve are provided below.

Sodalis Nature Preserve Hibernaculum: MDC will expand the existing avoidance buffer around the Sodalis Nature Preserve hibernaculum from 5 miles to 10 miles. This buffer will apply to MDC lands and lands covered by the MDC permit. In addition, forest management avoidance dates will be extended to include protections for summer roosting bats (timber harvest and prescribed burns will be implemented between November 1 and March 14 only).

Associated Conservation Measures: Conservation measures associated with this objective include the implementation of a 20-acre buffer around the 275 identified caves on MDC lands within which habitat will be managed to provide old-growth forest conditions, and activities associated with this management will be restricted between March 15 and April 30 and September 15 and October 31. In addition, activities within ¼ mile of all hibernacula will be limited to reduce the potential for noise or other disturbance during the winter season. At level-1 and -2 priority hibernacula for covered species, harvest activities will be restricted in the spring and fall within five miles. Around the Sodalis Nature Preserve, within 10 miles, harvest activities will be limited to the winter.

Objective 4.3: Maintain physical barriers at subterranean sites on MDC lands over the course of the permit term and gate additional sites as needed.[8]

Physical barriers at entrances to subterranean habitat, such as cave gates, are designed to prevent people from accessing caves and disturbing bats and/or cave habitat. Physical barriers are typically used at sites where human disturbance limits the site's value for bats. In some cases, physical barriers have been used to limit public access to dangerous underground areas.

Gates are often a preferred method of excluding humans from subterranean habitat. Modern gates are typically built of angle iron and designed to allow bats and air to pass with limited obstruction.

[8] As needed will be determined based on MDC framework for bat gating (see Appendix E [*Guidelines for Avoiding and Minimizing Impacts to Federally-Listed Bats on Missouri Department of Conservation Lands*]).

However, in some instances gates can have negative impacts on bats. Based on published literature (Richter et al. 1993; Currie 2002; Crimmins et al. 2014; Tobin and Chambers 2017), sites with the following conditions should not be gated.

- Sites where human disturbance is not expected to be a problem.
- Sites where water passes under the gate and may trap debris during extreme weather events.
- Sites where the gate may disrupt normal bat behavior for the following reasons:
    - The bats using the cave have long, narrow wings (not an issue for covered bat species).
    - Bats use the proposed gate location during swarming or other times of year and the gate is anticipated to negatively affect swarming.
    - Site-specific conditions expose bats to predators as they pass through the gate.
    - A gate of appropriate design cannot be installed (e.g., a chute or flyover gate for a gray bat maternity colony)

A physical barrier can be installed at any entrance to subterranean habitat known to have been used by one of the covered species within the past 10 years. For entrances that have already been gated the objective is to maintain the gate in good condition. The goal is to maintain gates or other physical barriers at the sites where they currently exist on MDC lands, when and where it is appropriate to do so, and on private lands where opportunities exist and it is feasible to do so throughout the permit term. MDC will prioritize additional subterranean habitat to be gated using the following criteria.

- Potential for disturbance (prioritize sites that are known targets for unauthorized entry i.e., archeological or popular recreational locations).
- Number of covered species occupying a site (prioritize sites that contain multiple species covered by this HCP).
- Number of individuals and listing status of bats known to use an individual site (prioritize sites that are currently used by many bats, used by bat species with state or federal listing status, or are established priorities for federally listed species).
- Ease of access (prioritize sites that are easily accessible by humans from roads, canoe rivers, campgrounds, or other areas of high human activity).
- Suitability for protection (reduce priority for sites where building an effective physical barrier would negatively impact bat use or is not logistically feasible).

Existing physical barriers (gates/fences) will be maintained through functional life unless there is evidence that the structure has become counterproductive (e.g., impedes the movement of bats). Whether to replace obsolete structures (gates/fences) will also be evaluated using the above criteria plus a review of how often the existing structure was challenged or breached.

As previously noted, not all entrances are suitable for physical barrier installation and not all installed barriers should remain. MDC will provide USFWS with rationale for not installing a gate or removing an existing gate as part of the assessment process.

Associated Conservation Measures: The conservation measures associated with this objective are the documentation of sites with existing physical barriers, prioritization of sites in need of physical barriers (including those on private lands where opportunity and feasibility allow), installation of

physical barriers at sites without barriers where they are determined to be beneficial, and maintenance of existing and future physical barriers.

5.2.2.3 Biological Goal 5: Avoid and minimize other effects from covered activities on covered species.

Landscape-level and site-level forestry practices, as well as practices to protect and maintain hibernacula, are the primary means of minimizing or compensating for take of covered bats. However, additional avoidance and minimization measures serve an important role in minimizing take from other covered activities, such as prescribed fire. Inclusion of targeted bat trainings will avoid and minimize effects on covered bats.

Objective 5.1: Implement bat-friendly management measures within burn plans beginning year 1 of the plan.

During fall and spring, bats use daily torpor as an energy-saving strategy. The time it takes for a bat to warm up to active temperatures delays its responsiveness to threats, such as fire. Relative to summer, bats concentrate in higher densities near hibernacula during fall and spring. This objective requires that all prescribed fires in high-quality modeled habitat be governed by a burn plan that prescribes the following bat-specific tactics.

- To avoid killing or injuring bats, use ignition tactics that reduce fire intensity and flame length so that the critical plume temperature at which bats could be injured (140°F) does not reach roost height. The covered bats typically roost between 15 and 30 feet above the ground. Leaf scorch (when leaves are visibly damaged) and trunk scorch provides a good indicator of when bats are at risk.
- Prescribed fire planners and practitioners are well versed in prescribed fire behavior modeling. Fire behavior models such as BehavePlus can be used to predict scorch height. MDC will utilize these models to ensure conditions are conducive to maintaining scorch heights below 15 feet from April 1 to August 31 in high-quality bat roosting habitat.
- To avoid killing or disturbing bats within the hibernacula, prescribe and burn under conditions that maximize smoke dispersal and will carry smoke away from the entrance(s) of the hibernacula.
- To minimize impacts on roosting bats, snags will be retained within fire lines when and where they do not pose a hazard to public or worker health and safety.
- Prescribe fire practitioners working with qualified private landowners must also consider these conditions. MDC approved burn plans for participating landowners will incorporate bat-friendly measures. Contractors used to carry out burns will also utilize bat-friendly management measures.

This objective applies to high-quality modeled habitat during the season when bats are likely to be present, for example, burning in high-quality spring/fall habitat during the spring and fall.

Associated Conservation Measures: The conservation measures associated with this objective are the development of burn plans and the implementation of these burn plans on modeled habitat during the spring and fall in areas where bats may be present.

Objective 5.2: Implement bat-friendly construction and demolition measures throughout the permit area.

Many of the objectives above address avoidance and minimization for activities associated with habitat management. MDC also covers public access and asset management. Over the course of these activities, trees may be removed to allow construction of buildings (e.g., offices or interpretive centers); development of restrooms, boat ramps, roads, and trails; and bank management associated with streams, engineered wetlands, and lakes. MDC also manages 872 miles of roads and 804 miles of trails that are used year-round by both MDC staff and the general public to access parts of the conservation lands. Collisions are a potential source of mortality for bats, especially when motorized activity is adjacent to suitable habitat and near day and maternity roosts (Gaisler et al. 2009; Russell et al. 2009; Lesiński et al. 2010; Lesiński et al. 2011; Medinas et al. 2013). Finally, a limited number of structures (approximately six) are estimated to be demolished per year, typically when MDC acquires a parcel with existing structures. Below are avoidance and minimization measures that address these activities.

- **Removal of Habitat for Construction or Maintenance:** When feasible, trees to be removed for road construction and maintenance will be felled when bats are not present. If the tree is less than 9 inches in diameter at breast height, is tight-barked, and contains no cavities, it can be removed at any time of year. Potential roosts in high-quality summer habitat (i.e., trees with cracks, crevices, or hollows, or trees in areas with known roosts) can be removed in fall, spring, or winter. Conversely, for areas near hibernacula but outside the 20-acre avoidance buffer, tree removal will be targeted for winter. Construction and maintenance activities will occur primarily during daylight hours to limit potential impacts on commuting and foraging bats.
- **Speed Limits:** As noted in Chapter 4, *Effects Analysis*, bats are most at risk when high-speed vehicle traffic intersects areas where bats are foraging or commuting. Lower speeds (such as the 45-mile-per-hour speed limit enforced on MDC lands) provide bats time to recognize vehicles and escape. MDC will maintain the existing 45-mile-per-hour speed limit on MDC lands. Within the first year of the plan, MDC bat biologists and staff from the Design and Development team will identify roads near priority hibernacula where bats may be at additional risk. These areas will be evaluated to determine if posting a lower speed limit or wildlife crossing signs is appropriate.
- **Snag Retention:** Staff will draw fire lines around large snags when and where they do not interfere with public and worker health and safety.
- **Demolition of Structures:** MDC operations also include the demolition of existing structures (e.g., buildings). This is commonly the result of MDC acquiring a new parcel of land with existing structures. Demolition eliminates maintenance and liability concerns while returning a developed area back to a natural area. Removal of buildings during winter substantially decreases the potential of bats being harmed. In cases where winter removal is not used, MDC will check each structure for signs of bats prior to demolition. Typically, buildings can be assessed with an internal survey where staff walk through the structure and search areas where bats may hide. During this search staff will not only look for bats, but also use other senses to detect them (such as the sound of chattering or the musty odor of guano) and also be aware of signs of bat use such as staining and guano piles. Emergence counts can be used to assess structures that cannot be safely accessed. If a colony of covered bats is found, MDC may opt to retain the structure as bat habitat or provide bats with replacement habitat such as an artificial

roost. If solitary bats are found, MDC can remove the bats, wait until winter, or exclude the bats during a time when pups are absent prior to demolition.

Associated Conservation Measures: The conservation measures associated with this objective are the implementation of seasonal guidelines on tree removal associated with road and trail construction, the maintenance of speed limits, investigation into additional speed restrictions near hibernacula, and bat-friendly demolition practices.

Objective 5.3: Provide training to new MDC staff to recognize and avoid potential roost trees.

Training MDC staff will allow successful implementation of the HCP conservation measures. MDC has provided guidance on identifying and avoiding potential roost trees on MDC lands (Missouri Department of Conservation 2016a). MDC will continue to provide this guidance to all MDC staff involved in land management activities. MDC staff positions specifically related to land management, staff will receive training during their orientation or within 6 months of hiring. MDC will determine appropriate staff for training.

Associated Conservation Measures: The conservation measure for this objective is bat-specific training as part of the on-boarding process for new staff.

Objective 5.4: Incorporate bat-friendly BMPs into the Professional Timber Harvester training.

Beginning in 1997, the Missouri Forest Products Association has provided the Professional Timber Harvester (PTH) training for professional loggers, foresters, landowners, and other interested individuals. The hands-on training emphasizes safety and sustainable timber harvesting in Missouri while providing a variety of continuing education courses, such as forest and wildlife management, necessary to maintain the PTH certification. MDC has partnered with the Missouri Forest Products Association and presented a variety of programs to educate participants about protecting and enhancing wildlife habitat. Also, MDC staff serve on the Missouri Forest Products Association's Education and Technical Services Committees, a platform that facilitates educating current and incoming forest industry professionals. MDC will assist in incorporating bat-friendly BMPs into the PTH training.

Associated Conservation Measures: The conservation measures for this objective are the development of bat-friendly BMPs and their integration into the PTH training.

5.2.3 Addressing White-Nose Syndrome

WNS is the primary threat to all five covered species. Although use of biological controls and ultraviolet light have shown promise in treatment of the fungal agent that causes WNS (Cornelison et al. 2014; Palmer et al. 2018), no feasible large-scale treatments are currently available. The MDC Bat HCP recognizes this primary threat to the species and includes a goal to foster recovery.

5.2.3.1 Biological Goal 6: Promote survival and recovery of bats affected by white-nose syndrome (WNS).

Objective 6.1: Update and implement MDC's WNS action plan by year 5.

In April 2010, MDC issued a WNS action plan for MDC-managed properties (Missouri Department of Conservation 2010). This plan guides the MDC response to WNS and provides a publicly available resource that educates readers about WNS and practices used to prevent its spread. The 2010 document indicates the desire of MDC and its partners to develop a general statewide WNS action plan.

Associated Conservation Measure: The conservation measure for this objective is the development of an updated action plan for MDC.

Objective 6.2: Collaborate with researchers to identify ways to ameliorate the impacts of WNS through treatment or habitat management.

While a widespread cure or treatment of WNS is not available, several experimental efforts are showing promise (U.S. Fish and Wildlife Service 2016c). MDC partners with USFWS and other entities (e.g., U.S. Forest Service) involved in bat research. This cooperation includes providing samples from MDC surveys, technical assistance to researchers in Missouri, and permits needed to complete the work. MDC commits to continue these efforts as part of this objective and to develop guidelines for future research requests.

Associated Conservation Measure: The conservation measure for this objective is the provision of technical assistance, permitting, and other collaborative efforts that could help treat WNS.

5.3 Beneficial and Net Effects

The conservation strategy described in Section 5.2, *Biological Goals and Objectives*, avoids, minimizes, and mitigates the impacts of covered activities such that the take described in Chapter 4, *Effects Analysis*, is fully offset. As noted below, quantifying the offset is difficult because the exact locations of bats are often unknown (making it difficult to quantify avoidance), and efforts to understand fecundity and recruitment of bats are in their infancy. For example, efforts to understand recruitment of little brown bat (Humphrey and Cope 1976; Szymanski 2013) or Indiana bat (Humphrey and Cope 1977; Sparks et al. 2008; Oyler-McCance et al. 2018) have produced widely variable estimates. However, the covered activities include many efforts documented as providing high-quality bat habitat (Yates and Muzika 2006; Sparks et al. 2009; Womack et al. 2013a; Starbuck et al. 2015; Womack 2017). Where feasible, (e.g., Table 5-4) the effect of avoidance has been quantified. Otherwise, beneficial and net effects are discussed qualitatively. As described under Objectives 1.1 and 1.2, MDC protects and sustainably manages over 900,000 acres of natural land owned by MDC, approximately 700,000 acres of which are preferred bat habitat (i.e., forests, woodlands, and glades; see Table 4-1) and 200,000 acres of which are open land types. Management of working forests protects potential habitat for bats, keeps lands out of the development stream, prevents habitat fragmentation, and maintains foraging and roosting habitat in high quality over time at the landscape level. The MDC also uses prescribed burning (Objective 1.3) to improve habitat for bats on 10,000 acres of forests and woodlands per year.

The conservation strategy increases stewardship outside MDC lands by promoting bat-friendly forestry practices, engaging in educational outreach efforts, and incorporating bat-friendly BMPs into professional timber harvester training (Objectives 2.1 and 5.4).

Minimization of the injury and mortality of bats during forestry management activities is achieved by leaving snags trees undisturbed (except in cases that threaten forest health and human safety), protecting known roosts with seasonal avoidance buffers, minimizing impacts within PBMZs, implementing bat-friendly burn plans, and training forestry professionals to recognize and avoid potential roost trees (Objectives 3.1, 3.2, 3.3, 5.1, and 5.3). Minimization of impacts to roosting or hibernating individuals will also be implemented during road and trail construction and building demolition (Objectives 4.2 and 5.2).

One highly effective measure is the implementation of a 10-mile protective buffer around Sodalis Nature Preserve, which is the largest known hibernaculum for Indiana bats and contains notable populations of all covered species (Table 5-3). The benefit of this conservation measures can be conservatively estimated by assuming all impacts to bats swarming and staging at the site are avoided. These numbers are relatively well known and the avoided take can thus be estimated (Table 5-3). This conservation measure also provides protections to bats (including many males and nonreproductive females) that summer near the mine, but these benefits are not quantified because the number of bats is unknown. Similarly, because the number of bats occurring within other buffers provided in the conservation strategy is unknown, benefits of these buffers are not calculated, but the effect is likely substantial.

Table 5-3. Conservative Estimate of Bats Avoided during Fall and Spring by Implementing a 10-Mile Buffer around Sodalis Nature Preserve

	Population in Sodalis Nature Preserve	Percent Fall/Spring Habitat Affected When Bats Are Present	Adult Bats Exposed	Mortality Rate for Flying Bats	Adult Mortality Avoided (Bats)	Predicted Total Mortality Without CM[a]	% Total Mortality Avoided
Indiana Bat	180,801	0.25%	453.57	3%	13.61	33.99	40.03%
Little Brown Bat	77	0.19%	0.14	3%	< 0.01	0.12	3.69%
Northern Long-eared Bat	10	0.21%	0.02	3%	< 0.01	0.02	3.09%
Tricolored Bat	359	0.22%	0.77	3%	0.02	1.83	1.26%

[a] From Table 4-13

Additional measures are focused on protecting and enhancing hibernacula. Actions will include removing obstructions around hibernacula entrances (Objective 4.1), maintaining and protecting high-quality habitat surrounding hibernacula (Objective 4.2), and maintaining physical barriers at occupied hibernacula (Objective 4.3). MDC will also promote recovery from WNS through distribution of state-specific recovery plans and collaboration with researchers (Objectives 6.1 and 6.2).

5.3.1 Indiana Bat

While addressed as covered activities, the forest management actions covered by the HCP have a net long-term positive effect on bat habitat (see Appendix D, *Literature Review for the Impact of Forestry on Bats*).

Further, the MDC Bat HCP will benefit Indiana bats by providing 50 years of guaranteed protection and management for a minimum of 900,000 acres of natural habitat, including 700,000 acres of preferred land covers (forests, woodlands, and glades) and 200,000 acres of open lands under MDC jurisdictions (Objectives 1.1 and 1.2 and associated conservation measures). The HCP represents a commitment by the state of Missouri to maintain and manage these lands for the 50-year permit term—an important assurance at a time when some states are considering divestment of public lands. MDC currently owns/manages approximately 5% of the nonfederal lands in the state that provide preferred habitat used by Indiana bats (Table 4-3). The HCP also provides a means by which MDC can support private landowners that seek to implement habitat management efforts to maintain these landscapes in habitat that is suitable for use by bats. This benefit is especially important in Missouri, where more than 36% of the global population and more than 70% of the population of the Ozark/Central Recovery Unit hibernate. While not all of these bats stay in Missouri, all available evidence supports the contention that densities of Indiana bats in areas of modeled high-quality habitat are as high as or higher than any other location in the world. Notably absent from these areas of highest density are large blocks of federal lands. Thus, the HCP provides the most direct means of ensuring protections of active season habitat for Indiana bats on working lands.

Within the 745,000 acres of preferred habitat currently managed by MDC, the following numbers are managed annually with retention guidelines (Objectives 3.1 and 3.2) and bat-friendly burn plans (Objective 5.1) in a way that benefits Indiana bat (Tables 4-2 and 4-3):

- Approximately 6,800 acres of preferred fall/spring habitat (forests, woodlands, and glades),
- Approximately 8,500 acres of preferred high-occupancy summer habitat, and
- More than 38,700 acres of preferred habitat types over all occupancy classes.

These values correspond to approximately 6% of preferred fall/spring and 6% of summer habitat on MDC lands each year, making these conservation measures highly relevant for the species (Tables 4-2 and 4-3). Similar efforts by MDC on private lands manage the following:

- Approximately 1,200 acres per year of preferred fall/spring habitat,
- Approximately 5,900 acres per year of preferred high-occupancy summer habitat, and
- More than 18,260 acres per year of preferred summer habitat types across all occupancy levels.

Prescribed Fire. Specifically, 24,000 acres per year (20,600 on MDC lands, Table 4-3) of prescribed fires in forests, woodlands, and glades are anticipated to create forest conditions that are desirable for covered bats (Objective 1.3). Of the 24,000 acres, 3,300 acres per year (3,156 on MDC lands, Table 4-2) on average will occur in fall/spring and 21,000 acres per year (17,998 on MDC lands, Table 4-3) will occur in summer Indiana bat occupied habitat. Prescribed fires provide multiple benefits for Indiana bats, such as the creation of high-quality foraging habitat and high-quality roosting habitat by killing and damaging trees such that future snags are created or roosting opportunities (e.g., crevices, cracks, dead limbs) on living trees are enhanced. The creation and

conservation of roosts is regularly recommended as a strategy to decrease the risk of threats to local bat populations (e.g., WNS) (Neubaum et al. 2017). Enhanced roosting conditions reduce energetic costs, increase survival, and enhance recovery from WNS (Wilcox and Willis 2016). In fact, studies completed on MDC's Deer Ridge Conservation Area provide evidence that roosting conditions for Indiana bats are ideal within woodlands that are managed, in part, with prescribed fire (Boyles and Aubrey 2006). Studies in other states have also provided evidence for the benefits of prescribed fire (Ford et al. 2016). By creating more and better roosts with increased solar exposure within a landscape that contains high-quality foraging habitat, prescribed fire provides a means of limiting post-emergence mortality from WNS and increasing survivorship and reproductive success in summer.

Tree Removals. Tree removals (especially limited timber harvest) are anticipated to impact individual bats over the short term but provide benefits to bats over the long term. On MDC lands tree removals will affect Indiana bat habitat annually as follows (Tables 4-2 and 4-3):

- Approximately 21,000 acres of preferred land cover,
- Approximately 3,600 acres of preferred fall/spring habitat, and
- Approximately 4,500 acres in areas where Indiana bats are most abundant (i.e., high-occupancy preferred land cover) during summer.
- Similar activities on other nonfederal lands will affect Indiana bat habitat annually as follows (Tables 4-2 and 4-3):
- Approximately 15,000 acres of preferred land cover in the summer,
- Approximately 1,000 acres of preferred fall/spring habitat, and
- Approximately 5,000 acres in high-occupancy preferred habitat during the summer.

Over 50 years, these activities are expected promote a diversity of forest types and ages and thus promote a diversity of suitable Indiana bat foraging and roosting habitat, across the state. A lack of forest management in some areas of Missouri has led to homogeneous forests composed of dense stands lacking species and structural diversity that provide high-quality bat habitat. Over 50 years of the permit, forestry activities will occur across approximately 13% of the summer habitat and 23% of fall/spring habitat, thus creating a variety of habitat types for Indiana bats. Most tree removal conducted by MDC is aimed at directing the long-term growth and development of a stand as it relates to the surrounding landscape. Different management techniques result in optimal conditions (e.g., low subcanopy clutter, diversity of snag-decay classes/sizes, higher solar exposure for roost trees, enhanced herbaceous vegetation promoting insect abundance and diversity) for Indiana bat. Management techniques implemented by MDC promote heterogeneity in forests across Missouri, providing appropriate species composition and forest structure necessary to maintain long-term viability of bat populations (Johnson and King 2018). Forests with greater diversity are more capable of coping with fluctuations in environmental conditions than even-aged forests composed of relatively few tree species. Such resilience can help buffer against climate change and its potential effects on Missouri's forests (e.g., increased risk of novel forest pathogens). Contemporary management of forests enhances future habitat quality, improving survival rates for Indiana bat.

As mentioned above, forest management activities – implemented in conjunction with conservation measures - improve conditions for covered bats (see Appendix D, Literature Review for the Impact of Forestry on Bats). Most trees removed during timber sales are mature, healthy trees that provide minimal roosting opportunities for Indiana bats. Snags and other suitable roosting trees specifically

retained within harvested stands will have increased solar exposure and consequently improved quality (Missouri Department of Conservation 2000; U.S. Fish and Wildlife Service 2007; Missouri Department of Conservation 2014; Johnson and King 2018). Over time, as the forest regenerates, the older trees retained during the harvest die and provide roosting opportunities in stands that otherwise are dominated by younger trees. In addition to improving the quality of retained roosts, the quality of foraging habitat is also improved after tree removal. Forest-management practices that create small forest openings reduce canopy cover, thus increasing light penetration to the forest floor. Increased light promotes growth of herbaceous vegetation, which contributes to increased diversity and abundance of insect populations that make up the diet of Indiana bat. Newly managed stands may also provide the edge habitat for foraging Indiana bats roosting in adjacent stands, which can be important in areas where access to edge is limited (Sparks et al. 2004; Taylor 2006). Increases in the quality and quantity of foraging and roosting habitat will have a beneficial effect on species reproduction, abundance, and distribution (Neubaum et al. 2017; Johnson and King 2018).

PBMZs. MDC is also committing to developing 7,000 acres of PBMZs in areas known to contain roosts of Indiana bats (Objective 3.3). Within PBMZs, the focus will be on managing for habitat that is beneficial for Indiana bats, including increasing the quality and quantity of potential roosts, foraging habitat, and close proximity to water (Taylor 2006; Johnson and King 2018)(see Appendix F, PBMZ Future Desired Conditions). Further, these zones (together with Objective 3.2) are committed to avoiding impacts on maternity colonies through time-of-year restrictions. Habitat management completed within these stands will avoid removal of trees greater than 9 inches diameter at breast height during the summer maternity season (April 1 to August 31). Prescribed fire will avoid the period when pregnant bats and pre-volant pups may have trouble escaping roosts (May 1 to July 31). As suggested by Johnson and King (2018), creation of PBMZs and adherence to time-of-year restrictions will avoid impacts on known maternity colonies when the species is most vulnerable, thus improving the survival rate of the species relative to baseline conditions. Management aimed at enhancing quality of foraging habitat in PBMZs will result in a net increase in the species' fitness by increasing quality of prey (e.g., increased diversity and abundance of lepidopterans) and decreasing energy demands associated with foraging. As described above, enhanced roosting conditions reduce energetic costs, increase survival, and improve chances of recovery from WNS (Wilcox and Willis 2016).

Buffers. Sodalis Nature Preserve protects Missouri's largest Indiana bat hibernaculum, which harbors an estimated population of 180,801 bats (34% of the range-wide population, 93% of state population). Areas near hibernacula host large densities of bats during fall swarming and spring staging, and bats can be particularly vulnerable to impacts from tree felling and other habitat management activities during these periods. The 10-mile buffer around Sodalis Nature Preserve (Objective 4.2) will dramatically increase protections for Indiana bat in the plan area (see Table 5-3). Over 40% of estimated mortality associated with covered activities is avoided through implementation of this buffer. Buffers of 5 miles will also be maintained around the four Priority 1 and three Priority 2 hibernacula on MDC lands, which avoid most remaining impacts on this species.

Cave Protections. MDC will also manage 20 acres as old-growth forest around entrances of every known hibernaculum on MDC lands (Objective 4.2). Indiana bats use caves and other subterranean sites during winter for hibernation. Hibernating bats are sensitive to human disturbance during this period and are vulnerable to impacts associated with unanticipated arousal, which is energetically demanding (Thomas et al. 1990; Boyles and Brack 2009). Conservation measures associated with this objective protect the entrances of 19 known and more than 100 potential hibernacula from most activities and provide an area with a high density of potential roosts for bats to use during

swarming and staging. This not only protects known hibernacula on MDC lands but also protects sites that may contain undetected populations of Indiana bats or sites that are used only during swarming. Objectives 4.1 and 4.3 further address the protection of critical winter habitat features on MDC lands. Protection of hibernacula and surrounding areas where bats swarm and stage for hibernation is invaluable to the species and perhaps the single biggest conservation benefit provided by the HCP (Furey and Racey 2016).

Outreach. Finally, the HCP extends MDC management criteria onto the lands of willing private citizens who have typically fallen beneath USFWS's enforcement threshold (Objective 2.1). Thus, not only do these conservation measures reduce the potential for incidental take on MDC lands, they also provide private citizens with an incentive and technical assistance to manage their lands to the benefit of covered species. Extension onto private lands increases the amount of managed preferred habitat covered by the MDC Bat HCP by approximately 47% (relative to coverage on MDC lands only), or approximately 18,270 acres annually. Such an increase in covered lands provides greater opportunities to support conservation of Indiana bats on private lands across Missouri.

5.3.1.1 Net Effects

Implementation of the HCP will allow development of approximately 9 acres of occupied preferred habitat (forests, woodlands, and glades) per year (459 acres over the permit term) including approximately 2 acres per year of fall/spring and 2 acres per year in areas where Indiana bats are most common during summer (Tables 4-7 and 4-8). This equates to less than 1% of the occupied preferred land cover types on MDC lands (0.07%) and on fall/spring habitat (0.07%) on MDC lands over the permit term.

MDC also seeks to permit trees removed for maintenance activities. Impacts from this activity will not result in land conversion and will affect 123 acres per year in occupied Indiana bat summer habitat (Table 4-8), with 22 (18%) of those being within fall/spring habitat (Table 4-7).

Clearing and maintaining developed areas are a minor portion of the HCP. The core activity permitted by the HCP—habitat management (e.g., prescribed fire and tree removal for habitat restoration and management)—maintains and improves habitat on the landscape over the long term but may take up to 21 Indiana bats (0.01% of the Indiana bats that hibernate in the state each winter) per year (Table 5-4). These covered activities will affect up to 2,480 acres of occupied preferred land covers within spring/fall habitat and 13,102 acres of occupied preferred land covers across all land owners annually (Tables 4-11 and 4-12). The retention guidelines as described in Objectives 3.1 and 3.3 are anticipated to avoid and minimize impacts on Indiana bat and improve foraging and roosting habitat over the long term. Notably, the number of snags per unit area is higher on MDC-managed lands, indicating that MDC activities create habitat relative to other land ownerships, consistent with cited literature on the benefits of active management for bats (Taylor 2006; Silvis et al. 2012; Sheets et al. 2013; Pauli et al. 2015a; Ford et al. 2016; Neubaum et al. 2017; Pauli et al. 2017; Johnson and King 2018). The covered activities, as implemented with the conservation measures described in Section 5.2, *Biological Goals and Objectives*, enhance foraging habitat by creating edge or by opening a stand so that it is easier for Indiana bats to fly (Taylor 2006; Sheets 2010; Neubaum et al. 2017). Forest treatments (especially timber harvest) also play a key role in directing the growth of young forest, some of which will become highly suitable roosting habitat during the permit term. Over time, this would be expected to result in a net increase in fecundity and reproduction (Silvis et al. 2012; Pauli et al. 2015a).

Avoidance and minimization measures will greatly reduce the potential loss of bats associated with implementation of the covered activities. This includes the implementation of a 10-mile protective buffer around the world's largest concentration of Indiana bats (Sodalis Nature Preserve), a measure that is expected to reduce potential mortality of Indiana bat by approximately 40%. Additionally, 5-mile protective buffers around Priority 1 and Priority 2 hibernacula along with the 20-acre buffer around other known and potential hibernacula are expected to all but eliminate mortality during fall/spring. Similarly, protection of 7,000 acres of known roosting habitat within PBMZs for Indiana bats, 21,000 acres of PBMZs for other species, and 150 feet (an area of 1.6 acres for a single tree) of known roosts, and retention of potential roost trees (snags and cavity trees) will greatly reduce the number of bats killed or harmed by forestry operations. Even when a tree containing bats is disturbed or felled, the presence of other suitable roost trees in the surrounding landscape should allow these bats to rapidly move to a new roost and minimize the potential for these bats to be taken by predators (Sparks 2008).

The few bats killed will be offset by increased bat fecundity and survivorship that is accomplished through habitat management. With the implementation of the HCP, 57,014 acres (0.41%) of occupied preferred land covers for Indiana bats in the plan area will be enhanced every year. In keeping with USFWS recommendations (Johnson and King 2018), this includes efforts to provide exceptional habitat for Indiana bats in areas where the species is known or suspected to concentrate. Every cave (i.e., a potential hibernacula) on MDC lands will be surrounded by 20 acres that are managed as old-growth forest to ensure stability of the site and provide exceptional roosting and foraging habitat for swarming/staging bats. MDC will also monitor cave entrances on MDC lands and take steps necessary to ensure these sites remain accessible for bats. MDC will develop 7,000 acres of PBMZs around known maternity roosts. Habitat within these areas will be managed to ensure bats have access to areas of high-quality foraging habitat and areas where high-quality potential roosts are abundant. PBMZs will target areas most likely to contain maternity colonies. These areas will be protected and enhanced and will be re-delineated to adjust for changes through time, particularly with respect to WNS.

In summary, the following measures highlight the beneficial effects on bats and contribute to the net effects analysis.

- Protection and management of 700,000 acres of forests, woodlands, and glades that cannot be developed.
- Protection and management of 200,000 acres of open habitats that cannot be developed.
- Management and enhancement activities on approximately 6,800 acres of preferred fall/spring habitat and 38,750 acres of occupied preferred summer habitat each year on lands owned/managed by MDC.
- Management and enhancement activities on approximately 1,200 acres of preferred fall/spring habitat and 18,270 acres of occupied preferred summer habitat each year on lands owned/managed by other nonfederal cooperators.
- Creation of 7,000-acre PBMZs around known Indiana bat maternity colonies in which MDC will apply seasonal avoidance to limit potential take and apply positive management to generate improved habitat in areas of known occupancy.
- Protective buffers (150 feet) around all known roosts on MDC lands outside the PBMZs.

- Implementation of a 10-mile buffer around Sodalis Nature Preserves that avoids approximately 40% of estimated impacts on Indiana bat.
- Implementation of seasonal avoidance within 5 miles of the seven Priority 1 and Priority 2 hibernacula on MDC lands.
- Protection and management of 20 acres around all caves on MDC land including 19 known Indiana bat hibernacula.
- Monitoring and maintenance of cave entrances on MDC lands.
- Creation of 21,000 acres of PBMZs around areas of known or suspected occupancy for little brown, northern long-eared, and tricolored bats, which may also contain Indiana bats. Within these areas MDC will apply seasonal avoidance to limit potential take and apply positive management to generate improved habitat in areas of known occupancy.
- Outreach, extension, WNS research, and training associated with Indiana bat.

Noting that the estimates of take in Chapter 4, *Effects Analysis*, are highly conservative and designed to overestimate impacts, the conservation strategy fully offsets the impact of the taking on 0.017% of the Indiana bat population that winters in Missouri and less than 0.3% and 0.1% of occupied preferred fall/spring and summer habitat for Indiana bats per year, respectively (Tables 4-11, 4-12, and 4-13). Table 5-4 provides an overview of those conservation measures that help avoid and offset take.

Table 5-4. Summary of Species Take During Spring and Fall after Sodalis Nature Preserve (SNP) and other Avoidance/Minimization and Offsetting Conservation Measures

Total Take of Bats	Reduction of Fall/Spring Take Due to SNP Buffer	Take Remaining after SNP Buffer (Bats/Year)	Additional Avoidance or Minimization	Conservation Offsetting Remaining Impacts
Indiana Bat				
33.99	13.61	20.38	• Implement retention guidelines that limit potential for taking an occupied roost and provide long-term habitat for bats • Avoidance of summer roosts within 10 miles of Sodalis Nature Preserve—eliminating the potential for take[b] • Management of 20-acres around all caves (known and unknown hibernacula) to avoid take • Creation of 7,000 acres of PBMZ around known roosts of Indiana bats where take will be avoided • Creation of 21,000 acres of PBMZs around known/suspected roosts of little brown, northern long-eared, and tricolored bats where take will be avoided • Seasonal avoidance of bat colonies within buildings to avoid direct impact • Protective buffers of 150 feet (1.6 acres) around maternity roosts	• Minimum of 700,000 acres of forests, woodlands, and glades maintained on MDC lands to provide active season roosting and foraging habitat for Indiana bats • Minimum of 200,000 acres of open habitats maintained on MDC lands to provide foraging habitat for Indiana bats • Habitat management on MDC that maintains and improves habitat for bats, including: o Forests, woodlands, and glades: approximately 18,000 (3,160 in fall/spring habitat) acres of prescribed fire, and 20,750 (3,640 in fall/spring) acres of forestry per year o Open habitats: approximately 24,500 (4,290 in fall/spring Habitat) acres of prescribed fire, and 14,200 (2,500 in fall/spring) acres of forestry per year • Habitat management on lands owned/managed by cooperators that maintains and improves habitat for bats, including o Forests, woodlands, and glades: approximately 3,080 (200 in fall/spring Habitat) acres of prescribed fire, and 15,200 (1,000 in fall/spring) acres of forestry per year o Open habitats: approximately 4,180 (280 in fall/spring Habitat) acres of prescribed fire, and 495 (30 in fall/spring) acres of forestry per year

Total Take of Bats	Reduction of Fall/Spring Take Due to SNP Buffer	Take Remaining after SNP Buffer (Bats/Year)	Additional Avoidance or Minimization	Conservation Offsetting Remaining Impacts
				• Avoidance of summer and fall/spring roosts within 5 miles of all Priority 1 and Priority 2 Indiana bat hibernacula—eliminating the potential for take in these areas • Protective buffers of 150 feet (1.6 acres) around maternity roosts • Management of 20-acres around all caves (known and unknown hibernacula) to create high-quality foraging and roosting habitat with old-growth forest • Creation of 7,000 acres of PBMZ around known roosts of Indiana bats where high-quality foraging and roosting habitat will be created with habitat management • Creation of 21,000 acres of PBMZs around known/suspected roosts of little brown, northern long-eared, and tricolored bats where high-quality foraging and roosting habitat will be created with habitat management • Outreach and education to other nonfederal landowners • WNS response plan and collaborations
Little Brown Bat				
0.12	< 0.01	0.11	• Implement retention guidelines that limit potential for taking an occupied roost and provide long-term habitat for bats • Avoidance of summer roosts within 10 miles of Sodalis Nature Preserve—eliminating the potential for take[a]	• Minimum of 700,000 acres of forests, woodlands, and glades maintained on MDC land to provide active season roosting and foraging habitat for little brown bats • Minimum of 200,000 acres of open lands maintained on MDC land to provide foraging habitat for little brown bats • Habitat management on MDC that maintains and improves habitat for bats including:

Total Take of Bats	Reduction of Fall/Spring Take Due to SNP Buffer	Take Remaining after SNP Buffer (Bats/Year)	Additional Avoidance or Minimization	Conservation Offsetting Remaining Impacts
			• Management of 20-acres around all caves (known and unknown hibernacula) to avoid take • Creation of 7,000 acres of PBMZs around known and suspected roosts of little brown bats where take will be avoided • Creation of 21,000 acres of PBMZs • around known/suspected roosts of Indiana, northern long-eared, and tricolored bats where take will be avoided • Seasonal avoidance of bat colonies within buildings to avoid direct impact • Protective buffers of 150 feet (1.6 acres) around maternity roosts	○ Forests, woodlands, and glades: including approximately 20,600 (4,270 in fall/spring habitat) acres of prescribed fire, and 23,750 (4,920 in fall/spring) acres of forestry per year ○ Open habitats: including approximately 28,010 (5,800 in fall/spring Habitat acres of prescribed fire, and 16,290 (3,370 in fall/spring) acres of forestry per year • Habitat management on Lands owned/managed by cooperators that maintains and improves habitat for bats including ○ Forests, woodlands, and glades: including approximately 3,440 (410 in fall/spring Habitat) acres of prescribed fire, and 16,980 (2,020 in fall/spring) acres of forestry per year ○ Open habitats: including approximately 4,670 (560 in fall/spring Habitat) acres of prescribed fire, and 550 (70 in fall/spring) acres of forestry per year • Avoidance of summer and fall/spring Roosts within 5 miles of all Priority 1 and Priority 2 Indiana bat hibernacula—eliminating the potential for take in these areas • Protective buffers of 150 feet (1.6 acres) around maternity roosts • Management of 20-acres around all caves (known and unknown hibernacula) create high-quality foraging and roosting habitat with old-growth forest • Creation of 7,000 acres of Priority Bat Management Zones around known and suspected roosts where high-quality foraging and roosting habitat will be created with habitat management

Total Take of Bats	Reduction of Fall/Spring Take Due to SNP Buffer	Take Remaining after SNP Buffer (Bats/Year)	Additional Avoidance or Minimization	Conservation Offsetting Remaining Impacts
				• Creation of 21,000 acres of Priority Bat Management Zones around known/suspected roosts of Indiana, northern long-eared, and tricolored bats where high-quality foraging and roosting habitat will be created with habitat management • Outreach and education to other nonfederal landowners • WNS response plan and collaborations
Northern Long-Eared Bat				
0.02	< 0.01	0.02	• Implement retention guidelines that limit potential for taking an occupied roost and provide long-term habitat for bats • Avoidance of summer roosts within 10 miles of Sodalis Nature Preserve—eliminating the potential for take[a] • Management of 20-acres around all caves (known and unknown hibernacula) to avoid take • Creation of 7,000 acres of PBMZs around known and suspected roosts of northern long-eared bats where take will be avoided • Creation of 21,000 acres of PBMZs around known/suspected roosts of Indiana, little brown, and tricolored bats where take will be avoided • Seasonal avoidance of bat colonies within buildings to avoid direct impact • Protective buffers of 150 feet (1.6 acres) around maternity roosts	• Minimum of 700,000 acres of forests, woodlands, and glades maintained on MDC land to provide active season roosting and foraging habitat for northern long-eared bats • Minimum of 200,000 acres of open lands maintained on MDC land to provide foraging habitat for northern long-eared bats • Habitat management on MDC that maintains and improves habitat for bats including: o Forests, woodlands, and glades: approximately 20,600 (4,440 in fall/spring habitat) acres of prescribed fire, and 23,750 (5,120 in fall/spring) acres of forestry per year o Open habitats: approximately 28,010 (6,040 in fall/spring habitat acres of prescribed fire, and 16,290 (3,510 in fall/spring) acres of forestry per year • Habitat management on Lands owned/managed by cooperators that maintains and improves habitat for bats including o Forests, woodlands, and glades: approximately 3,400 (360 in fall/spring habitat) acres of

Total Take of Bats	Reduction of Fall/Spring Take Due to SNP Buffer	Take Remaining after SNP Buffer (Bats/Year)	Additional Avoidance or Minimization	Conservation Offsetting Remaining Impacts
				prescribed fire, and 16,980 (1,790 in fall/spring) acres of forestry per year ○ Open habitats: ○ approximately 4,650 (490 in fall/spring Habitat) acres of prescribed fire, and 550 (60 in fall/spring) acres of forestry per year • Avoidance of summer and fall/spring roosts within 5 miles of all Priority 1 and Priority 2 Indiana bat hibernacula—eliminating the potential for take in these areas • Protective buffers of 150 feet (1.6 acres) around maternity roosts • Management of 20-acres around all caves (known and unknown hibernacula) to create high-quality foraging and roosting habitat with old-growth forest • Creation of 7,000 acres of PBMZs around known and suspected roosts of northern long-eared bats where high-quality foraging and roosting habitat will be created with habitat management • Creation of 21,000 acres of PBMZs around known/suspected roosts of Indiana, little brown, and tricolored bats where high-quality foraging and roosting habitat will be created with habitat management • Outreach and education to other nonfederal landowners • WNS response plan and collaborations
Tricolored Bat				
1.83	0.02	1.81	• Implement retention guidelines that limit potential for taking an occupied	• Minimum of 700,000 acres of forests, woodlands, and glades maintained on MDC land to provide

Total Take of Bats	Reduction of Fall/Spring Take Due to SNP Buffer	Take Remaining after SNP Buffer (Bats/Year)	Additional Avoidance or Minimization	Conservation Offsetting Remaining Impacts
			roost and provide long-term habitat for bats • Avoidance of summer roosts within 10 miles of Sodalis Nature Preserve—eliminating the potential for take[a] • Management of 20-acres around all caves (known and unknown hibernacula) to avoid take • Creation of 7,000 acres of PBMZs around known and suspected roosts of tricolored bats where take will be avoided • Creation of 21,000 acres of PBMZs around known/suspected roosts of Indiana, little brown, and northern long-eared bats where take will be avoided • Seasonal avoidance of bat colonies within buildings to avoid direct impact • Protective buffers of 150 feet (1.6 acres) around maternity roosts	active season roosting and foraging habitat for tricolored bats • Minimum of 200,000 acres of open lands maintained on MDC land to provide foraging habitat for tricolored bats • Habitat management on MDC that maintains and improves habitat for bats including: o Forests, Woodlands, and Glades: approximately 20,600 (4,920 in fall/spring habitat) acres of prescribed fire, and 23,750 (5,680 in fall/spring) acres of forestry per year o Open Habitats: approximately 28,010 (6,690 in fall/spring Habitat acres of prescribed fire, and 16,290 (3,890 in fall/spring) acres of forestry per year • Habitat management on lands owned/managed by cooperators that maintains and improves habitat for bats including o Forests, woodlands, and glades: approximately 3,400 (390 in fall/spring habitat) acres of prescribed fire, and 16,980 (1,910 in fall/spring) acres of forestry per year o Open habitats: approximately 4,650 (530 in fall/spring habitat) acres of prescribed fire, and 550 (60 in fall/spring) acres of forestry per year • Avoidance of summer and fall/spring roosts within 5 miles of all Priority 1 and Priority 2 Indiana bat hibernacula—eliminating the potential for take in these areas • Protective buffers of 150 feet (1.6 acres) around maternity roosts • Management of 20-acres around all caves (known and unknown hibernacula) to create high-quality

Total Take of Bats	Reduction of Fall/Spring Take Due to SNP Buffer	Take Remaining after SNP Buffer (Bats/Year)	Additional Avoidance or Minimization	Conservation Offsetting Remaining Impacts
				foraging and roosting habitat with old-growth forest • Creation of 7,000 acres of PBMZs around known and suspected roosts of tricolored bats where high-quality foraging and roosting habitat will be created with habitat management • Creation of 21,000 acres of PBMZs around known/suspected roosts of Indiana, little brown, and northern long-eared bats where high-quality foraging and roosting habitat will be created with habitat management • Outreach and education to other nonfederal landowners • WNS response plan and collaborations

[a] Take reduction calculated for spring fall only because population within ten miles of SNP in fall spring is well known and can be reliably calculated. Additional benefits from avoidance and minimization (column D) not calculated because the magnitude of the benefit is unknown.

[b] This measure is included here, because the take remaining after the SNP buffer has been applied includes take within 10 miles of the SNP during the fall/spring

5.3.2 Gray Bat

5.3.2.1 Beneficial Effects

While addressed as covered activities, the forest management actions covered by the HCP have a net long-term positive effect on bat habitat (see Appendix D, *Literature Review for the Impact of Forestry on Bats*). Further, unlike the other covered bats, gray bats are not expected to be taken during forestry operations.

The MDC Bat HCP will benefit gray bats by providing 50 years of guaranteed protection and management for a minimum of 900,000 acres of natural habitat, including 700,000 acres of preferred land covers (forests, woodlands, and glades) and 200,000 acres of open lands under MDC jurisdictions (Objectives 1.1 and 1.2). The HCP represents a commitment by the state of Missouri to maintain and manage these lands for the 50-year permit term—an important assurance at a time when some states are considering divestment of public lands. Both forests and open lands provide quality foraging habitat for gray bats. Forestry and prescribed fire activities that open the forest and allow gray bats to travel through the habitat will improve the quality of these habitats.

Gray bats are reliant on caves throughout the year. As populations have recovered, gray bats have begun using a wider variety of caves than they used at the time of listing (U.S. Fish and Wildlife Service 1982, 2009a, 2011). MDC's commitment to protect all caves on MDC lands, including those not known to contain bats, provides an important component of protecting habitats on which this species depends for recovery.

5.3.2.2 Net Effects

Lethal take of gray bats is not quantified in Chapter 4, *Effects Analysis*, because the species does not typically inhabit trees. Conservation measures outlined in this chapter will serve to greatly reduce the already limited potential for lethal take. Further, the 20-acre management area around caves and MDC's commitment to maintain these areas ensure that all caves on MDC lands remain functioning natural environments like those needed to further gray bat recovery.

5.3.3 Northern Long-Eared Bat

5.3.3.1 Beneficial Effects

While addressed as covered activities, the forest management actions covered by the HCP have a net long-term positive effect on bat habitat (see Appendix D, *Literature Review for the Impact of Forestry on Bats*).

Further, the MDC Bat HCP will benefit Northern long-eared bats by providing 50 years of guaranteed protection and management for a minimum of 900,000 acres of natural habitat, including 700,000 acres of preferred land covers (forests, woodlands, and glades) and 200,000 acres of open lands under MDC jurisdictions (Objectives 1.1 and 1.2 and associated conservation measures). The HCP represents a commitment by the state of Missouri to maintain and manage these lands for the 50-year permit term—an important assurance at a time when some states are considering divestment of public lands. MDC currently owns/manages approximately 5% of the nonfederal lands in the state that provide preferred habitat used by northern long-eared bats (Table 4-4). The HCP also provides

a means by which MDC can support private landowners that seek to implement habitat management efforts to maintain these landscapes in habitat that is suitable for use by bats. This benefit is especially important because most preferred habitat occurs on private lands. Thus, the HCP provides the most direct means of ensuring protections of active season habitat for northern long-eared bats on working lands.

Within the 745,000 acres of preferred habitat currently managed by MDC, the following numbers are managed annually with retention guidelines (Objectives 3.1 and 3.2) and bat-friendly burn plans (Objective 5.1) in a way that benefits northern long-eared bat (Tables 4-2 and 4-4):

- Approximately 9,560 acres of preferred fall/spring habitat (forests, woodlands, and glades),
- Approximately 37,300 acres of preferred high-occupancy summer habitat, and
- More than 44,000 acres of preferred habitat types over all occupancy classes.

These values correspond to approximately 6% of preferred fall/spring and 6% of summer habitat on MDC lands each year, making these conservation measures vital to the species (Tables 4-2 and 4-4). Similar efforts by MDC on private lands manage the following:

- Approximately 2,154 acres per year of preferred fall/spring habitat,
- Approximately 17,000 acres per year of preferred high-occupancy summer habitat, and
- More than 20,000 acres per year of preferred habitat types of all occupancy levels.

Prescribed Fire. Specifically, 24,040 acres per year (20,600 on MDC lands, Table 4-4) of prescribed fires in forests, woodlands, and glades are anticipated to create forest conditions that are desirable for covered bats (Objective 1.3). Of this total, 4,800 acres per year (4,440 on MDC lands, Table 4-2) on average will occur in fall/spring habitat. Prescribed fires provide multiple benefits for northern long-eared bats. While prescribed fires have the potential to remove some existing snags from burned areas, high recruitment of new day roosts compensates for any loss, resulting in positive impacts for northern long-eared bats (Ford et al. 2016). Prescribed fires increase the number of roosts because fire intolerant species, such as red maple (*Acer rubrum*), are killed or damaged such that snags and living trees with roost structures (e.g., exfoliating bark, cracks, cavities) are created. In addition, fires can remove clutter and create canopy gaps, allowing greater solar exposure of existing and newly created roosts. Bats using roosts with greater solar exposure following emergence from hibernation can benefit from access to warmer conditions, which may enhance chances of recovery from WNS (Wilcox and Willis 2016). The creation and conservation of roosts is regularly recommended as a strategy to decrease the risk of threats to local bat populations (e.g., WNS) (Neubaum et al. 2017). Prescribed fire can improve foraging quality in forests by removing understory and midstory vegetation, which promotes growth of herbaceous plants in the understory. Increased herbaceous vegetation contributes to greater richness and abundance in insects (Campbell et al. 2007), including Lepidoptera, an order of insects comprising a large portion of the diets of covered bat species (Tuttle et al. 2006). By creating more and better roosts with increased solar exposure located within a landscape that contains high-quality foraging habitat, prescribed fire provides a means of limiting post-emergence mortality from WNS, and increasing survivorship and reproductive success in summer.

Tree Removals. Tree removals (especially limited timber harvest) are anticipated to impact individual bats over the short term but provide benefits to bats over the long term. On MDC lands tree removals will affect Northern long-eared bat habitat annually as follows (Tables 4-2 and 4-4):

- Approximately 23,750 acres of preferred land cover in the summer,
- Approximately 5,120 acres of preferred fall/spring habitat, and
- Approximately 19,900 acres in in high-occupancy preferred habitat during the summer .
- Similar activities on other nonfederal lands will affect northern long-eared bat habitat annually as follows:
- Approximately 17,000 acres of preferred land cover in the summer,
- Approximately 1,790 acres of preferred fall/spring habitat, and
- Approximately 14,140 acres in high-occupancy preferred habitat during the summer.

Over 50 years, these activities are expected to provide improvements in diversity of forest types and ages, thus a diversity of suitable northern long-eared bat foraging and roosting habitat, across the state. A lack of forest management in some areas of Missouri has led to homogeneous forests composed of dense stands lacking species and structural diversity that provide high-quality bat habitat. Over 50 years of the permit, forestry activities will occur across approximately 13% of the summer habitat and 20% of fall/spring habitat, thus creating a variety of habitat types for northern long-eared bats. Most tree removal conducted by MDC is aimed at directing the long-term growth and development of a stand as it relates to the surrounding landscape. Unlike Indiana bat, northern long-eared bats are known to forage in cluttered forests. However, despite this particular life history strategy, evidence suggests that even bats adapted to foraging in cluttered forests are likely to benefit from removing clutter, which allows greater access to foraging areas (Blakey et al. 2016). Contemporary management of forests enhances future habitat quality, improving survival rates for Northern long-eared bat.

Forestry practices implemented and encouraged by MDC include retention of potential roost trees. Suitable roosting habitat drives occupancy by northern long-eared bat (Pauli et al. 2015b). The variety of tree harvest regimes implemented by MDC promote a mosaic of forest conditions (e.g., uneven-aged forests) that provide a balance between roosting and foraging needs of northern long-eared bats (Sheets et al. 2013; Pauli et al. 2015b), enhancing the ability of the species to persist on the landscape over time.

As noted by Silvis et al. (2012), widespread clearcutting in eastern North American forests through the early 20th century produced modern forests composed of early successional (i.e., pioneer) tree species that form dense stands of relatively low diversity. Subsequent suppression by competitors (i.e., overstory trees) results in increased decadence and, consequently, potential roost trees. This temporarily results in increased availability of roosts; however, roosts are of similar age and decay, meaning they are likely to lose their ability to support roosting bats around the same time. Without forest management practices that create new roosts, the availability of future roosts will diminish. Without intervention using forest management practices, existing forest dynamics are unlikely to provide optimal conditions for northern long-eared bat in the future. Forest management strategies implemented by MDC are expected to enhance future habitat quality, improving survival rates for northern long-eared bat.

As mentioned above, forest management activities – implemented in conjunction with conservation measures - improve conditions for covered bats (see Appendix D, Literature Review for the Impact of Forestry on Bats). Most trees removed during timber sales are mature, healthy trees that provide minimal roosting opportunities for Indiana bats. Snags and other suitable roosting trees specifically retained within harvested stands will have increased solar exposure and consequently improved quality (Missouri Department of Conservation 2000; U.S. Fish and Wildlife Service 2007; Missouri Department of Conservation 2014; Johnson and King 2018). Over time, as the forest regenerates, the older trees retained during the harvest die and provide roosting opportunities in stands that otherwise are dominated by younger trees. In addition to improving the quality of retained roosts, the quality of foraging habitat is also improved after tree removal. Forest-management practices that create small forest openings reduce canopy cover, thus increasing light penetration to the forest floor. Increased light promotes growth of herbaceous vegetation, which contributes to increased diversity and abundance of insect populations that make up the diet of Indiana bat. Newly managed stands may also provide the edge habitat for foraging Indiana bats roosting in adjacent stands, which can be important in areas where access to edge is limited (Sparks et al. 2004; Taylor 2006). Increases in the quality and quantity of foraging and roosting habitat will have a beneficial effect on species reproduction, abundance, and distribution (Neubaum et al. 2017; Johnson and King 2018).

PBMZs. MDC is also committing to developing 7,000 acres of PBMZs in areas known to contain roosts of northern long-eared bats (Objective 3.3). Within PBMZs, the focus will be on managing for habitat that is beneficial for northern long-eared bats, including increasing the quality and quantity of potential roosts, foraging habitat, and close proximity to water (Taylor 2006; Johnson and King 2018)(see Appendix F, PBMZ Future Desired Conditions). Further, these zones (together with Objective 3.2) are committed to avoiding impacts on maternity colonies through time-of-year restrictions. Habitat management completed within these stands will avoid removal of trees greater than 9 inches diameter at breast height during the summer maternity season (April 1 to August 31). Prescribed fire will avoid the period when pregnant bats and pre-volant pups may have trouble escaping roosts (May 1 to July 31). As suggested by Johnson and King (2018), creation of PBMZs and adherence to time-of-year restrictions will avoid impacts on known maternity colonies when the species is most vulnerable, thus improving the survival rate of the species relative to baseline conditions. Management aimed at enhancing quality of foraging habitat in PBMZs will result in a net increase in the species' fitness by increasing quality of prey (e.g., increased diversity and abundance of lepidopterans) and decreasing energy demands associated with foraging. As described above, enhanced roosting conditions reduce energetic costs, increase survival, and improve chances of recovery from WNS (Wilcox and Willis 2016).

Buffers. Northern long-eared bats are notoriously difficult to adequately document during hibernacula surveys because of their preference to roost in cracks and crevices in the walls of subterranean habitats. Nevertheless, areas near hibernacula host large densities of bats during fall swarming and spring staging, and bats can be particularly vulnerable to impacts from tree felling and other habitat management activities during these periods. MDC will implement a 10-mile buffer around Sodalis Nature Preserve, a documented hibernacula for northern long-eared bats, which is estimated to reduce over 3% of predicted mortality for the species associated with covered activities (see Table 5-3). Buffers of 5 miles will also be maintained around the four Priority 1 and three Priority 2 Indiana bat hibernacula, in which northern long-eared bats are known or assumed to occur, on MDC lands, which avoid impacts on this species.

Cave Protections. MDC will also manage 20 acres as old-growth forest around entrances of every known hibernaculum on MDC lands (Objective 4.2). Like other covered bats, northern long-eared

bats rely on caves and other subterranean sites during winter for hibernation. Hibernating bats are sensitive to human disturbance during this period and are vulnerable to impacts associated with unanticipated arousal, which is energetically demanding (Thomas et al. 1990; Boyles and Brack 2009). Conservation measures associated with this objective protect the entrances of 19 known and more than 100 potential hibernacula from most activities and provide an area with a high density of potential roosts for bats to use during swarming and staging. This not only protects known hibernacula on MDC lands, but also protects sites that may contain undetected populations of northern long-eared bats or sites that are used only during swarming. Objectives 4.1 and 4.3 further address the protection of critical winter habitat features on MDC lands. Protection of hibernacula and surrounding areas where bats swarm and stage for hibernation is invaluable to the species and perhaps the single biggest conservation benefit provided by the HCP (Furey and Racey 2016).

Outreach. Finally, the HCP extends MDC management criteria onto the lands of willing private citizens who have typically fallen beneath USFWS's enforcement threshold (Objective 2.1). Thus, not only do these conservation measures reduce the potential for incidental take on MDC lands, they also provide private citizens with an incentive and technical assistance to manage their lands to the benefit of covered species. Extension onto private lands increases the amount of managed preferred habitat covered by the MCD Bat HCP by approximately 46% (relative to coverage on MDC lands only), or approximately 20,400 acres annually over the course of the 50-year permit term. Such an increase in covered lands provides greater opportunities to support conservation of northern long-eared bats on private lands across Missouri.

5.3.3.2 Net Effects

Implementation of the HCP will allow development of approximately 11 acres of preferred habitat (forests, woodlands, and glades) per year (525 acres over the permit term) including approximately 2 acres per year of fall/spring and 9 acres per year in areas where northern long-eared bats are most common during summer (Tables 4-7 and 4-8). This equates to less than 1% of the preferred land cover types on MDC lands (0.07%) and on fall/spring habitat (0.07%) on MDC lands over the permit term.

MDC also seeks to permit trees removed for maintenance activities. Impacts from this activity will not result in land conversion and will affect 141 acres per year with 30 (22%) acres being within fall/spring habitat (Table 4-7).

Clearing and maintaining developed areas are a minor portion of the HCP. The core activity permitted by the HCP—habitat management (e.g., prescribed fire and tree removal for habitat restoration and management)—maintains and improves habitat on the landscape over the long term but may take up to 0.02 northern long-eared bats (0.02% of northern long-eared bats that hibernate in the state each winter) per year (Table 5-4). These covered activities will affect up to 3,606 acres of preferred land covers within spring/fall habitat and 14,809 acres of preferred land covers across all land owners annually (Tables 4-11 and 4-12). Retention guidelines as described in Objectives 3.1 and 3.3 are anticipated to avoid and minimize impacts on northern long-eared bat and provide long-term enhancements to foraging and roosting habitat. Notably, the number of snags per unit area is higher on MDC-managed lands, indicating that MDC activities create habitat relative to other land ownerships, consistent with cited literature on the benefits of active management for bats (Taylor 2006; Silvis et al. 2012; Sheets et al. 2013; Pauli et al. 2015a; Pauli et al. 2015b; Ford et al. 2016; Neubaum et al. 2017; Pauli et al. 2017; Johnson and King 2018). The covered activities, as implemented with the conservation measures described in Section 5.2, *Biological Goals and*

Objectives, enhance foraging habitat by creating edge or by opening a stand so that it is easier for northern long-eared bats to fly (Taylor 2006; Sheets 2010; Blakey et al. 2016; Neubaum et al. 2017). Forest treatments (especially timber harvest) also play a key role in directing the growth of young forest, some of which will become highly suitable roosting habitat during the permit term. Over time, this would be expected to result in a net increase in fecundity and reproduction (Silvis et al. 2012; Pauli et al. 2015b).

Avoidance and minimization measures will greatly reduce the potential loss of bats associated with implementation of the covered activities. This includes the implementation of a 10-mile protective buffer around Sodalis Nature Preserve, a measure that is expected to reduce potential mortality of northern long-eared bat by approximately 3%. Additional, 5-mile protective buffers around Priority 1 and Priority 2 hibernacula along with the 20-acre buffer around other known and potential hibernacula are expected to all but eliminate mortality during fall/spring. Similarly, protection of 7,000 acres of known roosting habitat within PBMZs for northern long-eared bats, 21,000 acres of PBMZs for other species, and 150 feet (an area of 1.6 acres for a single tree) around known roosts, and retention of potential roost trees (snags and cavity trees) will greatly reduce the number of bats killed or harmed by forestry operations. Even when a tree containing volant bats is disturbed or felled, the presence of other suitable roost trees in the surrounding landscape should allow these bats to rapidly move to a new roost and minimize the potential for these bats to be taken by predators (Sparks 2008).

The few bats killed will be offset by increased bat fecundity and survivorship that is accomplished through habitat management. With the implementation of the HCP, 64,773 acres (0.42%) of preferred land covers for northern long-eared bats in the plan area will be enhanced every year. In keeping with USFWS recommendations (Johnson and King 2018), this includes efforts to provide exceptional habitat for northern long-eared bats in areas where the species is known or suspected to concentrate. Every cave (i.e., potential hibernaculum) on MDC lands will be surrounded by 20 acres that are managed as old-growth forest to ensure stability of the site and provide exceptional roosting and foraging habitat for swarming/staging bats. This is especially important for northern long-eared bats and other covered bats, which tend to roost very close to hibernacula during swarming (Lowe 2012). MDC will also monitor cave entrances on MDC lands and take steps necessary to ensure these sites remain accessible for bats. MDC will develop 7,000 acres of PBMZs around known and suspected maternity roosts. Habitat within these areas will be managed to ensure bats have access to areas of high-quality foraging habitat and areas where high-quality potential roosts are abundant. These areas will be protected, enhanced, and, if necessary, will be redelineated to adjust for changes through time, particularly with respect to WNS.

In summary, the following measures highlight the beneficial effects on bats and contribute to the net effects analysis.

- Protection and management of 700,000 acres of forests, woodlands, and glades that cannot be developed.
- Protection and management of 200,000 acres of open habitats that cannot be developed.
- Management and enhancement activities on approximately 9,560 acres of preferred fall/spring habitat and 44,360 acres of preferred summer habitat each year on lands owned/managed by MDC.

- Management and enhancement activities on approximately 2,150 acres of preferred fall/spring habitat and 20,400 acres of preferred summer habitat (total habitat) each year on lands owned/managed by other nonfederal cooperators.
- Creation of 7,000-acre PBMZs around known northern long-eared bat maternity colonies in which MDC will apply seasonal avoidance to limit potential take and apply positive management to generate improved habitat in areas of known occupancy.
- Protective buffers (150 feet) around all known roosts on MDC lands outside the PBMZs
- Implementation of a 10-mile buffer around Sodalis Nature Preserves that avoids approximately 3% of estimated impacts on northern long-eared bat
- Implementation of seasonal avoidance within 5 miles of the seven Priority 1 and Priority 2 hibernacula for Indiana bats on MDC lands—most of which also contain northern long-eared bats.
- Protection and management of 20 acres around all caves on MDC land including all known northern long-eared bat hibernacula
- Monitoring and maintenance of cave entrances on MDC lands.
- Creation of 21,000 acres of PBMZs around areas of known or suspected occupancy for Indiana, little brown, and tricolored bats which may also contain northern long-eared bats. Within these areas MDC will apply seasonal avoidance to limit potential take and apply positive management to generate improved habitat in areas of known occupancy.
- Outreach, extension, WNS research, and training associated with northern long-eared bat and other covered bats.

Noting that the estimates of take in Chapter 4, *Effects Analysis*, are highly conservative and designed to overestimate impacts, the conservation strategy fully offsets the impact of the taking on 0.02% of the northern long-eared bat population that winters in Missouri and less than 0.2% and 0.1% of occupied preferred fall/spring and summer habitat for northern long-eared bats per year, respectively (Tables 4-12 and 4-13). Table 5-4 provides an overview of those conservation measures that help avoid and offset take.

5.3.4 Little Brown Bat

5.3.4.1 Beneficial Effects

While addressed as covered activities, the forest management actions covered by the HCP have a net long-term positive effect on bat habitat (see Appendix D, *Literature Review for the Impact of Forestry on Bats*).

Missouri has never been considered part of the "core" range of little brown bats. As part of the species assessment process, USFWS used expert solicitation to estimate populations of little brown bats (Szymanski 2013). Regional experts (bat biologists active in the region) indicated a median population of 3.5 million bats (range 1.5 to 8 million bats) in the United States east of the 100th meridian. The species was noted as being most abundant in the Northeast and upper Midwest, with Missouri near the southern edge of the species' range, where large hibernating populations are rare. Thus, the MDC Bat HCP will expose only a small portion of the overall little brown bat population to risk. However, conservation measures that protect and manage little brown bats may prove

important because marginal populations have proven to be crucial to conservation efforts for species whose ranges have collapsed (Channell and Lomolino 2000).

The MDC Bat HCP will benefit little brown bats by providing 50 years of guaranteed protection and management for a minimum of 900,000 acres of natural habitat, including 700,000 acres of preferred land covers (forests, woodlands, and glades) and 200,000 acres of open lands under MDC jurisdictions (Objectives 1.1 and 1.2). The HCP represents a commitment by the state of Missouri to maintain and manage these lands for the 50-year permit term—an important assurance at a time when some states are considering divestment of public lands. MDC currently owns/manages approximately 5% of the nonfederal lands in the state that provide preferred habitat used by little brown bats when they are above ground (Table 4-5). The HCP also provides a means by which MDC can also provide support to private landowners who seek to implement habitat management efforts that maintain these landscapes in habitat that is suitable for use by bats. This benefit is especially important in Missouri, where sustainable forestry and prescribed fire can improve habitat for little brown bats by supporting existing population and promote species recovery from WNS, should a cure be identified or natural recovery occur. Most little brown bats in Missouri likely form maternity colonies in buildings on private lands (Boyles et al. 2009), and coordination with these private landowners provides MDC with a means of locating and protecting such colonies.

Within the 745,000 acres of preferred habitat currently managed by MDC, the following numbers are managed annually with retention guidelines (Objectives 3.1 and 3.2) and bat-friendly burn plans (Objective 5.1) in a way that benefits little brown bat (Tables 4-2 and 4-5):

- Approximately 9,190 acres of preferred fall/spring habitat (forests, woodland, and glades),
- Approximately 38,800 acres of preferred high-occupancy summer habitat (where colonies of little brown bats are most abundant), and
- Approximately 44,360 acres of preferred habitat types over all occupancy levels.

This values correspond to managing approximately 6% of preferred fall/spring and 6% of preferred summer habitat types on MDC lands each year, making this conservation measure highly relevant for to the species (Tables 4-2 and 4-5). Similar efforts on private lands manage the following:

- Approximately 2,420 acres per year of preferred fall/spring habitat
- Approximately 18,410 acres per year of preferred high-occupancy summer habitat, and
- Approximately 20,420 acres per year of preferred habitat types of all occupancy levels.

Prescribed Fire. Specifically, 24,000 acres per year (20,600 on MDC lands, Table 4-5) of prescribed fires in forests, woodlands, and glades are anticipated to create forest conditions that are desirable for covered bats (Objective 1.3). Of the 24,000 acres, 4,600 acres per year (4,200 on MDC lands, Table 4-2) on average will occur in fall/spring habitat. Prescribed fires provide multiple benefits for little brown bats, such as the creation of high-quality foraging habitat and high-quality roosting habitat by killing and damaging trees such that future snags are created or roosting opportunities (e.g., crevices, cracks, dead limbs) on living trees are enhanced. The creation and conservation of roosts is regularly recommended as a strategy to decrease the risk of threats to local bat populations (e.g., WNS) (Neubaum et al. 2017). Enhanced roosting conditions reduce energetic costs, increase survival, and enhance recovery from WNS (Wilcox 2016). In fact, studies completed on MDC's Deer Ridge Conservation Area provide evidence that fires created roosts and improved foraging habitat for bats by removing clutter (Boyles and Aubrey 2006). Studies in other states have also provided

evidence for the benefits of prescribed fire (Ford et al. 2016). By creating more and better roosts with increased solar exposure within a landscape that contains high-quality foraging habitat, prescribed fire provides a means of limiting post-emergence mortality from WNS and increasing survivorship and reproductive success in summer.

Tree Removals. Tree removals (especially limited timber harvest) are anticipated to impact individual bats over the short term but provide benefits to bats over the long term. On MDC lands, tree removals will affect little brown bat habitat annual as follows (Tables 4-2 and 4-5):

Approximately 24,000 acres of preferred land cover,

- Approximately 5,000 acres of preferred fall/spring habitat, and
- Approximately 20,800 acres in areas where little brown bats are most abundant (i.e., high occupancy preferred land cover) during summer.

Similar activities on other nonfederal lands will affect little brown bat annually as follows (Tables 4-2 and 4-5):

- More than 17,000 acres of preferred land cover,
- Approximately 2,000 acres of preferred fall/spring habitat, and
- Approximately, 15,300 acres in preferred high-occupancy habitat during the summer.

Over 50 years, these activities are expected to promote diversity of forest types and ages, and thus a diversity of suitable little brown bat foraging and roosting habitat, across the state. A lack of forest management in some areas of Missouri has led to homogeneous forests composed of dense stands lacking species and structural diversity that provide high-quality bat habitat. Over 50 years of the permit, forestry activities will occur across approximately 13% of the summer habitat and 18% of fall/spring habitat, thus creating a variety of habitat types for little brown bats. Most tree removal conducted by MDC is aimed at directing the long-term growth and development of a stand as it relates to the surrounding landscape. Different management techniques result in optimal conditions (e.g., a mix of forests and openings, especially wetlands; low subcanopy clutter; diversity of snag-decay classes/sizes; higher solar exposure for roost trees; and a variety of habitats that yield a variety of insects) for the little brown bat. Management techniques implemented by MDC promote heterogeneity in forests across Missouri, providing appropriate species composition and forest structure necessary to maintain long-term viability of bat populations (Johnson and King 2018). Forests with greater diversity are more capable of coping with fluctuations in environmental conditions than even-aged forests composed of relatively few tree species. Such resilience can help buffer against climate change and its potential effects on Missouri's forests (e.g., increased risk of novel forest pathogens). Contemporary management of forests enhances future habitat quality, improving survival rates for the little brown bat.

As mentioned above, forest management activities improve conditions for covered bats (see Appendix D, *Literature Review for the Impact of Forestry on Bats*). When implemented with the conservation measures associated with Objective 3.2, these covered activities will benefit little brown bats. Most trees removed during timber sales are mature, healthy trees that provide minimal roosting opportunities for little brown bats. Snags and other suitable roosting trees specifically retained within harvested stands will have increased solar exposure and consequently improved quality (Missouri Department of Conservation 2000; U.S. Fish and Wildlife Service 2007; Missouri Department of Conservation 2014; Johnson and King 2018). Over time, as the forest regenerates, the

older trees retained during the harvest die and provide roosting opportunities in stands that otherwise are dominated by younger trees. In addition to improving the quality of retained roosts, the quality of foraging habitat is also improved after tree removal. Forest-management practices that create small forest openings reduce canopy cover, thus increasing light penetration to the forest floor. Increased light promotes growth of herbaceous vegetation, which contributes to increased diversity and abundance of insect populations that make up the diet of the little brown bat. Newly managed stands may also provide the edge habitat for foraging little brown bats roosting in adjacent stands, which can be important in areas where access to edge is limited (Bergeson et al. 2013). Increases in the quality and quantity of foraging and roosting habitat will have a beneficial effect on species reproduction, abundance, and distribution (Neubaum et al. 2017; Johnson and King 2018).

PBMZs. MDC is also committing to developing 7,000 acres of PBMZs in areas known or suspected to contain surviving populations of little brown bats (Objective 3.3). Within PBMZs, the focus will be on managing for habitat that is beneficial for little brown bats, including increasing the quality and quantity of potential roosts, foraging habitat, and close proximity to water (Taylor 2006; Johnson and King 2018) (see Appendix F, PBMZ Future Desired Conditions). Further, these zones (together with Objective 3.2) are committed to avoiding impacts on maternity colonies through time-of-year restrictions. Habitat management completed within these stands will avoid removal of trees greater than 9 inches diameter at breast height during the summer maternity season (April 1 to August 31). Prescribed fire will avoid the period when pregnant bats and pre-volant pups may have trouble escaping roosts (May 1 to July 31). As suggested by Johnson and King (2018), creation of PBMZs and adherence to time-of-year restrictions will avoid impacts on known maternity colonies when the species is most vulnerable, thus improving the survival rate of the species relative to baseline conditions. Management aimed at enhancing quality of foraging habitat in PBMZs will result in a net increase in the species' fitness by increasing quality of prey (e.g., increased diversity and abundance of lepidopterans) and decreasing energy demands associated with foraging. As described above, enhanced roosting conditions reduce energetic costs, increase survival, and improve chances of recovery from WNS (Wilcox and Willis 2016). Further, prior to WNS, all of the covered bats could be found within the same communities. These bats also share many similarities in habitat use. Thus, it is likely that the 21,000 acres of PBMZs created for Indiana, northern long-eared, and tricolored bats will also benefit little brown bats.

Buffers. Although the 10-mile buffer at Sodalis Nature Preserve is aimed primarily at protecting Indiana bats, the site also contains an estimated population of 77 little brown bats, one of Missouri's most populous sites. Areas near hibernacula host large densities of bats during fall swarming and spring staging, and bats can be particularly vulnerable to impacts from tree felling and other habitat management activities during these periods. The 10-mile buffer around Sodalis Nature Preserve will dramatically increase protections for little brown bats in the plan area (see Table 5-3). Nearly 4% of estimated mortality associated with covered activities is avoided through implementation of this buffer (Table 5-3). Buffers of 5 miles will also be maintained around the four Priority 1 and three Priority 2 Indiana bat hibernacula on MDC lands, which also contain little brown bats.

Cave Protections. MDC will also manage 20 acres as old-growth forest around entrances of every known hibernaculum on MDC lands (Objective 4.2). Little brown bats rely on a wide variety of caves and other subterranean sites during winter for hibernation. Hibernating bats are sensitive to human disturbance during this period and are vulnerable to impacts associated with unanticipated arousal, which is energetically demanding (Thomas et al. 1990; Boyles and Brack 2009). Conservation measures associated with this objective protect the entrances of hundreds of potential hibernacula from most activities and provide an area with a high density of potential roosts for bats to use

during swarming and staging. This not only protects known hibernacula on MDC lands, but also protects sites that may contain undetected populations of little brown bats or sites that are used only during swarming. Objectives 4.1 and 4.3 further address the protection of critical winter habitat features on MDC lands. Protection of hibernacula and surrounding areas where bats swarm and stage for hibernation is invaluable to the species and perhaps the single biggest conservation benefit provided by the HCP (Furey and Racey 2016).

Outreach. Finally, the HCP extends MDC management criteria onto the lands of willing private citizens who have typically fallen beneath USFWS's enforcement threshold (Objective 2.1). Thus, not only do these conservation measures reduce the potential for incidental take on MDC lands, they also provide private citizens with an incentive and technical assistance to manage their lands to the benefit of covered species. Extension onto private lands increases the amount of managed preferred habitat covered by the MDC Bat HCP by approximately 46% (relative to coverage on MDC lands only), or approximately 20,400 acres annually over the course of the 50-year permit term. Such an increase in covered lands provides greater opportunities to support conservation of little brown bats on private lands across Missouri.

5.3.4.2 Net Effects

Implementation of the HCP will allow development of approximately 11 acres of preferred habitat (forests, woodlands, and glades) per year (525 acres over the permit term) including approximately 2 acres per year of fall/spring and 9 acres per year in areas where little brown bats are most common during summer (Tables 4-7 and 4-8). This equates to less than 1% of the preferred land cover types on MDC lands (0.07%) and on fall/spring habitat (0.07%) on MDC lands over the permit term.

MDC also seeks to permit trees removed for maintenance activities. Impacts from this activity will not result in land conversion and will affect 141 acres per year with 29 (21%) of those being within fall/spring habitat (Table 4-7).

Clearing and maintaining developed areas are a minor portion of the HCP. The core activity permitted by the HCP—habitat management (e.g., prescribed fire and tree removal for habitat restoration and management—maintains and improves habitat on the landscape over the long term but may take up to 0.12 little brown bats (0.02% of little brown bats that hibernate in the state each winter) per year (Table 5-4). These covered activities will affect up to 3,556 acres of preferred land covers within spring/fall habitat and 14,809 acres of preferred land covers across all land owners annually (Tables 4-11 and 4-12). The retention guidelines as described in Objectives 3.1 and 3.3 are anticipated to avoid and minimize impacts on little brown bat and improve foraging and roosting habitat over the long term. Notably, the number of snags per unit area is higher on MDC-managed lands indicating that MDC activities create habitat relative to other land ownerships, consistent with cited literature on the benefits of active management for bats (Taylor 2006; Silvis et al. 2012; Sheets et al. 2013; Pauli et al. 2015a; Pauli et al. 2015b; Ford et al. 2016; Neubaum et al. 2017; Pauli et al. 2017; Johnson and King 2018). The covered activities, as implemented with the conservation measures described in Section 5.2, *Biological Goals and Objectives*, enhance foraging habitat by creating edge or by opening a stand so that it is easier for little brown bats to fly (Taylor 2006; Sheets 2010; Neubaum et al. 2017). Forest treatments (especially timber harvest) also play a key role in directing the growth of young forest some of which will become highly suitable roosting habitat during the permit term. Over time, this would be expected to result in a net increase in fecundity and reproduction (Silvis et al. 2012; Pauli et al. 2015b).

Avoidance and minimization measures will greatly reduce the potential loss of bats associated with implementation of the covered activities. This includes the implementation of a 10-mile protective buffer around Sodalis Nature Preserve, a measure that is expected to reduce potential mortality of little brown bat by approximately 4%. Additional, 5-mile protective buffers around Priority 1 and Priority 2 hibernacula along with the 20-acre buffer around other known and potential hibernacula are expected to all but eliminate mortality during fall/spring. Similarly, protection of 7,000 acres of known roosting habitat within PBMZs for little brown bats, 21,000 acres of PBMZs for other species, and 150 feet (an area of 1.6 acres for a single tree) of known roosts, and retention of potential roost trees (snags and cavity trees) should greatly reduce the number of bats killed or harmed by forestry operations. Even when a tree containing bats is disturbed or felled, the presence of other suitable roost trees in the surrounding landscape should allow these bats to rapidly move to a new roost and minimize the potential for these bats to be taken by predators (Sparks 2008).

The few bats killed will be offset by increased bat fecundity and survivorship that is accomplished through habitat management. With the implementation of the HCP, 64,733 acres (0.42%) of preferred land covers for little brown bats in the plan area will be enhanced every year. In keeping with USFWS recommendations (Johnson and King 2018), this includes efforts to provide exceptional habitat for little brown bats in areas where the species is known or suspected to concentrate. Every cave (i.e., a potential hibernacula) on MDC lands will be surrounded by 20 acres that are managed as old-growth forest to ensure stability of the site and provide exceptional roosting and foraging habitat for swarming/staging bats. This is especially important for little brown bats, which tend to roost very close to hibernacula during swarming (Lowe 2012). MDC will also monitor cave entrances on MDC lands and take steps necessary to ensure these sites remain accessible for bats. MDC will develop 7,000 acres of PBMZs around known maternity roosts. Habitat within these areas will be managed to ensure bats have access to areas of high-quality foraging habitat and areas where high-quality potential roosts are abundant. PBMZs will target areas most likely to contain maternity colonies. These areas will be protected and enhanced and will be redelineated to adjust for changes through time, particularly with respect to WNS.

In summary, the following measures highlight the beneficial effects on bats and contribute to the net effects analysis.

- Protection and management of 700,000 acres of forests, woodlands, and glades that cannot be developed.
- Protection and management of 200,000 acres of open habitats that cannot be developed.
- Management and enhancement activities on approximately 9,200 acres of preferred fall/spring habitat and 44,000 acres of preferred summer habitat each year on lands owned/managed by MDC.
- Management and enhancement activities on approximately 2,400 acres of preferred fall/spring habitat and 20,000 acres of preferred summer habitat each year on lands owned/managed by other nonfederal cooperators.
- Creation of 7,000-acre PBMZs around known Indiana bat maternity colonies in which MDC will apply seasonal avoidance to limit potential take and apply positive management to generate improved habitat in areas of known occupancy.
- Protective buffers (150 feet) around all known roosts on MDC lands outside the PBMZs.

- Implementation of a 10-mile buffer around Sodalis Nature Preserves that avoids approximately 4% of estimated impacts on little brown bat.
- Implementation of seasonal avoidance within 5 miles of the seven Priority 1 and Priority 2 hibernacula for Indiana bats on MDC lands—most of which also contain little brown bats.
- Protection and management of 20 acres around all caves on MDC land, including all known little brown bat hibernacula.
- Monitoring and maintenance of cave entrances on MDC lands.
- Creation of 21,000 acres of PBMZs around areas of known or suspected occupancy for Indiana, northern long-eared, and tricolored bats, which may also contain little brown bats. Within these areas MDC will apply seasonal avoidance to limit potential take and apply positive management to generate improved habitat in areas of known occupancy.
- Outreach, extension, WNS research, and training associated with little brown bat.

Noting that the estimates of take in Chapter 4, *Effects Analysis*, are highly conservative and designed to overestimate impacts, the conservation strategy fully offsets the impact of the taking on 0.02% of the little brown bat population that winters in Missouri and less than 0.2% and 0.1% of occupied preferred fall/spring and summer habitat for little brown bats per year, respectively (Tables 4-12 and 4-13). Note the mortality estimate does not account for the fact that most little brown bats roost in buildings, and thus are not exposed to forestry operations. Table 5-4 provides an overview of those conservation measures that help avoid and offset take.

5.3.5 Tricolored Bat

5.3.5.1 Beneficial Effects

While addressed as covered activities, the forest management actions covered by the HCP have a net long-term positive effect on bat habitat (see Appendix D, *Literature Review for the Impact of Forestry on Bats*).

Further, the MDC Bat HCP will benefit tricolored bats by providing 50-years of guaranteed protection and management for a minimum of 900,000 acres of natural habitat, including 700,000 acres of preferred land covers (forests, woodlands, and glades) and 200,000 acres of open lands under MDC jurisdictions (Objectives 1.1 and 1.2). The HCP represents a commitment by the state of Missouri to maintain and manage these lands for the 50-year permit term—an important assurance at a time when some states are considering divestment of public lands. MDC currently owns/manages approximately 5% of the nonfederal lands in the state that provide preferred habitat used by tricolored bats when they are above ground (Table 4-6). The plan also provides a means by which MDC can also provide support to private landowners who seek to implement habitat management efforts that maintain these landscapes in habitat that is suitable for use by bats. This benefit is especially important in Missouri, where sustainable forestry and prescribed fire can improve habitat for tricolored bats by supporting the existing population and promote species recovery from WNS, should a cure be identified or natural recovery occur. Thus, the HCP provides the most direct means of ensuring protections of activities season habitat for tricolored bats on working lands.

Within the 745,000 acres of preferred habitat currently managed by MDC, the following numbers are managed annually with retention guidelines (Objectives 3.1 and 3.2) and bat-friendly burn plans (Objective 5.1) in a way that benefits tricolored bat (Tables 4-2 and 4-6):

- Approximately 43,000 acres of preferred high-occupancy summer habitat (forests, woodlands, and glades),
- More than 44,000 acres of preferred habitat types overall occupancy levels.

These values correspond to managing approximately 6% of fall/spring and 6% of preferred summer habitat types on MDC lands each year, making this conservation measure highly relevant to the species (Tables 4-2 and 4-6). Similar efforts on private lands manage the following:

- Approximately 2,300 acers per year of preferred fall/spring habitat,
- Approximately 19,500 acres per year of preferred high-occupancy summer habitat, and
- More than 20,000 acres per year of preferred summer habitat types across all occupancy levels.

Prescribed Fire. Specifically, 24,000 acres per year (20,600 on MDC lands, Table 4-3) of prescribed fires in forests, woodlands, and glades are anticipated to create forest conditions that are desirable for covered bats (Objective 1.3). Of the 24,000 acres, 5,300 acres per year (4,900 on MDC lands, Table 4-2) on average will occur in fall/spring habitat. Prescribed fires provide multiple benefits for tricolored bats, such as the creation of high-quality foraging habitat and high-quality roosting habitat by favoring oak-hickory systems over those dominated by maples (Carter et al. 2002). The creation and conservation of roosts is regularly recommended as a strategy to decrease the risk of threats to local bat populations (e.g., WNS) (Neubaum et al. 2017). Enhanced roosting conditions reduce energetic costs, increase survival, and enhance recovery from WNS (Wilcox and Willis 2016). By creating more and better roosts with increased solar exposure located within a landscape that contains high-quality foraging habitat, prescribed fire provides a means of limiting post-emergence mortality from WNS, and increasing survivorship and reproductive success in summer.

Tree Removals. Tree removals (especially limited timber harvest) are anticipated to impact individual bats over the short term but provide benefits to bats over the long term. On MDC lands, tree removals will affect tricolored bat habitat annually as follows (Tables 4-2 and 4-6):

- Approximately 24,000 acres of preferred land cover,
- Approximately 5,600 acres of preferred fall/spring habitat, and
- Approximately 23,200 acres per year in areas where tricolored bats are most abundant (i.e., high-occupancy preferred land cover) during summer.

Similar activities on other nonfederal lands will affect tricolored bat habitat annually as follows (Tables 4-2 and 4-6):

- Approximately 17,000 acres of preferred land cover in the summers,
- Approximately 1,900 acres of preferred fall/spring habitat, and
- Approximately 16,000 acres in high-occupancy preferred habitat during the summer.

Over 50 years, these activities are expected to promote diversity of forest types and ages, and thus promote a diversity of suitable tricolored bat foraging and roosting habitat, across the state. A lack of forest management in some areas of Missouri has led to homogeneous forests composed of dense stands lacking species and structural diversity that provide high-quality bat habitat. Over 50 years of

the permit, forestry activities will occur across approximately 13% of the summer habitat and 21% of fall/spring habitat, thus creating a variety of habitat types for tricolored bats. Most tree removal conducted by MDC is aimed at directing the long-term growth and development of a stand as it relates to the surrounding landscape. Different management techniques result in optimal conditions (e.g., low subcanopy clutter, diversity of snag-decay classes/sizes, higher solar exposure for roost trees, enhanced herbaceous vegetation promoting insect abundance and diversity) for tricolored bat. Management techniques implemented by MDC promote heterogeneity in forests across Missouri, providing appropriate species composition and forest structure necessary to maintain long-term viability of bat populations (Johnson and King 2018). Forests with greater diversity are more capable of coping with fluctuations in environmental conditions than even-aged forests composed of relatively few tree species. Such resilience can help buffer against climate change and its potential effects on Missouri's forests (e.g., increased risk of novel forest pathogens). Contemporary management of forests enhances future habitat quality, improving survival rates for the tricolored bat.

As mentioned above, forest management activities improve conditions for covered bats (see Appendix D, *Literature Review for the Impact of Forestry on Bats*). When implemented with the conservation measures associated with Objective 3.2, these covered activities will benefit tricolored bats. Most trees removed during timber sales are mature, healthy trees that provide minimal roosting opportunities for tricolored bats. Snags and other suitable roosting trees specifically retained within harvested stands will have increased solar exposure and consequently improved quality (Missouri Department of Conservation 2000; U.S. Fish and Wildlife Service 2007; Missouri Department of Conservation 2014, Johnson and King 2018). For tricolored bats, retained trees provide access to leaf clusters that are both protected from predators and also have access to solar warming (Veilleux et al. 2003; Veilleux and Veilleux 2004; Veilleux et al. 2004; Boyles 2007; Perry and Thill 2007). Over time, as the forest regenerates, the older trees retained during the harvest die and provide roosting opportunities in stands that otherwise are dominated by younger trees. In addition to improving the quality of retained roosts, the quality of foraging habitat is also improved after tree removal. Forest-management practices that create small forest openings reduce canopy cover, thus increasing light penetration to the forest floor. Increased light promotes growth of herbaceous vegetation, which contributes to increased diversity and abundance of insect populations that make up the diet of Indiana bat. Newly managed stands may also provide the edge habitat for foraging Indiana bats roosting in adjacent stands, which can be important in areas where access to edge is limited (Sparks et al. 2004; Taylor 2006). Increases in the quality and quantity of foraging and roosting habitat will have a beneficial effect on species reproduction, abundance, and distribution (Neubaum et al. 2017; Johnson and King 2018).

PBMZs. MDC is also committing to developing 7,000 acres of PBMZs in areas known or suspected to contain maternity roosts of tricolored bats (Objective 3.3). Within PBMZs, the focus will be on managing for habitat that is beneficial for tricolored bats, including increasing the quality and quantity of potential roosts, foraging habitat, and close proximity to water (Taylor 2006; Johnson and King 2018) (see Appendix F, PBMZ Future Desired Conditions). Further, these zones (together with Objective 3.2) are committed to avoiding impacts on maternity colonies through time-of-year restrictions. Habitat management completed within these stands will avoid removal of trees greater than 9 inches diameter at breast height during the summer maternity season (April 1 to August 31). Prescribed fire will avoid the period when pregnant bats and pre-volant pups may have trouble escaping roosts (May 1 to July 31). As suggested by Johnson and King (2018), creation of PBMZs and adherence to time-of-year restrictions will avoid impacts on known maternity colonies when the

species is most vulnerable, thus improving the survival rate of the species relative to baseline conditions. Management aimed at enhancing quality of foraging habitat in PBMZs will result in a net increase in the species' fitness by increasing quality of prey (e.g., increased diversity and abundance of lepidopterans) and decreasing energy demands associated with foraging. As described above, enhanced roosting conditions reduce energetic costs, increase survival, and improve chances of recovery from WNS (Wilcox and Willis 2016).

Buffers. Although primarily targeted at protecting Indiana bats, Sodalis Nature Preserve protects an estimated population of 359 tricolored bats. Areas near hibernacula host large densities of bats during fall swarming and spring staging, and bats can be particularly vulnerable to impacts from tree felling and other habitat management activities during these periods. The 10-mile buffer around Sodalis Nature Preserve will dramatically increase protections for tricolored bats in the plan area (see Table 5-3). Over 1% of estimated mortality associated with covered activities is avoided through implementation of this buffer. Buffers of 5 miles will also be maintained around the four Priority 1 and three Priority 2 hibernacula of Indiana bats on MDC lands, which avoid most remaining impacts on this species.

Cave and Other Protections. MDC will also manage 20 acres as old-growth forest around entrances of every known hibernaculum on MDC lands (Objective 4.2). Tricolored bats use a wide variety of caves and other subterranean sites during winter for hibernation. Hibernating bats are sensitive to human disturbance during this period and are vulnerable to impacts associated with unanticipated arousal, which is energetically demanding (Thomas et al. 1990; Boyles and Brack 2009). Conservation measures associated with this objective will protect more than 100 potential hibernacula from most activities and provide an area with a high density of potential roosts for bats to use during swarming and staging. This not only protects known hibernacula on MDC lands, but also protects sites that may contain undetected populations of tricolored bats or sites that are used only during swarming. Objectives 4.1 and 4.3 further address the protection of critical winter habitat features on MDC lands. Protection of hibernacula and surrounding areas where bats swarm and stage for hibernation is invaluable to the species and perhaps the single biggest conservation benefit provided by the HCP (Furey and Racey 2015).

Tricolored bats routinely use buildings for roosts, especially in early spring (Whitaker 1998; Whitaker et al. 2014). By checking buildings for roosting bats before demolition, MDC can then use seasonal avoidance to prevent take of covered bats that are roosting in or on buildings.

Outreach. Finally, the HCP extends MDC management criteria onto the lands of willing private citizens who have typically fallen beneath USFWS's enforcement threshold (Objective 2.1). Thus, not only do these conservation measures reduce the potential for incidental take on MDC lands, they also provide private citizens with an incentive and technical assistance to manage their lands to the benefit of covered species. Extension onto private lands increases the amount of managed preferred habitat covered by the HCP by approximately 46% (relative to coverage on MDC lands only), or approximately 20,400 acres annually over the course of the 50-year permit term. Such an increase in covered lands provides greater opportunities to support conservation of tricolored bats on private lands across Missouri.

5.3.5.2 Net Effects

Implementation of the HCP will allow development of approximately 11 acres of preferred habitat (forests, woodlands, and glades) per year (525 acres over the permit term), including approximately

3 acres per year of fall/spring and 10 acres per year in areas where tricolored bats are most common during summer (Tables 4-7 and 4-8). This equates to less than 1% of the preferred land cover types on MDC lands (0.07%) and on fall/spring habitat (0.07%) on MDC lands over the permit term.

MDC also seeks to permit trees removed for maintenance activities. Impacts from this activity will not result in land conversion and will affect 141 acres per year, with 34 (25%) of those being within fall/spring habitat (Table 4-7).

Clearing and maintaining developed areas are a minor portion of the plan. The core activity permitted by the plan—habitat management (e.g., prescribed fire and tree removal for habitat restoration and management)—maintains and improves habitat on the landscape over the long term but may take up to 1.83 tricolored bats (0.02% of the tricolored bats that hibernate in the state each winter) per year (Table 5-4). These covered activities will affect up to 3,977 acres of preferred land covers within spring/fall habitat and 14,809 acres of preferred land covers across all land owners annually (Tables 4-11 and 4-12). The retention guidelines as described in Objectives 3.1 and 3.3 are anticipated to avoid and minimize impacts on tricolored bat and improve foraging and roosting habitat over the long term. Notably, the number of snags per unit area is higher on MDC-managed lands, indicating that MDC activities create habitat relative to other land ownerships, consistent with cited literature on the benefits of active management for bats (Taylor 2006; Silvis et al. 2012; Sheets et al. 2013; Pauli et al. 2015a; Pauli et al. 2015b; Ford et al. 2016; Neubaum et al. 2017; Pauli et al. 2017; Johnson and King 2018). The covered activities, as implemented with the conservation measures described in Section 5.2, *Biological Goals and Objectives*, enhance foraging habitat by creating edge or by opening a stand so that it is easier for Indiana bats to fly (Taylor 2006; Sheets 2010; Neubaum et al. 2017). Forest treatments (especially timber harvest) also play a key role in directing the growth of young forest, some of which will become highly suitable roosting habitat during the permit term. Over time, this would be expected to result in a net increase in fecundity and reproduction (Silvis et al. 2012; Pauli et al. 2015b).

Avoidance and minimization measures will greatly reduce the potential loss of bats associated with implementation of the covered activities. This includes the implementation of a 10-mile protective buffer around Sodalis Nature Preserve, a measure that is expected to reduce potential mortality by approximately 1%. Additional, 5-mile protective buffers around Priority 1 and Priority 2 hibernacula for Indiana bats along with the 20-acre buffer around other known and potential hibernacula are expected to all but eliminate mortality during fall/spring. Similarly, protection of 7,000 acres of known roosting habitat within PBMZs for tricolored bats, 21,000 acres of PBMZs for other species, and 150 feet (an area of 1.6 acres for a single tree) of known roosts, and retention of potential roost trees (live trees) should greatly reduce the number of bats killed or harmed by forestry operations. Even when a tree containing bats is disturbed or felled, the presence of other suitable roost trees in the surrounding landscape should allow these bats to rapidly move to a new roost and minimize the potential for these bats to be taken by predators (Sparks 2008).

The few bats killed will be offset by increased bat fecundity and survivorship that is accomplished through habitat management. With the implementation of the HCP, 64,773 acres (0.42%) of preferred land covers for tricolored bats in the plan area will be enhanced every year. In keeping with USFWS recommendations (Johnson and King 2018), this includes efforts to provide exceptional habitat for tricolored bats in areas where the species is known or suspected to concentrate. Every cave (i.e., a potential hibernacula) on MDC lands will be surrounded by 20 acres that are managed as old-growth forest to ensure stability of the site and provide exceptional roosting and foraging

habitat for swarming/staging bats. This is especially important for tricolored bats that are often found in caves unused by other species. MDC will also monitor cave entrances on MDC lands and take steps necessary to ensure these sites remain accessible for bats. MDC will develop 7,000 acres of PBMZs around known and suspected maternity roosts. Habitat within these areas will be managed to ensure bats have access to areas of high-quality foraging habitat and areas where high-quality potential roosts are abundant. These areas will be protected and enhanced and will be redelineated to adjust for changes through time, particularly with respect to WNS.

In summary, the following measures highlight the beneficial effects on bats and contribute to the net effects analysis:

- Protection and management of 700,000 acres of forests, woodlands, and glades that cannot be developed.
- Protection and management of 200,000 acres of open habitats that cannot be developed.
- Management and enhancement activities on approximately 10,600 acres of preferred fall/spring habitat and 44,000 acres of preferred summer habitat each year on lands owned/managed by MDC.
- Seasonal avoidance of tricolored bats roosting in buildings that are demolished.
- Management and enhancement activities on approximately 2,300 acres of preferred fall/spring habitat and 20,000 acres of summer habitat each year on lands owned/managed by other nonfederal cooperators.
- Creation of 7,000-acre PBMZs around known or suspected tricolored bat maternity colonies in which MDC will apply seasonal avoidance to limit potential take and apply positive management to generate improved habitat in areas of known occupancy.
- Protective buffers (150 feet) around all known roosts on MDC lands outside the PBMZs.
- Implementation of a 10-mile buffer around Sodalis Nature Preserves that avoids approximately 1% of estimated impacts on tricolored bats.
- Implementation of seasonal avoidance within 5 miles of the seven Priority 1 and Priority 2 hibernacula for Indiana bats on MDC lands—all of which also contain tricolored bats.
- Protection and management of 20 acres around all caves on MDC land—an important measure for bats that use a wide variety of caves.
- Monitoring and maintenance of cave entrances on MDC lands.
- Creation of 21,000 acres of PBMZs around areas of known or suspected occupancy for little brown, northern long-eared, and Indiana bats, which may also contain tricolored bats. Within these areas MDC will apply seasonal avoidance to limit potential take and apply positive management to generate improved habitat in areas of known occupancy.
- Outreach, extension, WNS research, and training associated with tricolored bats.

Noting that the estimates of take in Chapter 4, *Effects Analysis*, are highly conservative and designed to overestimate impacts, the conservation strategy fully offsets the impact of the taking on 0.02% of the tricolored bat population that winters in Missouri and less than 0.2% and 0.1% of occupied preferred fall/spring and summer habitat for tricolored bats per year, respectively (Tables 4-12 and 4-13). Table 5-4 provides an overview of those conservation measures that help avoid and offset take.

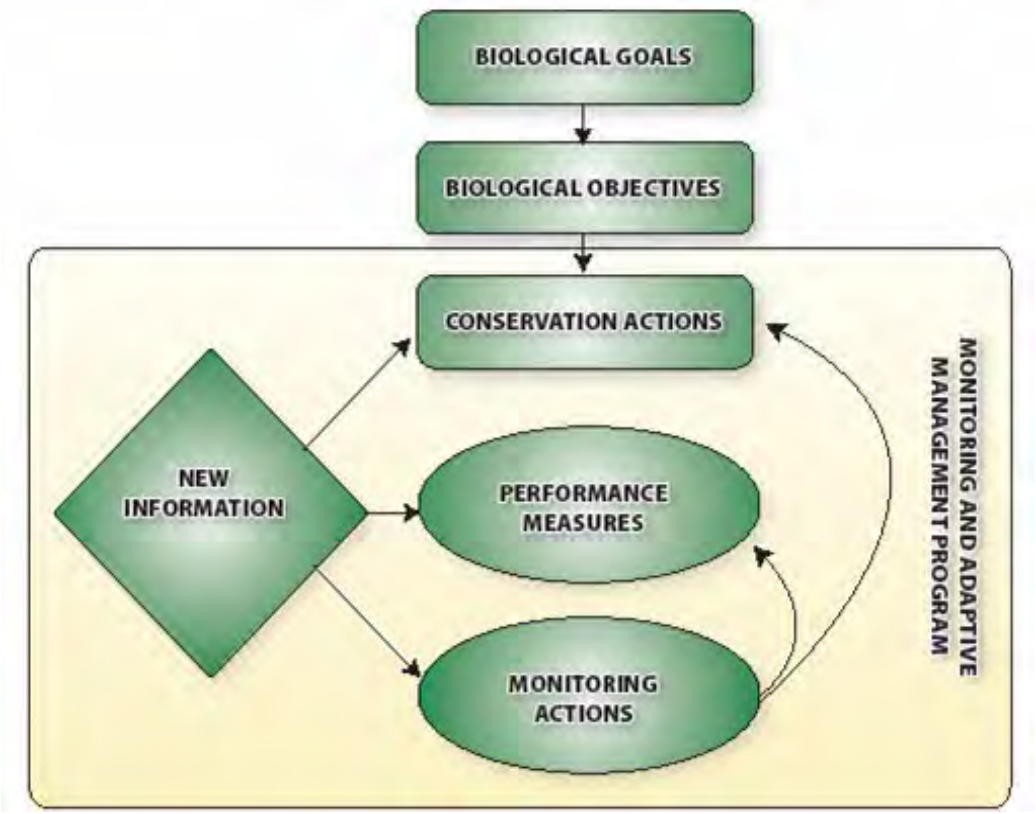
5.4 Adaptive Management

Adaptive management, as described in the HCP Handbook, is a tool to address uncertainty in the conservation strategy of an HCP (Figure 5-2) (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016). Proposed adaptive management measures must be documented up front so they can subsequently affect changes to the operating conservation strategy, as needed.

Based on the best scientific information available, it is expected that the biological goals and objectives described in the HCP will fully offset the effects of the take. However, the status of covered bats on covered lands could change dramatically during HCP implementation. Climate change may result in shifts in bat distribution, and the location of roosts and hibernacula may change. In addition, it is possible that additional and different management measures not identified in the HCP will be shown to be more effective in achieving biological goals and objectives than those currently being implemented. The adaptive management program describes processes for addressing these specific uncertainties. The program allows for flexibility should monitoring reveal that specific habitat objectives proposed in the conservation strategy are not being met. If there is a need to deviate from the adaptive management program as described in this section, USFWS approval will be needed prior to implementation.

The HCP adaptive management program incorporates the adaptive management approach recommended by USFWS (81 *Federal Register* 93702). Figure 5-2 shows the overall model of adaptive management.

Figure 5-2. Adaptive Management Concept Model



5.4.1 White-Nose Syndrome

As indicated in Chapter 3, *Environmental Setting*, WNS is currently affecting bats and will almost certainly continue to affect bats in Missouri throughout the permit term. For this reason, WNS is addressed as part of this HCP's adaptive management program. It is also described as a changed circumstance in Chapter 6, *Implementation and Assurances*, for completeness; however, actions associated with WNS are contained entirely within this section since they are already occurring and are thus not a "changed" circumstance.

WNS Adaptive Management

- Accelerated and prioritized PBMZ surveys
- Re-delineation, as needed, of PBMZs
- Monitoring
- Forest management study
- WNS treatment (if applicable)
- Shift proactive measures (with USFWS) should populations become very rare

Missouri's populations of covered bats, especially the four species[9] that roost in trees during the summer, are already impacted by WNS (Colatskie 2017; King 2019; Missouri Department of Conservation unpublished data). The lack of known roosting data, especially for northern long-eared, little brown, and tricolored bats, makes it difficult to site PBMZs. Because there is uncertainty regarding PBMZ placement and the effects of WNS on covered bat populations, this HCP proposes an adaptive management and monitoring approach to address these uncertainties and best target conservation.

In addition, MDC is currently engaged in a forest management study that will contribute to the adaptive management program for WNS by evaluating the response of Indiana bats to forest management practices including the proposed conservation measures. Example metrics being tested in this study include individual condition and estimates of density of bats by age. Relevant information from this study will be used, as appropriate, to help refine PBMZs as described below. Information from this study, as well as from the literature or studies conducted by other bat and forestry professionals, will also be integrated into PBMZ management to benefit the target species.

This HCP establishes a network of 28,000 acres of PBMZs in the plan area, with 7,000 acres dedicated to each of the four covered tree-roosting species[9]. As previously described (Objective 3.3), the 28,000 acres of PBMZs are designed to avoid impacts on covered bats and their pups during the summer. The PBMZs were delineated based on the best data available at the time of HCP development, but data for species other than Indiana bats are limited.[10] Consequently, it is unknown how well proposed PBMZs capture current areas of summer use, particularly the maternity colonies of little brown, northern long-eared, or tricolored bats. To address this issue, Objective 3.3 describes a survey process for all PBMZs with the intent of shifting PBMZ boundaries to protect all areas where use by the target bat species has been documented within the past decade. This will ensure that new PBMZs have greater conservation benefit. The concept of surveying PBMZs for occupancy use is summarized in Objective 3.3 and detailed in Table 5-5.

[9] Indiana bat, little brown bat, northern long-eared bat, and tricolored bat

[10] For other species, there are (1) little data on use and/or no known roosting areas on MDC lands, or (2) known roost locations that are many years old, or (3) there have been subsequent population declines, creating potential for abandonment of areas of known use.

The adaptive management program for WNS accelerates the frequency of PBMZ monitoring described in Table 5-5 for affected species. Species are considered affected using the general concept of WNS "impact triggers" proposed by Niver et al. (2014). In other words, if a species meets the WNS-affected trigger (or in the case of Indiana bat, if either trigger is met), PBMZs for that species will be prioritized for surveys the next summer season (unless a 10-year survey was completed the year before) so that PBMZ boundaries can be revised and PBMZ locations can be moved to more effectively protect known maternity colonies.

Following are proposed WNS adaptive management triggers for the covered species.

- **Indiana bats**
    - **Adaptive management** for Indiana bats will be triggered if the number of hibernacula in Missouri, other than Sodalis Nature Reserve, occupied by 1 or more hibernating Indiana bat decreases by 60% from the number considered occupied at the time this plan is implemented. This will be based on winter hibernacula survey data that MDC reports to USFWS as part of the range-wide Indiana bat population monitoring effort. If a hibernaculum has not been surveyed during the previous 10 years, it will not be considered as part of the percent change calculation, or if
    - The estimated number of Indiana bats hibernating in Sodalis Nature Reserve is 80,000 or less.
- **Gray bats**

    At present more than 775,000 gray bats are spread amongst four major and multiple minor hibernacula. The four major gray bat hibernacula (Bat Cave, Mose Prater, Coffin, and Martin Cave) all contain between 15,000 and 577,850 bats at last count (Colatksi 2017).

    - **Adaptive management** for gray bats will be triggered if the population of hibernating gray bats in three of the following four caves falls below 10,000 individuals: Bat Cave, Mose Prater, Coffin, and Martin Cave.
- **Northern long-eared bats**

    Data show that northern long-eared bats have declined by more than 90% in the state of Missouri. A 90% decline is clearly an indication of impact from WNS. Thus, the trigger for "severely WNS affected" has already been met.
- **Tricolored bats**

    Reference sites for tricolored bats were chosen to establish a consistent level of survey effort for an adaptive management trigger. These sites have dependably housed relatively high counts of the species and will be reliably accessible by MDC or partners for the permit term. The most recent count, conducted within the past 5 years, at each site will be used to produce the current estimate of tricolored bats. MDC commits to surveying or acquiring count data from each of these sites at least once every 5 years. If access or data availability issues at any of the 40 sites arise, MDC will coordinate with USFWS to potentially select a replacement site or reduce the number of sites. Additionally, if there is evidence of shifts in hibernacula use, suggesting population stabilization or recovery that is not reflected in the 40 chosen sites, MDC will coordinate with USFWS about how incorporate that information.

    - **Adaptive management** for tricolored bats will be triggered if the population of bats using 40 reference sites falls below 1,400 individuals.

- **Little brown bats**

  Reference sites for little brown bats were chosen to establish a consistent level of survey effort for an adaptive management trigger. These sites have dependably housed relatively high counts of the species and will be reliably accessible by MDC or partners for the permit term. The most recent count, conducted within the past five years, at each site will be used produce the current estimate of little brown bats. MDC commits to surveying or acquiring count data from each of these sites at least once every 5 years. If access or data availability issues at any of the 12 sites arise, MDC will coordinate with USFWS to potentially select a replacement site or reduce the number of sites. Additionally, if there is evidence of shifts in hibernacula use, suggesting population stabilization or recovery that is not reflected in the 12 chosen sites, MDC will coordinate with USFWS about how incorporate that information.

  - **Adaptive management** for little brown bats will be triggered if the population of bats using 12 reference sites falls below 350 individuals.

Because northern long-eared bats already meet the "WNS-affected" trigger, MDC will begin implementing the adaptive management program and the associated active surveys[11] for northern long-eared bats in year 1 of plan implementation. As part of adaptive management, active surveys of proposed PBMZs and other areas on MDC managed lands where northern long-eared bats have recently been captured will take place over five (rather than ten) years. The goal of the WNS-triggered adaptive management strategy for northern long-eared bats is to protect all northern long-eared bat maternity roost trees documented on MDC land over the previous 5 years within a maximum of 10 distinct PBMZs (for any species) by year seven[12] of the plan. Once all historic roosting areas and other locations with northern long-eared bat captures have been surveyed, and the PBMZs are re-delineated based on those results, surveys will revert to acoustic-only to document ongoing use by the target species every 10 years. It is likely that the active survey effort will also result in by-catch of other covered bats, which could potentially allow PBMZs for these species to be adjusted more quickly. These adjustments will not require an increase in total acres within PBMZs.

When or if other species reach the status of severely WNS-impacted (as defined by the triggers above), MDC will prioritize and accelerate survey efforts for that species. If more than two species meet the trigger for serious WNS-impacted declines while active survey efforts are ongoing, MDC will continue focusing on the first two species and will switch focus to the third species once the five-year survey effort for the first species has been completed. Attempting to intensively survey all PBMZs for more than two species within five years would exceed the capacity of MDC.

To meet these goals, northern long-eared bat PBMZs will be prioritized for surveys and the intensity of survey efforts will be increased relative to the typical PBMZ monitoring requirements outlined for Objective 3.3 in Table 5-5 (i.e., surveys at each PBMZs every 10 years). The monitoring approach to meet the above-stated goals is described in Section 5.5.2.2, *White Nose Syndrome and Monitoring*.

[11] Surveys will use multiple techniques. Activity areas will be documented through acoustics. Once a target species is detected, follow-up surveys will net the area and use radio telemetry to locate key roosting areas.

[12] It will take approximately one year to bid the surveys, five years for the surveys, and MDC will require approximately one year to re-delineate the PBMZs, once the survey results are finalized. Thus, by year seven at the latest the PBMZs will be re-delineated.

The white-nose syndrome adaptive management approach increases surveys and monitoring to identify vulnerable covered bats, to increase conservation efforts around active roosts, and to reduce stress and protect habitat features for maternity colonies.

In addition, the following measures will take place to manage WNS adaptively within the plan area.

- Continue to monitor the effect of WNS on covered bats in Missouri. The results of such monitoring activities will be used to update the habitat distribution model and to reflect changes in fall/spring and winter use habitat for all species.
- Continue to cooperate with such studies in hope of finding an effective treatment. MDC will review current research and will coordinate with USFWS regarding the testing or use of treatment methods, should they become available over the permit term.
- Should any of the covered species begin to recover from WNS, ensure that existing conservation measures are tailored to support that recovery.
- Should covered bats become isolated in only a few locations in Missouri, work with USFWS to determine if it may be necessary to shift existing protective measures to target these populations.

5.4.2 Climate Change Leading to Shifts in Distribution

An important component of adaptive management will include monitoring and modifying the conservation strategy in response to tracking shifting bat habitat and use driven by climate change. Of interest, conservation and recovery efforts of many rare species are hampered by the species' inability to disperse to new habitats, and this is especially problematic in a rapidly changing climate (Loarie et al. 2009). Climate change models have been completed for Indiana bats in summer (Loeb and Winters 2013) and little brown bats in winter (Humphries et al. 2002). All four of the covered species share many similarities in habitat that make it possible to generalize the models' conclusions across these species.

Humphries et al. (2002) developed a model that identified areas of North America that would provide suitable hibernacula for little brown bats. This model was then rerun based on predicted changes in climate. The resulting model predicted that the species might expand its range into more northern sites in response to a longer growing season (i.e., when insects are available) and because of warmer conditions within hibernacula. Similarly, Loeb and Winters (2013) developed a model of summer habitat and compared that to multiple models of future climatic conditions. Results indicated the western part of the species' current range, especially Missouri, would become climatically unsuitable for Indiana bats, resulting in declines and potential regional abandonment.

Among the covered species, the Indiana bat has the most restrictive range and is most reliant on unusual habitat conditions such as hibernacula with areas of cold and stable temperatures as well as warm summer roosts. The models provided by Loeb and Winters (2013) predict much of Missouri will become too hot to remain viable summer habitat for Indiana bats during the twenty-first century. Such a shift in habitat could result in Indiana bats moving north and east away from Missouri. Notably, these models do not account for hibernacula conditions nor do they account for behavior flexibility. One such example would be if bats shifted their summer roosting habits such that they made greater use of roosts with low solar exposure. Maintaining a diversity of forest conditions is the best way for MDC to respond to such a change.

The little brown and northern long-eared bats both have large distributions. As such, changes in habitat suitability are most likely to occur on the scale of individual sites. However, Missouri is near the western edge of the range for eastern populations of little brown bats—a situation that should be tracked.

New species occurrences will be monitored and compared to PBMZs and buffers associated with occupied hibernacula to track whether range shifts are occurring Adding or subtracting caves, mines and roost trees from the HCP conservation strategy obligations is described in detail in the sections below.

5.4.3 Addition and Subtraction of Subterranean Habitat and Maternity Colonies

This section will describe the process that MDC will take to incorporate information about new subterranean habitat or maternity colonies into the plan. Similarly, it will describe how they will respond to the elimination of these habitat features (i.e., colony or hibernaculum no longer being used) from covered lands.

The discovery of new hibernacula across Missouri may continue as long as the covered bat species do not become extinct. If new hibernacula are discovered on MDC lands or other covered lands, MDC will apply any relevant conservation objectives or measures.

The WNS threat makes it all but certain that bats will also cease to be found in some caves and mines. Absence of the target bat species can be demonstrated using the entrance-trapping and internal search protocols as outlined in the current USFWS survey protocols (U.S. Fish and Wildlife Service 2018a). If no covered bats are detected for the 5 most recent surveys during a 10-year period, the site will be considered unoccupied (i.e., historical) for the purposes of this HCP. Historical sites will be recorded and must be resurveyed every 5 years to be treated as historical sites for the purposes of the HCP. Sites considered unoccupied will not be subject to HCP restrictions (Objectives 4.1, 4.2, 4.3). If bats are subsequently detected, it will again be considered occupied and HCP restrictions will apply again.

The discovery of new summer roosts, including maternity colonies, is also likely to continue across Missouri. Similar to the procedures described for hibernacula above, if new roosts are discovered on MDC or other covered lands, MDC will apply any relevant conservation objectives or measures.

Once identified, a maternity roost is presumed to be occupied unless surveys are undertaken to establish absence. For hazard trees, an emergence count can be used to demonstrate absence prior to the tree being removed. In other cases, the tree will be left until if falls, or is no longer suitable as a roost (i.e., no bark or cavities remain). Once deemed historical (no longer occupied), maternity roosts will be recorded and resurveyed every 5 years to confirm that they remain unoccupied. If no surveys have been completed within the past 5 years, the site is again considered occupied unless a survey following USFWS guidelines is negative for the covered species.

5.4.4 Changes to Prescribed Burning Regulations

This section considers the possible impacts of potential changes to statutory or regulatory guidance on prescribed burning that may change MDC's ability to implement Objective 1.3. At present, MDC staff and cooperators are protected from criminal and civil liability associated with prescribed fires

that are completed in accordance with MDC policy, including the implementation of a burn plan. The projected level of 10,000 acres of prescribed fire per year assumes that prescribed fire will remain a legally protected activity. MDC will notify USFWS within 6 months should there be any new laws enacted that negatively affect MDC's ability to complete prescribed fire. Within 1 year of passage, MDC will provide an update to USFWS of the new level of prescribed fire that can be completed.

5.4.5 Addition and Subtraction of Priority Bat Management Zones

Objective 3.3 (described in Section 5.2.2.1, *Biological Goal 3*) provides for the protection of a portion of known summer maternity roost trees as well as suitable roost habitat during maternity and pupping season (April 1 to August 31). As described in that section, PBMZ boundaries are drawn in consideration of factors such as known maternity roost trees, maternity roost density, bat range and distribution within the state, and MDC conservation priorities. Over time, it is expected that the geographic locations of important summer roosting habitat will shift as more data become available. As a result, it is expected that there will be a need to shift the location of PBMZs.

PBMZs will be considered for redelineation every 10 years in coordination with USFWS. Unless WNS adaptive management is triggered to prioritize redelineation of PBMZs, MDC and USFWS staff will agree which PBMZs will be considered for redelineation and which locations will be targeted for the creation of a new PBMZ based on maternity colony occurrence data and other relevant information. The minimum total acreage of the PBMZs will be maintained at 28,000 acres. The PBMZ goal of protecting 7,000 acres per species will also continue to be a target; however, it is possible that protection priorities may shift in response to covered bat population changes. In these circumstances, it is possible that MDC and USFWS would agree to revise species-specific acreage targets.

5.5 Monitoring

This section provides an overview of the HCP monitoring program. Specific monitoring activities will be described and documented during implementation. This section is intended to provide the framework for that monitoring program.

Monitoring the outcomes of avoidance, minimization, and mitigation measures is the foundation of the HCP's adaptive management approach and can help advance scientific understanding and modify conservation measures to better achieve the HCP's biological goals and objectives. As stated in the HCP Handbook (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016):

When properly designed and implemented, the [monitoring and reporting] should provide us with the information we need to determine whether or not:

- a permittee is in compliance with their incidental take permit and HCP,
- progress is being made toward meeting an HCP's biological goals and objectives,
- the HCP's conservation program is effective at minimizing and/or mitigating impacts, and
- there is a need for adjusting measures to improve the HCP's conservation strategy.

This section describes both compliance and effectiveness monitoring activities as defined by the USFWS HCP Handbook. This section also describes critical components of the monitoring program status and trends monitoring, WNS protocols, and monitoring the biological goals and objectives. Table 5-5 summarizes the monitoring actions (both compliance and effectiveness) for each objective.

5.5.1 Types of Monitoring

5.5.1.1 Compliance Monitoring

Compliance monitoring (also known as implementation monitoring) tracks the status of the HCP implementation and documents that requirements of the HCP are met.

In other words, compliance monitoring verifies that MDC is implementing the terms of the HCP, incidental take permits, and the authorized level of incidental take. Management activities associated with conservation strategy actions will be documented to demonstrate that the HCP and the required commitments of the conservation strategy are being properly implemented. Documentation of compliance monitoring will be included in an annual report submitted to USFWS (Table 5-5).

5.5.1.2 Effectiveness Monitoring

Effectiveness monitoring assesses the biological success of the HCP. Effectiveness monitoring evaluates whether the effects of implementing the conservation strategy are consistent with the assumptions and predictions made when the HCP was developed and approved. Effectiveness monitoring is used to determine if the biological goals and objectives in the HCP are being realized (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016). See Table 5-5 for the compliance and effectiveness monitoring action items associated with each biological objective.

Effectiveness monitoring has two components: monitoring effects of conservation measures and monitoring the status and trends of the covered bat populations and habitat. Because of the uncertain future of bats affected by WNS, most of the effectiveness monitoring will focus on habitat quality (e.g., number and quality of roosts) with the goal of providing high-quality habitat should the species begin to recover.

5.5.2 Monitoring Program Elements

This section will outline the specific monitoring actions that will be implemented to ensure full compliance with the terms of the incidental take permit.

The status of covered bats will be monitored during the 50-year permit term. As stated in the HCP handbook: "The development of a monitoring program should be tailored to answer specific questions needed for the decisions that need to be made" (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016).

The following questions will be relevant for MDC Bat HCP conservation strategy.

1) Is MDC complying with the terms of the HCP (e.g., gates/fences are maintained at entrances to prioritized subterranean habitat; avoidance measures are implemented; communication plans are developed and used)?

2) What is the status (approximate number and distribution) of the covered species in Missouri and within PBMZs? (This will include an assessment of the effect of WNS on the populations.)

3) Are objectives to maintain and/or enhance roosting and foraging habitat (e.g., Objectives 1.3, 2.2, 3.1, 3.2, 3.3, and 4.2) creating the desired conditions (e.g., number of roost trees)?

4) Are bat management zones (Objective 4.2) and PBMZs (Objective 3.3) protecting vulnerable bat populations?

Table 5-5 provides additional detail on how each objective will be monitored, including these questions above. Monitoring will begin once the HCP is permitted.

5.5.2.1 Status and Trends Monitoring

Baseline data for covered bats on covered lands is documented in this HCP. Any changes to MDC's understanding of species numbers and distribution will be compiled before HCP permitting. Collectively, this information will provide the baseline of the status of all species and associated modeled habitat at the beginning of the permit term and will provide a reference point for future status and trends monitoring. Subsequently, population numbers will be updated annually and compared to baseline.

5.5.2.2 White-Nose Syndrome and Monitoring

Section 5.4.1, *White-Nose Syndrome*, describes the goals and triggers for the WNS adaptive management monitoring actions. Because the WNS-affected trigger has already been met for northern long-eared bat, the monitoring actions and approach described in this section are for that species. The monitoring action components are described below.

- Acoustic monitoring of all northern long-eared bat PBMZs and PBMZs for other species with known northern long-eared records using the acoustic survey guidelines outlined by the USFWS (2019) and as described below in Table 5-5.
- Where northern long-eared bats are found to be present either by MDC or another survey effort, the location will be mist netted and captured, and northern long-eared bat females will be tagged to identify roost locations.
- When a roost is located, the PBMZ boundaries will be evaluated in coordination with the USFWS to optimize protection of the roost.

In northern long-eared bat PBMZs where northern long-eared bats are found to be absent per the USFWS 2019 survey guidelines, additional acoustic surveys will be conducted in suitable locations where there is potential for occurrence. Locations near known northern long-eared bat hibernacula will be prioritized for acoustic presence/absence surveys. Surveys will continue using this approach for 5 years or until 10 northern long-eared bat roosts are protected within a PBMZ (of any species), whichever comes first.

At the end of 5 years, if there are northern long-eared bat PBMZs without known roost trees, MDC and the USFWS will coordinate to determine where PBMZ placement is feasible (from an MDC management perspective) and has the greatest potential to benefit northern long-eared maternity roosts. After year 5 and relocation or refinement of northern long-eared PBMZs, northern long-eared bat PBMZs will be acoustically monitored every 10 years (as is required for those species' PBMZs that do not meet the WNS trigger, as detailed in Table 5-5).

It is likely that the active survey effort for northern long-eared bats will also result in by-catch of other covered bats, which could potentially allow PBMZs for these species to be adjusted more quickly. These adjustments will not require an increase in total acres within PBMZs.

When or if other species reach the status of WNS-affected (as defined by the triggers above), MDC will prioritize and accelerate survey efforts using the same approach described for northern long-eared bats. If more than two species meet or exceed the WNS-affected trigger while active survey efforts are ongoing, MDC will continue focusing on the first two species and will switch focus to the third species once the five-year survey effort for the first species has been completed. Attempting to intensively survey all PBMZs for more than two species within a 5-year period would exceed the capacity of MDC. If the WNS-affected trigger for Indiana bat is reached, the PBMZ redelineation will be prioritized around Sodalis Nature Preserve.

To minimize the potential for the transmission of WNS during monitoring activities, all MDC staff, researchers, and consultants who perform cave and mist-netting survey work will adhere to the most current version of the *National White-Nose Syndrome Decontamination Protocol* available at the time of monitoring (U.S. Fish and Wildlife Service 2018b).

5.5.2.3 Monitoring Biological Goals and Objectives

Requirements for status and trends monitoring are described in Section 5.5.2.1, *Status and Trends Monitoring*. All other monitoring is tied directly to the biological goals and objectives as described in Table 5-5. A monitoring plan that will include a template reporting form and monitoring triggers will be drafted by year 2 of HCP implementation.

Table 5-5. Monitoring Associated with Biological Goals and Objectives

Goal	Objective	Monitoring Action
Biological Goal 1: Maintain a mosaic of contiguous or semi-contiguous natural lands to provide foundational habitat for covered bats.	Objective 1.1: Sustainably manage 700,000 acres of forest woodlands across MDC lands beginning in year 1 and continuing throughout the permit term.	MDC will document in their annual report the number of acres currently managed as forestland/woodlands.
	Objective 1.2: Sustainably manage over 200,000 acres of ecologically appropriate open habitats across MDC lands beginning in year 1 and continuing throughout the permit term.	MDC will document in their annual report the number of acres currently managed as open habitat, including open lands either sold or acquired during the year. Results of periodic reviews (every 5 years) will also be reported.
	Objective 1.3: Conduct 10,000 acres of targeted prescribed burning in forests and woodlands each year to increase native biological diversity and enhance forest regeneration, wildlife habitats, and ecological community types that benefit bats at the stand and landscape levels.	MDC will document the location and amount of prescribed burning in modeled bat habitat. The results of these burns (in terms of forest structure and potential roost habitat) will be documented and included in the annual report.
Biological Goal 2: Support land stewardship and bat conservation on lands not owned/managed by MDC.	Objective 2.1: Promote bat-friendly management practices on private and other nonfederal land in the plan area.	MDC will document updates to and promotion of the *Missouri Forest Management Guidelines* as well as the development of a communications plan in the annual report. The annual report will also quantify and describe outreach efforts related to bats, forestry, and WNS; report the amount of financial assistance provided on private land; detail the implementation of technical assistance programs and explain how bat conservation measures are incorporated into these programs.
Biological Goal 3: Enhance, maintain, and restore roosting and foraging habitat for covered bats.	Objective 3.1: Implement roost tree retention guidelines in all forest habitat on MDC lands.	MDC will report the location, harvest objective, total acres harvested, and number or acres of roost trees retained for each harvest location on MDC and other nonfederal lands.
	Objective 3.2: Protect all known roost trees using 150-foot buffer.	On MDC lands and other nonfederal lands: All forest management plans/wildlife habitat plans developed by MDC staff will provide 150-foot (1.62 acres) buffers around known roost trees (i.e., roost trees identified by monitoring performed by MDC or professionals from other organizations). Practice certification (i.e., review of a completed management activity or practice to ensure the specifications of the management plan are met) will be completed on 100% of private lands enrolled in an MDC

Goal	Objective	Monitoring Action
		forestry cost-share program prior to the financial reimbursement of a landowner, including compliance with the 150-foot buffer. The practice certification is completed by a MDC staff planner. Additionally, the PLS Regional Supervisors or designated MDC administrator will complete spot-check monitoring on 5% of the completed practices each year. The spot-check monitoring will verify that all actions within the management plan continue to be implemented in the years following the initial management action. Lands remain in the cost-share program, and thus are susceptible to follow-up spot-check monitoring, for ten years. All timber sales administered by MDC staff are monitored for retention, buffer, and seasonal avoidance compliance through the timber sale administration process.
	Objective 3.3: Establish priority bat management zones (PBMZs) to protect bats and promote high-quality bat habitat in areas of known or potential bat activity.	Enhancement actions implemented within all PBMZs to achieve the desired future conditions described in Appendix F, *PBMZ Future Desired Conditions*, will be documented. Once the desired future conditions are achieved, subsequent monitoring will take place at the next management entry to ensure the desired conditions are still being met. To document presence of the covered species for which the PBMZ was designated, acoustic surveys will be performed once every 10 years at each PBMZ using USFWS (2019) survey guidelines. So that all PBMZs are visited every 10 years, MDC will begin surveying a subset of the total PBMZs in year 1 of plan implementation to ensure that each site is surveyed once every 10 years for a total of five times for each location during the permit term. Surveys for Indiana bat will be prioritized in locations near the Sodalis Nature Preserve hibernacula in recognition that these locations are more likely to be occupied by the species. If the target species is not detected during the acoustic survey, MDC will shift the PBMZ location to one with confirmed presence (per USFWS 2019 survey guidelines) within 1 year of survey completion. It should be noted the confirmation of presence will likely come as a result of MDC monitoring, however any identified roost

Goal	Objective	Monitoring Action
		location located by a survey professional can be considered for inclusion within a PBMZ. If there are no known roost locations suitable for protection within a PBMZ, MDC will coordinate with the USFWS to either identify a potentially suitable location for the PBMZ or to keep the PBMZ where it is until a suitable PBMZ can be identified.
Biological Goal 4: Protect and enhance subterranean habitat and bats using that habitat.	Objective 4.1: Assess and, if necessary, improve 10 entrances to known subterranean habitat on MDC lands annually beginning in year 1 and continuing for the duration of the permit term.	Within the first 5 years of the permit, MDC will complete an assessment of all subterranean sites known to harbor covered bats on MDC lands. This assessment will provide the following data: • Information about current condition of hibernacula on MDC lands (number and type of bats present, if no longer occupied the time since last occupancy, documentation of specific issues at a site such as vandalism or potential for collapse or flooding). • Information about what sites currently have physical barriers (gates/fences) and about the condition of those barriers. • A prioritized list of sites on MDC lands. • A list of sites where additional data is needed to determine if a gate is appropriate. Gates/fences will be visited once every 5 years. Each year gate/fence assessments are completed; photographic documentation of gate condition will be provided in the annual report. Photos of hibernacula entrances will be taken upon scheduled site visits. Any management of hibernacula entrances that is undertaken, and the success of such action, will be included in annual reports.
	Objective 4.2: Implement bat management zones around known entrances to subterranean habitat.	MDC will generate a list of all known hibernacula on MDC lands and will develop biologically appropriate bat management zones of at least 20 acres around each hibernaculum entrance. The 20-acre buffer will be managed to promote old-growth habitat characteristics as described in Section 5.2.2.2, *Biological Goal 4*. Enhancement actions implemented within the 20-acre buffer will be documented in the annual report. Once the 20-acre forest buffer meets the criteria for "old growth," monitoring will take place once

Goal	Objective	Monitoring Action
		every 5 years to ensure that habitat targets are still in place. Monitoring for hibernacula use at specific sites, if needed, will involve a combination of bat detectors, guano traps, and counts, as applicable to a given site.
	Objective 4.3: Maintain physical barriers at subterranean sites on MDC lands over the course of the permit term and gate additional sites as needed.	This objective supports and is guided by monitoring results collected in support of Objective 4.1. Under Objective 4.1, the barriers in front of hibernacula are monitored every 5 years for functionality. Under Objective 4.3, when and where maintenance activities are determined to be needed at an entrance, the needed maintenance actions will be prioritized and implemented based on that priority. MDC will document the pre- and post-maintenance conditions associated with each barrier in annual reports.
Biological Goal 5: Avoid and minimize other effects from covered activities on covered species.	Objective 5.1: Implement bat-friendly management measures within burn plans beginning year 1 of the plan.	MDC will develop guidelines for burn plans in preferred bat habitat on covered lands and submit them to USFWS by end of year 1.
	Objective 5.2: Implement bat-friendly construction and demolition measures throughout the permit area.	MDC will develop and implement guidance for bat-friendly construction of roads, trails, and fire lines by year 3. The guidance document will be provided in an annual report.
	Objective 5.3: Provide training to new MDC staff to recognize and avoid potential roost trees.	MDC will report on training activities in the annual report.
	Objective 5.4: Incorporate bat-friendly best management practices (BMPs) into the Professional Timber Harvester (PTH) training.	MDC will report on training activities in the annual report
Biological Goal 6: Promote survival and recovery of bats affected by white-nose syndrome (WNS).	Objective 6.1: Update MDC's WNS action plan by year 5.	MDC will provide a statewide WNS action plan to USFWS by year 5. MDC will also document the publicly available website where the plan is available. MDC will describe collaboration with USFWS or other entities on research as part of the annual report.
	Objective 6.2: Collaborate with researchers to identify ways to ameliorate the impacts of WNS through treatment or habitat management.	MDC will report on research activities and ongoing collaboration in the annual report.

Chapter 6
Implementation and Assurances

6.1 Overview

Habitat Conservation Plan (HCP) implementation begins when the Section 10(a)(1)(B) incidental take permit is issued. The Missouri Department of Conservation (MDC) is responsible for implementing the MDC Bat HCP. This chapter describes the framework for HCP implementation, including organizational structure, reporting processes, and roles and responsibilities. This chapter also describes assurances, including No Surprises, changed circumstances, and unforeseen circumstances. Finally, this chapter discusses HCP modifications such as administrative changes and amendments.

6.2 Permit Structure

The United States Fish and Wildlife Service (USFWS) will issue the Section 10(a)(1)(B) incidental take permit to MDC to cover activities on lands throughout Missouri that are owned and managed by MDC. As described in Chapter 2, *Covered Lands and Activities*, actions undertaken on certain other lands under the authority of MDC are also covered by this HCP, including non-MDC lands that participate in qualifying MDC programs. Covered activities may also occur on other lands that are managed by MDC, such as lands leased by MDC from the U.S. Army Corps of Engineers (USACE).

6.2.1 Coverage to Other Nonfederal Landowners

MDC will extend incidental take authorization to third-party landowners who participate in conservation-related cost-share, habitat management, and grant programs under the authority of MDC, as described in Section 2.2.2.1, *Missouri Cost-Share Programs*, and Section 2.2.2.2, *State Forestry Programs*. These programs will be implemented by MDC in partial fulfillment of Objective 2.1, which commits to promoting bat-friendly management practices on private and other nonfederal land in the plan area.

In all cases, third-party landowners conduct activities on their lands that are consistent with the covered activities described in Chapter 2 and the biological goals and objectives detailed in Chapter 5, *Conservation Strategy*. These eligible activities will be carried out under a variety of cost-sharing, habitat management, or grant programs that MDC administers as listed in Table 6-1 and described in this section. MDC is likely to introduce new funding or grant programs not listed here that would support the same covered activities on lands of third-party landowners. These new funding programs can also be used by MDC to provide take coverage for third-party landowners as long as the covered activities and minimization and mitigation measures implemented on third-party lands are consistent with this HCP.

It is important to note that MDC activities on private lands are not meant to offset effects on covered species on MDC-owned lands. Forestry management activities on private lands are considered "self-mitigating." That is, the long-term benefits to covered bats from forest management on private lands are presumed to offset any potential short-term impacts from forestry management activities

implemented on private lands. Because activities on private lands do not offset impacts incurred elsewhere, any reduction in funding for private land programs (or any noncompliance on private lands) will not result in the need for replacement mitigation elsewhere.

To receive take authorization through MDC's permit, each participating landowner must agree to the applicable terms and conditions of the HCP, including the following:

- Implementation of conservation measures described in Chapter 5, *Conservation Strategy*. The relevant conservation measures are those associated with Objectives 3.1, 3.2, 5.1, and Table 5.2, which describes even- and uneven-stage stand management requirements.
- Allow MDC to implement the monitoring actions associated with the HCP objectives listed above (as described in Table 5-5).
- Allow MDC to report landowner's enrollment in the HCP and their compliance with the relevant HCP avoidance and minimization measures.
- Acknowledge that it is the landowner's responsibility to comply with the applicable terms of the HCP and that if the landowner fails to do so, MDC will offer guidance to the landowner to bring the site back into compliance.
- Acknowledge that MDC may, if the landowner continues to fail to comply with the applicable HCP terms, rectify noncompliance through means such as withdrawing technical or financial support or similar actions consistent with the scale of the violation and each MDC program.
- Acknowledge that MDC may, if noncompliance persists, withdraw the incidental take authorization provided to the noncompliant landowner. Depending on the scale and nature of the violation, MDC may pursue legal action against the landowner consistent with state law.

A template landowner agreement with these conditions is provided in Appendix G, *Template Landowner Agreement*. The specific mechanism by which MDC will extend take authorization to qualifying landowners varies depending on the program used. The elements relevant to the landowner from the Template Landowner Agreement will be incorporated into each program document as described and summarized in Table 6-1.

As described above and in Appendix G, the Template Landowner Agreement provides for a process by which MDC will work with a private landowner to identify and resolve noncompliance including a requirement that MDC alert the USFWS of noncompliance within 90 days of violation detection.

Noncompliance is expected to be very rare. MDC has been implementing many of the private lands programs for decades and landowner noncompliance in these existing programs has been rare. A summary of landowner compliance with each active program is provided below using available data.

- **Landowner Assistance Program:** This program has been implemented for 20 years. In the last 4 years, a total of 8,200 practices have been completed under this program with only two non-compliant practices.
- **Timber Sale Assistance Program:** MDC has been implementing this program since the early 1950s. In the last 9 years there have been 597 sales. Issues regarding noncompliance are not known.
- **Missouri Tree Farm Program**: This program has been implemented by MDC for 71 years as part of the American Tree Farm System (ATFS). Since 1992, 58 out of 668 (9%) tree farms have

been decertified because the landowner was not meeting the terms and conditions of the program (largely for administrative reasons).

- **Missouri Managed Woods Program**: This program has been active for 2 years and has not had any noncompliance issues.

Because noncompliance will be relatively rare and each instance is unique, MDC and USFWS will coordinate on a case-by-case basis to estimate impacts incurred as a result of noncompliance and to determine how best to offset any impacts. As the primary permit holder, MDC will work with the landowner to ensure that any necessary corrective actions agreed to in coordination with USFWS are implemented.

Table 6-1. Mechanisms for Permit Coverage to Non-MDC Lands

Landowner Program[a]	Title of Existing Agreement with Landowner	How Template Landowner Agreement Is Incorporated Into the Existing Agreement[b]
MDC cost-share programs (e.g., Landowner Assistance Program)	Cost-Share Agreement	Included within the portion of the agreement titled "landowner agreement" and/or as part of the management plan. Language will also be added in the "Policies and Procedures" portion of the docket under item 18, "Indiana and Northern Long-eared Bat Guideline"
Timber Sale Assistance Program	Timber Sale Assistance Agreement	As Exhibit A to Timber Sale Assistance Agreement
Missouri Tree Farm Program	American Tree Farm System Tree Farm Inspection Record	As part of an Appendix to the existing document (*Supporting Documents/Stand Information*)
Missouri Managed Woods Program	Forest Stewardship Plan	As part of an Appendix to the existing document (*Supporting Documents/Stand Information*)
Other grant programs[c]	Varies depending on grant program	As Exhibit of the Subgrant Agreement with MDC

[a] Legal authority for all programs: Article IV, Sec. 40(a) of the Missouri Constitution. Additional legal authority for Missouri Managed Woods Program: Missouri Revised Statutes, Sections 254.020 to 254.225

[b] Describes how the HCP template agreement is incorporated into the relevant landowner agreement used for each qualifying MDC program.

[c] Other grant programs of MDC may have a limited number of participants with impacts to habitat for covered species and who are interested in participating (e.g., Boating and Infrastructure Grant Program).

- **Landowner Assistance Program**. MDC provides for conservation management—prescribed burns, restoration, and other habitat management activities—of other nonfederal lands either through direct payment to landowners or MDC staff time. Because these management activities are under the direct control of MDC, coverage under the incidental take permit can be extended to private landowners participating in these activities through the template landowner agreement (see Appendix G) or through revisions to the existing Cost-Share Agreement which are consistent with the landowner agreement template in Appendix G.

- **Timber Sale Assistance Program**. Coverage will also be provided to those landowners who participate in MDC's timber sale assistance program. By signing MDC's Timber Sale Assistance Agreement, the landowner agrees to follow their Forest Stewardship Plan and the associated timber sale contract, both of which contain MDC's advice concerning bat management. Specific requirements from the Template Landowner Agreement (Appendix G) and the Forest Stewardship Plan will be incorporated directly into timber sale contracts.
- **Missouri Tree Farm Program**. The Missouri Tree Farm Program (MTFP) is governed by the MTFP Committee. This committee is responsible for monitoring the MTFP on behalf of the ATFS. All ATFS participants are guided by the American Forest Foundation *Standards of Sustainability for Forest Certification* (American Forest Foundation 2015). These standards have been written to conform to internationally recognized sustainability frameworks.

There are eight standards that define the elements that make up the definition of *sustainability* for the ATFS. How this pertains to MDC's HCP is found within ATFS Standard 5: Fish, Wildlife, Biodiversity, and Forest Health. Within the Standards the word *shall* indicates a core element required for certification under the ATFS.

Standard 5: Fish, Wildlife, Biodiversity, and Forest Health.

- Performance Measure 5.1: Forest-management activities shall protect habitats and communities occupied by threatened or endangered species as required by law.
  - Indicator 5.1.1: Landowner shall confer with natural-resource agencies, state natural-resource heritage programs, qualified natural-resource professionals or review other sources of information to determine occurrence of threatened or endangered species on the property and their habitat requirements.
  - Indicator 5.1.2: Forest-management activities shall incorporate measures to protect identified threatened or endangered species on the property.

MDC will extend incidental take authorization to landowners participating in the Missouri Tree Farm Program who sign a landowner agreement consistent with the Template Landowner Agreement (Appendix G).

- **Missouri Managed Woods Program**. Landowners participating in the Missouri Managed Woods Program must own a minimum of 20 contiguous wooded acres with a market value of less than $3,500 per acre, and participants must agree to a 15-year enrollment term. The landowner must also agree to enroll in the ATFS, thus making them adhere to the standards mentioned above. In return for this enrollment the landowner receives a reduced property tax rate, a forest management plan, priority technical service, and increased cost-share rates.

  MDC will extend incidental take authorization to landowners participating in the Missouri Managed Woods Program through the Forest Stewardship Plan, which the landowner must sign and agree to. The Forest Stewardship Plan will include an exhibit with the Template Landowner Agreement (Appendix G).

- **Other Grant Programs.** MDC implements grant-funded programs that may require activities on non-MDC lands. For example, MDC receives funds from the USFWS through the Boating and Infrastructure Grant Program. The MDC enters into a long-term subgrant agreement with the partner, the subgrantee. The grant program requires the subgrantee to obtain all necessary permits associated with implementation of the project. Because the subgrantee will perform the work consistent with the incidental take permit, any needed take coverage for these grant-funded activities would be provided by the HCP.

- **Other Future Programs.** The programs listed above are those in existence today that have goals consistent with those of the MDC Bat HCP. However, MDC may establish new landowner funding and technical assistance programs in the future that could expand the number and extent of landowners eligible for coverage under the HCP. MDC may extend incidental take authorization to participating private landowners under any new cost-share, habitat management, or grant program, so long as the new program is consistent with the goals and objectives of the MDC Bat HCP and MDC incorporates the Template Landowner Agreement (Appendix G) into the program agreement with the landowner. If the new program introduces covered activities that may be different from those specifically described within the HCP, MDC will seek input and approval from the USFWS prior to implementation. Substantial additional covered activities may require a plan and permit amendment described in Section 6.4.5, *Amendments*.

6.2.2 Coverage to MDC Managing U.S. Army Corps of Engineers Property

As described in Chapter 2, Section 2.2.1, *MDC-Owned and/or Managed Lands*, MDC manages approximately 178,000 acres of land owned by USACE under three programs (see Tables 2-1 and 2-2), primarily along the Mississippi and Missouri Rivers. In all cases, USACE has delegated all authority to MDC to manage these lands, including obtaining any necessary state or federal permits to conduct that management. MDC has notified USACE of the HCP process and given them an opportunity to participate as desired.

The incidental take permit issued by USFWS will cover MDC's management of these USACE lands consistent with the HCP. Upon issuance of the permit, MDC will review all leases, cooperative agreements, and other documents associated with the management of these lands to determine whether modifications may be necessary to ensure MDC's compliance with the HCP and permit. If necessary, MDC will immediately seek modification of these agreements with USACE.

6.3 Implementation Organization Structure

The MDC will oversee HCP implementation including staffing internal positions, hiring consultants, reporting, monitoring, and maintaining all program records. MDC staff includes biologists, foresters, administrators, and other natural resource specialists who will carry out planning and design, monitoring, adaptive management, and periodic coordination with and reporting to USFWS. To carry out this program, MDC will assign HCP implementation responsibilities to specific individuals, including an HCP administrator, geographic information system (GIS) technician, and community liaison. The following sections briefly describe the roles of these individuals. The MDC will provide USFWS with a list identifying the names and titles of all agency staff fulfilling the key oversight roles described in Section 6.3.1, *MDC Staffing and Decision Making*, within 30 days of permit issuance, and update that list through its annual reports, or more frequently, as warranted. The day-to-day implementation of the MDC Bat HCP will be managed by staff, involving coordination with other resource agencies, foresters, science advisors, and the public to ensure adequate and systematic implementation of their responsibilities under the MDC Bat HCP.

6.3.1 MDC Staffing and Decision Making

6.3.1.1 MDC Director and Resource Area Leaders

The MDC director will serve as the final decision maker regarding the implementation of the MDC Bat HCP and compliance with its terms and conditions. The director will be assisted by resource area leaders, such as branch chiefs. The resource area leaders and the Director will meet annually to be briefed on the progress of the HCP and to make decisions on outstanding HCP questions about implementation.

6.3.1.2 Missouri Conservation Commission

The Missouri Conservation Commission is composed of four members appointed by the governor of Missouri. The Conservation Commission is vested with control, management, restoration, conservation, and regulation of fish, forest, and wildlife resources of Missouri by the Missouri Constitution. The commission appoints the director of MDC and serves as MDC's policy makers, approving wildlife code regulations, strategic planning, budget development, and major expenditure decisions. The Conservation Commission will be briefed on the progress of the HCP and will provide input on key HCP decisions, particularly regarding amendments, negotiations with USFWS, or extending incidental take coverage to third parties.

6.3.1.3 Implementation Team

Members of the Implementation Team will be responsible for providing regular oversight of the MDC Bat HCP and will function similarly to the HCP Steering Committee. Each member of the team will provide support for and oversee tasks such as those listed; the HCP administrator is a member of the Implementation Team who will serve as a point of contact for HCP-related issues within MDC, other resource agencies, and for USFWS. (The HCP administrator position is described in more detail in Section 6.3.1.4, *HCP Support Staff*.) The Implementation Team's responsibilities are to ensure that the following tasks are being completed.

- Answer internal HCP-related questions.
- Coordinate bat surveys with supervising biologists.
- Coordinate compliance monitoring (as described in Section 5.5.1.1, *Compliance Monitoring*) and provide documentation of compliance in the annual report.
- Evaluate the effectiveness of the HCP as described in Section 5.5.1.2, *Effectiveness Monitoring*.
- Develop and maintain annual budgets and work plans.
- Coordinate with GIS staff to update HCP covered bat distribution models (Appendix A, *Species Accounts*) on MDC lands every 5 years.
- Maintain monitoring and survey data reports and archives, including monitoring results, and produce an annual report.
- Coordinate and deliver related training program(s) for MDC staff.

The Implementation Team will meet monthly during the first year of implementation to coordinate day-to-day tasks associated with HCP implementation and regularly, as needed, in the following years. Staff time for representatives of the Implementation Team and HCP support staff will be

assigned based on the respective responsibility and time required to complete the tasks listed above (see Chapter 7, *Cost and Funding*; Table 7-1).

6.3.1.4 HCP Support Staff

HCP Administrator

The HCP administrator will serve as the central point of contact for HCP implementation. The HCP administrator will be in charge of general oversight, calling and leading meetings, communicating directly with USFWS, and maintaining a schedule.

Geographic Information System Technician

MDC will provide one GIS technician who will develop GIS and other database systems to collect, store, and use spatial data necessary for MDC Bat HCP implementation. The comprehensive data repository for compliance tracking will be operational within 1 year of HCP permit issuance. The database will also be linked to supporting information documenting HCP compliance. These reports and other data will be stored and archived electronically whenever possible. Compliance monitoring will be addressed in part through the GIS database system. In addition, the status and trends of covered bats and their habitat across Missouri will be tracked through this system. To track these items, MDC will maintain the following baseline data.

- The location, extent, and timing of impacts according to the metrics described in Chapter 4, *Effects Analysis*.
- The location, extent, and timing of implementation of conservation measures (e.g., protecting hibernacula, gating cave entrances, monitoring existing hibernacula).
- The results of all monitoring described in Chapter 5, Section 5.5.2.1, *Status and Trends Monitoring*.

When electronic archiving is not available or feasible, MDC will retain hard-copy records, which, along with electronic records, will be available for inspection by USFWS.

Community Liaison

As described in the biological goals in Chapter 5, Section 5.2.1, *Landscape Conservation,* and Section 5.2.2, *Site-Level Conservation*, MDC will conduct public outreach, providing training to members of MDC staff and the public, such as visitors, private landowners, cavers, and foresters, about covered bat species to promote conservation efforts across Missouri. In addition, education and outreach efforts can help loggers and private landowners implement practices on other nonfederal lands that benefit covered bats. To that end, MDC will serve as community liaison and develop an outreach program to be delivered to the public. As community liaison, MDC will also coordinate efforts with other Missouri state outreach programs to maximize program reach and effectiveness. For example, MDC will exhibit and provide outreach materials at public events such as the Missouri Bat Festival (Onandaga Cave State Park, Leasburg, Missouri) and state fairs held each year. MDC incorporates bat-friendly best management practices (BMPs) into the Missouri Forest Products Association's Professional Timber Harvester training for professional loggers, foresters, landowners, and other interested individuals.

Qualified Staff

A qualified staff person, such as a biologist or forester, from MDC will provide oversight of HCP-related research and monitoring activities for covered bat species. The qualified staff person's duties include overseeing biologists, foresters, and other technical staff performing bat surveys and fieldwork, providing logistical support, and ensuring that all research and monitoring work helps fulfill the biological goals and objectives of the MDC Bat HCP.

Biological and Technical Staff

Biological and technical staff will implement covered bat surveys and other related work to inform implementation of the goals and objectives. They will work on the ground to ensure compliance with state and federal regulations; establish monitoring and reference sites; keep detailed and accurate field and analytical records; and use an information management system to track, control, and report as necessary on the status of covered bats.

Land Managers

Land managers are foresters and wildlife biologists that assist with planning and implementation of habitat enhancement and monitoring of forest management efforts, including timber harvest and prescribed fire. MDC field supervisors will ensure that field crews and contractors are trained in implementing the terms of the MDC Bat HCP. The supervisors will be responsible for requesting surveys, if needed, and ensuring compliance during activities. Field crews will implement the MDC Bat HCP by attending environmental training and adhering to the avoidance and minimization measures specified for each job.

Law Enforcement

Conservation agents (i.e., game wardens) enforce the rules of the *Wildlife Code of Missouri.* The agents also enforce state laws on lands owned, managed, or leased by MDC. The conservation agents ensure that regulations related to poaching, illegal tree cutting, vehicle restrictions in stream areas, speed limits, and other activities are followed. These activities will continue under the MDC Bat HCP.

Consultants and Contractors

Consultants and contractors are periodically retained by MDC to meet any technical or scientific needs that cannot be effectively or efficiently addressed by in-house staff. For example, outside qualified bat surveyors may be engaged for survey work if MDC qualified bat surveyors are not available. MDC will provide USFWS an updated list of all contractors engaged in activities related to the covered bat surveys in the previous year as part of its annual report.

Additionally, timber harvest and prescribed burning are implemented by third-party contractors. As described in Chapter 2, *Covered Lands and Activities*, MDC bids timber sales out to third-party contractors. Through the timber sale process (see Section 2.3.3, *Habitat Management*), MDC provides specific instructions describing the trees to be cut and the trees to be retained during a sale; these instructions will incorporate all MDC Bat HCP commitments. The third-party contractor then cuts in accordance with these provisions, which MDC strictly enforces. Third-party contractors are subject to strict enforcement if they fail to comply with the instructions.

For prescribed burns, MDC staff or a third-party contractor prepares a burn plan. The burn plan provides instructions, recommendations and a description of the desired habitat condition. The burn plan will include provisions that ensure compliance with the incidental take permit. Just as described above, third-party contractors are subject to penalties if they fail to comply with the burn plan.

6.3.2 Data Tracking

This section describes proper data management, analysis, and reporting practices. Proper data management, analysis, and reporting are critical to tracking the monitoring and adaptive management program. Data on monitoring methods, results, and analysis must be managed, stored, and made available to staff, decision makers, scientific advisors, USFWS, and others, as appropriate. A database and clear reporting procedures are also required for permit compliance. The database would be used to track HCP compliance, which includes the following elements.

- Progress toward achieving the biological goals and objectives by implementation of conservation actions (including avoidance, minimization, and mitigation).
- Implementation of covered activities, including location and extent of each activity (i.e., take allocated for that activity).
- Results of all monitoring activities described under Chapter 5, Section 5.5.2, *Monitoring Program Elements*.
- Changes to the boundaries of MDC lands resulting from land transfers, sales, or acquisitions.
- Implementation of the changed circumstances and the monitoring and adaptive management program.
- New information regarding subterranean habitat and maternity colonies for covered species as described in Section 5.4.3, *Addition and Subtraction of Subterranean Habitat and Maternity Colonies*.

6.3.3 Reporting

The HCP administrator and Implementation Team will prepare and submit an annual report for the duration of the 50-year permit term detailing, among other things, compliance, impacts, conservation actions, and monitoring. The annual reports will summarize the previous fiscal year's implementation activities (July through June) and be provided to USFWS by October 15 following the reporting fiscal year. Annual reports will require synthesis of data and reporting on important trends. A due date of October 15 will allow time for the data from the previous fiscal year to be assembled, analyzed, and presented in a clear and concise format. In addition to submitting to USFWS, annual reports will be made available to the public and posted on the HCP website. The goals of the annual reports are to demonstrate to USFWS and the public that the MDC Bat HCP is being implemented properly. If any implementation problems have occurred, they will be disclosed with a description of corrective measures planned or measures that have been taken to address the problems. The reports will also identify responses to changed circumstances and adaptive management.

The minimum required content of the annual reports is as follows.

- Description of covered activities implemented during the reporting year as well as cumulative total (i.e., from the start of the permit term). This will include:
    - Prescribed fire—Acres of prescribed fire, including the location and acres of burning in modeled habitat for covered bats when bats are present.
    - Tree removal—Total acres of all tree removal, including location; acres of extensive versus limited removal;[13] and the acres of harvest in modeled seasonal habitat (see Appendix A, *Species Accounts*) during times of year when bats are present.
    - Buildings demolished—Number of structures demolished.
    - Locations of newly acquired land.
- Calculated acreage of take for each type of modeled habitat (i.e., summer habitat, fall/spring habitat) by occupancy type (high, medium, and low, if modeled) when bats are present. Caps for take are based on the total spring/fall and total summer acres of habitat affected when bats are present. Acres of occupied habitat affected by the implementation of covered activities will be tracked annually. The total amount of take (cumulatively over the permit term) cannot be exceeded, without a permit amendment.
- Documentation of any known instances of take of individual covered bats.
- Description of any changes in HCP implementation resulting from the adaptive management process during the reporting year, as applicable. This description will include the information that triggered the adaptive management process, the rationale for the planned responses, and the results of any applicable monitoring actions. Summary of surveys conducted through the monitoring program for the reporting year including description of surveys conducted, protocols used, survey results, and discussion of each survey identifying any issues, limitations, and implications (e.g., the identification of any new subterranean habitat or roost trees). (This element can be provided in a separate monitoring report.)
- Discussion of possible changes to the monitoring and research program based on interpretation of monitoring results and research findings, if applicable.
- Assessment of the annual and cumulative impact of white-nose syndrome (WNS) (see Section 6.4.2.2, *White-Nose Syndrome*). This will include copies of reports or publications from MDC about WNS and covered bats released over the reporting year and the total number of hibernacula surveyed (including both known and potential habitat for covered species).
- Documentation of any changed circumstances described in Section 6.4.2, *Changed and Unforeseen Circumstances*, that were triggered during the reporting year, if applicable. If any such circumstances were triggered, the report shall also include any responses implemented (i.e., remedial measures) and resulting monitoring.
- If changed circumstances were triggered in prior years, documentation of on-going responses to those past changed circumstances in the current reporting year, and the on-going results of remedial measures.

[13] Extensive tree removal removes more than 75% of canopy trees from a forested or wooded landscape while leaving a small residual; limited tree removal removes less than 75% from a woodland or removes trees from other habitat types.

- Any administrative changes or amendments during the reporting year (see Section 6.4.3, *Modifications to the Plan and/or Permit(s)*).
- Description of any new programs implemented on other nonfederal lands that received take coverage under the HCP.

6.3.4 Role of U.S. Fish and Wildlife Service

MDC will coordinate with USFWS and provide annual reports concerning HCP implementation. The USFWS issues the incidental take permit and oversees implementation and enforcement of the permit. Successful execution of the conservation program by MDC—including monitoring, reporting, and adaptive management actions that are part of the MDC Bat HCP—may at times require USFWS review and technical assistance. When and where significant changes to the conservation or adaptive management program or its implementation are proposed, USFWS review and approval may be required. USFWS staff may also provide a guidance or technical assistance role in HCP interpretation (in cases of ambiguity) or in the interpretation of USFWS policy.

Through annual reports, MDC will keep USFWS apprised of progress toward conservation goals and objectives, funding, monitoring, adaptive management, and other relevant topics.

6.3.5 Scientific Advice

The function of scientific review is to provide technical advice and to help assemble the best available scientific data on conservation actions, monitoring, and adaptive management. Scientists with expertise in conservation biology, management of local natural communities, and the ecology of the covered bats will provide information, as appropriate, to MDC. The MDC will consult outside scientists on an ad hoc basis as issues arise related to species ecology, habitat management, and monitoring.

6.3.6 Public Input

The MDC will inform and seek comments from the public as part of the implementation of the MDC Bat HCP. The MDC will maintain an HCP website. Public input is an important part of HCP implementation and can help MDC generate continued support for the MDC Bat HCP throughout the process. The MDC will use its website to provide key program information, reports, and contact information to the public. The website will also allow members of the public to register for automatic project updates. The MDC will provide annual status updates to all interested parties and stakeholders.

6.4 Assurances Requested

This section discusses the assurances requested by MDC that are part of the ESA Section 10(a)(1)(B) permit issued by USFWS. These assurances require defining circumstances affecting the covered species that may change over the course of the permit term as well as those that are unforeseen.

6.4.1 No Surprises Regulation

This section describes the context of the federal No Surprises regulation as it relates to the MDC Bat HCP and MDC's incidental take permit. The federal No Surprises regulation was established by the Secretary of the Interior on March 25, 1998, and is codified at 50 Code of Federal Regulations [CFR] Sections 17.22(b)(5) (endangered species) and 17.32(b)(5) (threatened species). It provides assurances to Section 10 permit holders that no additional money, commitments, or restrictions of land or water will be required should unforeseen circumstances arise after the permit is in place that adversely affect species that are covered by an HCP.

Unforeseen circumstances are events that cannot be reasonably anticipated during development of the HCP. As a result of the unpredictable nature of unforeseen circumstances, response measures to such events are not included in the HCP. The difference between a "changed" and an "unforeseen" circumstance might depend upon the severity of the event. For example, a small fire that affects only limited acreage may be a "changed circumstance," but a rare, very large fire that destroys hundreds of thousands of acres may be considered "unforeseen."

USFWS defines *unforeseen circumstances* as those changes in circumstances that affect a species or geographic area covered by an HCP that may not reasonably have been anticipated by the plan participants during development of the conservation plan and that result in a substantial and adverse change in the status of a covered species.

Under ESA regulations, if unforeseen circumstances arise during the life of the HCP, USFWS may not require the commitment of additional land or financial compensation or additional restrictions on the use of land, water, or other natural resources, other than those agreed to in the HCP, unless the HCP authorized entities consent. Within these constraints, USFWS may require additional measures, but only if (1) USFWS proves an unforeseen circumstance exists, (2) such measures are limited to modifications of the HCP's operating conservation program for the affected species, (3) the original terms of the HCP are maintained to the maximum extent practicable, and (4) the overall cost of implementing the HCP is not increased by the modification.

The federal No Surprises regulation[14] defines *changed circumstances* as changes in circumstances that affect a species or geographic area covered by a conservation plan that can reasonably be anticipated by plan developers and USFWS and that can be planned for (e.g., the listing of a new species or a fire or other natural catastrophic event in areas that are prone to such events). The USFWS will not require any additional mitigation to address changed circumstances that are not identified in the HCP without the consent of MDC as long as MDC is properly implementing the HCP. *Properly implementing* means that MDC is implementing or has fully implemented the commitments and provisions of the HCP and permit.

6.4.2 Changed and Unforeseen Circumstances

Under ESA Section 10, an HCP is required to identify anticipated and possible circumstances that could change during implementation and that may affect the status of the covered species. The MDC must also identify remedial measures that it will take in response to a changed circumstance in accordance with the federal No Surprises regulation.

[14] See 63 *Federal Register* 35 (1998) (amending 50 CFR §§ 17.22(b)(5) and 222.307(g)).

The changed and unforeseen circumstances and their contingency actions are described in the following sections. The MDC will maintain sufficient financial reserves to fund all such contingency actions throughout the permit term.

6.4.2.1 Additional Species Listed

Over the course of the permit term (50 years), USFWS could list species that are not covered under the MDC Bat HCP as threatened or endangered under the ESA. The USFWS will notify MDC when a noncovered species associated with habitat on covered lands has been proposed for listing, becomes a candidate for listing, or is emergency-listed (new, noncovered species). Following such notification, MDC will take the following measures.

- Coordinate with USFWS and implement avoidance measures if necessary to avoid take. In coordination with USFWS, the potential effects of covered activities on the new, noncovered species will be evaluated, including an assessment of the presence of suitable habitat on covered lands. If MDC and USFWS determine that the new species occurs or could occur on covered lands and that covered activities may take the species, MDC will identify and implement reasonable measures to avoid the take of the new, noncovered species. These measures will be developed in coordination with USFWS.
- If necessary, apply for a permit amendment or alternative take coverage. If MDC wishes to proceed with activities that will cause take of the new, noncovered species, they can begin the process to amend the MDC Bat HCP incidental take permit to include these species, or MDC could apply for a new and separate permit.

The agencies will implement the interim take avoidance guidelines for the species until the permit amendment is finalized, or an alternate permit is issued to ensure compliance with the ESA. In most cases, permit amendments to include additional covered species require amendment to the HCP and the permit, and would require USFWS to re-initiate Section 7 consultation and conduct supplemental National Environmental Policy Act (NEPA) work. See Section 6.4.5, *Amendments*, for more details on the permit amendment process for this HCP.

6.4.2.2 White-Nose Syndrome

White-nose syndrome is a fungal disease that has caused the deaths of more than 5.5 million bats since it was first discovered in a cave near Albany, New York, in February 2006 (U.S. Fish and Wildlife Service 2012). Migrating bats can move spores of the fungus many miles (Minnis and Lindner 2013; Miller-Butterworth et al. 2014; Heffernan and Turner 2016), and the pathogen (*Pseudogymnoascus destructans*) is part of a family of soil fungi (Minnis and Lindner 2013) that does not need a bat host in order to survive. The result is a pathogen that can rapidly infect new sites, which can remain infected for multiple seasons. As of 2018, the disease has spread north to Labrador in Canada, south to Georgia, and west to Wyoming, with an isolated occurrence in Washington State (U.S. Geological Survey 2017). Within Missouri, the first suspected cases of the WNS fungus were reported in Pike and Shannon Counties in 2010. WNS was confirmed in 2012 in a cave at Cuivre River State Park in Lincoln County, Missouri. WNS has since spread to additional locations across Missouri. As of October 1, 2018, presence of WNS is confirmed or suspected in 48 counties in Missouri (see https://www.whitenosesyndrome.org/mmedia-education/october-10-2018).

Since WNS first began to spread across the United States, site-specific mortality of hibernating colonies has been as high as 90 to 100% (U.S. Fish and Wildlife Service 2018). These declines are severe enough to warrant concern that one or more covered species may become extirpated from the state. The arrival of WNS in Missouri prompted various stakeholders, including MDC and federal biologists, to initiate a collaborative effort to biannually survey winter hibernacula, focusing on biannual surveys of 183 hibernacula (Colatskie 2017). Since WNS was first confirmed in Missouri in 2012, survey efforts indicate species-specific responses. Once common species including little brown, northern long-eared, and tricolored bats all have suffered substantial population declines (Colatskie 2017). Also, bats migrate to and from the covered lands from surrounding states, including Arkansas, Illinois, Iowa, Kansas, Kentucky, Nebraska, Oklahoma, and Tennessee, all of which are known to be infected with WNS (www.whitenosesyndrome.org).

While the populations of some species, including Indiana bats and little brown bats, may eventually stabilize at lower levels (Langwig et al. 2012; Frick et al. 2015; Langwig et al. 2016; Frick et al. 2017), northern long-eared bats do not show this stabilizing response and thus face a higher extinction probability than the other species (Frick et al. 2015; Frick et al. 2017). Because changes to the populations of covered bats as the result of WNS are ongoing, and because it is more efficacious to address WNS up front as part of the conservation strategy rather than post hoc as a changed circumstance, HCP actions associated with WNS are described in the Conservation Strategy rather than here as a changed circumstances. See Section 5.4, *Adaptive Management,* for additional information.

Conservation Measures and Monitoring

This section summarizes conservation measures and monitoring related to the biological objectives and adaptive management actions associated with WNS in Chapter 5. Population declines due to WNS are a major driver for listing cave-dwelling bat species under the ESA. Species covered by the HCP have expressed species-specific responses to the arrival of WNS in Missouri with the gray bat wintering population experiencing no documented declines attributed to WNS (approximately stable since 2012) and northern long-eared bat population, at the other end of the spectrum, having nearly disappeared from hibernacula since 2012 (Colatskie 2017). Multiple conservation measures (Chapter 5, *Conservation Strategy*) were designed to help minimize impacts due to WNS. Objective 4.1 involves completing assessments of entrances to subterranean habitat known to harbor bats on MDC lands. Such assessments provide a proactive approach to identifying “red flags” that may suggest whether structural or other issues may be present, which may cause additive stress to bats exposed to WNS. Objective 4.3 ensures that gates are maintained at cave entrances to priority subterranean sites on MDC lands throughout the permit term. Objectives 6.1 and 6.2 promote recovery from WNS through updates to and distribution of a general statewide WNS action plan and MDC collaboration with researchers, respectively, throughout the permit term. Chapter 5, Section 5.4.1, *White-Nose Syndrome*, describes adaptive management responses to WNS including monitoring, implementing treatments/cures (if discovered), tailoring conservation measures, and shifting conservation priorities.

Thresholds

As described above, WNS is addressed as part of adaptive management rather than a changed circumstance. and remedial actions were not developed for WNS as these are addressed in Chapter 5, Section 5.4.1, *White-Nose Syndrome.*

Remedial Measures

Although disease is a natural component of all species' populations, North American bats have not evolved alongside the causative fungal agent of WNS that has the potential to extirpate covered species regionally, if not globally. The effects of WNS on bat species will be addressed in the HCP adaptive management program. Under that program, MDC will track hibernaculum occupancy and abundance through surveys and will adjust application of conservation measures accordingly (Chapter 5, Section 5.2, *Biological Goals and Objectives*).

6.4.2.3 Wildfire

Missouri wildfires are typically ignited by humans or require human intervention to spread significantly (MOGreenStats 2016b). Although Missouri is not known for large wildland fires, hot and dry conditions predicted to occur more frequently as a result of climate change may significantly increase the risk. Uncontrolled and particularly intense wildfires can negatively affect covered bats through heat and smoke exposure, by reducing roost availability, or by creating unsuitable conditions at existing roost sites. A stand-replacing fire that eliminates forest and favors shrub-scrub and grassland will reduce roosting and foraging habitat for covered bats. Alternatively, wildfire also has the potential to provide additional roosting resources for bats through the resulting creation of decaying trees and snags.

The development and spread of wildfires is related to fuel abundance and connectivity, soil and vegetation moisture, and weather and climate patterns (Cardille and Ventura 2001). In Missouri, moisture and habitat fragmentation lead to rare instances of wildfire. Lightning may strike the ground and cause something to burn, but it doesn't burn vigorously, and it goes out without spreading. Missouri fires tend to stay on the ground, rather than racing through tree crowns. The leading cause of wildfire continues to be the use of fire to dispose of debris (Missouri Department of Conservation 2015). From 2006 until 2015, the percent of wildfire area burned, according to cause, was reported as follows: (1) unknown—31%; (2) debris—29%; (3) arson—17%; (4) miscellaneous—12%; (5) equipment—5%; (6) smoking, campfire, and not reported—5%; and (7) lightning—1% (Missouri Department of Conservation 2016). The drivers of human-caused fire ignitions (e.g., road proximity) end up also being the dominant drivers of burn probability. Biotic (i.e., vegetation type) and abiotic (i.e., elevation) factors are likely important secondary factors influencing burn probability. In Missouri, wildfires are not anticipated to be distributed evenly across vegetation types (Yang et al. 2008).

The large forested and woodland areas, glades, and karst topography of the Missouri Ozarks, which is the preferred habitat of the covered species, constitute a distinctive landscape for fire. Topography and fuel influences on spatial burn patterns are not as prominent as human factors in the Missouri Ozarks (Yang et al. 2008). Wildfires in the Missouri Ozarks are characterized by many human-caused, small-size, low-intensity surface fires (Guyette et al. 2002) that are extinguished with rapid, effective fire suppression measures.

Some of the largest wildfire increases in the last 30 years have occurred in the Central Irregular Plains, which encompass parts of northern Missouri (Balch et al. 2017; Donovan et al. 2017). This area corresponds roughly to the Osage Plains Section and the Central Dissected Till Plain Section of the plan area (Section 3.4.4, *Ecological Classifications*). Much of this landscape is not preferred habitat for the covered species because it does not contain the caves and mines that allow the covered bats to hibernate through winter.

Conservation Measures and Monitoring

Because some bats and other wildlife species prefer forests that have an open canopy and a greater abundance and diversity of understory plants, prescribed burns are used as a management tool for the promotion of habitat and wildlife. Prescribed burns are also used to regenerate and improve habitats, increase native biological diversity, control invasive or pest species and diseases, improve watershed quality, and improve recreational and hunting opportunities. While fuel reduction is not a goal of the prescribed fire program, a beneficial effect of the program is a reduction in wildfire potential on MDC lands. Objective 5.1 develops and implements prescribed burn plans to minimize impacts of such wildfires. Objective 1.3 restricts the timing of prescribed burning in areas identified as known roost trees.

Thresholds

Wildfire on MDC lands is a foreseeable circumstance that, in some cases, can be beneficial to covered bats. Table 6-2 provides a history of wildfires on MDC and other nonfederal lands in Missouri for the period of 2002–2018 (Missouri Department of Conservation 2019). The data represent wildfires in natural cover, with no distinction between grass or forest wildfires. The MDC indicated that fires in Missouri are very small and occur mostly on private lands (as opposed to on MDC lands), with the primary cause cited as burning debris that becomes uncontrolled. Table 6-2 suggests that annual median wildfire sizes ranged 1–2 acres over the 16-year reporting period. Total acres burned varies from year to year with no obvious trend. Wildfires in Missouri are expected to remain low intensity (ground fires) and to be caused by human fire ignitions. Because wildfires generally improve habitat for covered bats, the trigger for remedial actions is focused on areas where specific habitat features for bats are found, such as known roosts and hibernacula. Any wildfire that occurs where there is a known roost or hibernaculum or within a PBMZ will be subject to the remedial measures described in the next section.

Table 6-2. MDC Wildfire Reporting on MDC and Other Nonfederal Lands (2002–2018)

Year	Total Wildfire Acres Per Year	Mean Size (Acres)	Median Size (Acres)	Largest Wildfire (Acres)
2002	7,222	9	1	602
2003	35,513	16	2	1,900
2004	31,822	13	2	1,320
2005	60,848	16	2	3,422
2006	58,757	15	2	3,500
2007	21,903	9	1	1,595
2008	13,344	7	1	360
2009	47,604	11	2	2,160
2010	27,854	9	1	2,855
2011	43,634	13	1	1,500
2012	52,665	10	1	2,000
2013	12,315	6	1	500
2014	48,966	11	2	1,129
2015	25,417	7	1	565
2016	29,777	9	1	1,027
2017	31,675	9	1	876
2018	21,208	11	1	1,366

Source: Missouri Department of Conservation 2019

Remedial Measures

To ensure roost trees and hibernacula addressed by the conservation strategy continue to provide habitat value, fires in stands with known roosts or hibernacula on MDC lands, or within designated PBMZs, will be evaluated within 6 months. The post-fire analysis will assess the potential cause of the fire and acres burned. The assessment will determine the extent to which the affected forest has retained suitable habitat features such as snags, tree species, and canopy. If this analysis indicates a degradation in habitat quality (e.g., known roost trees have been destroyed without replacement), MDC will develop a site-specific plan outlining rehabilitation needs. Short-term remedial measures will include the use of bat boxes or creating snags in adjacent stands if viable roost trees have been destroyed. Longer-term management efforts may include forest restoration or timber management that directs the forest back toward suitable bat habitat.

6.4.2.4 Climate Change

Climate change refers to the warming of the earth's climate system due to increases in greenhouse gas and aerosol emissions from industrialization and land use change. The evidence for this—increases in average air and ocean temperatures, melting of glacial and polar snow and ice, and rising global average sea level—is now considered unequivocal (Cook et al. 2016; Intergovernmental Panel on Climate Change 2007; National Research Council 2001; Oreskes 2004; Parmesan and Yohe 2003). Natural systems are being affected by regional climate changes, including changes in hydrological systems (e.g., runoff, peak discharges, water quality) and terrestrial systems (e.g., earlier timing of spring events, shifts in plant and animal ranges).

A warming climate has the potential to alter conditions for covered bats through several mechanisms (Humphries et al. 2004; Root et al. 2003). First, climate change can directly and indirectly affect the insect prey base (Sherwin et al. 2012) because insect food supplies are directly tied to weather conditions and indirectly to habitats such as wetlands, which may decrease in response to climate change (Frick et al. 2010; Lookingbill et al. 2010). Ambient temperature and precipitation directly alter bat foraging success by influencing insect behavior in ways that could positively or negatively affect foraging opportunities (Baerwald and Barclay 2009; Erickson and West 2002).

Second, forest structure and composition can be affected by several factors related to climate change. Ecologically, a warming climate is expected to alter the frequency, intensity, duration and timing of disturbance regimes such as wildfire, drought, invasive species colonization and spread of insect and pathogen outbreaks, wind and ice storms, and landslides—with some negative impacts on current forests (Dale et al. 2001) and, consequently, on bat habitat. Forest community changes have potential to affect the number of available roost trees (Barclay and Kurta 2007; Hellmann et al. 2008; Perkins 1996; Timpone et al. 2010).

Third, suitability of hibernacula may be affected by changes in the surrounding forest. Forest community changes, combined with rising ambient temperatures, can interact with land cover to influence surface temperature and air flow (Menzel et al. 2001). As described in Chapter 5, Section 5.4.2, *Climate Change Leading to Shifts in Distribution,* changes in hibernacula ambient temperature can improve suitability of hibernacula through the region. As discussed above, increased periods of warm temperatures due to climate change may eventually reduce the transmission rate of WNS among bats. A shorter hibernation period may reduce the spread of WNS between individuals (Maher et al. 2012).

As described in Chapter 5, Section 5.4.1.2, *Climate Change Leading to Shifts in Distribution,* climate change models have been completed for Indiana bats in summer (Loeb and Winters 2013) and little brown bats in winter (Humphries et al. 2002). Each provides insight regarding potential impacts to seasonal habitat due to climate change, and touches on aspects described in the previous paragraph. Humphries et al. (2002) developed a model that identified areas of North America that would provide suitable hibernacula for little brown bats. This model was then rerun based on predicted changes in climate. The resulting model predicted that the species would be able to expand its range into more northern sites in response to a longer growing season (i.e., when insects are available) and because of warmer conditions within hibernacula. Similarly, Loeb and Winters (2013) developed a model of summer habitat of the Indiana bat and compared that to multiple models of future climatic conditions. Results indicated the western part of the current range, especially Missouri, would become climatically unsuitable for Indiana bats, resulting in declines and potential regional abandonment. Covered species share many similarities in habitat that make it possible to generalize the models' conclusions across these species.

Conservation Measures and Monitoring

Relevant conservation measures in Chapter 5 promote using tree retention and landscape forest management, which promote resiliency to climate change effects by supporting and enhancing desirable habitat and habitat features. As described in Chapter 5, Section 5.4.2, *Climate Change Leading to Shifts in Distribution,* the monitoring program will track potential shifts in species distribution, namely through annual status and trend monitoring. In addition, other objectives in Chapter 5 aid in addressing potential issues that may arise or be exacerbated by climate change,

including Objective 4.3, which promotes installation and maintenance of physical barriers (e.g., cave gate) for priority subterranean sites on MDC lands. Presence of physical barriers can reduce the likelihood that bats are exposed to pervasive disruptions that may be especially deleterious when other stressors, such as climate change and WNS, are present.

Thresholds

Climate change is considered a foreseeable event that affects the environment in the plan area. While it is described herein as a changed circumstance, it is addressed as part of the conservation strategy (Chapter 5, Section 5.4.2, *Climate Change Leading to Shifts in Distribution*).

Remedial Measures

Some degree of climate change is a near certainty and addressing climate change and its effect on bat habitat as part of the conservation strategy up front will be more effective than addressing it post hoc as a changed circumstance (Bernazzani et al. 2012). Therefore, measures to address climate change will be implemented through the adaptive management program (Chapter 5, Section 5.4.2, *Climate Change Leading to Shifts in Distribution*).

6.4.2.5 Forest Pests, Disease, and Invasive Plant Species

Damage to trees caused by forest pests and pathogens can threaten the long-term health and sustainability of forest ecosystems. Native insects and diseases are part of the natural cycle of regeneration where aging, damaged, or stressed individual trees are susceptible to infestation (Sturrock et al. 2011). Affected trees are ultimately replaced by smaller trees, with advanced regeneration of shade-tolerant species and/or newly established pioneering species. Invasive pest and pathogen species alter this natural cycle and affect otherwise healthy vegetation that could resist infection under normal circumstances. These nuisance species can include nonnative insects, fungi, bacteria, viruses, or a combination of these, such as seen in emerald ash disease. Existing MDC forest management efforts to prevent or reduce the spread of nuisance species address both insect species and diseases. Focal insect species include the emerald ash borer (*Agrilus planipennis*), Asian long-horned beetle (*Anaplophora glabripennis*), gypsy moth (*Lymantria dispar dispar*), and the pine shoot beetle (*Tomiscus piniperda*). Focal diseases include oak wilt, hypoxylon canker, oak decline (a weakening condition caused by environmental stresses [e.g., drought, waterlogging, frost]), rapid white oak mortality (unknown cause), and butternut canker disease. Also of great concern in Missouri, but not yet detected, is the thousand cankers disease caused by the walnut twig beetle (*Pityophthorus juglandis*) and an associated fungus (*Geosmithia morbida*).

Overall forest structure, function, and diversity is also threated by nonnative invasive plant species that can outcompete native species for resources (such as light, space, nutrients, and moisture), leading to a shift in plant community composition. This shift can change ecosystem function, which affects the species dependent upon the ecosystem services provided (Pyšek and Richardson 2010). There are several dozen invasive terrestrial and aquatic plant species in Missouri. Missouri provides regulations pertaining to the prevention, control, or eradication of invasive species in the Missouri Revised Statutes, Insect Pests and Weeds (Chapter 263).

Climate change is expected to exacerbate this problem by facilitating new species establishment, potentially encouraging range expansion of current invasive species and changing the effectiveness of management techniques (Dale et al. 2001; Hellmann et al. 2008). While range expansions and contractions for many species are likely to occur because of climate change, invasive species are

more likely to either spread or have no change to current ranges (Hellmann et al. 2008). This is due to most invasive species' ability to propagate and proliferate under a wide variety of environmental conditions. Additionally, transportation of goods and the use of certain geographic areas by humans are expected to change in response to changes in climate, which can increase the number of invasive species and their rate of spread (Hellmann et al. 2008). Expected changes in the patterns and intensity of extreme weather conditions have the potential to further disperse invasive species (Dale et al. 2001; Schneider et al. 2005) Future exposure of covered lands to nonnative species and disease has the potential to reduce forest extent and change species composition.

Conservation Measures and Monitoring

When a species or pathogen has been recognized as potentially destructive to the natural ecosystem, the Missouri Invasive Forest Pest Council (MIFPC), a collaboration of state agencies (including MDC) and the University of Missouri, assesses the potential threats of invasive forest insects and diseases and prepares responses to those threats. Subsequent action plans are prepared for individual invasive forest pest species. Regarding the role of MDC within the MIFPC, responsibilities are outlined in the *Missouri Invasive Forest Pest Plan* (Missouri Invasive Forest Pest Council 2015). One of MDC's key roles is to provide technical information to MIFPC members and stakeholders regarding pest biology, management options, and economic impacts on forest resources. Prevention techniques may include quarantines and restrictions on the sale or transportation of live plants and untreated wood products, including firewood. Once an invasive species is located, early response can control its spread (Hellmann et al. 2008). When an invasive species becomes established, management techniques adapt to include appropriate stand thinning and salvaging, insecticide application, and root isolation cuts. Access to contaminated sites can also be restricted to reduce the spread of disease. Forest management plans often need to be long-term and MDC currently applies continued monitoring for insect pests and diseases to make informed management decisions.

Threshold

The threshold for changed circumstances is as follows.

- Infestations of new pests or diseases affecting up to 25% of the extent (acres) of a focal tree species as identified in Chapter 5, Section 5.2.2.1, *Biological Goal 3: Enhance, maintain, and restore roosting and foraging habitat for covered bats*. Infestation extent will be determined through implementing standardized monitoring protocol as part of a forest management plan once a species or pathogen has been located in the state.

The remedial measures described in the next section will be implemented to address the changed circumstance.

Infestations that affect more than 25% of the extent of a focal tree species as identified in Section 5.2.2.1, *Biological Goal 3: Enhance, maintain, and restore roosting and foraging habitat for covered bats*, are not expected and therefore would be unforeseen.

Remedial Measures

Because forest health and management techniques can change dependent upon new pests, invasive species, and diseases, it is important to ensure the protection and maintenance of roost trees for covered species. If any of the above foreseeable circumstances occur, MDC will follow the response protocols as directed by the *Missouri Invasive Forest Pest Plan* (Section VIII, *Response to Detection of*

an Invasive Forest Pest; Missouri Invasive Forest Pest Council 2015). The MDC will inform USFWS regarding any possible impacts to roosting habitat.

6.4.2.6 Species Delisting

Conservation Measures and Monitoring

Delisting a species is possible for a 50-year HCP. Over the term of the permit, one or more of the listed covered species could become delisted under the ESA. In the event that USFWS delists a listed covered species, the provisions of this changed circumstance will be triggered.

Threshold

Delisting of a covered species during the permit term.

Remedial Measures

If a listed covered species becomes delisted over the term of the permit, MDC will coordinate with the USFWS to evaluate and identify the applicable elements of the HCP and permit that are not necessary to preclude a potential relisting of the species.

With concurrence of the USFWS, any elements of the HCP and permit that are not deemed necessary to maintain the species delisting will no longer be required. MDC will continue to implement elements of the HCP and permit deemed necessary by the USFWS to maintain the delisting status will continue to be implemented. All mitigation for take of the delisted species incurred up until the time of the delisting must be implemented in accordance with the terms of the HCP and permit. All mitigation for the delisted species that has been implemented prior to delisting will be required to be maintained as provided for in the HCP and terms of the permit. Funding assurances are no longer required by MDC for the delisted species after delisting for any mitigation not deemed necessary to maintain the species delisting, including all monitoring, all changed circumstance and all adaptive management.

6.4.3 Modifications to the Plan and/or Permit(s)

The MDC Bat HCP or associated incidental take permit may be modified in accordance with the ESA, USFWS implementing regulations, and the provisions outlined in this chapter. Modifications to the HCP or permit may be requested by either MDC or USFWS. The USFWS also may amend the permit at any time for just cause, and upon a written finding of necessity, during the permit term in accordance with 50 CFR Section 13.23(b). The categories of modifications are administrative changes and amendments.

Any administrative changes arising during a reporting year will be submitted to USFWS as HCP addendums to the next annual report. HCP amendments, once approved by USFWS, will be documented by providing USFWS with a redline version of the MDC Bat HCP containing the relevant text change(s). Upon request from USFWS, MDC will provide a complete revised version of the MDC Bat HCP, including the revisions resulting from all administrative changes and amendments to date, every 5 years during the permit term.

6.4.4 Administrative Changes

Administrative changes are internal changes or corrections to the MDC Bat HCP that may be made by MDC, at their own initiative, or approved by MDC in response to a written request submitted by USFWS. Requests from USFWS will include an explanation of the reason for the change as well as any supporting documentation.

Administrative changes to the HCP must be consistent with the scope of the analysis in the HCP and the original NEPA document. Administrative changes will address small errors, omissions, or language that may be too general or too specific for practical application. Administrative changes do not require approval by USFWS.

Examples of administrative changes to the MDC Bat HCP are the following.

- Corrections of typographical, grammatical, and similar editing errors that do not change the intended meaning or obligations.
- Corrections of any minor errors in maps or exhibits.
- Corrections of any maps, tables, or appendices in the HCP to reflect approved amendments (Section 6.4.5, *Amendments*) to the HCP or incidental take permit.
- Adjustments to the tracking/reporting schedule timeline.
- Changes to MDC staff or changes to the membership of the HCP Steering Committee without changing the representation of MDC.
- Clarifications of HCP implementation where the HCP was vague or internally inconsistent.

6.4.5 Amendments

Changes to the HCP or incidental take permit that do not qualify for an administrative change can be accomplished through an amendment. Once an amendment is requested, it is up to USFWS to decide the level of review needed to satisfy ESA, NEPA and other regulatory requirements. Plan amendments require USFWS approval.

Depending on their scope, amendments to the HCP can be approved by USFWS through an exchange of formal correspondence, addendum to the HCP, revision to the HCP, or a permit amendment. Examples of changes that would require an amendment include, but are not limited to, the following actions.

- Addition or deletion of covered species.
- Increase in the allowable take limit for existing covered activities or the addition of new covered activities.
- Modifications of any important action or component of the conservation strategy under the HCP, including funding, that may substantially affect levels of authorized take, effects of the covered activities, or the nature or scope of the conservation strategy.
- A major change in the biological goals and objectives or conservation actions if monitoring or research indicates that they are not attainable because technologies to attain them are either unavailable or infeasible.

Chapter 7
Cost and Funding

The Endangered Species Act (ESA) requires that habitat conservation plans (HCPs) specify, "the funding that will be available to implement" conservation actions that minimize and mitigate impacts on covered species (16 United States Code [U.S.C.] § 1539(a)(2)(A)). The ESA also requires the U.S. Fish and Wildlife Service (USFWS) to find that the applicant will ensure that adequate funding is available to implement the HCP (16 U.S.C. § 1539(a)(2)(B)(iii)). This chapter outlines the estimated costs to implement the Missouri Department of Conservation (MDC) Bat HCP over the proposed 50-year permit term and provides assurances that MDC will pay for those costs.

The estimates outlined in this chapter reflect the costs to implement the plan during year 1 of the permit term based on 2019 dollars. These values are not adjusted for inflation because plan costs are expected to increase due to inflation at the same rate as increases in plan funding sources. For example, any revenue sources that fund agency operations are reevaluated each year and adjusted for actual or predicted inflation, as necessary. Similarly, MDC's annual budget process will adjust budget requests for inflation at the same rate that plan costs will increase due to inflation.

7.1 Cost to Implement the Habitat Conservation Plan

As described in Chapter 6, *HCP Implementation and Assurances*, MDC staff will be responsible for the implementation of the MDC Bat HCP. MDC staff members include an HCP administrator, geographic information system (GIS) technician, community liaison, qualified staff, biologists/technical staff, land managers, law enforcement, and consultants and contractors who will carry out planning and design, monitoring, adaptive management, and periodic coordination with and reporting to the USFWS (see Section 6.3.1.4, *HCP Support Staff,* for a full description of each position).

Costs to implement the MDC Bat HCP are divided into categories that are summarized in the following subsections.

- Program administration
- Conservation program and monitoring actions
- Adaptive management and changed circumstances

All costs were estimated based on cost estimates provided by MDC staff for the same or similar actions conducted currently. In cases where actual MDC cost data was unavailable (e.g., HCP costs are new to the agency), costs were estimated based on similar actions conducted by other entities in the state, or with data from comparable HCPs in other states.

It is important to note that these cost estimates are planning-level estimates only for the purpose of demonstrating assured funding for the HCP. MDC will prepare an annual budget to implement the HCP that may differ from these cost estimates (either more or less). These cost estimates are not requirements of funds MDC must spend, but rather reasonable estimates of total HCP costs over the entire permit term.

7.1.1 Program Administration

Program administration involves ongoing or yearly costs associated with staff time for coordination, agency meetings, database tracking, and reporting. MDC will provide an HCP administrator, who will be responsible for compiling the HCP annual report, coordinating HCP implementation and other HCP administration needs. Additional qualified staff, biologists and foresters, will also help with administration. GIS staff will maintain and update a database that houses spatial information necessary for tracking compliance with the MDC Bat HCP. Table 7-1 summarizes program administration costs by key HCP staff.

Table 7-1. Program Administration Costs

	MDC Full-Time Employees	Years Needed	Rate[a]	Annual Cost in Year 1	Cost Over 50-Year Permit Term
HCP Staff					
HCP Administrator	0.05	50	$138,278	$6,914	$345,696
GIS Technician	0.03	50	$122,949	$3,688	$184,423
Qualified Staff	0.05	50	$122,949	$6,147	$307,372
			TOTAL COST	**$16,750**	**$837,491**

[a] Rate for staff time includes staff base salary plus an overhead cost.
See Section 6.3, *Implementation Organization Structure*, for a description of the roles of HCP staff.
HCP = habitat conservation plan
GIS = geographical information system

7.1.2 Conservation Program and Monitoring Actions

As stated in Chapter 5, *Conservation Program,* biological goals and objectives must be implemented to fulfill the HCP requirement to fully offset effects on the covered species. Costs associated with the conservation program include the implementation of conservation measures, monitoring actions, and the staff time associated with tracking these elements. The adaptive management strategy costs are described separately in Section 7.1.3, *Adaptive Management and Changed Circumstances*. MDC staff will oversee conservation measures and design and implement monitoring actions. Each of the biological objectives within the conservation program has associated actions that may require additional staff time and direct costs. Staff positions for implementation of the HCP include an HCP administrator, GIS technician, community liaison, qualified staff, biologists or technical staff, land managers, law enforcement, and consultants and contractors. Existing MDC staff, such as biologists, foresters, and planners, will crosswalk to these positions to oversee and assist with implementation of the conservation program, so a portion of a full-time salary was allocated to account for these costs (Table 7-2).

Conservation Measures

This HCP commits MDC to continuing some current conservation measures that they already implement. MDC will incorporate new measures into currently established programs. Implementation of ongoing measures will require minimal new staff time or materials. Ongoing or existing costs are not estimated for the purposes of costing this HCP. Staff time and direct costs and materials for conservation measures were estimated only for new actions (Table 7-2).

Table 7-2. Conservation Program

Biological Objectives	Potential Associated Action(s)	Additional Staff Time Needed to Implement the HCP										Direct Costs				Total Annual Cost	Total Cost Over Permit Term
		MDC Full-Time Employees															
		GIS Technician	Community Liaison	Qualified Staff	Biological and Technical Staff	Land Manager	Consultant or Contractor	New Commitment	Annual Cost in Year 1	Number of Years	Over Permit Term	Cost Per Event	# of Actions	Annual Cost	Over Permit Term	Missouri	Missouri
Objective 1.1: Sustainably manage 700,000 acres of forest and woodlands across MDC lands beginning in year 1 and continuing throughout the permit term.	Continue existing management actions and maintaining forestland as forest.								Ongoing				Ongoing			Ongoing	
	Document acres of forestland managed by MDC for use in the annual report. Provide brief description of sustainable forest management approach.								Ongoing				Ongoing			Ongoing	
Objective 1.2: Sustainably manage over 200,000 acres of ecologically appropriate open habitats across MDC lands beginning in year 1 and continuing throughout the permit term.	Continue existing management actions and maintain open lands and edge habitat.								Ongoing				Ongoing			Ongoing	
	Document in the annual report the number of acres currently managed as open habitat.								Ongoing				Ongoing			Ongoing	
Objective 1.3: Conduct prescribed burning in forests and woodlands each year to increase native biological diversity and enhance forest regeneration, wildlife habitats, and ecological community types that benefit bats.	Implement prescribed burn plans (based on MDC Resource Policy Manual).								Ongoing				Ongoing			Ongoing	
	Document the location and amount of prescribed burning in modeled bat habitat in the annual report.		0.004			0.300		✓	$33,126	50	$1,656,282		$0	$0	$0	$33,126	$1,656,282
	Complete post-burn evaluation checklist and document any impacts on known existing maternity roost trees.								Ongoing				Ongoing			Ongoing	
Objective 2.1: Promote bat-friendly management practices on private and other nonfederal land in the plan area.	Document updates to and promotion of the *Missouri Forest Management Guidelines*.								Ongoing				Ongoing			Ongoing	
	Develop and implement a communication plan and revise as needed throughout the permit term.		0.004					✓	$334	50	$16,722	$6,689	1	$134	$6,689	$468	$23,411
	Provide financial support by maintaining cost-share program and incorporating HCP conservation measures into the program.								Ongoing				Ongoing			Ongoing	
	Provide technical assistance to nonfederal landowners and incorporate HCP conservation measures.								Ongoing				Ongoing			Ongoing	
	Document outreach efforts. Document implementation of technical assistance (in terms of acres or individuals assisted). Document financial support efforts (cost) in the annual report.					0.005		✓	$526	50	$26,275		$0	$0	$0	$526	$26,275
Objective 3.1: Minimize impacts and improve habitat for covered bats by implementing roost tree retention guidelines in all forest habitat on covered lands.	Implement retention guidelines as described and/or as adopted in the HCP.								Ongoing				Ongoing			Ongoing	
	Monitor timber sales on MDC lands and MDC forestry activities on other nonfederal lands.								Ongoing				Ongoing			Ongoing	

Biological Objectives	Potential Associated Action(s)	Additional Staff Time Needed to Implement the HCP: MDC Full-Time Employees: GIS Technician	Community Liaison	Qualified Staff	Biological and Technical Staff	Land Manager	Consultant or Contractor	New Commitment	Annual Cost in Year 1	Number of Years	Over Permit Term	Direct Costs: Cost Per Event	# of Actions	Annual Cost	Over Permit Term	Total Annual Cost: Missouri	Total Cost Over Permit Term: Missouri
Objective 3.2: Protect all known roost trees using 150-foot buffer.	Update summer bat roost tree data annually in Natural Heritage Database.								Ongoing				Ongoing			Ongoing	
	Delineate buffer areas in GIS.								Ongoing				Ongoing			Ongoing	
	Adapt existing silvicultural prescriptions and timber sale administration process.			0.500				✓	$69,139	5	$345,696	$4,200	5	$420	$21,000	$7,334	$366,696
	Perform practice certifications before cost-share is provided to a landowner (other nonfederal lands).								Ongoing				Ongoing			Ongoing	
	Spot-check monitoring on 5% of the completed practices each year (other nonfederal lands).								Ongoing				Ongoing			Ongoing	
Objective 3.3: Establish priority bat management zones (PBMZs) to protect bats and promote high-quality bat habitat in areas of known or potential bat activity.	Develop biologically appropriate PBMZs.	0.004	0.004	0.004		0.008		✓	$2,267	10	$22,672	$0	--	$0	$0	$453	$22,672
	Perform and document enhancement actions taken within all PBMZs.	0.002	0.002	0.002				✓	$696	50	$34,818	$0	--	$0	$0	$696	$34,818
	Monitor roosting activity, if needed, at specific sites (e.g., bat detectors, guano traps, and counts).			0.019	0.019		0.019	✓	$6,209	50	$310,469	$0	--	$0	$0	$6,209	$310,469
Objective 4.1: Assess and, if necessary, improve 10 entrances to known subterranean habitat on MDC lands annually beginning in year 1 and continuing for the duration of the permit term.	Check all known entrances on MDC lands by year 5.			0.019	0.019	0.010		✓	$4,675	5	$23,376	$0	--	$0	$0	$468	$23,376
	Assess entrances on MDC lands, at minimum, 10 times during the duration of the permit.			0.019		0.010		✓	$3,720	45	$167,415	$0	--	$0	$0	$3,348	$167,415
	Check 10 occupied subterranean habitat entrances annually and remove obstructions.			0.024		0.004		✓	$3,756	50	$187,795	$0	--	$0	$0	$3,756	$187,795
	Document any management actions for hibernacula entrances in the annual report.			0.004				✓	$553	50	$27,656	$0	--	$0	$0	$553	$27,656
Objective 4.2: Implement bat management zones around known entrances to subterranean habitat on MDC lands.	Generate a list of all known hibernacula on MDC lands.								Ongoing				Ongoing			Ongoing	
	Implement activity restrictions within 20-acre buffers.								Ongoing				Ongoing			Ongoing	
	Enhance habitat for bats within 20-acre buffers.								Ongoing				Ongoing			Ongoing	
	Assess 20-acre buffers every 5 years to ensure that habitat targets are still in place.			0.005		0.005		✓	$1,238	50	$61,896	$0	--	$0	$0	$1,238	$61,896
	Continue monitoring target bat species populations at priority hibernacula during hibernation.								Ongoing				Ongoing			Ongoing	

Biological Objectives	Potential Associated Action(s)	Additional Staff Time Needed to Implement the HCP: MDC Full-Time Employees: GIS Technician	Community Liaison	Qualified Staff	Biological and Technical Staff	Land Manager	Consultant or Contractor	New Commitment	Annual Cost in Year 1	Number of Years	Over Permit Term	Direct Costs: Cost Per Event	# of Actions	Annual Cost	Over Permit Term	Total Annual Cost: Missouri	Total Cost Over Permit Term: Missouri
Objective 4.3: Maintain physical barriers at subterranean sites on MDC lands over the course of the permit term and gate additional sites as needed.	Document sites with existing physical barriers and prioritize sites in need of physical barriers.								Ongoing				Ongoing			Ongoing	
	Install physical barriers at sites without barriers where they are determined to be beneficial.								Ongoing				Ongoing			Ongoing	
	Visit gates/fences once every 5 years. Photographic documentation of gate condition will be provided in the annual report.			0.004		0.004		✓	$990	50	$49,516	$0	--	$0	$0	$990	$49,516
	Maintenance and repair of existing gates.								Ongoing				Ongoing			Ongoing	
Objective 5.1: Implement bat-friendly management measures within burn plans beginning year 1 of the plan.	Develop guidelines for burn plans in preferred bat habitat by year 1.		0.077	0.077				✓	$17,343	1	$17,343	$0	--	$0	$0	$347	$17,343
	Train prescribed fire staff on new criteria and provide documentation.								Ongoing				Ongoing			Ongoing	
	Implement seasonal burn plans on modeled habitat.								Ongoing				Ongoing			Ongoing	
Objective 5.2: Implement bat-friendly construction and demolition measures throughout the permit area.	Document in the annual report the number of acres of bat-friendly tree removal for construction and maintenance.		0.019	0.019				✓	$4,331	50	$216,572	$0	--	$0	$0	$4,331	$216,572
	Train construction/maintenance staff on new criteria and provide documentation.								Ongoing				Ongoing			Ongoing	
	Maintain existing speed limits and investigation into additional speed restrictions near hibernacula.								Ongoing				Ongoing			Ongoing	
	Develop and implement bat-friendly demolition practices.				0.017			✓	$854	50	$42,715	$180	50	$180	$9,000	$1,034	$51,715
	Implement tree removal guidance associated with construction.								Ongoing				Ongoing			Ongoing	
Objective 5.3: Provide training to new MDC staff to recognize and avoid potential roost trees.	Implement bat-specific training as part of onboarding process for new staff.		0.019					✓	$1,672	50	$83,612	$0	--	$0	$0	$1,672	$83,612
	Continue to provide updated guidance to MDC staff on identifying and avoiding potential roost trees on MDC lands.								Ongoing				Ongoing			Ongoing	
	Report on training activities in the annual report.		0.006					✓	$830	50	$41,484	$0	--	$0	$0	$830	$41,484
Objective 5.4: Incorporate bat-friendly BMPs into the Professional Timber Harvester (PTH) training.	Develop bat friendly BMPs and integration into Professional Timber Harvester (PTH) training.								Ongoing				Ongoing			Ongoing	
	Report on training activities in the annual report.			0.006				✓	$830	50	$41,484	$0	--	$0	$0	$830	$41,484

Biological Objectives	Potential Associated Action(s)	Additional Staff Time Needed to Implement the HCP: MDC Full-Time Employees: GIS Technician	Community Liaison	Qualified Staff	Biological and Technical Staff	Land Manager	Consultant or Contractor	New Commitment	Annual Cost in Year 1	Number of Years	Over Permit Term	Direct Costs: Cost Per Event	# of Actions	Annual Cost	Over Permit Term	Total Annual Cost Missouri	Total Cost Over Permit Term Missouri
Objective 6.1: Update MDC's WNS action plan by year 5.	Develop the updated WNS action plan by year 5.			0.019				✓	$2,659	1	$2,659	$0	--	$0	$0	$53	$2,659
	Document the publicly available website where the plan is available and describe collaboration with USFWS for part of the annual report.				0.004			✓	$193	50	$9,664	$0	--	$0	$0	$193	$9,664
Objective 6.2: Collaborate with researchers to identify ways to ameliorate the impacts of WNS through treatment or habitat management.	Provide technical assistance, permitting, and other collaborative efforts with researchers.			0.004				✓	$532	50	$26,592	$0	--	$0	$0	$532	$26,592
	Report research activities and ongoing collaboration in the annual report.			0.002				✓	$266	50	$13,296	$0	--	$0	$0	$266	$13,296
		0.006	0.129	0.733	0.059	0.346	0.019	--	$156,741	--	$3,426,008	$11,069	--	$734	$36,689	$69,254	$3,462,697
															Total MDC Cost	**$69,254**	**$3,462,697**

BMP = best management practice
GIS = geographic information system
PBMZ = priority bat management zones
PTH = Professional Timber Harvester

Monitoring Actions

The HCP monitoring program is described in Section 5.5, *Monitoring*. Monitoring the outcomes of conservation measures is the foundation of the HCP's conservation program and adaptive management approach and can help advance scientific understanding to better achieve the HCP's biological goals and objectives. As with the conservation measures, many monitoring actions will be implemented by continuing existing practices. The costs of existing monitoring programs and actions are not included as HCP costs. The new HCP monitoring actions that will result in additional costs are shown in Table 7-2.

7.1.3 Adaptive Management and Changed Circumstances

In addition to costs associated with program administration and the conservation program, the HCP will also have costs associated with the adaptive management program. There may also be costs for remedial actions should any changed circumstances occur. These costs have a high degree of uncertainty because the level of adaptive management and the need for remedial measures is difficult to predict. Because of this uncertainty, most of these costs are estimated in this HCP as a percentage of the total cost of the conservation program and monitoring.[15]

Section 5.4, *Adaptive Management,* describes the processes for addressing the specific uncertainties associated with the conservation strategy. Adaptive management measures and potential responses associated with those measures are shown in Table 7-3. Proposed adaptive management measures must be documented up front so they can subsequently affect changes to the operating conservation program, as needed. Section 5.4.1, *White-Nose Syndrome,* describes the WNS adaptive management approach and the adaptive management triggers for each covered species. MDC estimated the costs associated with this adaptive management category only. The costs are shown in Table 7-4 below. The cost of the rest of the adaptive management measures is calculated as 8% of the cost of the conservation program.

Section 6.4,2, *Changed and Unforeseen Circumstances,* describes the actions and remedial measures associated with anticipated and possible circumstances that could change during implementation and that may affect the status of the covered species. Remedial measures may also be necessary if foreseeable changes occur that may alter the assumptions or information upon which the HCP is based (see Chapter 6, *Implementation and Assurances*, for a description of changed circumstances). The cost of remedial measures is calculated as 5% of the cost of the HCP conservation program. This assumption is consistent with the contingency amount that has been allocated in other HCPs and has been demonstrated to be adequate for these plans in implementation (Santa Clara Valley Habitat Agency 2018; East Contra Costa County Habitat Conservancy 2018).

[15] This estimation method has been used in several other approved programmatic HCPs currently in implementation in California, including *Yolo HCP/Natural Community Conservation Plan (NCCP)*, *Santa Clara Valley HCP/NCCP*, and *East Contra Costa County HCP/NCCP*.

Table 7-3. Adaptive Management and Changed Circumstances

Adaptive Management	Potential Response
White-Nose Syndrome	Monitor WNS effects and update the Habitat Distribution Model as necessary.
	Remain abreast of current research and coordinate with USFWS regarding the testing and/or use of treatment methods.
	Coordinate with USFWS.
	Incorporate forest management research study into adaptive management program.
	Survey (acoustic) all PBMZs every 10 years.[a]
	Adjust PBMZ boundaries in response to survey data within 1 year of full survey completion (i.e., every 10 years) and coordination with FWS.
	Survey for northern long-eared bat summer roosting habitat within the first 5 years of plan implementation.[b]
	Include all currently used northern long-eared bat maternity roosts that occur on MDC managed lands within a PBMZ by year 7.
	Prioritize and accelerate survey efforts when or if a species reaches the status of severely WNS-impacted (as defined by the triggers).[c]
Climate Change Adaptation	Revise species habitat models.
	Modify or enhance monitoring.
Addition and Subtraction of Subterranean Habitat and Maternity Colonies	Record and incorporate new hibernacula.
	Record and resurvey historic sites every 5 years.
Changes to Prescribed Burning Regulations	Modify the levels of prescribed fire that can be completed.
	Coordinate with USFWS.
Addition and Subtraction of Priority Bat Management Zones	Assess and coordinate changes to PBMZs every 10 years.
	Coordinate and revise species-specific acreage targets.
Changes to Sodalis Nature Preserve Buffer	Coordinate with USFWS and assess and implement changes to Sodalis Nature Preserve Buffer.
Changed Circumstances	**Potential Response**
Additional Species Listed	Determine the potential for Missouri covered activities to affect candidate species.
	Coordinate with USFWS and avoid affecting newly listed species.
White-Nose Syndrome	Address response through adaptive management process.
Wildfire	Conduct post-fire analysis and implement remedial actions.
Climate Change	Address measures through adaptive management process.
Forest Pests, Disease, and Invasive Plant Species	Follow the response protocols as directed by the *Missouri Invasive Forest Pest Plan* (Section VIII, Response to Detection of an Invasive Forest Pest) (Missouri Invasive Forest Pest Council 2015).
	Inform USFWS if necessary, regarding any possible impacts on roosting habitat
Species Delisting	Identify the applicable elements of the permit that are not necessary to preclude a potential relisting of the species.
	Make administrative changes to plan/permit as appropriate.

[a] This effort is replaced by species specific surveys when triggers are met.
[b] This will replace the acoustic survey of all PBMZs.
[c] When this is initiated based on triggers, it will replace the acoustic survey of all PBMZs.
PBMZ = priority bat management zones
USFWS = U.S. Fish and Wildlife Service
WNS = white-nose syndrome

Table 7-4. White Nose Syndrome Adaptive Management Costs

		Additional Staff Time Needed to Implement the HCP										Direct Costs				Total Annual Cost	Total Cost Over Permit Term
		MDC Full-Time Employees															
Adaptive Management	Potential Associated Action(s)	HCP Administrator	GIS Technician	Qualified Staff	Biological and Technical Staff	Land Manager	Consultant or Contractor	New Commitment	Annual Cost in Year 1	Number of Years	Over Permit Term	Cost Per Event	Number of Actions	Annual Cost	Over Permit Term	Missouri	Missouri
White-Nose Syndrome	Monitor WNS effects and update the Habitat Distribution Model as necessary.		0.005	0.010				✓	$1,921	50	$96,035	$0	--	$0	$0	$1,921	$96,035
	Remain abreast of current research and coordinate with USFWS regarding the testing and/or use of treatment methods (if applicable).			0.018	0.018			✓	$3,444	50	$172,216	$0	--	$0	$0	$3,444	$172,216
	Coordinate with USFWS.								Ongoing				Ongoing			Ongoing	
	Incorporate forest management research study into adaptive management program.	0.144	0.077	0.173				✓	$53,334	1	$53,334	$0	--	$0	$0	$1,067	$53,334
	Survey (acoustic) all PBMZs every 10 years.			0.154	0.308			✓	$36,736	5	$183,680	$24,000	5	$2,400	$120,000	$6,074	$303,680
	Adjust PBMZ boundaries in response to survey data within 1 year of full survey completion (i.e., every 10 years) and coordination with USFWS.	0.038	0.019	0.058				✓	$15,660	5	$78,302	$0	--	$0	$0	$1,566	$78,302
	Survey for northern long-eared bat summer roosting habitat within the first 5 years of plan implementation.				1.000		0.470	✓	$115,244	5	$576,218	$0	--	$0	$0	$11,524	$576,218
	Include all currently used northern long-eared bat maternity roosts that occur on MDC managed lands within a PBMZ by year 7.	0.005	0.010	0.038				✓	$7,165	1	$7,165	$0	--	$0	$0	$143	$7,165
	Prioritize and accelerate survey efforts when or if a species reaches the status of severely WNS-impacted (as defined by the triggers).				1.000		0.470	✓	$115,244	15	$1,728,655	$0	--	$0	$0	$34,573	$1,728,655
	Total	0.188	0.111	0.451	2.326	0.000	0.940	--	$348,749	--	$2,895,606	$24,000	--	$2,400	$120,000	$60,312	$3,015,606
															Total MDC Cost	**$60,312**	**$3,015,606**

HCP = habitat conservation plan
PBMZ = priority bat management zone
USFWS = U.S. Fish and Wildlife Service
WNS = white-nose syndrome

7.1.4 Summary of HCP Implementation Costs

Table 7-5. Summary of HCP Implementation Costs

Cost	Annualized Cost	Over Permit Term
Program Administration	$16,750	$837,491
Conservation Program	$69,254	$3,462,697
WNS Adaptive Management	$60,312	$3,015,606
Other Adaptive Management	$5,540	$277,016
Changed Circumstances	$3,463	$173,135
Total Cost of HCP	**$155,319**	**$7,765,945**

[a] All implementation costs were annualized over the permit term; however, not all implementation activities will occur on an annual basis, therefore not all costs will occur on an annual basis.
HCP = habitat conservation plan
WNS = white-nose syndrome

7.2 Funding Assurances

MDC is funded primarily through the Missouri Conservation Sales Tax (61.5%), where one-eighth of 1 cent on all taxable items goes to support fish, forest, and wildlife conservation efforts through MDC. Other sources of funding include hunting and fishing permit sales (16.9%) and federal reimbursement (15.6%) (Missouri Department of Conservation 2019). Most of MDC's funding is set by state law (Missouri Conservation Sales Tax), therefore budget deficits are not foreseen.

MDC spending authority is granted through an annual legislative process, with fiscal years beginning on July 1. At the beginning of each budgeting cycle, MDC submits its proposed budget and spending request for integration into the governor's upcoming annual budget. Part of the legislature's budgeting responsibility is authorizing the expenditure of federal funds, including grants and appropriations.

As a result of this annual budget process, MDC cannot guarantee state funds for the requirements set forth in the HCP over its permit term. However, as a commitment of this MDC Bat HCP, MDC will incorporate in its annual budget request to the legislature a budget that will be adequate to fulfill its obligations under the MDC Bat HCP, including all costs identified in Section 7.1, *Cost to Implement the Habitat Conservation Plan*. Each year's requests will be adjusted for inflation of hard and softs costs, including salaries and benefits. MDC will provide to USFWS evidence of both (1) their annual budget requests to the legislature and (2) that the legislature has appropriated sufficient funding to implement this HCP. In summary, HCP commitments will be reflected in the dedication of staff resources through MDC's annual budget, adjusted for inflation, and documented in the HCP annual report. MDC recognizes that failure to annually ensure adequate funding to implement the MDC Bat HCP may be grounds for suspension or partial suspension of the incidental take permit until adequate funding is restored.

Chapter 8
Alternatives to Take

8.1 Alternatives to Take

The Endangered Species Act (ESA) requires that applicants for an incidental take permit specify what alternative actions to the take of federally listed species were considered and why those alternatives were not selected. According to the *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (HCP Handbook), these alternatives should focus on significant differences in project approach that would avoid or reduce the take (U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration Fisheries Service 2016). The HCP Handbook identifies two approaches commonly used in habitat conservation plans (HCPs).

- Any specific alternative that would reduce take below levels anticipated for the proposed project.
- An alternative that would avoid take and, therefore, not require a permit from U.S. Fish and Wildlife Service (USFWS).

HCPs typically include a no-action alternative, in which the applicant would not proceed with their proposed project or would modify it to avoid take completely. Other types of alternatives depend on the project but can include changing the location of activities or changing land use practices in a way that would eliminate or reduce take. The choice of the preferred alternative as presented in the HCP represents the best attempt to reduce significant impacts on the two federally listed bat species and the three additional bat species covered by the HCP while allowing Missouri Department of Conservation (MDC) to conduct forest management activities and fulfill its mission.

In accordance with the ESA, this chapter discusses alternatives that were considered but not selected and the reasons those alternatives were not selected for analysis.

8.2 Description of Alternatives

The following three alternatives were considered but not selected for analysis in the MDC Bat HCP.

- No take,
- Retaining current Indiana and northern long-eared bat buffer zones, and
- Reduced covered activities.

These alternatives and the rationales for their elimination are discussed below. A comprehensive discussion and evaluation of these, as well as other potential alternatives considered, will be provided in the National Environmental Policy Act (NEPA) analysis for the MDC Bat HCP, which accompanies this document and which will be publicly available with release of the public draft MDC Bat HCP.

8.2.1 No Take Alternative

Under the no take alternative, MDC would not engage in forest management activities that result in the take of covered species, thereby removing the need for an incidental take permit from USFWS. However, MDC conducts forest management activities to meet their legal statutes, strategic goals, and mission statement. As stated in Chapter 1, *Introduction*, Section 1.1, *Purpos*e, the MDC mission statement is to sustain and improve fish, forest, and wildlife resources; enhance the relevance of conservation; connect Missourians with fish, forest, and wildlife resources; and strengthen operational excellence to deliver superior customer service.

Missouri Constitutional Amendment 4 created the Missouri Conservation Commission and gave MDC authority over fish, forest, and wildlife. The mission of MDC is to protect and manage the fish, forest, and wildlife resources of the state, and to facilitate and provide opportunities for all citizens to use, enjoy, and learn about these resources (Missouri Department of Conservation 2018). Through its many duties, MDC fulfills the designation and protection of threatened and endangered species statutes, which are outlined in the Missouri Code of State Regulations (Title 3, Department of Conservation, Division 10, Conservation Commission, Chapter 4—Wildlife Code: General Provisions).

In most cases, the goals of MDC are entirely aligned with the need to protect and improve habitat for covered species. However, MDC also has management goals for recreation, public access, and asset management, and the implementation of these goals (e.g., tree removal) may compete or conflict with implementation of bat habitat management goals, particularly in the short term. In addition, activities that provide long-term benefit to bat habitat (e.g., prescribed fire) may have direct, short-term impacts on individual bats.

Chapter 2, *Covered Lands and Covered Activities*, identifies the forest management activities that are necessary for MDC to meet its required mandates. Because covered activities are necessary, take of the covered species can be minimized but not entirely avoided. As a result, the no take alternative was rejected.

8.2.2 Retaining Current Indiana Bat and Northern Long-Eared Bat Buffer Zones

Currently, MDC avoids take of Indiana and northern long-eared bats by precluding or minimizing forest management activities around known roost locations during the active season. The active season is defined as the non-hibernating period outside of the hibernaculum, including spring emergence, maternity, and fall migration and swarming. These avoidance practices are described in the *Guidelines for Avoiding and Minimizing Impacts to Federally Listed Bats on Missouri Department of Conservation Lands* (Missouri Department of Conservation 2016). Avoidance areas are established by creating buffer zones around known roost trees.

The size of the buffer zone varies by species, and activities within the buffer zone are restricted depending on the season. The maternity roost buffers for the Indiana bat and the northern long-eared bat are 300 acres and 150 feet, respectively. Within these buffers, timber harvesting is prohibited between April 1 and August 31, and prescribed burns are not allowed, as much as possible, between May 1 and July 31, and are completely prohibited during June and July in woodland and forest communities.

Avoiding all timber harvest in the buffer zones between April 1 and August 31 prevents MDC from carrying out its mission with respect to forest health, wildlife management, and habitat restoration, particularly in the northeast section of Missouri where roost concentrations are highest (due to the proximity to the Sodalis Nature Preserve hibernaculum). In this part of the state, the unique climate together with soil type create conditions unsuitable for forestry activities in the fall and winter. Soils are highly erodible in this region, and freeze-thaw cycles that occur during the fall and winter months create unstable conditions for safe and effective forestry activities. In addition, it can be difficult to find qualified forest contractors during this time of the year.

The soil and weather conditions and seasonal restrictions greatly limit the number of days for timber harvest in the northeast. So much so that MDC is not able to meet its forestry management mandate in the region.

The reduction in forest management activities also has negative consequences for covered bats. Forest management has been shown to benefit covered bats by providing a mix of land cover types and forest seral stages that improve habitat for the species by providing roosting and foraging habitat types. Where forest management is limited or prohibited, covered bat habitat is expected to decline in quality and quantity. Because roost densities are greatest in the northeast, this management limitation could have a disproportionate effect on the long-term habitat quality of remaining populations, especially for northern long-eared bat.

Avoiding forest management activities within buffer areas minimizes flexibility and creates uncertainty (regarding the timing and feasibility of certain actions) for MDC forest managers. Increased certainty in forest management is one of the reasons MDC is pursuing an HCP. And finally, the buffer zones do not provide protection for little brown and tricolored bats, both of which are covered species under this HCP. The conservation strategy, as proposed, provides landscape-level protections for all covered species through the development of priority bat management zones in areas of high conservation value throughout the state.

MDC needs flexibility to perform the long-term planning necessary to implement successful forest management that benefits all covered bat species and fulfills MDC's mandate to protect and manage the fish, forest, and wildlife resources of the state. For these reasons, an alternative that maintains the avoidance buffer zones for Indiana bat and northern long-eared bat was rejected.

8.2.3 Reduced Covered Activities Alternative

Several options for reducing covered activities were considered. This alternative reduces take by discontinuing the prescribed burning practice. Removing prescribed fire as a covered activity from the HCP (rather than reducing the acres of both fire and harvest) provides MDC flexibility to meet its management objectives in a reduced covered-activity scenario and is a realistic alternative that can be reasonably considered.

Relative to tree cutting , prescribed burns make up a smaller proportion of the estimated take each year, particularly on nonfederal lands where fires constitutes less than one-quarter of the impacts to moderate- and high-occupancy bat habitat (see Tables 4-2 through 4-5). Also, there are fewer restrictions and considerations placed on tree cutting than on prescribed burns. Prescribed burns require specific weather conditions, additional agency coordination, and specialized staff, all of which constrain timing and feasibility. To provide the greatest flexibility to forest managers, MDC must maximize their ability to cut trees.

Prescribed burns make up a smaller proportion of total covered activities so this activity is the most likely to be modified or halted to reduce the potential take of bats. As a forest management tool, prescribed fire impacts are relatively low compared to tree cutting, both in terms of the frequency of burns and the number of acres burned. Fire likely results in lower levels of take, as bats can shelter from fire under tree bark. Also, prescribed fires primarily take place in March and April before the pupping season. The timing of fire activities minimizes the potential for take and allows foresters to conduct management before conditions are ready for cutting. Fire also kills smaller trees while leaving the larger, more mature trees that provide habitat for bats. And finally, prescribed fire may kill trees, but those dead trees remain on the landscape as snags and continue to provide habitat for bats for years to come. In fact, fire is documented to create roost trees for bats and improve habitat in many instances (Ford et al. 2016). Prescribed fire also provides a number of additional ecosystem services such as habitat regeneration and is widely used as a habitat and wildlife management tool. It can be applied to maintain desirable communities, increase biological diversity, control invasive or pest species and diseases, improve watershed quality, and improve recreational and hunting opportunities.

MDC currently uses a combination of timber harvest and prescribed burns to fulfill their habitat management mandate. Removing fire as a covered activity would reduce impacts by 46% and 17% on MDC forested lands and other nonfederal lands, respectively, for each species (see Tables 4-2 through 4-5) and would force MDC to rely only on tree cutting to manage forest ecosystems. Prescribed burns, however, have a disproportionate ecosystem benefit, especially for bats. Covering the full suite of MDC habitat management activities at the preferred extent and frequency will allow managers to better enhance forest conditions for bats and other wildlife species. The flexibility in timing of prescribed burning proposed by the HCP will allow MDC to take advantage of favorable environmental conditions and opportunistic burns. Management flexibility increases the potential for achieving conservation goals at the landscape level. Because prescribed fire benefits forest ecosystems and bats and because including fire as a covered activity provides MDC with needed flexibility, this alternative to reduce take of covered by bats by eliminating fire as a covered activity was rejected.

Chapter 9
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