Chapter 4
Potential Effects of Covered Activities

4.1 Introduction

This chapter addresses the potential effects of covered activities (Chapter 2, *Covered Lands and Activities*) on covered species and, describes the amount of take of covered species in the Lake States Habitat Conservation Plan (HCP). The Habitat Conservation Planning and Incidental Take Permit Processing Handbook (HCP Handbook) (U.S. Fish and Wildlife Service 2016a) states that "quantifying the amount of take provides a key basis for evaluating project impacts." Take can be quantified as numbers of affected individuals or number of breeding groups. Alternatively, acres of habitat can be used as a surrogate for numbers of individuals.

This chapter shows how information on covered activities is integrated with information about covered lands, including bat distributions, to produce an estimate of the number of acres and (for context) the number of bats at risk from various activities. While bat populations may decrease over time due to the impact of white-nose syndrome (WNS), it is assumed that the impact of covered activities will be proportional to the population.

This chapter quantifies the potential effect of timber harvest and prescribed fire. Other covered activities (i.e., roads and trail maintenance and use) are ongoing efforts that are not easily or reliably quantified and that, with conservation measures, result in a very small amount of take. Furthermore, these covered activities often occur as part of forest management. As such, they will not be quantified separately, but will be assumed to be addressed through the larger (and very conservative) calculations for timber harvest and prescribed fire.

While timber harvest and prescribed fire have the potential to harm individual bats or roosts directly, Department of Natural Resource (DNR) forest management with retention improves habitat for bats over the long term (Sparks 2018). The beneficial effects of covered activities coupled with conservation measures are described in Chapter 5, *Conservation Strategy* (Section 5.3, *Offsetting the Effects of the Take*). Indirect (i.e., long term) and cumulative effects are described qualitatively in this chapter, although a detailed case study quantifies the positive effect on bats habitat to illustrate how covered activities have benefit bats.

This chapter includes the following sections.

- Introduction
- Methods
- Direct Effects
- Indirect (Beneficial) Effects
- Direct and Indirect Effects Summary
- Cumulative Effects

4.1.1 Definitions

4.1.1.1 ESA Definitions

This chapter addresses bats protected under the Endangered Species Act (ESA). The following definitions are derived from the HCP Handbook.

- **Take.** Take, as defined under the HCP Handbook, *Section 1.1,* is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct.
- **Harm.** Harm is an act which actually kills or injures wildlife and further defined by the U.S. Fish and Wildlife Service (USFWS) to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns such as breeding, feeding, or sheltering (HCP Handbook*, Section 1.3*).
- **Direct effects.** Direct effects occur at the time and place of project implementation (e.g., ground disturbance or removal of roost trees). Direct effects can be either temporary or permanent (HCP Handbook*, Section 13.3*).
- **Temporary effects.** Temporary effects result in short-term changes and are typically restricted to construction activities (such as vehicle noise) that cease when construction ceases or landcover changes that begin recovering when construction is complete (such as a temporary workspace).
- **Permanent effects.** Permanent effects result in permanent habitat loss and the result of construction of permanent features (e.g., creation of a new right-of-way or access road).
- **Indirect effects.** Indirect effects are manifested after a covered activity has occurred and are reasonably certain to occur (e.g., trees killed by a prescribed fire could become viable bat roosts in several years and may remain in use for several years thereafter). Indirect effects can occur outside the area directly affected by the action (HCP Handbook, *Section 13.3*).
- **Cumulative effects.** Cumulative effects include effects of future state, local, or private activities, not involving federal activities that are reasonably certain to occur within the permit area (HCP Handbook, *Section 13.3*). Future federal actions require separate consultation in accordance with ESA Section 7 (this includes all Section 10 compliance efforts that are permitted by USFWS and thus trigger an internal Section 7 review). However, under the National Environmental Policy Act (NEPA), cumulative effects also include future federal actions.

4.1.1.2 Additional HCP Definitions

The following terms have been defined in a prior chapter but are included here for reference.

- **Stand.** A part of the forest that, due to its age, species composition, and other conditions, is identifiably different from its surroundings. A forest is composed of many stands.
- **Final harvest.** Final harvest activities have the greatest potential direct effect on bat habitat because they remove all or most of the canopy trees serving as potential roost trees from a stand. Landowners following silvicultural guidelines always leave a few canopy trees standing in a final harvest. In Michigan, this equates to approximately 3 to 10% of trees in a stand. In Minnesota, at least 5% of the area is left standing in either reserve areas and/or as scattered trees, and in Wisconsin 5 to 15% crown cover or area is left standing. The category of final harvest was created to simplify and group various harvest types (e.g., regeneration).

- **Partial harvest.** Partial harvest activities have a lower potential effect on bats because they remove only some of the potential roost trees from a stand while retaining other bat habitat features. The category of partial harvest was created in order to simplify and group various harvest types.
- **Canopy closure.** Canopy closure measures the proportion of the sky covered by vegetation from a single point (Paletto and Tosi 2009). This term is relevant to the HCP because it provides a measure (actually the inverse) of solar exposure at potential bat roosts.
- **Basal area.** Basal area is the amount of land covered by the stems of trees measured at breast (4.5 feet or 1.4 m) height (Elledge and Barlow 2009).

4.1.2 ESA Requirements

Per the HCP Handbook, Habitat Conservation Plans (HCPs) must include a description of the "impact that will likely result from the taking of covered species" (U.S. Fish and Wildlife Service 2016a). This "impact of the taking" must be described in defined units in terms of either individuals or habitat. When habitat is used as a proxy for individuals, it should be quantified in terms of the units of habitat to be affected. The Lake States HCP uses acres of habitat affected when bats are present to specify the authorized levels of incidental take on the permit issued by USFWS.

4.2 Methods

As noted above, take in this HCP is quantified based on acres of potentially occupied bat habitat. This method is practicable because tracking and monitoring take of individuals at a landscape level are not feasible. Furthermore, the anticipated take of individual bats will change over time in an unpredictable way as the effects of WNS are experienced by local bat populations. We do, however, also assess the number of individuals potentially taken using current (as of 2019) densities of bats on the landscape. This number is provided to contextualize the estimate of habitat acres used in the HCP. Note that numbers of bats on the landscape are low and will decrease over time as effects of WNS are experienced by local bat populations (see Chapter 3, *Environmental Setting*, Section 3.3.1, *White-Nose Syndrome*, for more details). Habitat is also the metric used in the Conservation Strategy to demonstrate benefits of the HCP, allowing for a like-to-like comparison of impacts and conservation. This section describes how impacts on bat habitat (when bats are present) are quantified and how impacts on individual bats (provided for context) are estimated.

The effects analysis provided in this section is based on 1) the covered activities described in Chapter 2, 2) forestland ownership information provided in Chapter 2, 3) landcover data provided in Chapter 3, and 4) the seasonal species distribution and abundance models presented in Chapter 3. This take assessment uses these previous analyses to estimate the amount of affected habitat when bats are present and (for context) the number of bats taken by covered activities. To the extent feasible, we reference the tables and sections from which information is drawn.

4.2.1 Direct Effects

Effects on bats can be both direct and indirect. As defined in the ESA, direct effects are the direct or immediate effects of the project on the species or its habitats. The methods for assessing these direct effects are described below. Four groups of covered activities were identified in Chapter 2: timber

harvest and related forest management practices; prescribed fire; road and trail construction, maintenance, and use; and conservation strategy implementation. Direct effects are quantified with respect to timber harvest and related forest practices and prescribed fire. Direct effects pertaining to road and trail construction, maintenance, and use are described in narrative form. The effects of implementing the conservation strategy are not quantified as impacts but are described as a conservation benefit in Chapter 5.

4.2.1.1 Habitat

The direct effects of covered activities on bats are estimated using the following information (Figure 4-1): acres of impact, type of harvest, seasonality of impacts, habitat quality, and seasonal use by bats.

- **Acres of Impact.** The acres of impact of impact from covered activities were estimated in Chapter 2 and are described in Sections 2.3, 2.4, and 2.5.
- **Type of Harvest**. The type of harvest, or intensity of harvest, is defined as either partial or final based on Table 2-3.
- **Impact by Season.** The seasonality of impacts pertains to the timing of covered activities during the year and is determined, for timber harvest, using estimates provided by each DNR as described in Chapter 2, Section 2.2.1.2, *Timber Harvest*, and quantified in Sections 2.3.1.2 (Michigan), 2.4.1.2 (Minnesota), and 2.5.1.2 (Wisconsin), *Covered Activities*, under *Timber Harvest*.[1] Information about seasonality of prescribed fire in woodlands is limited, and thus it was assumed to follow the same seasonality as timber harvest.
- **Habitat Quality.** Habitat quality is broken into high- and low-quality types, as outlined in Chapter 3, Table 3-2. Deciduous and mixed forests are considered high quality unless they are dominated by invasive species as are Aspen/Birch stands with a diameter at breast height (dbh) of 9 inches or less. All coniferous forest types are considered low suitability.
- **Seasonal Distribution.** Seasonal distribution or use identifies when bats are present on the landscape and is determined based on the bat activity windows and seasonal distribution assumptions (e.g., distance from hibernacula) described in Table 3-3.

Direct impacts on habitat are quantified by estimating the acres of harvest (partial or final) in bat habitat (high- and low-quality) when bats are present. Covered activities that occur in suitable habitat at a time when bats are absent have no direct effects. Acres of harvest are determined in different ways depending on ownership (i.e., state lands versus other nonfederal lands).

Timber Harvest on State Lands

For timber harvest on state lands, levels of harvest by acres and by intensity (i.e., partial versus final) are straightforward to calculate because the DNRs maintain partial versus final harvest information for their lands. Chapter 2, Tables 2-6, 2-11, and 2-17, for Michigan, Minnesota, and Wisconsin, respectively, provide the projected annual acres of timber harvest and intensity for each state DNR. The effects analysis also requires an understanding of the seasonal timing of activities

[1] In Michigan and Wisconsin timber harvest occurs evenly over the year. In Minnesota, approximately 75% of harvest on DNR lands occurs from December 1 to March 31, with the rest occurring in approximately equal portions during the remaining months. A complete description of this rationale is found in Chapter 2, Section 2.2.1.2, under *Seasonality of Harvest*.

and the presence or absence of bats on the landscape at different times of year. The method for determining seasonality of harvest is described in Chapter 2, Section 2.2.1.2*,* under *Seasonality of Harvest*. To determine when bats are present in bat habitat, see Chapter 3, Table 3-3, for seasonal occupancy windows. The estimated bat distribution by season across high- and low-quality habitat is summarized in Tables 3-10, 3-13, and 3-16 for Michigan, Minnesota, and Wisconsin, respectively.[2] The effects analysis uses this collective information to determine the amount and type of harvest in areas where bats are present, at times of year when bats are present.

Timber Harvest on Other Nonfederal Lands

For timber harvest on other nonfederal lands (private, county, and municipal), acres of harvest were estimated using Forest Inventory and Analysis (FIA) data. FIA provides the volume of merchantable timber sold and the age at which a typical harvest occurs. We describe an approach that uses this information to convert volume to equivalent acres in Chapter 2, Section 2.2.2.2, *Timber Harvest*, under *Volume-to-Acres Conversions*.[3] The FIA data do not distinguish between partial and final harvest. To convert these equivalent acres to partial and final harvest, we used the proportions of each partial versus final harvest for each forest type as described in Tables 2-8, 2-13, and 2-19, for Michigan, Minnesota, and Wisconsin, respectively. It was assumed that 3 acres of partial harvest will yield a volume equivalent to 1 acre of cleared forest.[4] The acres of partial and final harvest on county, municipal, and private lands is found in Tables 2-9, 2-14, and 2-20 for Michigan, Minnesota, and Wisconsin, respectively. For the seasonal timing of activities and the presence or absence of bats on the landscape at different times of year, we used the same assumptions as those described above for state lands. Collectively, this information provides the amount of partial versus final harvest that occurs on federal lands during times of year when bats are present.

All DNR lands are automatically enrolled in the HCP and all county and municipal lands are able to enroll. However, not all private landowners are anticipated to enroll in the HCP. The DNRs recognize that take of bats is most likely to occur on larger parcels, where the chance of encountering a single bat is higher because the parcel is larger, and, in general, because more timber occurs on larger parcels. An approach was developed (Appendix F) to estimate the number of ownerships that may impact a single bat and thus have a need to enroll in the HCP. See Appendix F for an explanation of this approach. The analysis concluded that take, at current densities, is reasonably foreseeable[5] when the property contains 1,000 or more acres of forest in Michigan, 1,000 or more acres of forest in Wisconsin, 10,000 or more acres of forest in Minnesota. These thresholds were determined using little brown bat, as it is currently the most abundant of the covered species on the landscape. Appendix F contains additional details pertaining to the other covered species. Take is also considered foreseeable if the property contains a known summer roost or one or more hibernacula. The landowners that meet these thresholds are eligible for enrollment. Based on these ownership thresholds, the plan is expected to enroll up to 80% of lands in private ownership in Michigan and Wisconsin and 30% of lands in private ownership in Minnesota. Differences between Minnesota and the other two states are the result of much lower density of bats in Minnesota (where major

[2] The covered activities are estimated to occur over a 50-year period; thus, this analysis is not spatially explicit. Rather, effects are assumed to be proportional to the presence of affected landcover on the landscape.

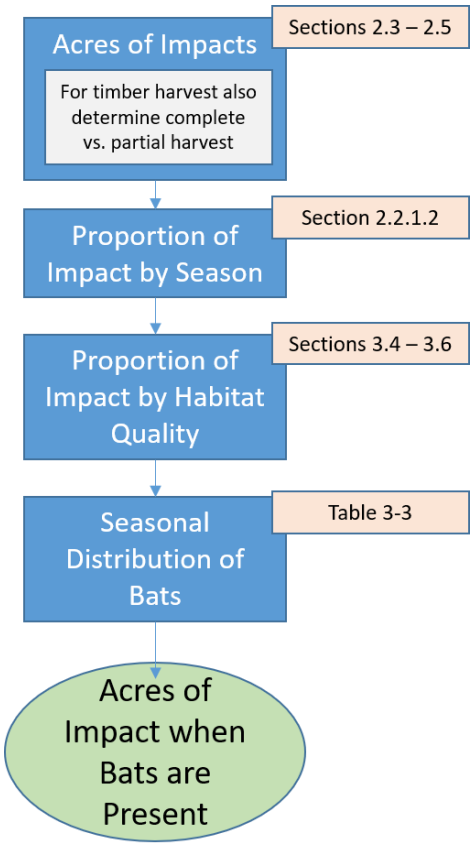
[3] This estimate should over-represent harvest acres when trees are left on the landscape because 1) residual trees are deliberately left as part of a final removal; 2) as noted in Chapter 2, *Covered Activities*, partial harvests leave most canopy trees; and 3) not all trees are harvested due to retention guidelines and site-specific constraints.

[4] This estimate was developed based on the professional experience of DNR foresters.

[5] Reasonably foreseeable is defined as the projected take of at least one of the covered bats per year.

hibernacula are rare) and the fact that 75% of timber harvest in Minnesota occurs during winter, when no impacts are expected.

Figure 4-1. Flowchart Illustrating Method for Estimating Acres Affected by Covered Activities when Bats are Present



Prescribed Fire

For prescribed fire, the acres of forest burned on state lands were provided by each DNR and can be found in Tables 2-7, 2-12, and 2-18 for Michigan, Minnesota, and Wisconsin, respectively. The amount of forest burned on other nonfederal lands is described in Chapter 2, Sections 2.3.2.2, 2.4.2.2, and 2.5.2.2, *Timber Harvest*, under *Prescribed Fire*, for Michigan, Minnesota, and Wisconsin, respectively. For the presence or absence of bats on the landscape at different times of year, the same assumptions were used as those described above for timber harvest. Collectively, this information is used to determine the amount and type of prescribed fire on covered lands in areas where bats are present, at times of year when bats are present.

4.2.1.2 Bats

The impacts on individual bats are provided for context only and are derived from the estimates of habitat affected above. The number of individual bats taken is anticipated to track populations as they change and as bats succumb to or recover from WNS.

To estimate effects on individual bats, we distributed the number of bats known to be present[6] evenly across the landscape based on the assumed location of bats at different times of year. For example, during the spring, the known bat population was distributed entirely within spring habitat (i.e., 5 or 10 miles from the hibernaculum as per Table 3-3). The number of bats assumed affected (either killed or harmed) was based on the number of acres affected when bats were present, the number of bats present, and published risk of mortality (see Mortality section below) (USFWS 2016b). For timber harvest this analysis includes an assessment of final or partial harvest. Two different types of impacts on bats are assessed, mortality (or lethal take) and harm, as described below.

Mortality

Bats may be killed as a direct result of forestry operations. For example, Belwood (2002) documented the death of an adult and three juvenile Indiana bats (*Myotis sodalis*) during tree harvest. Two additional juveniles survived the initial event and died later. In another case, 11 dead adult female Indiana bats were retrieved (by people) when their roost was felled in Knox County, Indiana (Whitaker, pers. comm., 2005 cited in U.S. Fish and Wildlife Service 2016b). Based on these data, USFWS (2016b) suggested a mortality rate for forestry of 3% for adult bats and 15% for juvenile bats. This rate is also consistent with impacts observed when a tree was bulldozed to clear pasture (Cope et al. 1974).

The number of bats present (calculated for each state in Tables 3-10, 3-13, and 3-16 for Michigan, Minnesota, and Wisconsin, respectively) was assessed relative to acres affected as described above (Section 4.2.1.1, *Habitat*). To determine the number of bats killed, the numbers of bats present was prorated by the mortality rate used by USFWS for northern long-eared bats, 15% for nonvolant juveniles and 3% for adult bats that are present in trees when felled (U.S. Fish and Wildlife Service 2016b). This figure was scaled to partial versus final harvest: it was conservatively assumed that 50% of the mortality would occur in partial versus final harvest. Figure 4-2 illustrates the process for determining the mortality of bats from timber harvest. The same approach was used to estimate the number of bats killed by prescribed fire; however, all impacts from fire were considered equivalent to final harvest.

Harm

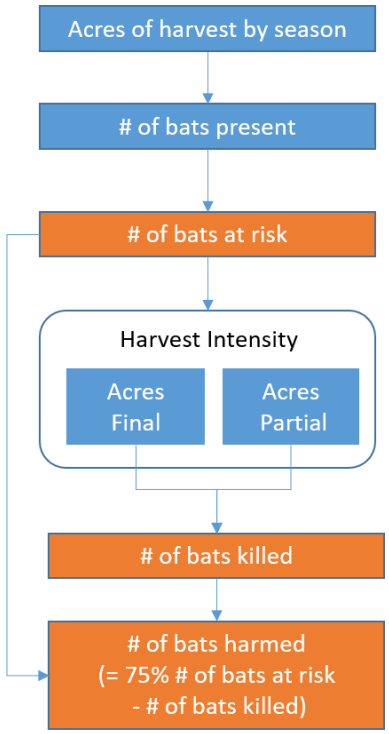
The definition of harm is provided in Section 4.1.1, *Definitions*. In short, harm is disturbance that rises to the level of take by significantly impairing essential behavioral patterns such as breeding, feeding, or sheltering.[7] USFWS is required to consider all forms of take, including non-lethal take such as disturbance, on bats (HCP Handbook, *Section 8.2*). Not all bats within a stand are likely to be disturbed, and not all disturbance of bats within a stand rises to the level of take. We conservatively estimate that 75% of bats in a stand are harmed, as defined by the ESA, by forest management activities. Bats may be harmed by actions when flushed from their roosts and exposed to physiological stress, increased risk of predation, or injury as they move between roosts. Some individuals may suffer minor injuries and could be considered harmed by activities such as tree felling, noise and machinery, human presence, and other forms of disturbance. Such disturbance can

[6] Estimate based on winter hibernacula surveys and summer capture records with input from DNR bat biologists.

[7] *Arizona Cattle Grower's Association v. USFWS* confirmed that, to qualify as harm under the ESA, habitat modification must result in actual death or injury to wildlife. This decision also held that potential for harm is insufficient. Rather, a take must be *reasonably certain to occur*.

cause flushing from trees and is a temporary effect. The number of bats harmed by timber harvest and prescribed fire is estimated as 75% of the number of bats present minus any bats killed. This process is illustrated in Figure 4-2.

Figure 4-2. Flowchart Illustrating Method for Estimating the Number of Bats Killed and Harmed by Timber Harvest



Changing Bat Populations

Populations of all covered species have undergone substantial declines since the arrival of WNS in the region in winter 2013/2014 approximately (Indiana bats: 20.4% decline, northern long-eared bats 97%, little brown bats 83%, and tricolored bats 90%). Population numbers presented in Chapter 3 are current as of 2019. If bat populations in the Lake States follow the pattern seen in states to the east, declines will continue for several years following implementation of the HCP. When combined with the colonial nature of bats, the resulting distribution is one where a few bats are concentrated in a very small (and often unpredictable) part of the landscape. As bat densities continue to decline, most covered activities completed under the HCP will result in very low numbers of take (or no take) of individual bats. Further, as outlined in Chapter 5, conservation measures focus on protecting those trees most likely to be used by bats and avoiding areas of known or suspected bat concentrations. While take is tracked as acres of impact for ease of implementing the permit, it is important to clarify that the take of individual bats is anticipated to go down over time.

4.2.2 Indirect (Beneficial) Effects

As defined in Section 4.1.1, indirect effects are manifested later in time and are reasonably certain to occur. For the covered species, these indirect effects are largely beneficial. In the biological opinion for the northern long-eared bat 4(d) rule, USFWS notes that some forestry activities improve habitat quality for bats. By following habitat quality through time in three case studies, we demonstrate that activities covered by the Lake States HCP improve both roosting and foraging opportunities for bats on the covered lands. These case studies are provided in Section 4.4. Chapter 5 proposes conservation measures that will provide additional benefits.

The analysis of indirect effects is programmatic and focuses on long-term changes in habitat quality. It is known that, over the long-term, sustainable forest management practices can create and maintain foraging and roosting habitat for bats (Carter et al. 2002; Guldin et al. 2007; Sheets et al. 2013a, 2013b; Pauli et al. 2015a, 2015b; Blakey et al. 2016; Silvis et al. 2016; U.S. Fish and Wildlife Service 2016b). An exact quantification of habitat effects would require detailed site-specific data on conditions before and after harvest—a level of detail beyond the scope of this HCP. However, it is possible to categorize effects within a stand relative to baseline for a variety of harvest types. The approach used herein assigns an effect size to both the direct effects of harvest and changes in a stand that occur as a result of ecological succession and subsequent stand development. Thus, stand development is treated as an indirect effect of harvest—a critical concept to understand because many of the harvests completed in the Lake States are designed to regenerate the stand.

The example provided in Section 4.4.1.2, *Case Study of Indirect Effects in High-Quality Forest,* is based on northern long-eared bats within a stand of mesic hardwoods. To quantify these changes through time, a numeric value is assigned that represents changes in habitat quality compared to the initial baseline and is termed a magnitude of effect. This magnitude of effect is on a scale of -1.0 to +1.0 where the sign indicates the direction of the effect (i.e., negative effects are expressed as negative numbers), and is typically based on the graphs presented in Sheets et al. (2013b). The magnitude of effect for a given covered activity is based on best available information, as well as professional judgment. The assignment of a magnitude of effect value was done separately for foraging and roosting habitat because roosting habitat for covered bats is estimated to be twice as important as foraging habitat.

Magnitude of effect values are described as follows.

- 0.0 No Effect
- +/-0.05 Trace Effect
- +/-0.25 Minor Effect
- +/-0.5 Moderate Effect
- +/-0.75 High Effect
- +/-1.00 Complete Change of Habitat Value

By following changes in the stand over time it is possible to arrive at an understanding of the relative quality of that stand at any given time as compared to the value of the original stand. Working at a landscape scale, it is also possible to see how having a variety of stands managed with multiple techniques provides bats with long-term access to foraging and roosting habitat (O'Keefe 2009; Sheets et al. 2013b; Pauli 2014; Pauli et al. 2015a, 2015b).

Section 4.4.1.3*, Qualitative Examples of Habitat Changes Associated with Common Management Systems of the Lake States,* describes how silvicultural techniques influence forest succession, which in turn, results in changes in habitat quality for bats roosting or foraging in a stand. For illustrative purposes, changes in habitat quality (both roosting and foraging) will be described through time for three types of forests (aspen/birch, pine plantation, and oak hickory) common to the Lake States. Indirect effects are also described for roads and trails and prescribed fire based on available scientific literature and input from professional foresters.

4.3 Direct Effects

This section provides the results of the analysis for the three states: Michigan, Minnesota, and Wisconsin. The methods for estimating direct effects are described in Section 4.2.1, *Direct Effects*.

4.3.1 Michigan

This section describes effects on the covered species from covered activities in the state of Michigan. For timber harvest and prescribed fire this is done quantitatively. For roads and trails, effects are described qualitatively. The effects of HCP Implementation are described in Chapter 5.

4.3.1.1 Timber Harvest

Habitat Effects

Based on data presented in Chapter 2, Table 2-6, Michigan DNR expects to complete approximately 64,000 acres per year of timber harvest including 40,000 acres per year of final harvest and 24,000 acres per year of partial harvest. Timber harvest on other covered lands was derived from FIA data and approximates final harvest of 139,297 acres across all forest types (Chapter 2, Table 2-8). Tables 4-1 through 4-4 provide acres harvested each year by ownership category along with the amount of harvest (in acres and percent) expected to occur by season.

Table 4-1. Acres of High- and Low-Quality Indiana Bat Habitat Harvested in Winter, Fall/Spring, and Summer by Ownership Type (Michigan)

Acres of Forested Habitat in Michigan[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Winter Habitat[d]							
26	25	DNR	100%	0	0	0	0
		County & Municipal	100%	0	0	0	0
		Private	80%	0	0	0	0
		Annual Total	-	0	0	0	0
		Permit Duration	-	0	0	0	0
Fall/Spring Habitat[e]							
31,957	10,784	DNR	100%	100	34	25	8
		County & Municipal	100%	5	6	1	2
		Private	80%	149	84	24	17
		Annual Total	-	254	124	50	27
		Permit Duration	-	12,676	6,195	2,486	1,329
Summer Habitat[f]							
3,780,278	485,046	DNR	100%	11,841	1,519	2,960	380
		County & Municipal	100%	537	287	71	72
		Private	80%	17,613	3,767	2,850	744
		Annual Total	-	29,991	5,573	5,882	1,196
		Permit Duration	-	1,499,528	278,656	294,075	59,786
Annual Totals[g]							
-	-	DNR	100%	-	-	2,985	388
		County & Municipal	100%	-	-	72	73
		Private	80%	-	-	2,874	761
		Annual Total	-	-	-	5,931	1,222
Permit Duration (50 Years)							
-	-	DNR	100%	-	-	149,258	19,413
		County & Municipal	100%	-	-	3,600	3,664
		Private	80%	-	-	143,703	38,038
		Grand Total	**-**	**-**	**-**	**296,561**	**61,116**

Notes:
[a] All forest types were assigned to either high- or low-quality bat habitat per Table 3-2.
[b] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[c] Bats are assumed to be present in different locations on the landscape at different seasons as described in Table 3-3.
[d] Winter habitat is modeled as ¼ mile around known hibernacula from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[e] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[f] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[g] Annual totals were calculated as a sum of Winter, Fall/Spring, and Summer habitat values. Annual totals for seasonal habitat harvested were not provided because Winter, Fall/Spring, and Summer habitat overlap geographically.

Table 4-2. Acres of High- and Low-Quality Northern Long-eared Bat Habitat Harvested in Winter, Fall/Spring, and Summer by Ownership Type (Michigan)

Acres of Forested Habitat in Michigan[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Winter Habitat[d]							
197,010	55,151	DNR	100%	0	0	0	0
		County & Municipal	100%	0	0	0	0
		Private	80%	0	0	0	0
		Annual Total	-	0	0	0	0
		Permit Duration	-	0	0	0	0
Fall/Spring Habitat[e]							
Near Large Hibernacula							
695,870	192,663	DNR	100%	2,180	603	545	151
		County & Municipal	100%	99	114	13	28
		Private	80%	3,242	1,496	525	296
		Annual Total	-	5,521	2,214	1,083	475
		Permit Duration	-	276,032	110,684	54,133	23,747
Near Small Hibernacula							
669,293	165,593	DNR	100%	2,096	519	524	130
		County & Municipal	100%	95	98	13	24
		Private	80%	3,118	1,286	505	254
		Annual Total	-	5,310	1,903	1,041	408
		Permit Duration	-	265,489	95,132	52,066	20,411
Summer Habitat[f]							
16,171,003	4,261,940	DNR	100%	50,651	13,349	12,663	3,337
		County & Municipal	100%	2,296	2,373	305	593
		Private	80%	75,345	31,174	12,191	6,159
		Annual Total	-	128,291	46,896	25,159	10,089
		Permit Duration	-	6,414,573	2,344,792	1,257,975	504,458

Acres of Forested Habitat in Michigan[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Annual Totals[g]							
-	-	DNR	100%	-	-	13,732	3,618
		County & Municipal	100%	-	-	331	646
		Private	80%	-	-	13,221	6,708
		Annual Total	-	-	-	27,283	10,972
Permit Duration (50 Years)							
-	-	DNR	100%	-	-	686,584	180,892
		County & Municipal	100%	-	-	16,561	32,310
		Private	80%	-	-	661,028	335,414
		Grand Total	**-**	**-**	**-**	**1,364,174**	**548,616**

Notes:
[a] All forest types were assigned to either high- or low-quality bat habitat per Table 3-2.
[b] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[c] Bats are assumed to be present in different locations on the landscape at different seasons as described in Table 3-3.
[d] Winter habitat is modeled as ¼ mile around known hibernacula from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[e] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[f] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[g] Annual totals were calculated as a sum of Winter, Fall/Spring, and Summer habitat values. Annual totals for seasonal habitat harvested were not provided because Winter, Fall/Spring, and Summer habitat overlap geographically.

Table 4-3. Acres of High- and Low-Quality Little Brown Bat Habitat Harvested in Winter, Fall/Spring, and Summer by Ownership Type (Michigan)

Acres of Forested Habitat in Michigan[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Winter Habitat[d]							
37,102	27,858	DNR	100%	0	0	0	0
		County & Municipal	100%	0	0	0	0
		Private	80%	0	0	0	0
		Annual Total	-	0	0	0	0
		Permit Duration	-	0	0	0	0
Fall/Spring[e]							
Near Large Hibernacula							
695,870	192,663	DNR	100%	2,180	603	545	151
		County & Municipal	100%	99	114	13	28
		Private	80%	3,242	1,496	525	296
		Annual Total	-	5,521	2,214	1,083	475
		Permit Duration	-	276,032	110,684	54,133	23,747
Near Small Hibernacula							
626,935	165,583	DNR	100%	1,964	519	491	130
		County & Municipal	100%	89	98	12	24
		Private	80%	2,921	1,286	473	254
		Annual Total	-	4,974	1,903	975	408
		Permit Duration	-	248,687	95,126	48,771	20,410
Summer Habitat[f]							
Near Large Hibernacula							
7,326,831	2,010,343	DNR	100%	22,949	6,297	5,737	1,574
		County & Municipal	100%	1,040	1,189	138	297
		Private	80%	34,138	15,613	5,524	3,085
		Annual Total	-	58,127	23,099	11,399	4,956
		Permit Duration	-	2,906,344	1,154,932	569,969	247,793

Acres of Forested Habitat in Michigan[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
General Landscape							
8,844,172	2,251,597	DNR	100%	27,702	7,052	6,925	1,763
		County & Municipal	100%	1,256	1,331	167	333
		Private	80%	41,207	17,487	6,668	3,455
		Annual Total	-	70,165	25,871	13,760	5,551
		Permit Duration	-	3,508,229	1,293,531	688,006	277,530
Annual Totals[g]							
-	-	DNR	100%	-	-	13,699	3,618
		County & Municipal	100%	-	-	330	683
		Private	80%	-	-	13,189	7,089
		Annual Total	-	-	-	27,218	11,390
Permit Duration (50Years)							
-	-	DNR	100%	-	-	684,926	180,892
		County & Municipal	100%	-	-	16,521	34,143
		Private	80%	-	-	659,432	354,446
		Grand Total	**-**	**-**	**-**	**1,360,879**	**569,481**

Notes:
[a] All forest types were assigned to either high- or low-quality bat habitat per Table 3-2.
[b] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[c] Bats are assumed to be present in different locations on the landscape at different seasons as described in Table 3-3.
[d] Winter habitat is modeled as ¼ mile around known hibernacula from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[e] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[f] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[g] Annual totals were calculated by as a sum of Winter, Fall/Spring, and Summer habitat values. Annual totals for seasonal habitat harvested were not provided because Winter, Fall/Spring, and Summer habitat overlap geographically.

Table 4-4. Acres of High- and Low-Quality Tricolored Bat Habitat Harvested in Winter, Fall/Spring, and Summer by Ownership Type (Michigan)

Acres of Forested Habitat in Michigan[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Winter Habitat[d]							
4,055	1,178	DNR	100%	0	0	0	0
		County & Municipal	100%	0	0	0	0
		Private	80%	0	0	0	0
		Annual Total	-	0	0	0	0
		Permit Duration	-	0	0	0	0
Fall/Spring[e]							
312,837	96,305	DNR	100%	980	302	245	75
		County & Municipal	100%	44	57	6	14
		Private	80%	1,458	748	236	148
		Annual Total	-	2,482	1,107	487	237
		Permit Duration	-	124,094	55,326	24,336	11,870
Summer Habitat[f]							
9,908,015	2,553,973	DNR	100%	31,034	8,000	7,758	2,000
		County & Municipal	100%	1,407	1,510	187	377
		Private	80%	46,164	19,835	7,470	3,919
		Annual Total	-	78,605	29,345	15,415	6,296
		Permit Duration	-	3,930,225	1,467,244	770,764	314,801
Annual Totals[g]							
-	-	DNR	100%	-	-	8,003	2,075
		County & Municipal	100%	-	-	193	392
		Private	80%	-	-	7,706	4,066
		Annual Total	-	-	-	15,902	6,533
Permit Duration (50 Years)							
-	-	DNR	100%	-	-	400,172	103,765
		County & Municipal	100%	-	-	9,653	19,586
		Private	80%	-	-	385,277	203,321
		Grand Total	**-**	**-**	**-**	**795,101**	**326,671**

Notes:
[a] All forest types were assigned to either high- or low-quality bat habitat per Table 3-2.
[b] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[c] Bats are assumed to be present in different locations on the landscape at different seasons as described in Table 3-3.
[d] Winter habitat is modeled as ¼ mile around known hibernacula from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[e] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[f] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[g] Annual totals were calculated as a sum of Winter, Fall/Spring, and Summer habitat values. Annual totals for seasonal habitat harvested were not provided because Winter, Fall/Spring, and Summer habitat overlap geographically.

Impacts on Individuals

Impacts on individual bats are provided for context, noting that the number of individual bats taken will go down as bat populations decrease due to WNS (see Chapter 3, Section 3.3.1). Impacts on individual bats were derived from estimates of impacts on habitat (Tables 4-5 through 4-8). These are overlaid with bat densities estimated in Table 3-10. Results have been provided for number of bats harmed through disturbance and killed if conservation measures are not applied. These data are presented in Tables 4-5 through 4-8.

Table 4-5. Number of Indiana Bats Killed or Harmed (Disturbed) by Timber Harvest in Winter, Fall/Spring, and Summer by Ownership Type (Michigan)

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Winter[b]						
DNR	NA	54.87	5.49	0.00	0.00	0.00
County & Municipal	-	54.87	5.49	0.00	0.00	0.00
Private	-	54.87	5.49	0.00	0.00	0.00
Fall/Spring[c]						
DNR	38%	0.05	<0.01	0.01	<0.01	0.01
County & Municipal	-	0.05	<0.01	<0.01	<0.01	<0.01
Private	-	0.05	<0.01	0.03	<0.01	0.02
Early Summer (Before pups are born)[d,e]						
DNR	38%	0.01	<0.01	0.04	<0.01	0.03
County & Municipal	-	0.01	<0.01	<0.01	<0.01	<0.01
Private	-	0.01	<0.01	0.09	<0.01	0.07
Dependent Pup Season (Adults)[f]						
DNR	38%	0.01	<0.01	0.17	<0.01	0.12
County & Municipal	-	0.01	<0.01	0.01	<0.01	0.01
Private	-	0.01	<0.01	0.38	<0.01	0.28
Dependent Pup Season (Non-volant pups)[f]						
DNR	38%	<0.01	<0.01	0.08	0.01	0.05
County & Municipal	-	<0.01	<0.01	<0.01	<0.01	<0.01
Private	-	<0.01	<0.01	0.19	0.01	0.13
Late Summer (After pups can fly)[g]						
DNR	38%	0.01	<0.01	0.06	<0.01	0.05
County & Municipal	-	0.01	<0.01	<0.01	<0.01	<0.01
Private	-	0.01	<0.01	0.14	<0.01	0.11
Annual Totals[h]						
DNR	38%	-	-	<1	<1	<1
County & Municipal	-	-	-	<1	<1	<1

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Private	-	-	-	1	<1	1
Annual Total	-	-	-	1	<1	1
Permit Duration (50 years)[h]						
DNR	38%	-	-	18	1	13
County & Municipal	-	-	-	1	<1	1
Private	-	-	-	42	1	31
Grand Total	**-**	**-**	**-**	**61**	**2**	**44**

Notes:
[a] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[b] Winter habitat is modeled as ¼ mile around known hibernacula with bats assumed to be present from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[c] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[d] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[e] Early summer is from May 16 through May 31.
[f] Dependent pup season is from June 1 through July 31 (Table 3-3).
[g] Late summer is from August 1 through August 15.
[h] Numbers may not total due to rounding.
NA = not applicable

Table 4-6. Number of Northern Long-eared Bats Killed or Harmed (Disturbed) by Timber Harvest in Winter, Fall/Spring, and Summer by Ownership Type (Michigan)

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Winter Habitat[b]						
DNR	NA	5.36	0.54	0.00	0.00	0.00
County & Municipal	-	5.36	0.54	0.00	0.00	0.00
Private	-	5.36	0.54	0.00	0.00	0.00
Fall/Spring[c]						
Near Large Hibernacula						
DNR	38%	1.29	0.13	7.23	0.22	5.26
County & Municipal	-	1.29	0.13	0.42	0.01	0.31
Private	-	1.29	0.13	16.57	0.21	12.27
Near Small Hibernacula						
DNR	38%	0.24	0.02	1.28	0.04	0.93
County & Municipal	-	0.24	0.02	0.07	<0.01	0.05
Private	-	0.24	0.02	2.92	0.04	2.16
Early Summer (Before pups are born)[d,e]						
DNR	38%	0.07	0.01	1.42	0.04	1.03
County & Municipal	-	0.07	0.01	0.08	<0.01	0.06
Private	-	0.07	0.01	3.24	0.04	2.40
Dependent Pup Season (Adults)[f]						
DNR	38%	0.07	0.01	5.67	0.17	4.12
County & Municipal	-	0.07	0.01	0.32	<0.01	0.24
Private	-	0.07	0.01	12.97	0.17	9.60
Dependent Pup Season (Non-flying pups)[f]						
DNR	38%	0.03	<0.01	2.83	0.43	1.81
County & Municipal	-	0.03	<0.01	0.16	0.01	0.11
Private	-	0.03	<0.01	6.49	0.42	4.55

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Late Summer (After pups can fly)[g]						
DNR	38%	0.10	0.01	2.13	0.06	1.55
County & Municipal	-	0.10	0.01	0.12	<0.01	0.09
Private	-	0.10	0.01	4.86	0.06	3.60
Annual Totals[h]						
DNR	38%	-	-	21	1	15
County & Municipal	-	-	-	1	<1	1
Private	-	-	-	47	1	35
Annual Total	-	-	-	69	2	50
Permit Duration (50 years)[h]						
DNR	38%	-	-	1,027	48	734
County & Municipal	-	-	-	59	1	43
Private	-	-	-	2,353	47	1,729
Grand Total	**-**	**-**	**-**	**3,439**	**96**	**2,507**

Notes:
[a] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[b] Winter habitat is modeled as ¼ mile around known hibernacula with bats assumed to be present from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[c] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[d] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[e] Early summer is from May 16 through May 31.
[f] Dependent pup season is from June 1 through July 31 (Table 3-3).
[g] Late summer is from August 1 through August 15.
[h] Numbers may not total due to rounding.
NA = not applicable

Table 4-7. Number of Little Brown Bats Killed or Harmed (Disturbed) by Timber Harvest in Winter, Fall/Spring, and Summer by Ownership Type (Michigan)

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Winter Habitat[b]						
DNR	NA	213.10	21.31	0.00	0.00	0.00
County & Municipal	-	213.10	21.31	0.00	0.00	0.00
Private	-	213.10	21.31	0.00	0.00	0.00
Fall/Spring[c]						
Near Large Hibernacula						
DNR	38%	10.10	1.01	56.58	1.70	41.16
County & Municipal	-	10.10	1.01	3.26	0.05	2.41
Private	-	10.10	1.01	129.77	1.68	96.07
Near Small Hibernacula						
DNR	38%	1.98	0.20	9.98	0.30	7.26
County & Municipal	-	1.98	0.20	0.57	0.01	0.42
Private	-	1.98	0.20	22.89	0.30	16.95
Early Summer (Before pups are born)[d,e]						
Near Large Hibernacula						
DNR	38%	0.17	0.02	1.68	0.05	1.22
County & Municipal	-	0.17	0.02	0.10	<0.01	0.07
Private	-	0.17	0.02	3.84	0.05	2.84
General Landscape						
DNR	38%	0.15	0.02	1.78	0.05	1.30
County & Municipal	-	0.15	0.02	0.10	<0.01	0.08
Private	-	0.15	0.02	4.09	0.05	3.03
Dependent Pup Season (Adults)[f]						
Near Large Hibernacula						
DNR	38%	0.17	0.02	6.70	0.20	4.88
County & Municipal	-	0.17	0.02	0.39	0.01	0.29
Private	-	0.17	0.02	15.37	0.20	11.38

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
General Landscape						
DNR	38%	0.15	0.02	7.14	0.21	5.19
County & Municipal	-	0.15	0.02	0.41	0.01	0.30
Private	-	0.15	0.02	16.37	0.21	12.12
Dependent Pup Season (Non-flying pups)[f]						
Near Large Hibernacula						
DNR	38%	0.09	0.01	3.35	0.50	2.14
County & Municipal	-	0.09	0.01	0.19	0.01	0.13
Private	-	0.09	0.01	7.69	0.50	5.39
General Landscape						
DNR	38%	0.08	0.01	3.57	0.54	2.28
County & Municipal	-	0.08	0.01	0.20	0.02	0.14
Private	-	0.08	0.01	8.18	0.53	5.74
Late Summer (After pups can fly)[g]						
Near Large Hibernacula						
DNR	38%	0.26	0.03	2.51	0.08	1.83
County & Municipal	-	0.26	0.03	0.14	<0.01	0.11
Private	-	0.26	0.03	5.76	0.07	4.27
General Landscape						
DNR	38%	0.23	0.02	2.68	0.08	1.95
County & Municipal	-	0.23	0.02	0.15	<0.01	0.11
Private	-	0.23	0.02	6.14	0.08	4.54
Annual Totals[h]						
DNR	38%	-	-	96	4	69
County & Municipal	-	-	-	6	<1	4
Private	-	-	-	220	4	162
Annual Total	-	-	-	322	7	236

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Permit Duration (50 years)[h]						
DNR	38%	-	-	4,799	185	3,460
County & Municipal	-	-	-	276	5	203
Private	-	-	-	11,006	183	8,117
Grand Total	**-**	**-**	**-**	**16,080**	**374**	**11,779**

Notes:
[a] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[b] Winter habitat is modeled as ¼ mile around known hibernacula with bats assumed to be present from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[c] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[d] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[e] Early summer is from May 16 through May 31.
[f] Dependent pup season is from June 1 through July 31 (Table 3-3).
[g] Late summer is from August 1 through August 15.
[h] Numbers may not total due to rounding.
NA = not applicable

Table 4-8. Number of Tricolored Bats Killed or Harmed (Disturbed) by Timber Harvest in Winter, Fall/Spring, and Summer by Ownership Type (Michigan)

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Winter Habitat[b]						
DNR	NA	0.24	0.02	0.00	0.00	0.00
County & Municipal	-	0.24	0.02	0.00	0.00	0.00
Private	-	0.24	0.02	0.00	0.00	0.00
Fall/Spring[c]						
DNR	38%	<0.01	<0.01	0.01	<0.01	0.01
County & Municipal	-	<0.01	<0.01	<0.01	<0.01	<0.01
Private	-	<0.01	<0.01	0.02	<0.01	0.01
Early Summer (Before pups are born)[d,e]						
DNR	38%	<0.01	<0.01	<0.01	<0.01	<0.01
County & Municipal	-	<0.01	<0.01	<0.01	<0.01	<0.01
Private	-	<0.01	<0.01	<0.01	<0.01	<0.01
Dependent Pup Season (Adults)[f]						
DNR	38%	<0.01	<0.01	0.01	<0.01	<0.01
County & Municipal	-	<0.01	<0.01	<0.01	<0.01	<0.01
Private	-	<0.01	<0.01	0.01	<0.01	0.01
Dependent Pup Season (Non-flying pups)[f]						
DNR	38%	<0.01	<0.01	0.01	<0.01	<0.01
County & Municipal	-	<0.01	<0.01	<0.01	<0.01	<0.01
Private	-	<0.01	<0.01	0.01	<0.01	0.01
Late Summer (After pups can fly)[g]						
DNR	38%	<0.01	<0.01	<0.01	<0.01	<0.01
County & Municipal	-	<0.01	<0.01	<0.01	<0.01	<0.01
Private	-	<0.01	<0.01	0.01	<0.01	<0.01
Annual Totals[h]						
DNR	38%	-	-	<1	<1	<1
County & Municipal	-	-	-	<1	<1	<1
Private	-	-	-	<1	<1	<1

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Annual Total	-	-	-	<1	<1	<1
Permit Duration (50 years)[h]						
DNR	38%	-	-	1	<1	1
County & Municipal	-	-	-	<1	<1	<1
Private	-	-	-	3	<1	2
Grand Total	**-**	**-**	**-**	**4**	**<1**	**3**

Notes:
[a] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[b] Winter habitat is modeled as ¼ mile around known hibernacula with bats assumed to be present from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[c] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[d] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[e] Early summer is from May 16 through May 31.
[f] Dependent pup season is from June 1 through July 31 (Table 3-3).
[g] Late summer is from August 1 through August 15.
[h] Numbers may not total due to rounding.
NA = not applicable

4.3.1.2 Roads and Trails

Effects associated with road and trail maintenance are captured by other analyses: trees removed for maintenance were included as a type of salvage, and the value of these roads as foraging and commuting habitat is considered under Section 4.4, *Indirect (Beneficial) Effects*. The construction of new roads and trails has minimal impacts when relative to timber harvest, and these impacts are addressed as part of those activities.

4.3.1.3 Prescribed Fire

As noted in Section 4.4, prescribed fire has dramatic, long-term benefits to bat habitat, but the activity may have short-term impacts due to 1) the loss of some roost trees to the fire itself and trees removed to limit the spread of a fire and 2) the harm and mortality of some bats within the stand at the time of fire. Results of prescribed fire on bat habitat and bat individuals is presented in Table 4-9.

Table 4-9. Impact (Number of Bats Killed and Harmed) from Prescribed Fire on Covered Bats (Michigan)

Acres of Prescribed Fire	Percent Eligible for Enrollment	Maximum Acres of Forest/Brushland Affected	Species	Impacts on Covered Lands	
				Bats Killed	Bats Harmed
Annual					
Michigan DNR					
8,400	100%	2,100	Indiana Bat	<0.01	0.01
			Northern Long-eared bat	0.03	0.48
			Little Brown Bat	0.12	2.27
			Tricolored Bat	<0.01	<0.01
Counties and Municipalities					
Unknown	100%	35	Indiana Bat	<0.01	<0.01
			Northern Long-eared Bat	<0.01	0.01
			Little Brown Bat	<0.01	0.03
			Tricolored Bat	<0.01	<0.01
Private					
Unknown	80%	772	Indiana Bat	<0.01	<0.01
			Northern Long-eared Bat	0.01	0.20
			Little Brown Bat	0.02	0.93
			Tricolored Bat	<0.01	<0.01
Permit Duration (50 years)					
Michigan DNR					
-	-	-	Indiana Bat	0.03	0.42
420,000	100%	105,000	Northern Long-eared bat	1.57	24.10
-	-	-	Little Brown Bat	6.09	113.53
-	-	-	Tricolored Bat	< 0.01	0.03

Acres of Prescribed Fire	Percent Eligible for Enrollment	Maximum Acres of Forest/Brushland Affected	Species	Impacts on Covered Lands	
				Bats Killed	Bats Harmed
Counties and Municipalities					
-	-	-	Indiana Bat	< 0.01	0.01
Unknown	100%	1,747	Northern Long-eared Bat	0.01	0.32
-	-	-	Little Brown Bat	0.04	1.46
-	-	-	Tricolored Bat	< 0.01	< 0.01
Private					
-	-	-	Indiana Bat	0.01	0.18
Unknown	80%	38,602	Northern Long-eared Bat	0.27	9.92
-	-	-	Little Brown Bat	1.05	46.61
-	-	-	Tricolored Bat	< 0.01	0.01

4.3.1.4 Effects of HCP Implementation

Conservation efforts outlined in Chapter 5 are designed to benefit all four covered species of bats. These include the protection of hibernacula and strategic restoration of foraging and roosting habitat associated with both summer and fall/spring habitat, as well as monitoring for compliance with the conservation strategy. All mitigation efforts will improve habitat quality and have no direct impacts on bats. Monitoring may have negligible impacts on bats and will be carried out in the least intrusive way for the data required.

4.3.2 Minnesota

This section describes effects on the covered species from covered activities on covered lands in Minnesota. For timber harvest and prescribed fire this is done quantitatively. For roads and trails, effects are described qualitatively. The effects of HCP Implementation are described as part of the Conservation Strategy in Chapter 5.

4.3.2.1 Timber Harvest

Habitat Effects

Based on data presented in Table 2-11, the Minnesota DNR expects to complete approximately 49,500 acres per year of timber harvest including 36,500 acres per year of final harvest and 13,000 acres per year of partial harvest. Timber harvest on other covered lands was derived from the FIA data and approximates annual harvest of 145,611 acres across all forest types (Chapter 2, Table 2-13). Tables 4-10 through 4-12 provide acres harvested each year by ownership category along with the amount of harvest (in acres and percent) expected to occur by season.

Table 4-10. Acres of High- and Low-Quality Northern Long-eared Bat Habitat Harvested in Winter, Fall/Spring, and Summer by Ownership Type (Minnesota)

Acres of Forested Habitat in Minnesota[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Winter Habitat[d]							
7,952	6,990	DNR	100%	0	0	0	0
		County & Municipal	100%	0	0	0	0
		Private	30%	0	0	0	0
		Annual Total	-	0	0	0	0
		Permit Duration	-	0	0	0	0
Fall/Spring Habitat[e]							
Near Large Hibernacula							
122,817	62,787	DNR	100%	328	168	31	16
		County & Municipal	100%	354	321	34	22
		Private	30%	125	136	15	14
		Annual Total	-	807	625	80	52
		Permit Duration	-	40,345	31,267	4,007	2,588
Near Small Hibernacula							
343,891	210,948	DNR	100%	918	563	86	53
		County & Municipal	100%	991	1,080	96	75
		Private	30%	350	458	43	46
		Annual Total	-	2,259	2,101	224	174
		Permit Duration	-	112,968	105,050	11,220	8,696
Summer Habitat[f]							
13,661,487	4,872,450	DNR	100%	36,487	13,013	3,421	1,220
		County & Municipal	100%	39,371	24,941	3,804	1,729
		Private	30%	13,898	10,574	1,690	1,069
		Annual Total	-	89,756	485,29	8,915	4,017
		Permit Duration	-	4,487,790	2,426,438	445,737	200,869

Acres of Forested Habitat in Minnesota[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Annual Totals[g]							
-	-	DNR	100%	-	-	3,537	1,289
		County & Municipal	100%	-	-	3,934	1,826
		Private	30%	-	-	1,748	1,129
		Annual Total	-	-	-	9,219	4,243
Permit Duration (50 Years)							
-	-	DNR	100%	-	-	176,875	64,426
		County & Municipal	100%	-	-	196,699	91,295
		Private	30%	-	-	87,391	56,432
		Grand Total	**-**	**-**	**-**	**460,965**	**212,154**

Notes:
[a] All forest types were assigned to either high- or low-quality bat habitat per Table 3-2.
[b] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[c] Bats are assumed to be present in different locations on the landscape at different seasons as described in Table 3-3.
[d] Winter habitat is modeled as ¼ mile around known hibernacula from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[e] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[f] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[g] Annual totals were calculated as a sum of Winter, Fall/Spring, and Summer habitat values. Annual totals for seasonal habitat harvested were not provided because Winter, Fall/Spring, and Summer habitat overlap geographically.

Table 4-11. Acres of High- and Low-Quality Little Brown Bat Habitat Harvested in Winter, Fall/Spring, and Summer by Ownership Type (Minnesota)

Acres of Forested Habitat in Minnesota[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Winter Habitat[d]							
140	209	DNR	100%	0	0	0	0
		County & Municipal	100%	0	0	0	0
		Private	30%	0	0	0	0
		Annual Total	-	0	0	0	0
		Permit Duration	-	0	0	0	0
Fall/Spring Habitat[e]							
Near Large Hibernacula							
122,817	62,787	DNR	100%	328	168	31	16
		County & Municipal	100%	354	321	34	22
		Private	30%	125	136	15	14
		Annual Total	-	807	625	80	52
		Permit Duration	-	40,345	31,267	4,007	2,588
Near Small Hibernacula							
161,312	64,777	DNR	100%	431	173	40	16
		County & Municipal	100%	465	332	45	23
		Private	30%	164	141	20	14
		Annual Total	-	1,060	645	105	53
		Permit Duration	-	52,991	32,258	5,263	2,670
Summer Habitat[f]							
Near Large Hibernacula							
4,256,531	1,924,070	DNR	100%	11,368	5,139	1,066	482
		County & Municipal	100%	12,267	9,849	1,185	683
		Private	30%	4,330	4,176	527	422
		Annual Total	-	27,965	19,163	2,778	1,586
		Permit Duration	-	1,398,268	958,170	138,879	79,321

Acres of Forested Habitat in Minnesota[a]		Ownership Type	Percent of Lands Eligible for Enrollment [b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	**Low-Quality Habitat**			**High-Quality Habitat**	**Low-Quality Habitat**	**High-Quality Habitat**	**Low-Quality Habitat**
General Landscape							
9,404,956	2,948,380	DNR	100%	25,119	7,874	2,355	738
		County & Municipal	100%	27,104	15,092	2,619	1,046
		Private	30%	9,568	6,399	1,164	647
		Annual Total	-	61,790	29,365	6,137	2,431
		Permit Duration	-	3,089,522	1,468,268	306,858	121,548
Annual Totals[g]							
-	-	DNR	100%	-	-	3,492	1,252
		County & Municipal	100%	-	-	3,883	1,774
		Private	30%	-	-	1,725	1,097
		Annual Total	-	-	-	9,100	4,123
Permit Duration (50 Years)							
-	-	DNR	100%	-	-	174,589	62,596
		County & Municipal	100%	-	-	194,157	88,702
		Private	30%	-	-	86,262	54,829
		Grand Total	**-**	**-**	**-**	**455,008**	**206,128**

Notes:
[a] All forest types were assigned to either high- or low-quality bat habitat per Table 3-2.
[b] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[c] Bats are assumed to be present in different locations on the landscape at different seasons as described in Table 3-3.
[d] Winter habitat is modeled as ¼ mile around known hibernacula from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[e] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[f] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[g] Annual totals were calculated as a sum of Winter, Fall/Spring, and Summer habitat values. Annual totals for seasonal habitat harvested were not provided because Winter, Fall/Spring, and Summer habitat overlap geographically.

Table 4-12. Acres of High- and Low-Quality Tricolored Bat Habitat Harvested in Winter, Fall/Spring, and Summer by Ownership Type (Minnesota)

Acres of Forested Habitat in Minnesota[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Winter Habitat[d]							
1,218	472	DNR	100%	0	0	0	0
		County & Municipal	100%	0	0	0	0
		Private	30%	0	0	0	0
		Annual Total	-	0	0	0	0
		Permit Duration	-	0	0	0	0
Fall/Spring Habitat[e]							
266,218	121,292	DNR	100%	711	324	67	30
		County & Municipal	100%	767	621	74	43
		Private	30%	271	263	33	27
		Annual Total	-	1,749	1,208	174	100
		Permit Duration	-	87,452	60,402	8,686	5,000
Summer Habitat[f]							
8,345,931	3,393,876	DNR	100%	22,290	9,064	2,090	850
		County & Municipal	100%	24,052	17,373	2,324	1,204
		Private	30%	8,490	7,365	1,032	744
		Annual Total	-	54,833	33,802	5,446	2,798
		Permit Duration	-	2,741,633	1,690,121	272,305	139,914
Annual Totals[g]							
-	-	DNR	100%	-	-	3,421	1,220
		County & Municipal	100%	-	-	3,804	1,729
		Private	30%	-	-	1,690	1,069
		Annual Total	-	-	-	8,915	4,017
Permit Duration (50 Years)							
-	-	DNR	100%	-	-	3,537	1,289
		County & Municipal	100%	-	-	3,934	1,826
		Private	30%	-	-	1,748	1,129
		Grand Total	**-**	**-**	**-**	**89,756**	**48,529**

Notes:
[a] All forest types were assigned to either high- or low-quality bat habitat per Table 3-2.
[b] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[c] Bats are assumed to be present in different locations on the landscape at different seasons as described in Table 3-3.
[d] Winter habitat is modeled as ¼ mile around known hibernacula from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[e] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[f] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[g] Annual totals were calculated as a sum of Winter, Fall/Spring, and Summer habitat values. Annual totals for seasonal habitat harvested were not provided because Winter, Fall/Spring, and Summer habitat overlap geographically.

Impacts on Individuals

Impacts on individual bats are provided for context, noting that the number of individual bats taken will go down as bat population decreases due to WNS (see Chapter 3, Section 3.3.1). Impacts on individual bats were derived from estimates of impacts on habitat (Tables 4-13 through 4-15). These values are overlaid with bat densities estimated in Table 3-13. Results have been provided for number of bats harmed through disturbance and killed if conservation measures are not applied. These data are presented in Tables 4-13 through 4-15.

Table 4-13. Number of Northern Long-eared Bats Killed or Harmed (Disturbed) by Timber Harvest in Winter, Fall/Spring, and Summer by Ownership Type (Minnesota)

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Winter Habitat[b]						
DNR	NA	101.50	0.64	0	0	0
County & Municipal	-	101.50	0.64	0	0	0
Private	-	101.50	0.64	0	0	0
Fall/Spring[c]						
Near Large Hibernacula						
DNR	26%	5.78	0.58	1.87	0.06	1.36
County & Municipal	-	5.78	0.58	2.84	0.06	2.08
Private	-	5.78	0.58	1.56	0.03	1.15
Near Small Hibernacula						
DNR	26%	0.36	0.04	0.33	0.01	0.24
County & Municipal	-	0.36	0.04	0.50	0.01	0.37
Private	-	0.36	0.04	0.28	0.01	0.20
Early Summer (Before pups are born)[d,e]						
DNR	26%	0.06	0.01	0.37	0.01	0.27
County & Municipal	-	0.06	0.01	0.56	0.01	0.41
Private	-	0.06	0.01	0.30	0.01	0.22
Dependent Pup Season (Adults)[f]						
DNR	26%	0.06	0.01	1.47	0.04	1.07
County & Municipal	-	0.06	0.01	2.22	0.05	1.63
Private	-	0.06	0.01	1.22	0.02	0.90
Dependent Pup Season (Non-flying pups)[f]						
DNR	26%	0.03	<0.01	0.73	0.11	0.47
County & Municipal	-	0.03	<0.01	1.11	0.12	0.74
Private	-	0.03	<0.01	0.61	0.06	0.41

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Late Summer (After pups can fly)[g]						
DNR	26%	0.09	0.01	0.55	0.02	0.40
County & Municipal	-	0.09	0.01	0.83	0.02	0.61
Private	-	0.09	0.01	0.46	0.01	0.34
Annual Totals[h]						
DNR	26%	-	-	5	<1	4
County & Municipal	-	-	-	8	<1	6
Private	-	-	-	4	<1	3
Annual Total	-	-	-	18	1	13
Permit Duration (50 years)[h]						
DNR	26%	-	-	266	12	190
County & Municipal	-	-	-	403	14	292
Private	-	-	-	221	6	161
Grand Total	**-**	**-**	**-**	**890**	**33**	**643**

Notes:
[a] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[b] Winter habitat is modeled as ¼ mile around known hibernacula with bats assumed to be present from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[c] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[d] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[e] Early summer is from May 16 through May 31.
[f] Dependent pup season is from June 1 through July 31 (Table 3-3).
[g] Late summer is from August 1 through August 15.
[h] Numbers may not total due to rounding.
NA = not applicable

Table 4-14. Number of Little Brown Bats Killed or Harmed (Disturbed) by Timber Harvest in Winter, Fall/Spring, and Summer by Ownership Type (Minnesota)

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Winter Habitat[b]						
DNR	NA	2,635.63	263.56	0.00	0.00	0.00
County & Municipal	-	2,635.63	263.56	0.00	0.00	0.00
Private	-	2,635.63	263.56	0.00	0.00	0.00
Fall/Spring[c]						
Near Large Hibernacula						
DNR	26%	2.80	0.28	0.90	0.03	0.66
County & Municipal	-	2.80	0.28	1.38	0.03	1.01
Private	-	2.80	0.28	0.75	0.01	0.56
Near Small Hibernacula						
DNR	26%	0.38	0.04	0.16	<0.01	0.12
County & Municipal	-	0.38	0.04	0.24	0.01	0.18
Private	-	0.38	0.04	0.13	<0.01	0.10
Early Summer (Before pups are born)[d,e]						
Near Large Hibernacula						
DNR	26%	0.17	0.02	0.32	0.01	0.23
County & Municipal	-	0.17	0.02	0.48	0.01	0.35
Private	-	0.17	0.02	0.26	<0.01	0.19
General Landscape						
DNR	26%	0.15	0.02	0.61	0.02	0.44
County & Municipal	-	0.15	0.02	0.92	0.02	0.68
Private	-	0.15	0.02	0.51	0.01	0.37
Dependent Pup Season (Adults)[f]						
Near Large Hibernacula						
DNR	26%	0.17	0.02	1.27	0.04	0.92
County & Municipal	-	0.17	0.02	1.92	0.04	1.41
Private	-	0.17	0.02	1.05	0.02	0.78

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
General Landscape						
DNR	26%	0.15	0.02	2.44	0.07	1.78
County & Municipal	-	0.15	0.02	3.70	0.08	2.71
Private	-	0.15	0.02	2.02	0.04	1.49
Dependent Pup Season (Non-flying pups)[f]						
Near Large Hibernacula						
DNR	26%	0.09	0.01	0.63	0.09	0.40
County & Municipal	-	0.09	0.01	0.96	0.11	0.64
Private	-	0.09	0.01	0.53	0.05	0.36
General Landscape						
DNR	26%	0.08	0.01	1.22	0.18	0.78
County & Municipal	-	0.08	0.01	1.85	0.21	1.23
Private	-	0.08	0.01	1.01	0.09	0.69
Late Summer (After pups can fly)[g]						
Near Large Hibernacula						
DNR	26%	0.26	0.03	0.47	0.01	0.35
County & Municipal	-	0.26	0.03	0.72	0.02	0.53
Private	-	0.26	0.03	0.40	0.01	0.29
General Landscape						
DNR	26%	0.23	0.02	0.92	0.03	0.67
County & Municipal	-	0.23	0.02	1.39	0.03	1.02
Private	-	0.23	0.02	0.76	0.01	0.56
Annual Totals[h]						
DNR	26%	-	-	9	<1	6
County & Municipal	-	-	-	14	1	10
Private	-	-	-	7	<1	5
Annual Total	-	-	-	30	1	21

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Permit Duration (50 years)[h]						
DNR	26%	-	-	447	25	317
County & Municipal	-	-	-	678	28	488
Private	-	-	-	371	12	269
Grand Total	**-**	**-**	**-**	**1,497**	**65**	**1,074**

Notes:
[a] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[b] Winter habitat is modeled as ¼ mile around known hibernacula with bats assumed to be present from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[c] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[d] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[e] Early summer is from May 16 through May 31.
[f] Dependent pup season is from June 1 through July 31 (Table 3-3).
[g] Late summer is from August 1 through August 15.
[h] Numbers may not total due to rounding.
NA = not applicable

Table 4-15. Number of Tricolored Bats Killed or Harmed (Disturbed) by Timber Harvest in Winter, Fall/Spring and Summer by Ownership Type (Minnesota)

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Winter Habitat[b]						
DNR	NA	7.90	0.79	0.00	0.00	0.00
County & Municipal	-	7.90	0.79	0.00	0.00	0.00
Private	-	7.90	0.79	0.00	0.00	0.00
Fall/Spring[c]						
DNR	26%	0.04	<0.01	0.03	<0.01	0.02
County & Municipal	-	0.04	<0.01	0.04	<0.01	0.03
Private	-	0.04	<0.01	0.02	<0.01	0.02
Early Summer (Before pups are born)[d,e]						
DNR	26%	<0.01	<0.01	<0.01	<0.01	<0.01
County & Municipal	-	<0.01	<0.01	0.01	<0.01	<0.01
Private	-	<0.01	<0.01	<0.01	<0.01	<0.01
Dependent Pup Season (Adults)[f]						
DNR	26%	<0.01	<0.01	0.02	<0.01	0.01
County & Municipal	-	<0.01	<0.01	0.03	<0.01	0.02
Private	-	<0.01	<0.01	0.01	<0.01	0.01
Dependent Pup Season (Non-flying pups)[f]						
DNR	26%	<0.01	<0.01	0.02	<0.01	0.01
County & Municipal	-	<0.01	<0.01	0.03	<0.01	0.02
Private	-	<0.01	<0.01	0.01	<0.01	0.01
Late Summer (After pups can fly)[g]						
DNR	26%	<0.01	<0.01	0.01	<0.01	0.01
County & Municipal	-	<0.01	<0.01	0.01	<0.01	0.01
Private	-	<0.01	<0.01	0.01	<0.01	0.01

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Annual Totals[h]						
DNR	26%	-	-	<1	<1	<1
County & Municipal	-	-	-	<1	<1	<1
Private	-	-	-	<1	<1	<1
Annual Total	-	-	-	<1	<1	<1
Permit Duration (50 years)[h]						
DNR	26%	-	-	4	<1	3
County & Municipal	-	-	-	5	<1	4
Private	-	-	-	3	<1	2
Grand Total	**-**	**-**	**-**	**12**	**1**	**9**

Notes:
[a] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[b] Winter habitat is modeled as ¼ mile around known hibernacula with bats assumed to be present from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[c] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[d] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[e] Early summer is from May 16 through May 31.
[f] Dependent pup season is t from June 1 through July 31 (Table 3-3).
[g] Late summer is from August 1 through August 15.
[h] Numbers may not total due to rounding.
NA = not applicable

4.3.2.2 Roads and Trails

Effects associated with road and trail maintenance are captured by other analyses: trees removed for maintenance were included as a type of salvage, and the value of these roads as foraging and commuting habitat is considered under Section 4.4. The construction of new roads and trails has minimal impacts when relative to timber harvest, and these impacts are addressed as part of those activities.

4.3.2.3 Prescribed Fire

As noted in Section 4.4, prescribed fire has dramatic, long-term benefits to bat habitat, but the activity may have short-term impacts due to 1) the loss of some roost trees to the fire itself and trees removed to limit the spread of a fire and 2) the harm and mortality of some bats within the stand at the time of fire. Results of prescribed fire on bat habitat and bat individuals is presented in Table 4-16.

Table 4-16. Impact (Number of Bats Killed and Harmed) from Prescribed Fire on Covered Bats (Minnesota)

Acres of Prescribed Fire	Percent Eligible for Enrollment	Maximum Acres of Forest/ Brushland Affected	Species	Impacts on Covered Lands	
				Bats Killed	Bats Harmed
Annual					
Minnesota DNR					
34,300	100%	6,800	Northern Long-eared Bat	0.03	0.52
			Little Brown Bat	0.07	0.87
			Tricolored Bat	<0.01	0.01
Counties and Municipalities					
1,738	100%	141	Northern Long-eared Bat	<0.01	0.01
			Little Brown Bat	<0.01	0.02
			Tricolored Bat	<0.01	<0.01
Private					
2,203	30%	54	Northern Long-eared Bat	<0.01	<0.01
			Little Brown Bat	<0.01	<0.01
			Tricolored Bat	<0.01	<0.01
Permit Duration (50 years)					
Minnesota DNR					
-	-	-	Northern Long-eared bat	1.70	26.10
1,715,000	100%	340,000	Little Brown Bat	3.37	43.55
-	-	-	Tricolored Bat	0.03	0.34
Counties and Municipalities					
-	-	-	Northern Long-eared Bat	0.03	0.64
86,900	100%	7,056	Little Brown Bat	0.06	1.07
-	-	-	Tricolored Bat	< 0.01	0.01

Acres of Prescribed Fire	Percent Eligible for Enrollment	Maximum Acres of Forest/ Brushland Affected	Species	Impacts on Covered Lands	
				Bats Killed	Bats Harmed
Private					
-	-	-	Northern Long-eared Bat	< 0.01	0.01
110,150	30%	2,683	Little Brown Bat	0.01	0.04
-	-	-	Tricolored Bat	< 0.01	< 0.01

4.3.2.4 Effects of HCP Implementation

Conservation efforts outlined in Chapter 5 are designed to benefit all four covered species of bats. These include the protection of hibernacula and strategic restoration of foraging and roosting habitat associated with both summer and fall spring habitat, as well as monitoring for compliance with the conservation strategy. All mitigation efforts will improve habitat quality and have no direct impacts on bats. Monitoring may have negligible impacts on bats and will be carried out in the least intrusive way for the data required.

4.3.3 Wisconsin

This section describes effects on the covered species from covered activities in the state of Wisconsin. For timber harvest and prescribed fire this is done quantitatively. For roads and trails, effects are described qualitatively. The effects of HCP Implementation are described as part of the Conservation Strategy in Chapter 5.

4.3.3.1 Timber Harvest

Habitat Effects

Based on data presented in Chapter 2, Table 2-17, and in the appendix to Chapter 2, Wisconsin DNR expects to complete approximately 20,000 acres per year of timber harvest on state lands including 10,000 acres per year of final harvest and 10,000 acres per year of partial harvest. Timber harvest on other covered lands was derived from the FIA data and approximates harvest of 167,000 acres across all forest types (Chapter 2, Table 2-19). Tables 4-17 through 4-19 provide acres harvested each year by ownership category along with the amount of harvest (in acres and percent) expected to occur by season.

Table 4-17. Acres of High- and Low-Quality Northern Long-eared Bat Habitat Harvested in Winter, Fall/Spring, and Summer by Ownership Type (Wisconsin)

Acres of Forested Habitat in Wisconsin[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Winter Habitat[d]							
32,510	4,335	DNR	100%	0	0	0	0
		County & Municipal	100%	0	0	0	0
		Private	80%	0	0	0	0
		Annual Total	-	0	0	0	0
		Permit Duration	-	0	0	0	0
Fall/Spring Habitat[e]							
Near Large Hibernacula							
166,812	22,101	DNR	100%	194	26	49	6
		County & Municipal	100%	241	130	45	32
		Private	80%	825	275	140	64
		Annual Total	-	1,067	405	184	96
		Permit Duration	-	53,332	20,229	9,215	4,802
Near Small Hibernacula							
774,039	125,642	DNR	100%	902	146	225	37
		County & Municipal	100%	1,120	737	207	181
		Private	80%	3,829	1,563	649	365
		Annual Total	-	4,949	2,300	855	546
		Permit Duration	-	247,468	115,002	42,760	27,300
Summer Habitat[f]							
14,380,649	2,782,124	DNR	100%	16,758	3,242	4,189	811
		County & Municipal	100%	20,811	16,317	3,838	4,017
		Private	80%	71,142	34,614	12,051	8,073
		Annual Total	-	91,953	50,931	15,888	12,090
		Permit Duration	-	4,597,643	2,546,531	794,420	604,515

Acres of Forested Habitat in Wisconsin[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	**Low-Quality Habitat**			**High-Quality Habitat**	**Low-Quality Habitat**	**High-Quality Habitat**	**Low-Quality Habitat**
Annual Totals[g]							
-	-	DNR	100%	-	-	4,464	854
		County & Municipal	100%	-	-	4,089	4,231
		Private	80%	-	-	12,839	8,502
		Annual Total	-	-	-	21,391	13,586
Permit Duration (50 Years)							
-	-	DNR	100%	-	-	223,179	42,678
		County & Municipal	100%	-	-	204,431	211,527
		Private	80%	-	-	641,964	425,091
		Grand Total	**-**	**-**	**-**	**1,069,574**	**679,295**

Notes:
[a] All forest types were assigned to either high- or low-quality bat habitat per Table 3-2.
[b] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[c] Bats are assumed to be present in different locations on the landscape at different seasons as described in Table 3-3.
[d] Winter habitat is modeled as ¼ mile around known hibernacula from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[e] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[f] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[g] Annual totals were calculated as a sum of Winter, Spring/Fall, and Summer habitat values. Annual totals for seasonal habitat harvested were not provided because Winter, Fall/Spring, and Summer habitat overlap geographically.

Table 4-18. Acres of High- and Low-Quality Little Brown Bat Habitat Harvested in Winter, Fall/Spring, and Summer by Ownership Type (Wisconsin)

Acres of Forested Habitat in Wisconsin[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Winter Habitat[d]							
5,864	2,235	DNR	100%	0	0	0	0
		County & Municipal	100%	0	0	0	0
		Private	80%	0	0	0	0
		Annual Total	-	0	0	0	0
		Permit Duration	-	0	0	0	0
Fall/Spring Habitat[e]							
Near Large Hibernacula							
166,812	22,101	DNR	100%	194	26	49	6
		County & Municipal	100%	241	130	45	32
		Private	80%	825	275	140	64
		Annual Total	-	1,261	430	233	102
		Permit Duration	-	63,051	21,517	11,645	5,124
Near Small Hibernacula							
670,434	104,196	DNR	100%	781	121	195	30
		County & Municipal	100%	970	611	179	150
		Private	80%	3,317	1,296	562	302
		Annual Total	-	5,068	2,029	936	483
		Permit Duration	-	253,408	101,444	46,802	24,158
Summer Habitat[f]							
Near Large Hibernacula							
9,154,011	1,761,326	DNR	100%	10,667	2,052	2,667	513
		County & Municipal	100%	13,247	10,330	2,443	2,543
		Private	80%	45,286	21,914	7,671	5,111
		Annual Total	-	69,200	34,296	12,781	8,167
		Permit Duration	-	3,459,997	1,714,800	639,030	408,367

Acres of Forested Habitat in Wisconsin[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
General Landscape							
5,226,638	1,020,798	DNR	100%	6,091	1,190	1,523	297
		County & Municipal	100%	7,564	5,987	1,395	1,474
		Private	80%	25,857	12,700	4,380	2,962
		Annual Total	-	39,511	19,877	7,297	4,733
		Permit Duration	-	1,975,544	993,833	364,865	236,674
Annual Totals[g]							
-	-	DNR	100%	-	-	4,433	847
		County & Municipal	100%	-	-	4,061	4,200
		Private	80%	-	-	12,752	8,440
		Annual Total	-	-	-	21,247	13,486
Permit Duration (50 Years)							
-	-	DNR	100%	-	-	221,670	42,365
		County & Municipal	100%	-	-	203,049	209,979
		Private	80%	-	-	637,623	421,979
		Grand Total	**-**	**-**	**-**	**1,062,342**	**674,323**

Notes:

[a] All forest types were assigned to either high- or low-quality bat habitat per Table 3-2.

[b] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.

[c] Bats are assumed to be present in different locations on the landscape at different seasons as described in Table 3-3.

[d] Winter habitat is modeled as ¼ mile around known hibernacula from October 16 through April 14 (Table 3-3). No timber harvest takes place in winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.

[e] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.

[f] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat between May 15 through August 15.

[g] Annual totals were calculated as a sum of Winter, Spring/Fall, and Summer habitat values. Annual totals for seasonal habitat harvested were not provided because Winter, Fall/Spring, and Summer habitat overlap geographically.

Table 4-19. Acres of High- and Low-Quality Tricolored Bat Habitat Harvested in Winter, Fall/Spring, and Summer by Ownership Type (Wisconsin)

Acres of Forested Habitat in Wisconsin[a]		Ownership Type	Percent of Lands Eligible for Enrollment[b]	Maximum Acres of Seasonal Habitat Harvested[c]		Maximum Acres of Seasonal Habitat Harvested When Bats Are Present	
High-Quality Habitat	Low-Quality Habitat			High-Quality Habitat	Low-Quality Habitat	High-Quality Habitat	Low-Quality Habitat
Winter Habitat[d]							
25,017	3,754	DNR	100%	0	0	0	0
		County & Municipal	100%	0	0	0	0
		Private	80%	0	0	0	0
		Annual Total	-	0	0	0	0
		Permit Duration	-	0	0	0	0
Fall/Spring Habitat[e]							
788,739	108,423	DNR	100%	919	126	230	32
		County & Municipal	100%	1,141	636	210	157
		Private	80%	3,902	1,349	661	315
		Annual Total	-	5,962	2,111	1,101	503
		Permit Duration	-	298,125	105,559	55,061	25,138
Summer Habitat[f]							
6,431,046	1,360,493	DNR	100%	7,494	1,585	1,874	396
		County & Municipal	100%	9,307	7,979	1,716	1,964
		Private	80%	31,815	16,927	5,389	3,948
		Annual Total	-	48,616	26,491	8,979	6,309
		Permit Duration	-	2,430,781	1,324,555	448,943	315,433
Annual Totals[g]							
-	-	DNR	100%	-	-	2,103	428
		County & Municipal	100%	-	-	1,927	2,121
		Private	80%	-	-	6,050	4,262
		Annual Total	-	-	-	10,080	6,811
Permit Duration (50 Years)							
-	-	DNR	100%	-	-	105,166	21,397
		County & Municipal	100%	-	-	96,332	106,051
		Private	80%	-	-	302,506	213,123
		Grand Total	**-**	**-**	**-**	**504,004**	**340,571**

Notes:
[a] All forest types were assigned to either high- or low-quality bat habitat per Table 3-2.
[b] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[c] Bats are assumed to be present in different locations on the landscape at different seasons as described in Table 3-3.
[d] Winter habitat is modeled as ¼ mile around known hibernacula from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[e] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[f] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[g] Annual totals were calculated as a sum of Winter, Fall/Spring, and Summer habitat values. Annual totals for seasonal habitat harvested were not provided because Winter, Fall/Spring, and Summer habitat overlap geographically.

Impacts on Individuals

Impacts on individual bats are provided for context, noting that the number of individual bats taken will go down as bat population decreases due to WNS (see Chapter 3, Section 3.3.1). Impacts on individual bats were derived from estimates of impacts on habitat (Tables 4-20 through 4-22). These are overlaid with bat densities estimated in Table 3-16. Results have been provided for number of bats harmed through disturbance and killed if conservation measures are not applied. These data are presented in Tables 4-20 through 4-22.

Table 4-20. Number of Northern Long-eared Bats Killed or Harmed (Disturbed) by Timber Harvest in Winter, Fall/Spring, and Summer by Ownership Type (Wisconsin)

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Winter Habitat[b]						
DNR	NA	6.41	0.64	0.00	0.00	0.00
County & Municipal	-	6.41	0.64	0.00	0.00	0.00
Private	-	6.41	0.64	0.00	0.00	0.00
Fall/Spring[c]						
Near Large Hibernacula						
DNR	50%	1.19	0.12	0.58	0.02	0.43
County & Municipal	-	1.19	0.12	1.09	0.02	0.80
Private	-	1.19	0.12	3.26	0.05	2.41
Near Small Hibernacula						
DNR	50%	0.01	<0.01	0.03	<0.01	0.02
County & Municipal	-	0.01	<0.01	0.06	<0.01	0.04
Private	-	0.01	<0.01	0.17	<0.01	0.13
Early Summer (Before pups are born)[d,e]						
DNR	50%	0.01	<0.01	0.10	<0.01	0.07
County & Municipal	-	0.01	<0.01	0.19	<0.01	0.14
Private	-	0.01	<0.01	0.58	0.01	0.43
Dependent Pup Season (Adults)[f]						
DNR	50%	0.01	<0.01	0.41	0.01	0.30
County & Municipal	-	0.01	<0.01	0.77	0.01	0.57
Private	-	0.01	<0.01	2.31	0.04	1.70
Dependent Pup Season (Non-flying pups)[f]						
DNR	50%	0.01	<0.01	0.21	0.03	0.13
County & Municipal	-	0.01	<0.01	0.39	0.03	0.27
Private	-	0.01	<0.01	1.15	0.09	0.80

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Late Summer (After pups can fly)[g]						
DNR	50%	0.02	<0.01	0.15	<0.01	0.11
County & Municipal	-	0.02	<0.01	0.29	<0.01	0.21
Private	-	0.02	<0.01	0.87	0.01	0.64
Annual Totals[h]						
DNR	50%	-	-	1	<1	1
County & Municipal	-	-	-	3	<1	2
Private	-	-	-	8	<1	6
Annual Total	-	-	-	13	<1	9
Permit Duration (50 years)[h]						
DNR	50%	-	-	74	3	53
County & Municipal	-	-	-	139	3	102
Private	-	-	-	417	10	305
Grand Total	**-**	**-**	**-**	**631**	**17**	**460**

Notes:
[a] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[b] Winter habitat is modeled as ¼ mile around known hibernacula with bats assumed to be present from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[c] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[d] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[e] Early summer is from May 16 through May 31.
[f] Dependent pup season is from June 1 through July 31 (Table 3-3).
[g] Late summer is from August 1 through August 15.
[h] Numbers may not total due to rounding.
NA = not applicable

Table 4-21. Number of Little Brown Bats Killed or Harmed (Disturbed) by Timber Harvest in Winter, Fall/Spring, and Summer by Ownership Type (Wisconsin)

		Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
Ownership Type	% Partial Harvest	High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Winter Habitat[b]						
DNR	NA	921.56	92.16	0.00	0.00	0.00
County & Municipal	-	921.56	92.16	0.00	0.00	0.00
Private	-	921.56	92.16	0.00	0.00	0.00
Fall/Spring[c]						
Near Large Hibernacula						
DNR	50%	31.53	3.15	15.53	0.47	11.30
County & Municipal	-	31.53	3.15	28.81	0.45	21.27
Private	-	31.53	3.15	86.53	1.38	63.86
Near Small Hibernacula						
DNR	50%	0.41	0.04	0.82	0.02	0.59
County & Municipal	-	0.41	0.04	1.53	0.02	1.13
Private	-	0.41	0.04	4.57	0.07	3.37
Early Summer (Before pups are born)[d,e]						
Near Large Hibernacula						
DNR	50%	0.17	0.02	0.77	0.02	0.56
County & Municipal	-	0.17	0.02	1.46	0.02	1.07
Private	-	0.17	0.02	4.35	0.07	3.21
General Landscape						
DNR	50%	0.15	0.02	0.39	0.01	0.28
County & Municipal	-	0.15	0.02	0.74	0.01	0.54
Private	-	0.15	0.02	2.20	0.04	1.62
Dependent Pup Season (Adults)[f]						
Near Large Hibernacula						
DNR	50%	0.17	0.02	3.09	0.09	2.25
County & Municipal	-	0.17	0.02	5.82	0.09	4.30
Private	-	0.17	0.02	17.39	0.28	12.83

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
General Landscape						
DNR	50%	0.15	0.02	1.56	0.05	1.14
County & Municipal	-	0.15	0.02	2.94	0.05	2.17
Private	-	0.15	0.02	8.79	0.14	6.48
Dependent Pup Season (Non-flying pups)[f]						
Near Large Hibernacula						
DNR	50%	0.09	0.01	1.55	0.23	0.99
County & Municipal	-	0.09	0.01	2.91	0.23	2.01
Private	-	0.09	0.01	8.70	0.70	6.00
General Landscape						
DNR	50%	0.08	0.01	0.78	0.12	0.50
County & Municipal	-	0.08	0.01	1.47	0.12	1.02
Private	-	0.08	0.01	4.39	0.35	3.03
Late Summer (After pups can fly)[g]						
Near Large Hibernacula						
DNR	50%	0.26	0.03	1.16	0.03	0.84
County & Municipal	-	0.26	0.03	2.18	0.03	1.61
Private	-	0.26	0.03	6.52	0.10	4.81
General Landscape						
DNR	50%	0.23	0.02	0.59	0.02	0.43
County & Municipal	-	0.23	0.02	1.10	0.02	0.81
Private	-	0.23	0.02	3.29	0.05	2.43
Annual Totals[h]						
DNR	50%	-	-	26	1	19
County & Municipal	-	-	-	49	1	36
Private	-	-	-	147	3	108
Annual Total	-	-	-	222	5	162

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Permit Duration (50 years)[h]						
DNR	50%	-	-	1,311	53	944
County & Municipal	-	-	-	2,448	52	1,797
Private	-	-	-	7,336	159	5,383
Grand Total	**-**	**-**	**-**	**11,096**	**265**	**8,123**

Notes:
[a] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[b] Winter habitat is modeled as ¼ mile around known hibernacula with bats assumed to be present from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[c] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[d] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[e] Early summer is from May 16 through May 31.
[f] Dependent pup season is from June 1 through July 31 (Table 3-3).
[g] Late summer is from August 1 through August 15.
[h] Numbers may not total due to rounding.
NA = not applicable

Table 4-22. Number of Tricolored Bats Killed or Harmed (Disturbed) by Timber Harvest in Winter, Fall/Spring, and Summer by Ownership Type (Wisconsin)

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Winter Habitat[b]						
DNR	NA	0.906	0.091	0.00	0.00	0.00
County & Municipal	-	0.906	0.091	0.00	0.00	0.00
Private	-	0.906	0.091	0.00	0.00	0.00
Fall/Spring[c]						
DNR	50%	0.03	<0.01	0.07	<0.01	0.05
County & Municipal	-	0.03	<0.01	0.12	<0.01	0.09
Private	-	0.03	<0.01	0.37	0.01	0.28
Early Summer (Before pups are born)[d,e]						
DNR	50%	<0.01	<0.01	0.01	<0.01	0.01
County & Municipal	-	<0.01	<0.01	0.02	<0.01	0.02
Private	-	<0.01	<0.01	0.06	<0.01	0.05
Dependent Pup Season (Adults)[f]						
DNR	50%	<0.01	<0.01	0.04	<0.01	0.03
County & Municipal	-	<0.01	<0.01	0.08	<0.01	0.06
Private	-	<0.01	<0.01	0.25	<0.01	0.19
Dependent Pup Season (Non-flying pups)[f]						
DNR	50%	<0.01	<0.01	0.04	0.01	0.03
County & Municipal	-	<0.01	<0.01	0.08	0.01	0.06
Private	-	<0.01	<0.01	0.25	0.02	0.17
Late Summer (After pups can fly)[g]						
DNR	50%	0.01	<0.01	0.02	<0.01	0.02
County & Municipal	-	0.01	<0.01	0.04	<0.01	0.03
Private	-	0.01	<0.01	0.13	<0.01	0.09

Ownership Type	% Partial Harvest	Density (Bats/100 Acres)		Impacts on Covered Lands[a]		
		High-Quality Habitat	Low-Quality Habitat	Bats Present	Bats Killed	Bats Harmed
Annual Totals[h]						
DNR	50%	-	-	<1	<1	<1
County & Municipal	-	-	-	<1	<1	<1
Private	-	-	-	1	<1	1
Annual Total	-	-	-	2	<1	1
Permit Duration (50 years)[h]						
DNR	50%	-	-	9	1	7
County & Municipal	-	-	-	18	1	13
Private	-	-	-	53	2	39
Grand Total	**-**	**-**	**-**	**81**	**3**	**58**

Notes:
[a] Appendix F explains the insignificant effect of low levels of forestry activities by some landowners and details what makes landowners eligible to enroll in the HCP.
[b] Winter habitat is modeled as ¼ mile around known hibernacula with bats assumed to be present from October 16 through April 14 (Table 3-3). No timber harvest takes place in Winter habitat during the winter; therefore, effects on bats in Winter habitat are zero.
[c] Fall/Spring habitat is modeled as either 5 to 10 miles around hibernacula, depending on the size of the hibernaculum (see Table 3-3). Bats are assumed to be present in Spring habitat from April 15 through May 14 and in Fall habitat from August 16 through October 15.
[d] Summer habitat for bats is all forested habitat. Bats are assumed to be present in Summer habitat from May 15 through August 15.
[e] Early summer is from May 16 through May 31.
[f] Dependent pup season is from June 1 through July 31 (Table 3-3).
[g] Late summer is from August 1 through August 15.
NA = not applicable
Numbers may not total due to rounding.

4.3.3.2 Roads and Trails

Effects associated with road and trail maintenance are captured by other analyses: trees removed for maintenance were included as a type of salvage, and the value of these roads as foraging and commuting habitat is considered under Section 4.4. The construction of new roads and trails has minimal impacts when relative to timber harvest, and these impacts are addressed as part of those activities.

4.3.3.3 Prescribed Fire

As noted in Section 4.4, prescribed fire has dramatic, long-term benefits to bat habitat, but the activity may have short-term impacts due to 1) the loss of some roost trees to the fire itself and trees removed to limit the spread of a fire and 2) the harm and mortality of some bats within the stand at the time of fire. Results of prescribed fire on bat habitat and bat individuals is presented in Table 4-23.

Table 4-23. Impacts (Number of Bats Killed and Harmed) from Prescribed Fire on Covered Bats (Wisconsin)

Acres of Prescribed Fire	Percent Eligible for Enrollment	Maximum Acres of Forest/Brushland Affected	Species	Impacts on Covered Lands	
				Bats Killed	Bats Harmed
Annual					
Wisconsin DNR					
25,800	100%	4,000	Northern Long-eared Bat	0.01	0.21
			Little Brown Bat	0.21	3.77
			Tricolored Bat	<0.01	0.03
Counties and Municipalities					
1,089	100%	272	Northern Long-eared Bat	<0.01	0.02
			Little Brown Bat	0.01	0.27
			Tricolored Bat	<0.01	<0.01
Private					
3,911	80%	782	Northern Long-eared Bat	<0.01	0.01
			Little Brown Bat	0.02	2.06
			Tricolored Bat	<0.01	<0.01
Permit Duration (50 years)					
Wisconsin DNR					
-	-	-	Northern Long-eared bat	0.69	10.64
1,290,000	100%	200,000	Little Brown Bat	10.66	188.71
-	-	-	Tricolored Bat	0.11	1.34
Counties and Municipalities					
-	-	-	Northern Long-eared Bat	0.03	0.76
54,450	100%	13,617	Little Brown Bat	0.39	13.45
-	-	-	Tricolored Bat	< 0.01	0.10

Acres of Prescribed Fire	Percent Eligible for Enrollment	Maximum Acres of Forest/Brushland Affected	Species	Impacts on Covered Lands	
				Bats Killed	Bats Harmed
Private					
-	-	-	Northern Long-eared Bat	0.06	0.38
195,550	80%	39,106	Little Brown Bat	0.95	102.78
-	-	-	Tricolored Bat	0.01	0.01

4.3.3.4 Effects of HCP Implementation

Conservation efforts outlined in Chapter 5 are designed to benefit all four covered species of bats. These include the protection of hibernacula and strategic restoration of foraging and roosting habitat associated with both summer and fall/spring habitat, as well as monitoring for compliance with the conservation plan. All mitigation efforts will improve habitat quality and have no direct impacts on bats. Monitoring may have negligible impacts on bats and will be carried out in the least intrusive way for the data required.

4.4 Indirect (Beneficial) Effects

Indirect effects are those effects that occur at a different time and/or place than the initial action or covered activity. The following sections discuss indirect effects qualitatively, with the exception of Section 4.4.1.2, which quantifies indirect effects using a case study approach.

4.4.1 Timber Harvest

4.4.1.1 Changes in Habitat Quality

In the case of timber harvest, the most important indirect effect is that it sets in motion long-term changes in habitat quality that can be seen for decades after the harvest has ended. The four covered bat species all use forested areas for roosting and foraging; thus, timber harvest can dramatically affect habitat quality for bats, which can continue for years after a stand is manipulated. These habitat changes, and the resulting successional dynamics and changes in succession, are especially important when the effects occur in Summer habitat, when bats are not necessarily congregating around hibernacula but are rearing nonvolant pups. Several recent publications have reviewed the impact of forest management on bats (Sheets et al. 2013a; Pauli 2014, 2015a, 2015b; Silvis et al. 2016; Voigt and Kingston 2016). Figures 4-3 and 4-4 were prepared by Sheets et al. (2013a) to predict how one of the covered species (the Indiana bat) would react to a variety of potential forest management practices in the oak/hickory forests of central Indiana. While this study was on Indiana bats outside of this HCP's focus area, many of the observations noted in Sheets et al. (2013a) apply to all four covered species.

The most salient observations of Sheets et al. in the context of this HCP are discussed below.

- Timber harvest is a disturbance event and sets in motion an ecological chain of events that lead to further changes in the stand. Silvicultural practices often take advantage of these patterns by creating disturbance events at specific times and places to produce changes that result in a stand developing to a desired end-product, which can then be harvested again.

- The same timber harvest can have dramatically different effects on roosting and foraging habitat. For example, some types of timber harvest, especially a final harvest with limited residuals such as the final harvest of Jack Pine on well-drained, sandy soil, can remove most of the potential roosts from a stand. However, the open space created by that harvest, and more importantly the edge around that open space, provides bats with high-quality foraging habitat.
- Stands are undergoing natural changes even when they are not being manipulated by forest management practices (i.e., logging).
- The interaction between bats, timber harvest, and succession is complex. When considered at a landscape scale, stands of multiple ages and types of forest create a mosaic of habitat that provides for all life cycle needs of bats.

4.4.1.2 Case Study of Indirect Effects in High-Quality Forest

Timber harvest can change the value of a stand for bats in both positive and negative ways over various time scales. Many actions can have direct, negative impacts over the short term but substantive positive impacts over the long term. For example, actions that improve foraging habitat can negatively affect roosting habitat. For these reasons, the net effects of a timber harvest vary depending on the type of harvest and on the type of stand.

The analysis presented in Table 4-24 and Figure 4-3 provides an overview of changes over time for a potential oak hickory system "case study" that is manipulated in one of two ways. The first is final harvest where the residual consists of both scattered individual and small islands of trees but most all other timber is removed. This is compared to a partial harvest (such as a preparation/regeneration cut for a shelterwood). A subsequent removal in these systems would be classified as a final harvest. This case study relies heavily on the results of Sheets et al. (2013a) who examined impacts for timber harvests on Indiana bats on two state forests in Indiana. Into that basic theoretical framework, species-specific habitat requirements provided by the literature (see Species Appendices) and information about habitat and silvicultural practices in the Lake states were also incorporated.

Figure 4-3. Impacts of Final Harvest on Habitat Quality for Northern Long-eared Bats

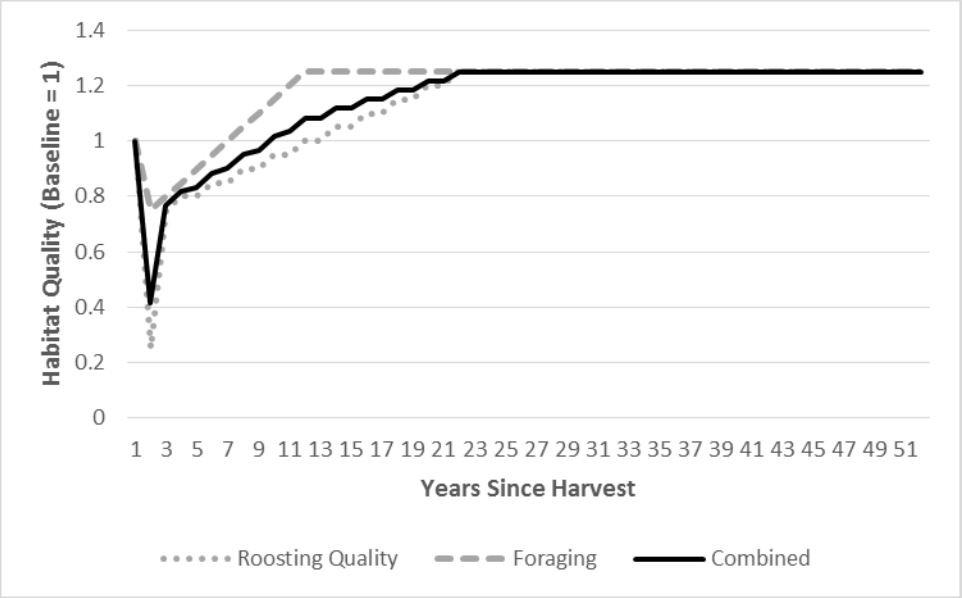


Table 4-24. Levels of Direct and Indirect Effects from Timber Harvest on Forest Habitat for Northern Long-Eared Bats

Harvests	Direct Effects		Indirect Effects			
	Category of Effect	Magnitude of Effect[a]	Years of Effects	Category of Effect	Magnitude of Effect[a]	Justification
Effects on Roosting Habitat						
Final Harvest	High Negative Effect	-0.75	Year 1	Moderate improvement	0.50	Retained roost trees have higher solar exposure. Some retained trees die/become decadent and become roosts. Damaged and broken limbs are regularly used by northern long-eared bats.
			Biannually years 2–20	Trace Improvement	0.05 per every other year	Retained roost trees have higher solar exposure. Some retained trees die/become decadent and become roosts. Remaining trees get larger.
			Year 21–50	No Change	0.00	Young trees begin to fill the stand. Northern long-eared bats will continue to roost in residual trees.
Partial Harvest	No Change	0.00	Annually Years 1–10	Trace improvement	0.05 per year	Retained roost trees have higher solar exposure. Some retained trees die and become roosts. Surviving damaged trees become more decadent and become roosts. Remaining trees get larger.
			Annually years 10–50	No Change	0.00	As the trees grow there is less space between them for bats to fly. However, residual trees become older and become decadent.
Effects on Foraging Habitat						
Final Harvest	Minor decline	-0.25	Year 1–10	Trace improvement	0.05	Understory regenerates and provides a second vegetative interface.
			Years 10–50	No Change	0.00	Saplings begin to fill the understory. Vegetation begins to fill the stand, but it remains usable for northern long-eared bats.
Partial Harvest	No Change	0.00	Year 1–10	Trace improvement	0.05	Saplings begin to fill understory. More cluttered understory becomes prime foraging.
			Years 11–50	No Change	0.00	Understory becomes progressively more full of vegetation but remains usable by northern long-eared bats.

Notes:

[a] Effect size (sign indicates the direction of the effect): 0.00 = no effect; 0.05 = trace; 0.25 = minor; 0.50 = moderate; 0.75 = major; 1.00 = complete.

Final Harvest

In this case study, the direct effects of a final harvest are an intense negative effect on both roosting and foraging habitat within the stand. However, the forest begins to recover habitat value within a year of harvest.

Roosting Habitat

In this example, a final harvest is assumed to remove most, but not all, roosting potential from the stand. These initial effects are the direct effect of harvest that are captured in Section 4.2.1. Retained trees have some value as roosting habitat for bats, especially those trees with extensive systems of cracks and hollows. Within a year, roosting quality begins to increase. These initial changes in roosting habitat quality are the result of 1) increased solar exposure to residual trees (bats prefer warmer temperatures), 2) accelerated decline of these trees due to damage occurring during harvest or increased exposure to storms (dead and declining trees provide more roosting opportunities for bats), and 3) subsequent increase in size and age of surviving residual trees, all of which increase roosting quality for the first 20 years. From years 21 through 50, no changes to roosting habitat quality are predicted for northern long-eared bats.

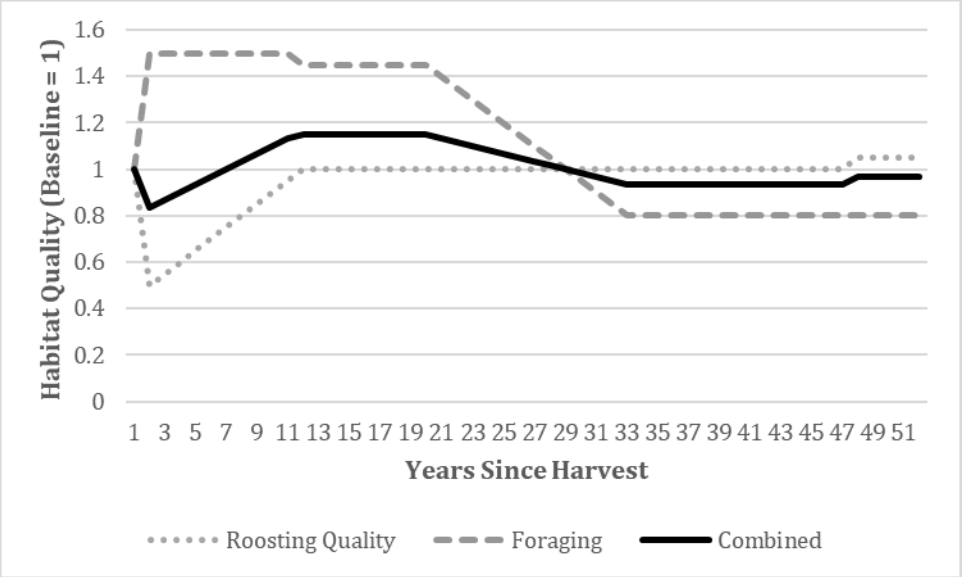
For species such as the Indiana and little brown bat (i.e., those that are more likely to roost under bark and are less tolerant of clutter [Pauli 2014; Pauli et al. 2015a, 2015b]), the initial negative effects of harvest are less (these bats are more likely to use trees in open landscapes), but these bats are also more quickly excluded from stands that become full of young trees.

Foraging Habitat

Many bats preferentially forage at the forest edges where more densely forested areas are adjacent to more open areas (Sparks et al. 2004; O'Keefe 2009). This leads to a selection of forests with some degree of openness (Brack 2006; O'Keefe 2009), although northern long-eared bats are among the most clutter-adapted of eastern species (Owen et al. 2003; Schirmacher et al. 2007; O'Keefe 2009; Pauli 2014). A final harvest initially results in a minor decline in foraging quality for this species due to its reliance on forested areas for foraging. Habitat quality within this stand gradually increases (effectively comes back to baseline) during the first 10 years post-harvest as the under-story recovers and new edges develop. Residual trees that fall create tip-up mounds, which also provide increased foraging opportunities. Benefits stop accruing for northern long-eared bats after the first decade.

The other covered species (Figure 4-4) are more likely to be associated with foraging along an edge and in open areas, and thus, a final harvest initially causes a moderate improvement in habitat quality. After 10 years, as the stand becomes full of young trees, the value begins to decline with a return to near baseline occurring by year 30.

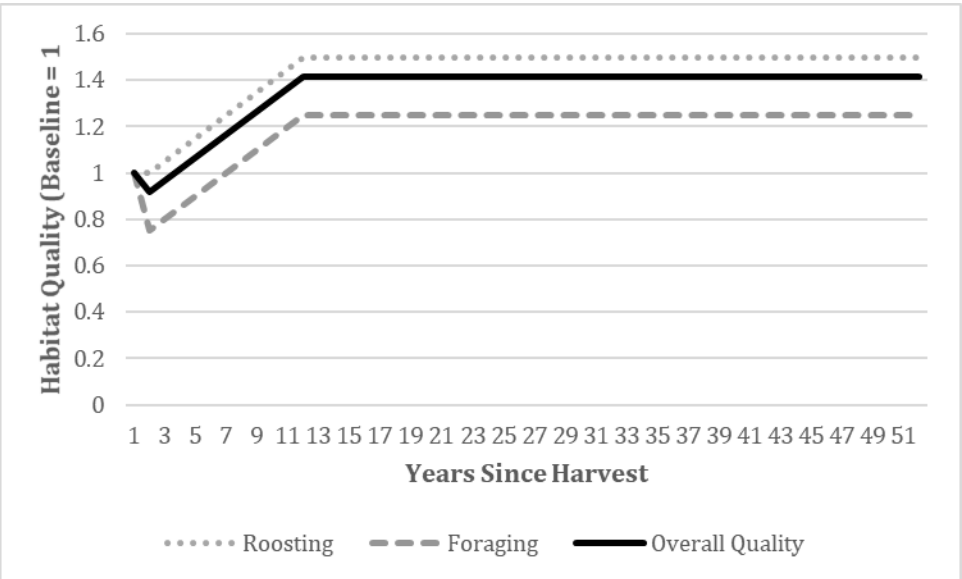
Figure 4-4. Impact of Final Harvest on Habitat Quality for Indiana, Little Brown, and Tricolored Bats



Partial Harvest

Because partial harvests leave substantial numbers of trees (some of which are damaged), the initial impacts on roosting and foraging habitat are less intense. Over time, trees that are removed are replaced and the stand again becomes filled with trees unless the stand is manipulated or otherwise disturbed again (Figure 4-5).

Figure 4-5. Impacts of Partial Harvest on Habitat Quality for Northern Long-eared Bats



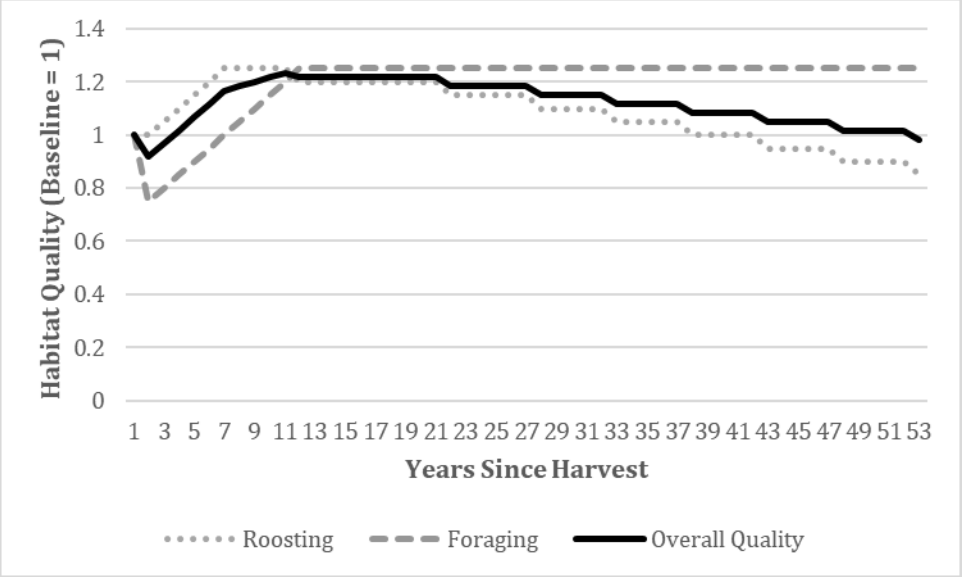
Roosting Habitat

A partial harvest removes some roost trees, but other silvicultural practices such as retention of large cull trees for wildlife benefit, retention of legacy trees, and incidental residual tree damage

occurring during harvest also create roosting opportunities. In fact, telemetered northern long-eared bats in Kentucky moved into a partial harvest before it was even completed (MacGregor et al. 1999). As such, the effect on roosting habitat is neutral at the stand level. Some of the residual trees die over time and become higher-quality roost trees, and some that were damaged remain living but also offer higher-quality roosting opportunities with greater solar exposure, although this benefit is less pronounced for northern long-eared bats. Therefore, roosting habitat quality at the stand level shows trace improvements throughout the first 10 years. Stand improvement declines over time, and no changes are seen in years 10 to 50, although benefits gained in the first 10 years remain on the landscape.

For the other covered species (Figure 4-6) a similar pattern is noted, although the increasing clutter of the stand after year 10 gradually reduces roosting habitat quality back to baseline.

Figure 4-6. Impact of Partial Harvest on Habitat Quality for Indiana, Little Brown, and Tricolored Bats



Foraging Habitat

As with roosting, the initial impacts on foraging habitat for northern long-eared bats are neutral at the stand level. Regeneration in the understory adds forest complexity and increases foraging habitat quality in years 1 to 10, an effect that becomes less noticeable as the regenerating stand becomes increasingly cluttered.

The other covered species are less clutter-adapted and see a moderate immediate benefit from a partial harvest at the stand level. This includes a more open stand that allows bats to forage around and between trees, as well as tip-up mounds from windthrow, which provide habitat for aquatic insects. This benefit is lost beginning around year 10 when the regeneration layer begins to clutter the understory. After year 20, the stand continues to decline for covered bats until reaching the baseline. Table 4-25 demonstrates how the assumptions described above impact habitat quality over time. Roosting quality is primarily driven by the number of viable roosts assumed to remain in the residual. Similarly, residual trees and effective regeneration make a stand attractive to multiple species of foraging bats.

Table 4-25. Indirect Effects on Northern Long-eared Bats in an Oak-Hickory Stand after Harvest[a]

Year	Final Harvest					Partial Harvest				
	Roosting Quality		Foraging Quality		Combined	Roosting Quality		Forging Quality		Combined
	Magnitude of Effect	Current Quality	Magnitude of Effect	Current Quality		Magnitude of Effect	Current Quality	Magnitude of Effect	Current Quality	
0	-	1	-	1	1	-	1	-	1	1
1	-0.75	0.25	-0.25	0.75	0.42	0	1	-0.25	0.75	0.92
1	0.5	0.75	0.05	0.8	0.77	0.05	1.05	0.05	0.8	0.97
2	0.05	0.8	0.05	0.85	0.82	0.05	1.1	0.05	0.85	1.02
3	-	0.8	0.05	0.9	0.83	0.05	1.15	0.05	0.9	1.07
4	0.05	0.85	0.05	0.95	0.88	0.05	1.2	0.05	0.95	1.12
5	-	0.85	0.05	1	0.90	0.05	1.25	0.05	1	1.17
6	0.05	0.9	0.05	1.05	0.95	0.05	1.3	0.05	1.05	1.22
7	-	0.9	0.05	1.1	0.97	0.05	1.35	0.05	1.1	1.27
8	0.05	0.95	0.05	1.15	1.02	0.05	1.4	0.05	1.15	1.32
9	-	0.95	0.05	1.2	1.03	0.05	1.45	0.05	1.2	1.37
10	0.05	1	0.05	1.25	1.08	0.05	1.5	0.05	1.25	1.42
11	-	1	0	1.25	1.08	0	1.5	0	1.25	1.42
12	0.05	1.05	0	1.25	1.12	0	1.5	0	1.25	1.42
13	-	1.05	0	1.25	1.12	0	1.5	0	1.25	1.42
14	0.05	1.1	0	1.25	1.15	0	1.5	0	1.25	1.42
15	-	1.1	0	1.25	1.15	0	1.5	0	1.25	1.42
16	0.05	1.15	0	1.25	1.18	0	1.5	0	1.25	1.42
17	-	1.15	0	1.25	1.18	0	1.5	0	1.25	1.42
18	0.05	1.2	0	1.25	1.22	0	1.5	0	1.25	1.42
19	-	1.2	0	1.25	1.22	0	1.5	0	1.25	1.42
20	0.05	1.25	0	1.25	1.25	0	1.5	0	1.25	1.42
21 to 50	0	1.25	0	1.25	1.25	0	1.5	0	1.25	1.42

Notes:

[a] Assumes a residual and successful regeneration.

4.4.1.3 Qualitative Examples of Habitat Changes Associated with Common Management Systems of the Lake States

Oak/Hickory

Depending on species and site-specific growth conditions, oak/hickory stands may be managed using a combination of intermediate and regeneration harvests. These stands also provide excellent examples of how forest management activities can influence future habitat quality for bats.

Oak/Hickory systems are often harvested at an age of 80 years or older. At the time of harvest, these stands often contain multiple dead and damaged trees per acre, and these tree species are preferentially used by tricolored bats. Some species, especially shagbark hickory, can provide bark roosts even when living, and damaged oaks and hickories can live for many years with broken tops, cavities, and retained dead limbs. Under natural conditions, these communities are maintained by understory fires and grazing—without such disturbance they succeed to beech/maple systems. Thus, at the time of harvest many oak/hickory systems contain a dense understory of shrubs including pole-sized representatives of beech and maple. Quality of foraging habitat for all covered species is reduced in areas of high clutter, although northern long-eared bats are more tolerant than the other three species. In all cases, woodlands with a relatively open understory provide high quality foraging than sites with dense clutter.

Clear cuts with residuals are often used to manage oak/hickory stands. Harvest removes the majority of potential roosts, and thus greatly reduces roosting potential. Residual trees, including wildlife trees and any damaged during harvest now have substantial solar exposure. As such, these individual trees are more suitable than before. Within a year after harvest, the open understory begins to produce an abundance of vegetation including coppice (stump) sprouts of the harvested trees. This provides an abundant foraging resource and provides bats with a high-quality foraging habitat. Oaks and hickories grow more slowly than aspen/birch and thus the stand fills in slowly and some of the residual is lost to wind events and entropy. These stands provide relatively low value roosting and foraging habitat when at pole stage, although a thinning or timber stand improvement (types of partial harvests) can both significantly increase the value for bats and increase the rate of growth in the remaining trees.

Shelterwood systems are also used to manage oak/hickory communities. Unlike a clear cut, the preparatory and seeding cuts (stages of the shelterwood system) leave a significant number of potential roost trees and can also result in damage (such as broken limbs) to the remaining trees. Thus, the stand increases in foraging quality, and roosting quality remains similar. In most cases, a final harvest (i.e., removal harvest) is completed and leaves the site for several years in a situation similar to a completed clear cut.

Many private landowners choose to either not harvest oak and hickory stands or do so using a technique known as a diameter-limit harvest. Both of these approaches eventually lead to the replacement of oak/hickory stands with later successional types such as beech/maple forest. These habits are valuable to bats but are not typically viewed as being as beneficial as oak hickory stands.

Pine Plantations

Pine plantations are a forestry practice whereby a stand often contains a single species of pine, and in the Lake States the common plantation species are red and jack pine. At the time of harvest

(approximately 50 to 90 years), pine plantations typically consist of trees that are large and relatively healthy. Trees are typically of a single height class. The stands have a nearly continuous canopy, but the level of understory clutter and roosting potential differs between species and sites.

At final harvest, the understory of a red pine is typically open, and allows foraging bats to fly through the understory and provides a substantial air/vegetation interface for foraging bats. Bark and cavity roosting bats are restricted to using the few trees that have died or been damaged by weather events, whereas, foliage roosting bats (such as the tricolored bat) can select a number of shaded locations. At the time of harvest a typical stand of red pine provides low to moderate quality foraging habitat and very low-quality roosting habitat.

Jack pine, conversely, retain lower branches long after they are dead. The result is a thick layer of dead limbs that limits the ability of bats to forage in the area but provides an abundance of locations for individual bats to roost. At the time of harvest a typical stand of jack pine provides very low-quality foraging habitat and low-quality roosting habitat for bats.

Harvesting of pine plantations occurs via a series of predictable steps. The final of this is usually a clear cut (i.e., final harvest). The resulting open stand creates a substantial edge for the foraging bats, which may also access the surrounding stands via the remaining forest roads. After replanting, the former clear cut begins to fill in with young healthy trees that provide no roosting habitat for bark and cavity roosting bats, and limited opportunities for foliage roosting bats. Larger trees (especially if damaged during harvest) of the adjacent stands have higher solar exposure and may provide high quality roosts. Foraging habitat remains high along the borders and bats will forage in between the regenerating trees as long as there is space between the rows. As the woodland reaches pole stage it provides little habitat for bats. Thinning, especially the third row approach that is common in red pine stands (Tibbels and Kurta 2003), can reopen the understory and leads to a significant increase in foraging activity by the covered bats a few trees damaged during the thinning process may provide limited roosting habitat. Within several years the stand returns to its mature condition.

Aspen/Birch

Like pine plantations, aspen/birch stands are often harvested using clear cuts (i.e., final harvests), are harvested at a young age, and are not typically thinned. At the time of harvest these stands are densely packed with most trees being healthy which allows high volumes of commercially viable trees to be obtained on relatively short rotations. Older aspen are prone to cavity formation. A few trees develop cavities early and broken trees are common especially in regions with extensive snowfall. As such, an aspen stand does provide some potential roosts and low-quality foraging habitat. Unlike pine plantation, aspen/birch regenerate rapidly following harvest, and those trees with potential roosts are often part of the residual. A newly harvested aspen stand provides high quality foraging habitat along its margins and, especially for those stands that grow on moist sites where aquatic insects can thrive. Even the center of the clear cut is likely to be used by foraging little brown and tricolored bats. Within and along the borders of harvested stands are trees left as part of the residual. These trees are now exposed to more sunlight and may have damage, making them potential roosts for all covered species. Aspen/birch stands fill in rapidly, and within 5 years foraging quality begins to diminish. By 20 years of age, an aspen/birch stand has little value for bats. This value increases only slightly until the stand is harvested again. Aspen/birch stands that are not harvested until later become more open with time and a greater proportion of trees in these stands

are hollow. The taller trees are also more likely to be used by tricolored bats. Thus, over-mature aspen/birch stands (and even individual trees) may provide hot spots of bat roosting habitat.

4.4.1.4 Summary of Habitat Effects of Timber Harvest

On a stand-by-stand basis, the indirect effects of timber harvest range widely and depend greatly on when the site is analyzed. At the landscape-level, forest management, including timber harvest, is likely to have a neutral effect on bats and bat habitat. However, the economic benefits of timber harvest also provide an incentive to retain forestland as forest, rather than converting it to non-forest uses including residential or, commercial development (Radeloff et al. 2005, Kobilinsky 2019, Miller et al. 2019). Taking this factor into account, timber harvest has a strong positive effect on bats and bat habitat.

4.4.2 Roads and Trails Maintenance and Use

While large roads with abundant traffic can have important negative impacts on bats and their habitat (Zurcher et al. 2010; Bennett et al. 2013), the small roads used in forestry are attractive to bats as they provide bats with the type of linear landscape element that serves as foraging and commuting corridors (Murray and Kurta 2004; Sparks et al. 2004; Menzel et al. 2005). In fact, small roads are considered important enough that USFWS recommends their use as trapping locations during presence/absence surveys (Brown and Brack 2003; Kiser and MacGregor 2004; U.S. Fish and Wildlife Service 2016c). As a result, the small roads built and maintained under this HCP are expected to provide a long-term positive benefit to bats.

4.4.3 Prescribed Fire

The use of fire to manage vegetation and wildlife dates to pre-settlement times, when native people routinely used fire to manage both wildlife and their habitats (Trefethen 1975). Modern prescribed fires in the Lake States are primarily used to 1) maintain or restore fire-dependent communities, and 2) remove leftover debris following harvest. It is also used as silvicultural tool, especially in oak management. A number of studies have addressed potential effects of fire on bat species and their habitat (Carter et al. 2000; Boyles and Aubrey 2006; Dickinson et al. 2009; Lacki et al. 2009; Dickinson et al. 2010; Johnson et al. 2010; Johnson et al. 2012; Zuckerberg et al. 2012). The broad consensus among the authors of these studies is that prescribed fire is a tool that can greatly improve habitat for bats, but one that bears a risk (although relatively low) of wounding or killing individual bats.

The effects of prescribed fire on habitat are difficult to predict due to the multitude of variables surrounding the characteristics of a single fire, fire regimes, and environmental conditions across time and space. All components of an ecosystem could be affected either by direct exposure to a fire's flames or through interactions with the changed environment as a site recovers from fire. Regarding bat habitat, effects from prescribed fires include facilitation of foraging from reduced clutter, increased roost availability, and increased prey productivity. Opening the understory reduces clutter around roost trees, improving the microclimate, and improving travel and foraging conditions. Early pole stands and shrub-scrub habitats are usually too cluttered for Indiana bats to forage in, but prescribed fire can open these habitats to allow bats to access the habitat. Without periodic fire, forests understories can become dominated by shrubs and saplings, resulting in a cluttered forest that inhibits bat movement and foraging.

Prescribed fires can create roost trees by immediately killing a tree that remains standing or from trees that continue to succumb to fire damage up to a decade after the fire. Intentional use of prescribed fire can also increase regeneration of oaks, hickories, and other species of trees used as roosts.

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 could lead to higher quality and quantity of insect prey. In one of the studies (Lacki et al. 2009) where bats likely switched roosts during a prescribed fire, these same bats preferentially foraged in burned areas after the fire. Several studies have documented extensive use of burned areas by cavity and bark roosting bats, including the Indiana bat (Boyles and Aubrey 2006; Dickinson et al. 2009; Lacki et al. 2009; Johnson et al. 2010, 2012).

These observations indicate that the continued use of prescribed fire in the Lake States is expected to provide a substantial habitat benefit despite the relatively small amount of forest that is burned.

4.5 Direct and Indirect Effects Summary

Direct effects on habitat must be considered in light of 1) the relatively small portion of the landscape that is manipulated every year, 2) the fact that many of the covered activities occur when bats are hibernating, 3) intensively managed stands are often of limited value for bats, and 4) the ability of forest to regenerate following harvest. These effects are summarized in Table 4-26.

Due in large part to the small amount of land that is harvested during the active season and the current low populations of bats, very few bats are expected to be directly affected by forestry practices each year (Tables 4-5 through 4-9, 4-13 through 4-16, and 4-20 through 4-23). Direct effects on individual bats are relatively minor (mortality often approximating 0.01% of the current population during a year); less than 1% of the bats are harmed per year. Areas where mortality and disturbance are concentrated include the Fall/Spring habitat, especially in the Upper Peninsula of Michigan, where approximately half the bats are thought to hibernate. A second area of potential concern is the band of Summer habitat that connects the three major little brown hibernacula of Wisconsin. These mines contain the majority of the tricolored bats that occur in the covered lands.

Indirect effects range from neutral in the case of timber harvest to highly beneficial in the case of prescribed fire.

Table 4-26. Summary of Direct Annual Effects Associated with Activity on All Covered Lands[a] by State

States and Bats	Timber Harvest				Prescribed Fire				All Impacts	
	Acres Harvested/Year		Bats Impacted/Year		Acres Burned		Bats Impacted		Bats Impacted	
	Total Acres[b]	While Bats Present[c]	Killed[d]	Disturbed[d]	All Fires[e]	Forest[e]	Killed[e]	Disturbed[e]	Killed	Disturbed
Michigan										
Indiana										
Annual	176,378	7,154	0.04	0.88	8,400	3,100	<0.01	0.01	< 1	1
50 Years	8,818,920	357,677	2.10	44.24	420,000	155,000	0.04	0.70	2	45
Northern Long-Eared										
Annual	176,378	37,436	1.93	50.14	8,400	3,100	0.04	0.80	2	51
50 Years	8,818,920	1,871,779	96.33	2,506.79	420,000	155,000	2.00	39.92	98	2,547
Little Brown										
Annual	176,378	27,665	7.48	235.59	8,400	3,100	0.16	3.76	8	239
50 Years	8,818,920	1,383,230	374.19	11,779.47	420,000	155,000	7.77	187.82	382	11,967
Tricolored										
Annual	176,378	22,435	<0.01	0.05	8,400	3,100	<0.01	<0.01	< 1	< 1
50 Years	8,818,920	1,121,772	0.13	2.69	420,000	155,000	<0.01	0.04	< 1	3
Minnesota										
Northern Long-Eared										
Annual	138,131	13,462	0.65	12.86	38,241	7,120	0.04	0.56	1	13
50 Years	6,906,535	673,119	32.56	643.16	1,912,050	356,000	1.78	27.92	34	671
Little Brown										
Annual	138,131	13,223	1.29	21.49	38,241	7,120	0.07	0.93	1	22
50 Years	6,906,535	661,136	64.55	1,074.30	1,912,050	356,000	3.52	46.59	68	1,121
Tricolored										
Annual	138,131	8,518	0.01	0.17	38,241	7,120	<0.01	0.01	< 1	< 1
50 Years	6,906,535	425,906	0.54	8.50	1,912,050	356,000	0.03	0.37	1	14

States and Bats	Timber Harvest				Prescribed Fire				All Impacts	
	Acres Harvested/Year		Bats Impacted/Year		Acres Burned		Bats Impacted		Bats Impacted	
	Total Acres[b]	While Bats Present[c]	Killed[d]	Disturbed[d]	All Fires[e]	Forest[e]	Killed[e]	Disturbed[e]	Killed	Disturbed
Wisconsin										
Northern Long-Eared										
Annual	160,891	34,977	0.35	9.20	30,800	5,250	0.02	0.29	< 1	9
50 Years	8,044,574	1,748,870	17.27	460.08	1,540,000	262,500	0.82	14.25	18	474
Little Brown										
Annual	160,891	34,733	5.30	162.46	30,800	5,250	0.25	5.05	6	168
50 Years	8,044,574	1,736,665	265.07	8,123.22	1,540,000	262,500	12.54	252.51	278	8,376
Tricolored										
Annual	160,891	16,892	0.06	1.17	30,800	5,250	<0.01	0.04	< 1	1
50 Years	8,044,574	844,575	2.77	58.45	1,540,000	262,500	0.13	1.80	3	60
Lake States Total										
Indiana										
Annual	176,378	7,154	0.04	0.88	8,400	3,100	<0.01	0.01	**< 1**	**1**
% Regional Population	-	-	0.01%	0.28%	-	-	<0.01%	<0.01%	**0.01%**	**0.28%**
50 Years	8,818,920	357,677	2.10	44.24	420,000	155,000	0.04	0.70	**2**	**45**
Northern Long-Eared										
Annual	475,401	85,875	2.92	72.20	77,441	15,470	0.09	1.64	**3**	**74**
% Regional Population	-	-	0.01%	0.33%	-	-	<0.01%	0.01%	**0.01%**	**0.34%**
50 Years	23,770,029	4,293,767	146.15	3,610.03	3,872,050	773,500	4.59	82.09	**151**	**3,692**
Little Brown										
Annual	475,401	75,621	14.08	419.54	77,441	15,470	0.48	9.74	**15**	**429**
% Regional Population	-	-	0.01%	0.29%	-	-	<0.01%	0.01%	**0.01%**	**0.30%**
50 Years	23,770,029	3,781,031	703.82	20,977.0	3,872,050	773,500	23.84	486.92	**728**	**21,464**
Tricolored										
Annual	475,401	47,845	0.07	1.39	77,441	15,470	<0.01	0.04	**< 1**	**2**
% Regional Population	-	-	0.02%	0.41%	-	-	<0.01%	0.01%	**0.02%**	**0.45%**
50 Years	23,770,029	2,392,253	3.44	69.65	3,872,050	773,500	0.16	2.21	**4**	**77**

[a] All covered lands includes DNR, county and municipal, and private lands.

[b] A sum of harvest in high-quality and low-quality habitats for all landowner categories. DNR total acres of harvest can be found in Tables 2-6 (Michigan), 2-11 (Minnesota), and 2-17 (Wisconsin). Total acres of harvest on other lands based on FIA data can be found in Tables 2-8 (Michigan), 2-13 (Minnesota), and 2-19 (Wisconsin). These numbers were then adjusted to account for spatial conversion. Seasonal harvest numbers for Michigan came from Tables 4-1 through 4-4, for Minnesota from Tables 4-10 through 4-12, and for Wisconsin from Tables 4-17 through 4-19. Annual totals for seasonal habitat harvested are adjusted to account for geographical overlap between Winter, Fall/Spring, and Summer habitats (e.g., not double counting acres that are both Fall/Spring and Summer Habitat).

[c] A sum of all harvest in high-quality and low-quality habitats when bats are present. Seasonal harvest numbers for Michigan came from Tables 4-5 through 4-8, for Minnesota from Tables 4-13 through 4-15, and for Wisconsin from Tables 4-20 through 4-22.

[d] A sum of impacts across DNR, county and municipal, and private lands for Michigan (Tables 4-5 through 4-8), Minnesota (Tables 4-13 through 4-15), and Wisconsin (Tables 4-20 through 4-22).

[e] Based on the total anticipated amount of prescribed fire on all covered lands for all landcover types (All Fires) and amount limited to forest/brushland landcover types (Forest). Acres burned and bats impacted values found in Tables 4-9 (Michigan), 4-16 (Minnesota), and 4-23 (Wisconsin).

4.6 Cumulative Effects

Cumulative effects as defined in the revised HCP Handbook are the effects of future state or private activities, not involving federal activities that are reasonably certain to occur within the plan area. A discussion of cumulative effects is not a required component of an HCP but rather facilitates the internal Section 7 consultation the USFWS will conduct. This discussion is distinct from the NEPA analysis of cumulative effects in that it focuses on state or private activities and excludes activities with a federal nexus. Cumulative effects are human activities that when considered collectively may affect the covered species in a significant way. Disease, climate change, and naturally occurring events are not considered as part of the cumulative effects analysis.

4.6.1 Impacts on Individual Bats

Incidental mortality at wind energy facilities and incidental mortality due to timber management not permitted under this HCP are nonfederal actions with the potential to cumulatively affect bat individuals.

4.6.1.1 Wind Energy Development

The Lake States are highly conducive to the development of wind energy. Unfortunately, bats are killed at nearly every wind energy facility. As a result of this incidental mortality, USFWS has worked with those who develop, own, and operate wind energy facilities to develop the proposed Midwest Wind Energy HCP (MWEHCP). The proposed MWEHCP covers eight states including Michigan, Minnesota, and Wisconsin, and surrounding states. Given that some bats winter in the Lake States and summer in surrounding states and vice versa, it is important to understand these impacts at a region-wide scale.

The proposed MWEHCP addresses incidental take of six species including the Indiana bat, the northern long-eared bat, and the little brown bat. Coverage for this proposed HCP is based on existing and expected future wind energy developments in the region, with the permit tied to the amount of energy produced (in megawatts [MW]), which is the currency of electricity and allows comparison between different turbine designs. A typical wind turbine in the Lake States is rated to produce between 1.5 and 2 MW of power. Region-wide, the plan can include up to 51,004 MW of capacity (approximately 26,000 turbines). Based on current trends, most development is expected to occur on existing agricultural lands with only limited loss of forest expected. Over the proposed 45-year permit term, it is estimated in the public draft of the proposed Midwest Wind HCP that wind energy in the Midwest will result in the mortality of 16,822 Indiana bats, 9,753 northern long-eared bats, and 440,830 little brown bats.

Within the Lake States over the proposed life of the permit, it is estimated that Michigan will be home to 727 MW of new development on 44,643 acres of land; Minnesota will develop 2,030 MW of power on 124,657 acres; and 2,457 MW on 15,879 acres in Wisconsin. It is important to note that these impact estimates are based on 1) the best available science as to how much wind energy will be developed (i.e., extrapolations of current development patters), 2) the levels of mortality prior to the implementation of conservation measures, and 3) with the exception in the southern Michigan (where Indiana bats occur) these impacts are not currently illegal because take of northern long-

eared bats is covered by the 4(d) rule and no ESA protections currently exist for little brown or tricolored bats.

Through the implementation of conservation measures included in the Midwest Wind HCP, mortality of all bat species is expected to be reduced by 50%. The HCP precludes construction of facilities within areas of the Midwest where large numbers of bats congregate (such as major hibernacula, near woodlands used by summer colonies of bats, along large rivers, and along the shores of the Great Lakes). The plan also requires the implementation of curtailment measures that reduce mortality by preventing wind turbines from spinning during the low wind conditions when bats are most at risk. Some level of mortality will occur, and this will be offset by the creation and management of habitat with the intent of producing replacement bats. Thus, the plan is expected to be population neutral for those wind farms that are covered under the plan. It is also important to note that it is not mandatory for wind farms to join the proposed MWEHCP.

Erickson et al. (2016) provided examples of the scenarios where WNS-induced mortality associated with high mortality at wind energy sites near hibernacula created a cumulative effect on one of the covered species (Indiana bat). This cumulative effect was realized both in a greater potential for extinction and in different patterns of regional extinction. Such scenarios would be increased by adding a third stressor (i.e., forest management) if it was truly a new effect. The models created by Erickson et al. (2016) were created without regard to the conservation measures contained in the MWEHCP. By preventing the construction of wind turbines near key hibernacula and near known summering areas the chances of a cumulative effect are greatly reduced even without accounting for the positive effects of mitigation. Successful mitigation of losses due to wind mortality would greatly reduce the potential for a cumulative interaction between wind energy and WNS.

Mortality of covered bats due to forest management was not specifically included as component of the models prepared by Erickson et al. (2016), but forest management activities are ongoing in the Lake States and, thus, were part of the population baseline used in each of the models. It is important to note that the MWEHCP and the Lake States HCP address ongoing activities, most of which currently face little regulatory scrutiny in terms of their impact on bats. WNS is an ongoing disease that is not subject to regulation.

4.6.1.2 Current Forest Management Efforts

The analyses provided in Section 4.3, *Direct Effects,* are based on the best understanding of impacts of current forest management efforts in the Lake States. Not all private landowners are anticipated to opt in to the Lake States HCP via a certificate of inclusion. As such some level of forest management activities will occur in the plan area but will not be addressed by the current HCP. Estimating this level of enrollment is not currently possible. Enrollment in the HCP means that landowners will commit to conservation measures for covered bats. As such, every additional acre that is enrolled decreases the potential for cumulative effects on individual bats.

4.6.2 Impacts on Habitat Used by Bats

All covered bats make use of forests and other land classes for both foraging and roosting when they are not hibernating. Major factors affecting the quantity and quality of forests in the Lake States include timber harvest, mineral extraction, and growth of towns and cities.

4.6.2.1 Timber Harvest

As discussed above, it is unlikely that all private landowners will participate in the Lake States HCP through a certificate of inclusion, and some forest management activities will occur in the plan area but will not be covered by the Plan. Estimating this level of enrollment is not possible at this time. As these private landowners could elect to conduct clear cuts or convert their forestland to non-forest uses over the permit term, timber harvest not covered by the HCP has the potential to decrease or fragment forested habitat used by bats.

4.6.2.2 Mineral Extraction

The Lake States have a long history of mining and mineral extraction. All three states maintain limited levels of metallurgical mining (including efforts to extract minerals from discarded tailings). Iron, in the form of taconite, continues to be an important product from Minnesota, but is also mined in Michigan and Wisconsin. Sand and gravel pits are relatively common, and sand from Wisconsin is a critical component to the process of hydraulic fracturing that is being used to release oil and gas reserves throughout the United States. Despite its importance in extracting hydrocarbons, Wisconsin has no active oil, gas, or coal fields (U.S. Energy Information Administration 2017a). Likewise, Minnesota has no active hydrocarbon production (U.S. Energy Information Administration 2017b) Michigan has historically been an important producer of oil, gas, and coal (U.S. Energy Information Administration 2017c). Coal production has ceased, and oil and gas production has greatly decreased, but active wells are scattered throughout the Michigan basin and the Antrim field remains one of the nation's most important regions of natural gas extraction. All three states play critical roles in the transport and consumption of fossil fuels as pipelines, railroads, and ports along both the Great Lakes and Mississippi River provide transport to outside markets.

The scattered nature of these developments and compliance efforts associated with existing environmental laws reduce the potential for cumulative effects. A possible exception is when the DNR owns surface rights above extractable minerals (including oil and gas).

4.6.2.3 Growth of Towns and Cities

As development encroaches on forest lands it brings within it a series of challenges including an increased risk from fire at the wildland/urban interface, exotic pest infestations, unmanaged outdoor recreation, and forest fragmentation (Novak and Walton 2005). These challenges also affect the bats living in these forests, but these effects differ by species.

How Development Impacts Bats

The most obvious effect of development is the removal of forest that provides roosting habitat. However, there is limited data to support the contention that bats are unable to roost in/near developed areas. Northern long-eared bats are able to survive in very small woodlands found within suburban environments (Whitaker et al. 2004). Little brown bats are known to roost in anthropogenic structures (Kurta 2008), but are often lacking from the most developed areas (Whitaker et al. 2004).Indiana and tricolored bats are able to roost immediately adjacent to extensive developments (Whitaker et. al 2004; Helms 2009). Surprisingly, the most significant impact of urbanization on bats in the loss of foraging habitat through either direct conversion of by blocking the routes bats use to access such areas (Sparks et al. 2005, Sparks et al. 2009).

How Much Development is Occurring

Novak and Walton (2015) explored the impact of urbanization of U.S. Forests. Included in this paper is an estimate of the amount of forest within each state that will be impacted by urbanization between 2000 and 2050. According to these authors urbanization will affect 913,000, 277,000, and 325,000 acres of forests in Michigan, Minnesota, and Wisconsin respectively. Importantly, these authors are not suggesting that all such forests will be removed, as some are expected to become urban forests. Some of these forests will be lost, and this loss is a major reason why the authors predict a decline of forest cover is likely during the permit duration.

Where is Development Most Likely to Occur in the Lake States

Data from the United States Census Bureau (2016), indicates that population in the Lake States (Michigan 0.4 %, Minnesota 4.1%, and Wisconsin 1.6 % growth rates respectively) is increasing at lower levels than the national average of 4.7%. Population expansion in the Lake States is centered in select urban centers. Madison, Wisconsin experienced an increase in population of 6.8% since 2010. The Twin Cities of Minneapolis and Saint Paul in Minnesota has grown an estimated 7.4 and 5.5% respectively since 2010 (United States Census Bureau 2016). These metropolitan areas represent places where the limited existing forests may either be converted to landscapes that are less suitable for bats or that become urban forests that, with effort, can be successfully managed for bats (Sparks et al. 2009).

Impacts of the Lake States HCP

A goal of the Lake States HCP is to ensure that privately owned forests remain economically viable for timber production. Such economic value can play an important role in preventing deforestation. It is also notable that a key component of the HCP is the inclusion of county and municipal lands. As an increasing proportion of forest lands become embedded in urban communities, it becomes increasingly important to manage these resources in a manner that they maintain their value as bat habitat between harvests. Implementation of the conservation strategy will minimize the potential for a cumulative effect as these urban forests become less connected to other forested lands.

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