Forestry Habitat Conservation Plan for Bats

on Pennsylvania State Game Lands, State Forests, and State Parks

October 2020

PREPARED FOR:
Pennsylvania Game Commission and
Department of Conservation and Natural Resources

Forestry Habitat Conservation Plan for Bats on Pennsylvania State Game Lands, State Forests, and State Parks

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Acronyms and Abbreviations

°F	degrees Fahrenheit
ATV	all-terrain vehicle
AUC	area under the curve
BA	biological assessment
BO	biological opinion
CFR	Code of Federal Regulations
CWA	Clean Water Act
DCNR	Department of Conservation and Natural Resources
DEP	Department of Environmental Protection
EA	environmental assessment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FR	*Federal Register*
HCP	habitat conservation plan
GIS	geographic information systems
ITP	incidental take permit
MBTA	Migratory Bird Treaty Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRHP	*National Register of Historic Places*
PGC	Pennsylvania Game Commission
PNHP	Pennsylvania Natural Heritage Program
ROC	receiver operator characteristic
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
WNS	white-nose syndrome

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Executive Summary

ES.1 Overview

The Pennsylvania Game Commission (PGC) and the Pennsylvania Department of Conservation and Natural Resources (DCNR) have developed this habitat conservation plan (HCP) to address the potential for forest management activities to cause incidental take of the federally endangered Indiana bat (*Myotis sodalis*) and the federally threatened northern long-eared bat (*Myotis septentrionalis*). This *Forestry Habitat Conservation Plan for Bats on Pennsylvania State Game Lands, State Forests, and State Parks* (State Lands Forestry HCP) provides the information necessary to obtain a federal incidental take permit (ITP) pursuant to Section 10(a)(1)(B) of the Endangered Species Act (ESA).

Forest management activities are used by both PGC and DCNR to create a shifting mosaic of forest of different size and age classes. This seral diversity enhances forest health and creates habitat for a variety of wildlife species (including bats). In addition, both PGC and DCNR have a constitutional mandate to ensure sustainable and diverse forest habitat conditions across the Commonwealth. While implementation of forest management activities has the potential to adversely affect listed bats at the site level (e.g., harvest activities could result in the removal of trees containing roosting bats), overall, PGC and DCNR forest management activities result in long-term habitat maintenance and the creation of forest conditions that are beneficial to bats. As a result, PGC and DCNR seek to avoid, minimize, and mitigate for potential site-level effects on bats while continuing to manage forests to provide long-term habitat benefits for bats and other wildlife. The U.S. Fish and Wildlife Service (USFWS) has advised that, under certain circumstances, state forest management practices and other related PGC and DCNR activities have the potential to incidentally take Indiana bats and northern long-eared bats. To provide for the continuance of these activities while minimizing the potential for take of Indiana bats and northern long-eared bats, PGC and DCNR have developed the State Lands Forestry HCP.

ES.2 Plan Area and Permit Area

PGC manages 1.5 million acres of State Game Lands, and DCNR manages 2.2 million acres of State Forests and approximately 300,000 acres of State Parks. These 4 million acres of largely forested lands (collectively referred to as the State Lands) provide potential foraging, roosting, maternity colony, and fall swarming habitat for all bat species in Pennsylvania, including the Indiana bat and the northern long-eared bat.

This HCP covers activities on all lands owned and managed by PGC and DCNR. This area is defined as the permit area. All conservation actions, effects, and monitoring will take place in the permit area. However, the lands owned by PGC and DCNR will shift slightly over time as new lands are acquired and small areas are disposed of. The intent of this HCP is to cover all lands owned or managed by PGC and DCNR during the permit term, including future lands. To account for these changes, this HCP defines the plan area as the entire State of Pennsylvania.

ES.3 Covered Species

As noted, PGC and DCNR are requesting incidental take coverage for Indiana bats and northern long-eared bats for forest management practices and other related activities. Several other federal species of concern were considered for inclusion in the State Lands Forestry HCP. To be covered, a species had to meet all of the following five criteria.

- **Occurrence.** The species must be known to occur or likely to occur on State Lands.
- **Status.** The species must be currently listed, proposed for listing, or a candidate species under the ESA.
- **Effect.** Covered activities must have the potential to result in incidental take of the species.
- **Data.** Sufficient data must exist on the species' life history and habitat requirements to evaluate effects and develop conservation measures to mitigate these effects to regulatory standards.
- **Distribution.** The distribution of the species and the potential effects likely to result from covered activities must be well suited for coverage in a statewide programmatic HCP.

Using these criteria, PGC and DCNR evaluated 17 federal species of concern in addition to Indiana bats and northern long-eared bats (Appendix A, *Species Evaluation*). Because Indiana bats and northern long-eared bats are the only species evaluated to meet all five criteria, these are the only species selected for inclusion in the State Lands Forestry HCP.

ES.4 Permit Term

PGC and DCNR are seeking a 30-year permit from USFWS. All assessments in the State Lands Forestry HCP are therefore based on a 30-year period. The permit term of 30 years was selected because it provides a foreseeable planning horizon for covered activities and for the full implementation and evaluation of the conservation strategy, including monitoring and adaptive management. In addition, 30 years allows PGC and DCNR to complete a sufficient assessment of the effects of the proposed forest management activities on Indiana bats and northern long-eared bats and allows for the tracking of resource responses to climate change and the implementation of management actions. Before the permit expires, PGC and DCNR could apply to renew or amend the State Lands Forestry HCP and to extend its associated permit.

ES.5 Covered Activities

The primary goal of the State Lands Forestry HCP is to obtain authorization for incidental take of Indiana bats and northern long-eared bats under the ESA for specific activities, called *covered activities,* as administered by PGC and DCNR. These covered activities include timber harvest; operations (fencing and firewood collection); road and trail construction, maintenance, and use; prescribed fire; and implementation of the conservation program. Fencing is associated with forestry practices because its installation and maintenance could require tree cutting. In addition, fences on State Lands are often used to exclude white-tailed deer from areas where forest regeneration is in progress. Firewood collection also involves tree cutting, because DCNR designates hazardous dead or live trees along public roads in State Forests and State Parks that may be cut for firewood. Road and trail construction provides access to State Lands for forestry activities. Road and trail maintenance is performed as needed to prevent deterioration of the road system and to maintain road use for PGC and DCNR staff, timber operators, contractors, and visitors on State Lands. Prescribed fire is an important forest management practice aimed at removing unwanted species and promoting the regeneration of tree species.

This HCP is focused on forestry and forestry-related activities because these activities enable PGC and DCNR to meet multiple objectives, including the improvement of habitat for wildlife, enhancement of recreational opportunities, the maintenance of healthy and safe forests, and economic contributions toward the respective programs and goals of each agency. This HCP does not address other activities on State Lands, such as oil and gas development, coal mining, and renewable energy development. These activities undergo their own environmental compliance process, separately from timber operations, that includes ESA compliance. Although some of these activities do result in tree cutting, often the clearing is permanent (i.e., vegetation conversion) and represents fundamentally different activities from those covered by this HCP.

ES.6 Conservation Program

The conservation program for the State Forestry Lands HCP is designed to avoid, minimize, and mitigate effects on Indiana bats and northern long-eared bats. The conservation program is based on a set of biological goals and objectives developed specifically for this HCP. Conservation measures were then identified to achieve these goals and objectives.

Both timber harvest and prescribed fire can have long-term beneficial effects on bat habitat by decreasing tree clutter and inducing successional patterns that lead to high-quality roosting and foraging habitat for bats. In particular, prescribed fire can facilitate the development of roosting habitat by increasing roost availability and solar exposure. Relative to taking no action (that is, allowing succession to continue naturally across State Lands), implementing the covered activities will improve foraging habitat and roosting habitat for bats over the long term (Table 5-1, *Summary of Annual Acres of Indirect Effects for Indiana and Northern Long-Eared Bats*).

Because covered bat species are not habitat-limited, and because timber harvest and prescribed fire will continue to create a substantial amount of high-quality habitat for both species over the permit term, the conservation program is focused on retaining these beneficial activities across State Lands and on reducing the limited amount of disturbance and mortality to individuals associated with covered activities. The program is structured to rely primarily on avoidance, followed by minimization, then mitigation for unavoidable effects.

ES.7 Monitoring and Adaptive Management

Adaptive management is a decision-making process promoting flexible management that can be adjusted as uncertainties become better understood or as conditions change. Monitoring the outcomes of management actions is the foundation of an adaptive approach.

The State Lands Forestry HCP includes two principal types of monitoring: compliance monitoring and effectiveness monitoring. Compliance monitoring tracks the status of HCP implementation and documents that the requirements of the State Lands Forestry HCP are being met. Effectiveness monitoring assesses the biological success of the State Lands Forestry HCP by measuring the fulfillment of the biological goals and objectives.

Adaptive management will combine monitoring results with advances in conservation science, potential changing environmental conditions (e.g., shifts in conditions driven by climate change), and unexpected changes to Indiana bat and northern long-eared bat status to improve management over the permit term.

ES.8 Implementation

The State Lands Forestry HCP will be jointly implemented by PGC and DCNR, which share the responsibility for executing the requirements of the HCP. PGC will assign an employee to serve as the HCP administrator. This staff member will be responsible for managing the implementation of the State Lands Forestry HCP and coordinating the work of staff and consultants responsible for implementing the conservation program (to include monitoring, reporting, and adaptive management). While PGC will be the lead agency for administration, day-to-day implementation of the State Lands Forestry HCP will be managed collectively by both PGC and DCNR staff. PGC and DCNR staff include scientists, administrators, biologists, foresters, and other natural resource specialists that carry out planning and design, monitoring, adaptive management programs, and periodic coordination with USFWS.

USFWS is the regulatory agency that issues the federal permit for incidental take and that will oversee implementation of the State Lands Forestry HCP. PGC and DCNR will continue to engage USFWS as specified in the HCP and will coordinate with USFWS quarterly.

While no formal scientific review committee will be established, PGC and DCNR will consult with outside scientists to get advice on issues related to habitat management and monitoring (e.g., the PGC Technical Advisory Committee on Mammals), as needed. PGC and DCNR will also solicit input from stakeholders with an interest in the State Lands Forestry HCP and will present an annual update to all interested parties on the status of HCP implementation.

ES.9 Cost and Funding

The direct cost to implement the State Lands Forestry HCP is estimated at approximately $10 million over the 30-year permit term, or approximately $338,190 annually (Chapter 7, *Cost and Funding*). Direct costs include program administration, conservation program implementation, monitoring, adaptive management, and changed circumstances.

PGC and DCNR are currently solvent and committed to funding the implementation of the State Lands Forestry HCP, including program administration and implementation of the conservation program.

Chapter 1
Introduction

1.1 Overview

The Commonwealth (State) of Pennsylvania manages state-owned lands for their natural resource values. The Pennsylvania Game Commission (PGC) manages 1.5 million acres of State Game Lands, and the Pennsylvania Department of Conservation and Natural Resources (DCNR) manages 2.2 million acres of State Forests and approximately 300,000 acres of State Parks. Collectively, the lands managed by PGC and DCNR are referred to as State Lands. These 4 million acres of largely forested lands provide potential foraging, roosting, maternity colony, and fall swarming habitat for all bat species in Pennsylvania, including the Indiana bat (*Myotis sodalis)*, federally listed as endangered, and the northern long-eared bat (*Myotis septentrionalis*), federally listed as threatened in April 2015.

Of these 4 million acres, PGC and DCNR actively conduct forest management on approximately 3.2 percent or 127,479 acres of State Lands annually[1]. Forest management activities on State Lands are used by both PGC and DCNR to create a shifting mosaic of forest of different size and age classes. This seral diversity enhances forest health and creates habitat for a variety of wildlife species (including bats). While implementation of forest management activities has the potential to adversely affect listed bats at the site level (e.g., harvest activities could result in the removal of trees containing roosting bats), overall, PGC and DCNR forest management activities result in long-term habitat maintenance and the creation of forest conditions that are beneficial to bats. As a result, PGC and DCNR seek to avoid, minimize, and mitigate for potential site-level effects on bats while continuing to manage forests to provide long-term habitat benefits for bats and other wildlife.

1.1.1 Background

The U.S. Fish and Wildlife Service (USFWS) has advised that, under certain circumstances, state forest management practices and other related PGC and DCNR activities have the potential to incidentally take Indiana bats and northern long-eared bats. To help land managers avoid impacts on Indiana bats, the Pennsylvania Field Office of the USFWS developed guidelines for forest management (*USFWS Forest Management Practices for Conserving Indiana Bats*, hereafter referred to as USFWS Forest Management Practices) (U.S. Fish and Wildlife Service undated). Similarly, prior to listing the northern long-eared bat as a threatened species under the Endangered Species Act (ESA), USFWS issued the *Northern Long-Eared Bat Interim Conference and Planning Guidance* in January 2014 (2014 Conference Guidance) (U.S. Fish and Wildlife Service 2014). The 2014 Conference Guidance provides recommendations on how to avoid impacts to northern long-eared bats.

Strict adherence by PGC and DCNR to the USFWS Forest Management Practices and 2014 Conference Guidance constrains PGC's and DCNR's ability to manage forests to promote habitat for bats and other wildlife. For example, some recommended seasonal restrictions on timber harvest and prescribed fire prohibit these activities during the only times of year when parts of the state are accessible to foresters, thereby effectively preventing these beneficial activities in these areas.

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[1] Data presented in Table 4-17 in Chapter 4, *Effects of Covered Activities*.

Similarly, some of the recommended canopy-retention guidelines for timber management inhibit the ability of PGC and DCNR to manage forests to promote wildlife habitat for bats and other species.

In addition, both PGC and DCNR have a constitutional mandate to ensure sustainable and diverse forest habitat conditions across the Commonwealth. As stated in Article I, Section 27 of the Pennsylvania Constitution:

> *The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.*

Both PGC and DCNR have specific legal mandates and missions that implement the Commonwealth's role as trustee of the state's natural resources. These mandates and missions are described below.

1.1.1.1 Pennsylvania Game Commission

Title 34 of Pennsylvania's Consolidated Statutes assigns its trust and control to PGC[2] and defines its role as follows:[3]

> *It shall be the duty of the Commission to protect, propagate, manage and preserve the game or wildlife of this Commonwealth and to enforce, by proper actions or proceedings, the laws of this Commonwealth relating thereto.*

PGC fulfills this mandate through its strategic goals and objectives, outlined in the 2015–2020 Strategic Plan (Pennsylvania Game Commission 2015).[4] PGC's core goals are stated as follows:

- Put wildlife first.
- Improve wildlife habitat.
- Follow sound business practices.
- Serve the Pennsylvania public.
- Improve support for hunting/trapping.

1.1.1.2 Department of Conservation and Natural Resources

DCNR's mission is to serve as Pennsylvania's leader in conservation and outdoor recreation and to inspire Pennsylvanians to value its natural resources, engage in conservation practices, and experience the outdoors (Pennsylvania Department of Conservation and Natural Resources 2013). As outlined in Title 18 of the Conservation and Natural Resources Act, DCNR is responsible for the following mandates:

- Maintain, improve, and preserve state parks.
- Manage state forest lands to ensure their long-term health, sustainability, and economic use.

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[2] 34 Pa.C.S. § 103, Ownership, jurisdiction and control of game and wildlife.

[3] 34 Pa.C.S. § 322, Powers and duties of commission.

[4] This is not intended to present a comprehensive list of PGC duties under the Game and Wildlife Code; rather, this list highlights duties relevant to this HCP.

- Provide information on Pennsylvania's ecological and geologic resources.
- Administer programs that will benefit rivers conservation, trails and greenways, local recreation, regional heritage conservation, and environmental education programs across Pennsylvania.

Fulfilling these mandates also includes taking measures to prevent, control, and extinguish forest fires; administer federal and state heritage conservation programs to enhance and promote natural, recreational, cultural, and scenic resources for heritage conservation, tourism, and economic development; and promote healthful outdoor recreation and education by making available for use natural areas of unusual scenic beauty, such as waterfalls, gorges, creeks, and caves (18 Pennsylvania Consolidated Statutes [Pa.C.S.] §§ 302, 303, 306).[5]

1.1.1.3 State Lands Forestry Habitat Conservation Plan

PGC and DCNR prepared this *Forestry Habitat Conservation Plan for Bats on Pennsylvania State Game Lands, State Forests, and State Parks* (abbreviated as State Lands Forestry HCP) to provide the information necessary to obtain a federal incidental take permit (ITP) pursuant to Section 10(a)(1)(B) of the ESA.

The overall goal of this State Lands Forestry HCP is to develop and implement a conservation plan that will accomplish the following objectives:

- Avoid, minimize, and mitigate for incidental take of Indiana bats and northern long-eared bats resulting from forest management and other related activities on State Lands.
- Accommodate current and future forest management activities on State Lands.
- For effects that cannot be avoided, provide the basis for take authorization pursuant to the federal ESA.
- Support state conservation goals such as those described in the Game and Wildlife Code, Conservation and Natural Resources Act, Wild Resource Conservation Act, Cave Protection Act, and other applicable state statutes and regulations.
- Identify targeted conservation efforts that can improve the value of State Lands for Indiana bats and northern long-eared bats and thus help stabilize and aid in the recovery of both species.

1.2 Scope of this State Lands Forestry HCP

This section introduces key elements of this State Lands Forestry HCP—covered activities, plan and permit area, permit term, and covered species.

1.2.1 Covered Activities

A primary goal of this State Lands Forestry HCP is to obtain authorization for incidental take of ESA-listed species for specific activities, called *covered activities*. This HCP is focused on forest

[5] Similarly, this is not intended to present a comprehensive list of DCNR duties under the Conservation and Natural Resources Act, but to highlight duties that are relevant to this HCP.

management activities, including timber harvest; forestry-related road and trail construction, maintenance, and use; fencing; firewood collection; and prescribed fire.

Chapter 2, *State Lands and Covered Activities*, provides a detailed description of these covered activities and describes the selection process used to evaluate activities for coverage.

1.2.2 Plan Area and Permit Area

This State Lands Forestry HCP covers activities on State Lands owned and/or managed by PGC and DCNR.[6] This area is defined as the *permit area*. All conservation actions, impacts, and monitoring will take place on State Lands and in the permit area. However, as described in Chapter 2, the lands owned by PGC and DCNR will shift slightly over time as new lands are acquired and small areas are disposed of. The intent of this HCP is to cover all lands owned by PGC and DCNR during the permit term, including future lands. To account for these changes, this HCP defines the *plan area* for this HCP as the entire State of Pennsylvania.

PGC currently manages 1.5 million acres of State Game Lands, and efforts are underway to expand this holding. State Game Lands account for approximately 9 percent of the forested area in the state; PGC manages those lands for recreation and wildlife habitat. Except for the urban areas surrounding the major metropolitan areas of Pittsburgh and Philadelphia, State Game Lands are present throughout Pennsylvania with the largest tracts in the north-central part of the state.

The 2.2 million acres of State Forests account for 12 percent of the forested area in the state. DCNR manages more than half (53 percent) of these lands for multiple uses, including commercial timber harvest (Pennsylvania Department of Conservation and Natural Resources 2007). Although State Forests are also present throughout the state, they are heavily concentrated in central Pennsylvania, particularly in Potter, Cameron, and Clinton Counties in north-central Pennsylvania.

DCNR also manages approximately 300,000 acres of State Parks to provide outdoor recreation and serve as outdoor classrooms for environmental education. These lands are also widely distributed throughout the state.

Chapter 2, *State Lands and Covered Activities*, and Chapter 3, *Environmental Setting*, provide more information about covered lands.

[6] Lands managed by PGC or DCNR but owned by federal agencies such as the U.S. Army Corps of Engineers are not covered by this HCP. Compliance with endangered species laws on those lands would be addressed separately through a consultation with USFWS under Section 7 of the ESA.

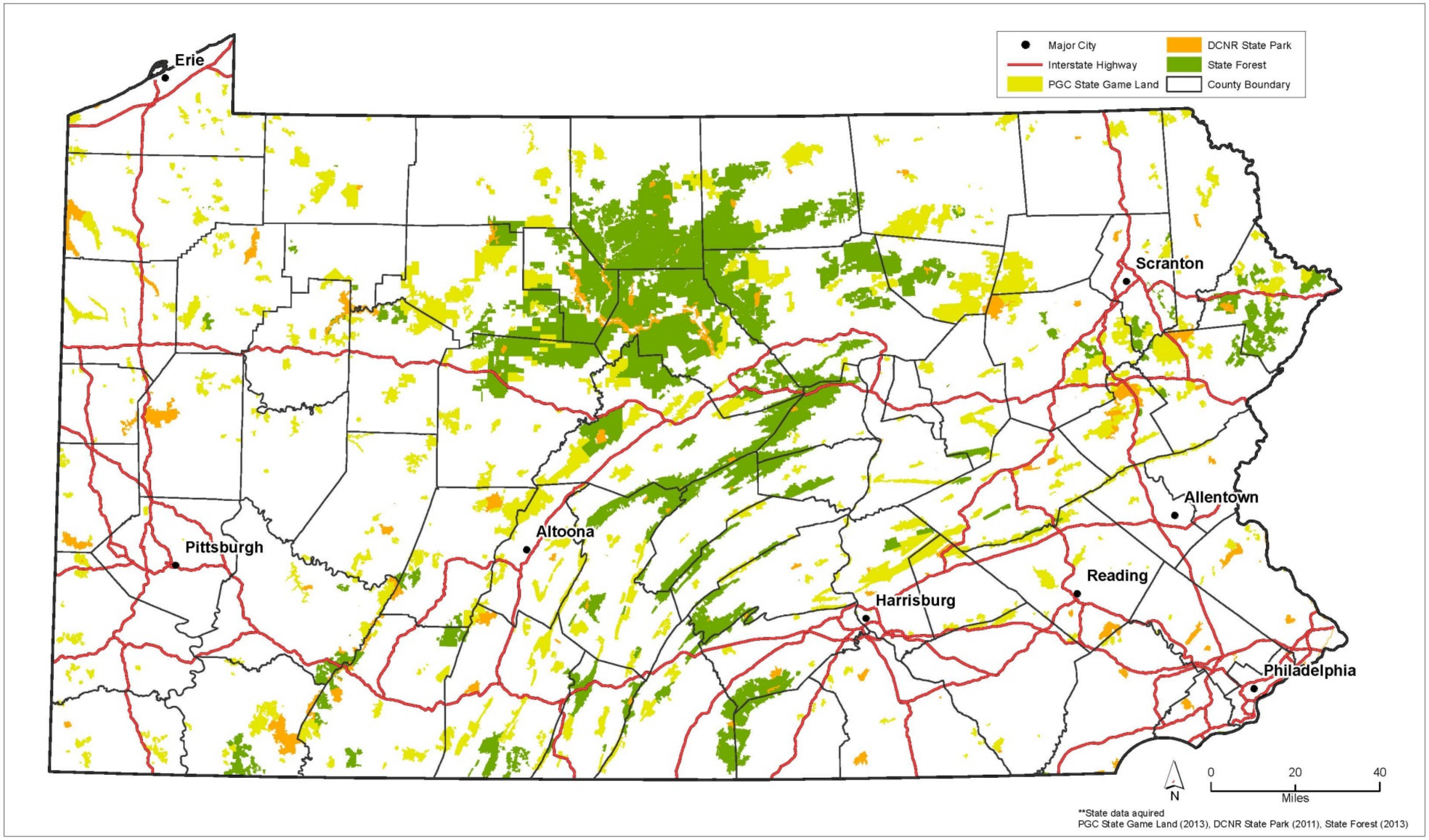

Figure 1-1. Plan Area (State of Pennsylvania) and Permit Area (State Game Lands, State Forests, State Parks)

1.2.3 Permit Term

PGC and DCNR are seeking a 30-year ITP from USFWS. All assessments in this State Lands Forestry HCP are therefore based on this 30-year period. The permit term of 30 years was selected because it provides a foreseeable planning horizon for covered activities and for the full implementation and evaluation of the conservation strategy, including monitoring and adaptive management. In addition, 30 years allows PGC and DCNR to complete a sufficient assessment of the impacts of the proposed forest management activities on Indiana bats and northern long-eared bats and allows the tracking of resource responses to climate change and the implementation of management actions. The requested permit term is based on the time needed for meaningful conservation, including the interpretation of new information and its integration into changes in forest management. PGC and DCNR originally considered a permit term longer than 30 years to better correspond to the typical rotation schedule of Pennsylvania forests. However, as described in Chapter 3, there is considerable uncertainty about how the primary threat to covered bat species, white-nose syndrome (WNS), may interact with covered activities. Therefore, PGC and DCNR have selected an intermediate permit term of 30 years coupled with robust changed circumstances provisions and adaptive management to account for these important unknown factors. Before the permit expires, PGC and DCNR could apply to renew or amend this HCP and the associated permit to extend its term.

1.2.4 Permittees

The permittees under the ITP are PGC and DCNR. PGC was created by the state legislature in the late 1800s to protect and conserve wildlife: it is a stand-alone agency within the state government of Pennsylvania (Pennsylvania Game Commission 2017). DCNR is a state agency established in 1995 by the Conservation and Natural Resources Act to conserve and sustain Pennsylvania's natural resources for present and future generations' use and enjoyment. Within DCNR, two bureaus manage DCNR-owned lands: the Bureau of Forestry, which manages State Forests, and the Bureau of State Parks, which manages State Parks. For the purposes of this State Lands Forestry HCP, the permittees are referred to as PGC and DCNR, although the text may specify DCNR's Bureau of Forestry or Bureau of State Parks when necessary.

PGC and DCNR will apply to USFWS to issue a single permit with both agencies as co-permittee with joint liability. PGC will be the main point of contact on behalf of both agencies; however, the agencies will jointly implement this HCP and the impact mitigation and avoidance measures that apply to each agency's lands. DCNR, as a co-permittee, will act through its Bureau of State Parks and Bureau of Forestry.

1.2.5 Covered Species

PGC and DCNR are requesting incidental take coverage for Indiana bats and northern long-eared bats for forest management activities. Other federally listed species in the plan area are not expected to be adversely affected by covered activities. For further rationale, see Appendix A, *Species Evaluation*.

1.2.5.1 Indiana Bat

The Indiana bat is a medium-sized, insectivorous bat found in an area roughly delineated by the Great Lakes to the north, Appalachian Mountains to the east, Ohio River to the south, and Great Plains to the west. In winter, Indiana bats hibernate in cool, humid limestone caves or abandoned mines (hibernacula); in summer, these bats roost under loose tree bark on dead or dying trees and forage for flying insects in uplands and along river and lake shorelines. Factors such as habitat loss and degradation, disturbance during hibernation, and environmental contamination contributed to the species' decline, and USFWS listed the species as endangered on March 11, 1967 (32 *Federal Register* [FR] 4001). In addition to these factors, WNS has emerged as a significant threat to Indiana bat populations, causing the mortality of thousands of hibernating Indiana bats since the disease was identified in winter 2006 (U.S. Fish and Wildlife Service 2009). In Pennsylvania, Indiana bats are found throughout the plan area.

Further details on the life history of the Indiana bat, its range in Pennsylvania, and its recovery status are presented in Chapter 3, *Environmental Setting*, and in Appendix B, *Species Accounts*.

1.2.5.2 Northern Long-Eared Bat

The northern long-eared bat is a medium-sized, insectivorous bat distinguished from other eastern species of *Myotis* by its long ears. The species ranges from eastern-most Quebec to Saskatchewan in Canada and south to the Florida Panhandle. Prior to the arrival of WNS, it was most prolific across heavily forested regions of Appalachia. In Pennsylvania, northern long-eared bats are found throughout the plan area, although they are less frequently captured on the Piedmont and Coastal Plain.

Northern long-eared bats are known to overwinter in caves, tunnels, and mines. They are typically found in small crevices (including broken stalactites) or cracks, or on cave or mine walls or ceilings, making them easy to overlook during population surveys. In summer, northern-long eared bats forage along forested hillsides and ridges and consume a varied diet that includes moths, flies, leafhoppers, arachnids, and beetles. More opportunistic in tree roost selection than other bat species, northern long-eared bats roost singly or in colonies underneath bark or in cavities and crevices of both live and dead trees. The species regularly makes use of bat boxes and occasionally is found in buildings and utility poles. Males and non-reproductive females may also roost in cooler caves and mines.

The predominant threat to northern long-eared bats is WNS; studies of northern-long eared bat populations in the northeastern United States have shown a 98 to 99 percent decline in the number of hibernating northern-long eared bats since the arrival of WNS. Other factors contributing to the northern long-eared bats' decline include modifications to bat hibernacula, anthropogenic disturbance of hibernating bats, and habitat loss and degradation.

Because of these threats, USFWS published a proposed rule to list the northern long-eared bat as endangered under the ESA on October 2, 2013 (78 FR 61046). USFWS subsequently revised this rule and published a final listing rule designating the species as threatened on April 2, 2015 (80 FR 17974). In addition to the final listing rule, USFWS established, and requested comments on, an interim Section 4(d) rule that would exempt certain activities, including forest management practices, from the take prohibition under Section 9 of the ESA. The final Section 4(d) rule for the northern long-eared bat was published on January 14, 2016 (81 FR 1900). This rule clarified that the ESA's take prohibitions for this species extend only to WNS-affected areas, and in those areas only under any one of the following conditions:

- Within known hibernacula.
- Within 0.25 mile of known hibernacula.

- If known and occupied maternity roosts are destroyed.
- If any tree within 150 feet of those occupied maternity roosts is destroyed.

As a result, any incidental take that may result from covered activities under this State Lands Forestry HCP would comply with the final Section 4(d) rule for this species.

Section 4(d) rules only apply to threatened species; therefore, these exemptions would no longer apply should the species subsequently be listed as endangered. As northern long-eared bats could be listed as endangered at some point during the 30-year permit term, the state agencies included this species for coverage under this HCP.

Further details on the life history of the northern long-eared bat, its range in Pennsylvania, and its recovery status are presented in Chapter 3, *Environmental Setting*, and in Appendix B, *Species Accounts*.

1.3 Regulatory Setting

USFWS issuance of an ITP under the ESA is subject to certain federal regulatory requirements associated with federal actions. Applicable state laws, guidelines, and mandates must also be addressed for wildlife species, including the Indiana bat and northern long-eared bat. This section describes the relevant and applicable laws and regulations.

1.3.1 Federal Laws

1.3.1.1 Endangered Species Act

In 1973, the federal government enacted the ESA (16 United States Code [U.S.C.] § 1531 *et seq*.). Congress intended to improve previous protective regulations by creating a more comprehensive approach that would protect not only individual species but also their habitats. For the first time, the ESA enunciated the intention of conserving the ecosystems on which endangered and threatened species depend, with a goal of restoring listed species to a demographic condition that would render the protections of the ESA unnecessary.

USFWS and the National Marine Fisheries Service (NMFS) jointly administer the ESA. The ESA requires USFWS and NMFS to maintain lists of threatened and endangered species and provides substantial protections for listed species. NMFS jurisdiction under the ESA is limited to marine mammals, marine fish, and anadromous fish; USFWS has jurisdiction over all other species. All terrestrial and freshwater species in Pennsylvania are subject to USFWS jurisdiction.

Section 9 of the ESA prohibits the take of any fish or wildlife species listed under the ESA as endangered and most species listed as threatened. USFWS may issue a special rule for threatened species, as it did for the northern long-eared bat, to prohibit a more narrow range of activities.

Exceptions to these prohibitions on take are addressed in Section 7 of the ESA (for federal actions) and Section 10 of the ESA (for nonfederal actions).

Section 7

Section 7 of the ESA requires all federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of habitat critical to such species' survival. To ensure that its actions do not result in jeopardy to listed species or adverse modification of designated critical habitat, each federal agency must consult with USFWS, NMFS, or both regarding federal agency actions. The consultation is initiated when the federal agency submits a written request for initiation of consultation to USFWS or NMFS, along with the agency's biological assessment of its proposed action. If USFWS and NMFS conclude that the action is not likely to adversely affect a listed species or its designated critical habitat, then the action may be carried forward without further review under the ESA. Otherwise, USFWS, NMFS, or both must prepare a written biological opinion describing how the agency's action will affect the listed species and its critical habitat.

If the biological opinion concludes that the proposed action would jeopardize the continued existence of a listed species or adversely modify its critical habitat, the opinion will suggest "reasonable and prudent alternatives" to the proposed action that would avoid that result, if any can be formulated. The biological opinion also would include an incidental take statement for the reasonable and prudent alternative. If the biological opinion concludes that the proposed action would involve the take of a listed species but not to an extent that would jeopardize the species' continued existence, the biological opinion also would include an incidental take statement if incidental take results from the proposed action. The incidental take statement must specify an amount of take that could occur as a result of the action and suggest reasonable and prudent measures to minimize the impact of the take.

Although this State Lands Forestry HCP constitutes a nonfederal project and, accordingly, must use the exemption provided under Section 10 of the ESA (described below), the USFWS issuance of an ITP is a federal action subject to the consultation process in Section 7 of the ESA. This federal action triggers an internal consultation whereby USFWS must prepare a biological opinion that addresses actions permitted under this HCP and their effects on listed species and critical habitat.

Section 10

In cases where there is no federal nexus (e.g., federal land, funding, or authorization) and activities by a nonfederal entity may result in incidental take of an ESA-listed species, the ESA allows USFWS and/or NMFS to authorize the take of listed species through the process defined in Section 10 of the ESA. Private landowners, corporations, state agencies, local agencies, and other nonfederal entities must obtain an ITP under Section 10(a)(1)(B) of the ESA for take of federally listed fish and wildlife species "that is incidental to, but not the purpose of, otherwise lawful activities." Because Section 9 of the ESA limits its definition of take for listed plants to lands under federal jurisdiction, Section 10 ITPs are only necessary for take of wildlife and fish species. Nonetheless, plants are often included in habitat conservation plans (HCPs) so that USFWS can make findings of no jeopardy when the Section 7 process is triggered.

To receive an ITP, the nonfederal entity is required to meet the issuance criteria laid out in the Department of the Interior regulations at 50 Code of Federal Regulations (CFR) §§ 17.22(b)(1)and (2):

> **(1) Application requirements for permits for incidental taking.** A person wishing to get a permit for an activity prohibited by § 17.21(c) submits an application for activities under this

paragraph. The Service provides Form 3-200 for the application to which all of the following must be attached:

(i) A complete description of the activity sought to be authorized;

(ii) The common and scientific names of the species sought to be covered by the permit, as well as the number, age, and sex of such species, if known;

(iii) A conservation plan that specifies:

(A) The impact that will likely result from such taking;

(B) What steps the applicant will take to monitor, minimize, and mitigate such impacts, the funding that will be available to implement such steps, and the procedures to be used to deal with unforeseen circumstances;

(C) What alternative actions to such taking the applicant considered and the reasons why such alternatives are not proposed to be utilized; and

(D) Such other measures that the Director may require as being necessary or appropriate for purposes of the plan.

(2) Issuance criteria.

(i) Upon receiving an application completed in accordance with paragraph (b)(1) of this section, the Director will decide whether or not a permit should be issued. The Director shall consider the general issuance criteria in § 13.21(b) of this subchapter, except for § 13.21(b)(4), and shall issue the permit if he or she finds that:

(A) The taking will be incidental;

(B) The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such takings;

(C) The applicant will ensure that adequate funding for the conservation plan and procedures to deal with unforeseen circumstances will be provided;

(D) The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild;

(E) The measures, if any, required under paragraph (b)(1)(iii)(D) of this section will be met; and

(F) He or she has received such other assurances as he or she may require that the plan will be implemented.

(ii) In making his or her decision, the Director shall also consider the anticipated duration and geographic scope of the applicant's planned activities, including the amount of listed species habitat that is involved and the degree to which listed species and their habitats are affected.

As mentioned previously, issuance of an ITP is a federal action and, as such, is subject to Section 7 consultation. Therefore, before it approves an HCP, USFWS is required to undertake an internal Section 7 consultation. USFWS evaluates the HCP to ensure that it accurately documents the expected impacts of its federal action (i.e., issuance of an ITP), appropriate avoidance and minimization measures are applied, the proposed mitigation compensates for those impacts, and other ITP issuance criteria are met.

1.3.1.2 National Environmental Policy Act

The National Environmental Policy Act (NEPA) (42 U.S.C. § 4332 *et seq*.) requires federal agencies to examine the environmental impacts of their actions and provide for public participation. Issuance of an ITP is a federal action subject to compliance with NEPA. To comply with NEPA, USFWS must conduct detailed analyses of all direct, indirect, and cumulative impacts of issuing the permit, as well as alternatives, on the human environment, not just on the covered species or resources. Here, USFWS has determined that permit issuance is unlikely to have a significant impact on the human environment, and therefore has decided to prepare an environmental assessment (EA). The EA provides a detailed evaluation of the effects of the federal action and alternatives to mitigate these effects. The draft EA will be made available for public review along with this draft State Lands Forestry HCP.

1.3.1.3 National Historic Preservation Act

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

In accordance with Section 101(b)(3) of the NHPA, the State Historic Preservation Officer (SHPO) has a specific consultative function in the Section 106 process and advises and assists federal agencies in carrying out their Section 106 responsibilities. The SHPO reflects the interests of the state and its citizens and advises the consultation process to help ensure that historic properties are considered throughout an undertaking’s planning and development. SHPO responsibilities include participating in consultation and reviewing an agency’s documentation and effect finding.

USFWS issuance of an ITP is a federal action subject to Section 106 of the NHPA. To comply with Section 106, USFWS will have to consider the effects of permit issuance on properties listed on or eligible for listing in the National Register.

1.3.2 State Laws

1.3.2.1 Pennsylvania Constitution

Article I, Section 27 of the Pennsylvania Constitution provides as follows:

> *The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania’s public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.*

This amendment, which was adopted in 1972, encompasses two basic principles. First, Pennsylvanians have a right to a decent environment; second, Pennsylvania government has a trusteeship responsibility to protect that environment on behalf of future generations.

1.3.2.2 Game and Wildlife Code

The Pennsylvania Game and Wildlife Code (34 Pa.C.S. §§ 2101, 2167, 2924, 925) establishes the powers and duties of PGC and sets forth Pennsylvania's endangered species provisions. Section 2101 gives PGC authority to administer and enforce the Game and Wildlife Code and all laws of Pennsylvania relating to the encouragement, promotion, and development of game or wildlife conservation interests and the protection, propagation, distribution, and control over game or wildlife.

Specifically, Section 2167 of the Game and Wildlife Code gives PGC the authority to add or remove any wild bird or wild animal native to Pennsylvania to or from the Pennsylvania native list of endangered or threatened species and establishes prohibitions and penalties on possession, transportation, capturing, killing, purchasing, sale, barter, or exchange of state-protected species. Section 2924 gives PGC the authority to issue permits for the importation, exportation, sale, exchange, taking, or possession of any birds or animals classified as endangered or threatened, and establishes prohibitions and penalties related to such permits. Section 925 outlines enforcement jurisdiction as well as fines and penalties for violations.

Section 133, Wildlife Classification, provides the list of birds and mammals classified as endangered and threatened in the state. The Indiana bat is classified as endangered and the northern long-eared bat as threatened under this section.[7] Section 137, Wildlife, makes it unlawful to import, possess, sell, offer for sale, or release protected species in the state.

1.3.2.3 Conservation and Natural Resources Act: Act 18

Act 18 created DCNR to manage Pennsylvania's parks, forests, rivers, trails, greenways, and community recreation and heritage conservation programs and to provide more focused management of the state's recreation, natural, and river environments. The primary mission of DCNR is to maintain, improve, and preserve State Parks; to manage State Forests to ensure their long-term health, sustainability, and economic use; to provide information on Pennsylvania's ecological and geologic resources; and to administer grant and technical assistance programs that will benefit river conservation, trails and greenways, local recreation, regional heritage conservation, and environmental education programs across Pennsylvania.

1.3.2.4 Wild Resource Conservation Act

The Wild Resource Conservation Act (32 Pa.C.S. §§ 5301–14) was enacted in 1982 to preserve and enhance flora and fauna species, including those that are rare or endangered in Pennsylvania. The act accomplishes this goal by establishing the Wild Resource Conservation Program, funded by the

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[7] While the northern long-eared bat is not explicitly listed under the Game and Wildlife Code, it is considered threatened in the state in accordance with Section 102 of the Game and Wildlife Code, which defines a threatened species as: "All species and subspecies of wildlife which have been declared by: (1) the Secretary of the United States Department of the Interior to be in such small numbers throughout their range that they may become endangered if their environment worsens and appear on a Threatened Species List published in the Federal Register."

Wild Resource Conservation Fund. Taxpayers support this fund through a check-off on state income tax return forms and the sale of Wild Resource license plates. The Wild Resource Conservation Board, comprising representatives of the Pennsylvania Fish and Boat Commission, PGC, and DCNR, selects and administers the projects and studies to be funded through the Wild Resource Conservation Program.

The act also directs DCNR to provide for the protection and management of wild plants in the state. DCNR regulations at 17 Pa.C.S. 45 (described in Section 1.3.2.6, *Conservation and Natural Resources Regulations—Title 17*) implement these provisions.

1.3.2.5 Cave Protection Act

The Cave Protection Act (32 Pa.C.S. §§ 5601–5607) protects cave environments in Pennsylvania to preserve their unique natural and cultural resources. Section 5605 makes it unlawful to kill, injure, disturb, or otherwise interfere with cave-roosting bats or to interfere with or obstruct the free movement of any cave life into or out of caves.

1.3.2.6 Conservation and Natural Resources Regulations—Title 17

State regulations under Title 17 of the Pennsylvania Code establish guidelines for activities and conduct in State Parks and State Forests. Section 17.1 provides for the designation of natural areas in State Parks with outstanding, unique, or sensitive resources that should be set aside for protection to ensure their continued quality for future generations. Sections 21.31 through 21.35 establish prohibitions and guidelines for removal of forest products in State Forests.

Chapter 45 of this title implements the Wild Resource Conservation Act by establishing provisions for the conservation of Pennsylvania native wild plants. These provisions include conducting investigations to determine the status of Pennsylvania wild plants; establishing a plant classification system; creating an enforcement system to protect endangered, threatened, and vulnerable wild plant species; creating procedures for wild plant management and trade in vulnerable plants; creating provisions for the establishment and designation of private wild plant sanctuaries; and establishing penalties for unlawful conduct pertaining to native wild plants.

1.4 Development of this State Lands Forestry HCP

This State Lands Forestry HCP was developed with input from several groups that provided technical advice and guidance, as described in the following sections.

1.4.1 Steering Committee

The Steering Committee has primary responsibility for making the decisions that led to development of this State Lands Forestry HCP. It is composed of key representatives from PGC and DCNR (Table 1-1); USFWS was also represented in Steering Committee meetings in an advisory capacity. The Steering Committee met quarterly to review draft materials and discuss the HCP development process. The committee used a consensus-based approach to make decisions about the overall development of this HCP.

Table 1-1. Participants in the Steering Committee[a]

Name	Agency	Title
Peter Sussenback	PGC—Bureau of Wildlife Habitat Management	Director
Tracey Librandi Mumma	PGC—Bureau of Wildlife Habitat Management	Division of Environmental Planning and Habitat Protection, Habitat Protection Section Chief
Olivia Braun	PGC—Bureau of Wildlife Habitat Management	Division of Environmental Planning and Habitat Protection, Habitat Protection Section Environmental Planner
David Gustafson	PGC—Bureau of Wildlife Habitat Management	Division of Forestry Chief
Scott Bearer	PGC—Bureau of Wildlife Habitat Management	Division of Habitat Planning and Development Chief
Ron Gensil	PGC—Bureau of Administrative Services	Fiscal Division, Federal Aid and Grant Coordinator
Daniel Brauning	PGC—Bureau of Wildlife Management	Division of Wildlife Diversity Chief
Greg Turner	PGE—Bureau of Wildlife Management	Division of Wildlife Diversity, Endangered and Threatened Mammal Section Chief
Michael Scafini	PGC—Bureau of Wildlife Management	Division of Wildlife Diversity, Endangered and Threatened Mammal Section, Wildlife Biologist
Rachel Reese	DCNR—Bureau of State Parks	Division of Resource Management and Planning, Resource Management Section, Park Chief
Paul Zeph	DCNR—Bureau of State Parks	Division of Resource Management and Planning, Planning Section Chief
Ellen Shultzabarger	DCNR—Bureau of Forestry	Director
Rebecca Bowen	DCNR—Bureau of Forestry	Division of Conservation Science and Ecological Resources Chief
Emily Domoto	DCNR—Bureau of Forestry	Division of Conservation Science and Ecological Resources Chief
Aura Stauffer	DCNR—Bureau of Forestry	Division of Conservation Science and Ecological Resources, Ecological Services Section, Wildlife Biologist
Bob Beleski	DCNR—Bureau of Forestry	Silviculture Section Chief
Chad Voorhees	DCNR—Bureau of Forestry	Silviculture Section, Forest Program Specialist
Scott Miller	DCNR—Bureau of Forestry	Tuscarora State Forest District, District Forester
Michael Kern	DCNR—Bureau of Forestry	Division of Forest Fire Protection Chief
Ryan Szuch	DCNR—Bureau of Forestry	Planning Section Chief
Pamela Shellenberger	USFWS Pennsylvania Field Office	Fish and Wildlife Biologist

[a] The individuals listed are those that participated in the Steering Committee at the time of HCP publication.

1.4.2 Stakeholder Group

The Stakeholder Group was formed in 2012 and comprises a range of interests from the environmental community to forest product associations. In addition, the Stakeholder Group includes bat and other scientific or technical experts that provided valuable outside scientific review. The Stakeholder Group met quarterly to identify HCP goals and objectives, identify areas of interest, determine milestones for completion of the State Lands Forestry HCP, and review draft HCP materials. The following member organizations participated in the Stakeholder Group:

- Allegheny National Forest
- Bat Conservation International
- Forest Investment Associates
- Fort Indiantown Gap National Guard Training Center
- Generations Forestry
- Glatfelter Pulpwood
- Kane Hardwood
- National Park Service
- Pennsylvania Biological Survey
- Pennsylvania Forest Products Association
- Pennsylvania State University
- The Nature Conservancy—Pennsylvania Chapter [8]
- U.S. Forest Service
- Western Pennsylvania Conservancy
- Wildlife Society—Pennsylvania Chapter

1.5 Document Organization

The State Lands Forestry HCP contains the following chapters and appendices:

- Chapter 1, *Introduction*
- Chapter 2, *State Lands and Covered Activities*
- Chapter 3, *Environmental Setting*
- Chapter 4, *Effects of Covered Activities*
- Chapter 5, *Conservation Program*
- Chapter 6, *Implementation and Assurances*
- Chapter 7, *Cost and Funding*

[8] This organization participated in plan development in year 1. The Pennsylvania chapter was subsequently closed.

- Chapter 8, *Alternatives to Take*
- Chapter 9, *List of Preparers*
- Chapter 10, *Literature Cited*
- Appendix A, *Species Evaluation*
- Appendix B, *Species Accounts*
- Appendix C, *State Game Lands*
- Appendix D, *State Forest Units*
- Appendix E, *State Parks*
- Appendix F, *Erosion and Sediment Control Plan*
- Appendix G, *Vegetation Crosswalk*
- Appendix H, *Habitat Distribution Modeling Using MaxEnt*
- Appendix I, *Field Key to the Ecological Systems and Habitat Systems of the Northeastern United States*
- Appendix J, *Supplemental Effects Analysis*
- Appendix K, *Canoe Creek State Park Prescribed Fire Plan*
- Appendix L, *Stream Buffer Guidelines*
- Appendix M, *Estimating Summer Densities of Indiana Bats in Pennsylvania*
- Appendix N, *Timber Sale Process on Pennsylvania State Lands*
- Appendix O, *Firewood Program*
- Appendix P, *Justification for Indiana Bat and Northern Long-Eared Bat Conservation Programs in the State Lands Forestry Habitat Conservation Plan*

Chapter 2
State Lands and Covered Activities

2.1 Introduction

This chapter provides an overview of lands and activities that will be covered by the State Lands Forestry HCP. State Lands include all areas owned and managed by PGC or DCNR. Covered activities are forest management activities on State Lands that could result in take of Indiana bats and northern long-eared bats or their habitat. The descriptions of covered activities are based on current operations and existing projections. As a programmatic plan, the amount and exact location of these activities may shift over time. The nature of each activity is described in Section 2.3, *Covered Activities*, and the extent (acres) of each activity is provided for context. Chapter 4, *Effects of Covered Activities*, quantifies the potential impacts of these activities on Indiana bats and northern long-eared bats and provides take limits for this HCP.

2.2 State Lands

The State Lands Forestry HCP covers activities on 4 million acres of land managed by PGC and DCNR as three types of properties. [1] A relatively large portion of Pennsylvania's forest land is in public ownership, with approximately 12 percent in State Forests and 8 percent in State Game Lands (Pennsylvania Game Commission 2008). Thus, the permit would cover 20 percent of Pennsylvania's forest lands, which account for 14 percent of the area of Pennsylvania. The following State Lands contain activities that are covered by the State Lands Forestry HCP.

- **State Game Lands.** PGC manages approximately 1.5 million acres of State Game Lands with the primary purposes of conserving wildlife habitat and providing hunting and trapping opportunities.
- **State Forests.** The DCNR Bureau of Forestry manages more than 2.2 million acres to provide a wide range of ecological, social, and economic values, including timber production, mineral resources production, watershed protection, rare-species protection, and public recreation.
- **State Parks.** The DCNR State Parks system owns more than 120 parks ranging in size from 3 to almost 23,000 acres, with an aggregate total of approximately 300,000 acres. The goals of the park system are to provide opportunities for outdoor recreation and to serve as an outdoor classroom for environmental education. In State Parks, timber harvesting occurs when trees would be removed for another activity, such as construction of a new facility or removal of sick or hazard trees.

A driving force for the State Lands Forestry HCP is the need to conduct forest management activities, especially timber harvest, on State Lands. Both PGC and DCNR manage habitat to benefit a variety of organisms, maintain ecological services, and provide recreational opportunities for Pennsylvanians. To meet these requirements, each agency must manage the forest to ensure that these specific goals

[1] Of these 4 million acres, PGC and DCNR actively conduct forest management on approximately 3.2 percent or 127, 479 acres of State Lands annually. Data presented in Table 4-17 in Chapter 4, *Effects of Covered Activities*.

are met. The specific responsibilities of each agency are discussed further in Section 2.2.1, *State Game Lands*, Section 2.2.2, *State Forests*, and Section 2.2.3, *State Parks*.

2.2.1 State Game Lands

PGC manages State Game Lands organized in six regions (Northwest, Northcentral, Northeast, Southwest, Southcentral, and Southeast). The Pennsylvania State Legislature created PGC in the late 1800s to protect and conserve wildlife. PGC is responsible for managing all of Pennsylvania's wild birds and mammals, such as the Indiana bat and northern long-eared bat. PGC conducts the following activities on State Game Lands: monitoring wildlife populations, implementing and enforcing wildlife laws and regulations, setting seasonal limits on hunting, making habitat improvements, providing outright protection, informing and educating the public, and assessing public expectations and satisfaction. As with other similar agencies, PGC was initially tasked with managing hunting and trapping activities (i.e., consumptive uses), but now a greater emphasis is placed on managing for wildlife diversity and nonconsumptive uses of wildlife. Managing game species remains an important responsibility; PGC is almost entirely funded by hunters and trappers or by assets that have been procured with hunting and furtaker license dollars (Pennsylvania Game Commission 2013). Most popular game species are associated with early successional or edge habitats. Therefore, much of the habitat management on State Game Lands is aimed at creating these types of habitats, and timber harvest is an important tool for wildlife managers. Although wildlife conservation is a primary focus, other activities affecting natural resources on State Game Lands include oil, mineral, coal, and gas extraction; public access; recreation; and the development and protection of rights-of-way. The State Lands Forestry HCP does not cover these activities because the plan focuses on forestry and forestry-related activities (Section 2.4, *Lands and Activities Not Covered by the State Lands Forestry HCP*).

Since 1920, PGC has been purchasing lands for inclusion in its State Game Lands system, which currently contains about 321 separate tracts comprising 1.5 million acres; efforts to expand this system are currently underway (Appendix C, *State Game Lands*). The dominant land cover types on State Game Lands are oak-pine forest (687,397 acres), northern hardwood/conifer forest (666,256 acres), and swamps and marsh (55,332 acres) (Chapter 3, *Environmental Setting*, Table 3-1).[2] Forests cover approximately 88 percent of State Game Lands.

Each State Game Land unit has a comprehensive management plan that addresses wildlife habitat management in the unit for game and nongame species, including state and federally listed species. The plan also describes recreational opportunities applicable to each unit. Recreational opportunities vary by unit and are permitted when not in conflict with a unit's primary management goals. These opportunities include hunting; public shooting ranges; snowmobiling and horseback riding; access to ponds, lakes, and streams; fishing; bird watching; hiking; and collecting edible berries (Pennsylvania Game Commission 2006, revised 2010). Comprehensive management plans are written to address management actions over a 15-year timeline; each plan is to be updated every 5 years. The comprehensive management plan for each State Game Land unit containing habitat for covered bats will be updated to reflect HCP commitments, as described in Chapter 6, *Implementation and Assurances*, Section 6.2.1, *Implementation of Conservation Program.*

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[2] A description of the methods used to develop ecosystems and vegetation types is provided in Chapter 3, Section 3.2, *Environmental Setting*.

The six regions of State Game Lands include lands that are widely distributed throughout rural areas. Many State Game Lands are dominated by forest tracts smaller than those managed by DCNR and include open, grassy areas. Vehicle trails, snowmobile routes, and utility rights-of-way are more abundant on State Game Lands than in State Forests. Important subsets of State Game Lands are those lands dominated by historic mine workings. While many of these areas are reclaimed strip mines, some areas have underground workings with the potential to support hibernating populations of bats, including Indiana bats and northern long-eared bats.

On State Game Lands, habitats are defined by vegetation type at various successional stages. Habitat management is designed to balance and intersperse these stages for specific wildlife species. Activities such as timber harvest, mowing, prescribed burning, and border edge cutting (cuttings designed to mimic the transition area between biological communities, as opposed to "hard" edges between habitat types) set back succession and create a range of age classes on the landscape.

2.2.2 State Forests

DCNR manages State Forests organized in 20 districts (Appendix D, *State Forest Units*). Pennsylvania's 2.2-million-acre State Forest system, found in 48 of Pennsylvania's 67 counties, accounts for 12 percent of the forested area in the state (Appendix D). The State Forest system represents one of the largest expanses of public forest land in the eastern United States, encompassing about half of the lands covered in the State Lands Forestry HCP. Geographically, about half of the State Forests are clustered in seven counties in north-central Pennsylvania on the Allegheny Plateau. Other large tracts of land in the State Forest system are distributed across the Central, Southcentral, Southwestern, and Pocono Regions of the state.

DCNR's core mission for State Forests is to ensure the long-term health, viability, and productivity of Pennsylvania's forests and to conserve native wild plants. State Forests are managed to retain their wild character; maintain biological diversity; and provide pure water, opportunities for low-density recreation, habitats for forest plants and animals, and sustained yields of quality timber. State Forests contain an abundance of high-quality forest products, an integral part of the materials base of the state's $19-billion-per-year forest products industry, which employs nearly 58,000 people. Timber sales generate significant revenue for the commonwealth, with the income from timber sales averaging approximately $22.5 million per year (Commonwealth of Pennsylvania 2016).

As the name implies, most State Forests (98 percent) are forest or scrubland, of which only 6 percent are dominated by conifers. More than 60 percent are dominated by large trees (12 inches or larger diameter at breast height). The primary land cover types in State Forests are oak-pine forest (1,120,989 acres), northern hardwood/conifer forest (850,903 acres), and rocky outcrops (111,040 acres). Slightly more than half (53 percent) of State Forests are managed for multiple uses, such as commercial timber harvests. An additional 23 percent are considered a limited resource area where timber harvest is typically impractical, and recreation, aesthetics, water, and soil protection are the primary management values. Other large amounts of land are set aside as aesthetic buffers (11 percent), wild areas (8 percent), and designated natural areas (4 percent). Approximately 2 percent of the total is associated with mineral extraction, service buildings, parking areas, and open wetlands.

Recreational opportunities include bird and wildlife watching, fishing, rock climbing, hiking, camping, boating, kayaking, mountain biking, horseback riding, all-terrain vehicle (ATV) use, sightseeing, and hunting. There are approximately 13,984 miles of recreational trails in State Forests and 101 miles of rivers that provide water-based recreational opportunities. There are 54 lakes totaling 1,479 acres in State Forests. Winter recreation activities include snowmobile riding and cross-country skiing.

State Forest management is guided by the *2016 State Forest Resource Management Plan* (Commonwealth of Pennsylvania 2016). The goals of the plan are to lay the groudwork for ensuring that sustainability in forest management is achieved. The plan establishes a landscape approach to ecosystem management where the interdependency of biological and nonbiological systems and cycles is the management focus (Commonwealth of Pennsylvania 2016). Management actions in individual State Forest districts (each of which have individual Landscape Management Units with goals and objectives) tier off of this plan but are implemented through the Bureau of Forestry's Silviculture Manual (Pennsylvania Department of Conservation and Natural Resources undated), timber sale checklists, and other similar procedural documents. Each individual State Forest Resource Management Plan also has goals and objectives. These documents will be updated to reflect HCP commitments as described in Section 6.2.1, *Implementation of Conservation Program.*

2.2.3 State Parks

DCNR manages State Parks to provide opportunities for outdoor recreation and to serve as outdoor classrooms for environmental education. From one park in 1893 to 121 parks in 2016, the State Parks system has grown into one of the largest in the United States, with more than 37.8 million visitors each year. State Parks provide most lands for outdoor recreation in Pennsylvania, and these parks allow DCNR to interface with the public to promote conservation awareness, outdoor ethics, and physical activity.

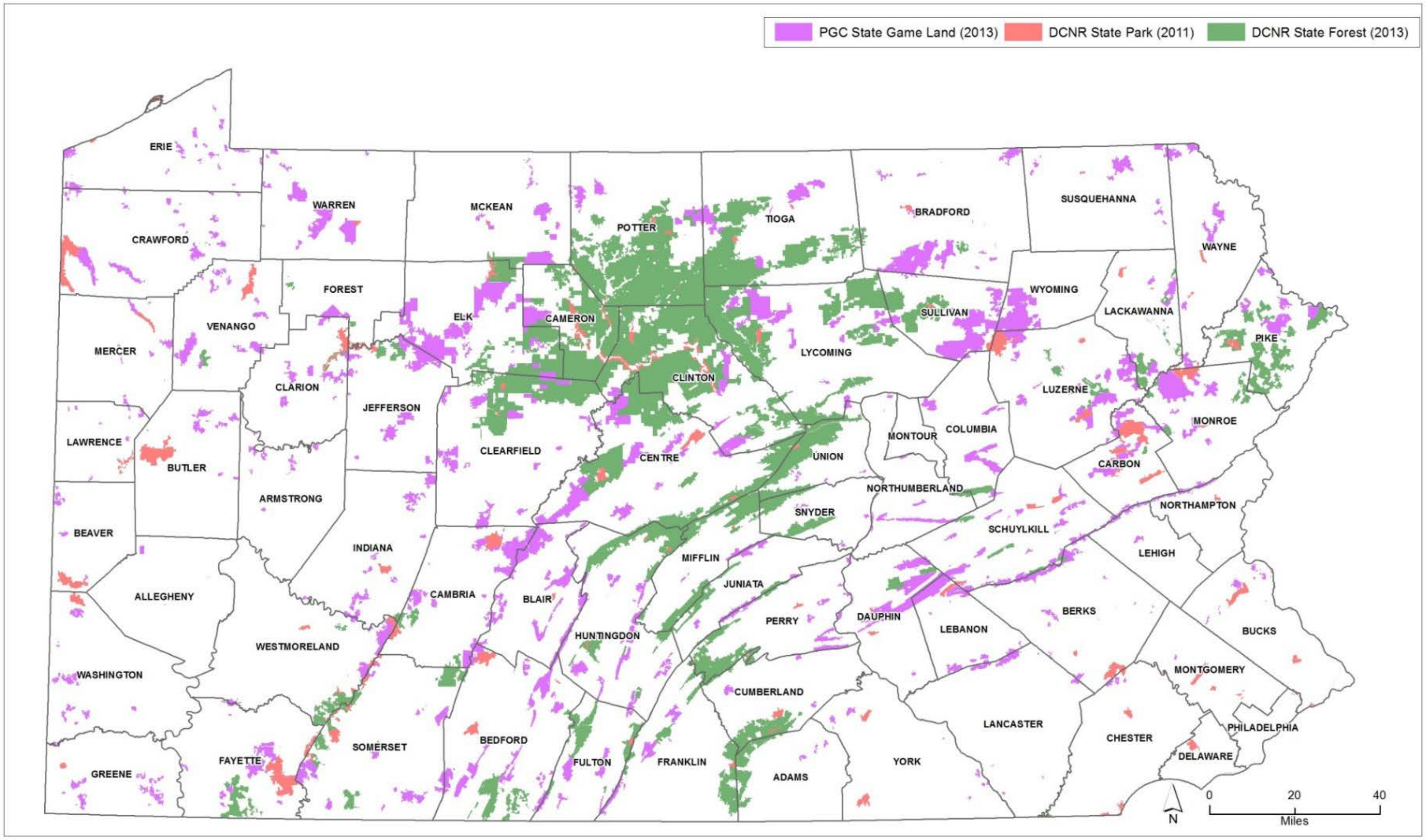
State Parks currently include 121 parks covering approximately 300,000 acres (Figure 2-1 and Appendix E, *State Parks*). Sixty of the state's 67 counties have State Parks. These parks occur in settings ranging from near wilderness to urban downtowns and are more widely distributed and typically smaller than State Forests (Pennsylvania State University 2008). Although a significant portion of State Parks are forested, some units focus on historic preservation or other cultural values, and some areas are set aside for special uses like picnicking. Recreational activities available at parks include camping, golfing, fishing, hiking, whitewater boating, horseback riding, wildlife watching, and downhill skiing. Collectively, the State Parks have 80 lakes available for water-based recreational activities and 1,453 miles of trails for hiking and other uses.

Land cover types in State Parks range from grasslands (1,714 acres) to forests (214,899 acres). Other habitats common in State Parks include open water (33,1275 acres) and developed urban/suburban area (14,540 acres) (Chapter 3, *Environmental Setting*, Table 3-1).

DCNR manages State Forests and State Parks to meet its strategic goals, which are to conserve natural resources, manage the sustainability of State Parks and State Forests, improve access to quality recreational resources, and operate more effectively and efficiently. These goals are accomplished through forest, land, and river conservation and resource management (Pennsylvania Department of Conservation and Natural Resources 2016). Each park has a resource management plan that describes management activities relevant to that park, including habitat management for sensitive species. These plans will be updated to reflect HCP commitments as described in Section 6.2.1, *Implementation of Conservation Program.*

2.3 Covered Activities

The State Lands Forestry HCP addresses PGC's and DCNR's forest management activities that have the potential to incidentally take Indiana bats and northern long-eared bats or their habitat. The potential for take of Indiana bats and northern long-eared bats ranges from direct injury or death (e.g., when a tree is cut down with roosting bats inside), to disturbance (e.g., from human sound or equipment), to removal of habitat that may reduce breeding, foraging, or cover for the species. In addition, many PGC and DCNR activities may positively affect habitat for Indiana bats and northern long-eared bats. For example, prescribed fire can both remove trees that are used as roosts and create new roosts. PGC and DCNR activities that could affect Indiana bats and northern long-eared bats can be categorized in five major groups—timber harvest, operations (fencing and firewood collection), road and trail construction and maintenance, prescribed fire, and implementation of the conservation program. Table 2-1 describes what specific activities occur on the two agencies' lands.



Source: Pennsylvania Game Commission, Pennsylvania Department of Conservation and Natural Resources, Bureau of Forestry (districts), Pennsylvania Department of Conservation and Natural Resources, State Parks (districts), Northeast Terrestrial Habitat Classification System (vegetation)

Figure 2-1. Location of State Lands in Pennsylvania

Table 2-1. Covered Activities by Current Land Ownership

	PGC	DCNR	
Covered Activity	**State Game Lands**	**State Forests**	**State Parks**
Timber Harvest			
Regeneration	✓	✓	
Intermediate (improvement)	✓	✓	
Salvage cutting	✓	✓	✓
Operations			
Fencing	✓	✓	✓
Firewood		✓	✓
Roads and Trails			
Road and trail construction	✓	✓	✓
Maintenance and use	✓	✓	✓
Prescribed Fire	✓	✓	✓
Firebreaks	✓	✓	✓
Burning	✓	✓	✓
Implementation of the Conservation Program			
Habitat restoration (plantings and other practices)	✓	✓	✓
HCP monitoring	✓	✓	✓

PGC = Pennsylvania Game Commission; DCNR = Pennsylvania Department of Conservation and Natural Resources; HCP = habitat conservation plan

2.3.1 Timber Harvest

Timber harvests are a forestry practice intended to grow and regenerate stands to achieve specified management objectives. The rate of timber harvest ranges in intensity and extent. Ecologically, these practices mimic natural disturbances at various levels. Timber harvests are aimed at controlling the growth, development, health, composition, and quality of forest stands to meet an identified set of needs and values and to maintain a sustainable forest ecosystem. The commercial value of trees depends on their species, size, location, and current market conditions. Some harvesting, referred to as precommercial thinning or timber stand improvement, removes trees with no commercial value and represents investment in the future quality of the forest for timber, habitat, or other ecosystem services.

Timber harvests are the most important tools of forest management. Harvest techniques used by PGC and DCNR are generally similar but are named and reported differently by each agency. Timber harvesting, as practiced by the agencies, occurs in three main categories.

- **Regeneration cuts** promote regeneration by creating openings ranging in size from entire stands to the gaps caused by removing individual trees. Removing an entire stand results in regeneration of an even-aged stand, while removing smaller patches results in establishment of a new age cohort or canopy class within an uneven-aged stand.

- **Intermediate cuts** thin and release timber to enhance timber quality or the wildlife value of the remaining trees.
- **Salvage cuts** harvest dead, dying, damaged, or deteriorating trees primarily for safety reasons or to minimize the spread of disease. Salvage cuts can include regeneration cuts or intermediate cuts.

In keeping with their differing mission statements, each agency uses a different mix of practices, and not all activities occur on all lands. Because the terminology used to refer to forestry practices varies across agencies, a crosswalk to standardized terms is provided in Table 2-2.

Table 2-2. Comparison of Commercial Timber Harvest Terminology Used by State Agencies

Timber Harvest Type	Society of American Foresters Handbook[a,b]	PGC	State Forests	State Parks[c]
Regeneration Harvest				
Even-aged stands	Clear cut	Regeneration cut[4]	Overstory removal[d]	N/A
	Shelterwood or seed tree preparatory cut Second or final removal	Improvement cut Second or final removal	Shelterwood, or seed tree cut Second or final removal	N/A
	Shelterwood or seed tree removal Second or final removal	Regeneration cut Second or final removal	Overstory removal Second or final removal	N/A
Uneven-aged stands	Group selection	Improvement cut	Group selection	N/A
	Single-tree selection	Improvement cut	Single-tree selection	N/A
Intermediate Harvests				
All Stands	Release cut	Improvement cut	Improvement cut	N/A
	Commercial thinning	Improvement cut	Improvement cut	Salvage
	Sanitation cut	Improvement cut	Improvement cut	Salvage
	Salvage cut	Improvement or regeneration cut[e]	Improvement, overstory removal, or shelterwood cut[f]	Salvage
	Precommercial Thinning	Timber stand Improvement	Timber stand improvement	Salvage

[a] Categories of harvesting planned and monitored by the agencies, as shown in Table 2-4 and Table 2-5.
[b] Society of American Foresters 1984.
[c] N/A = technique not used.
[d] Clear cuts on State Lands involve retention of selected individual trees or clumps of trees and are referred to as clear cuts with residuals.
[e] PGC counts salvage cuts as improvement cuts if the dead trees removed composed less than half of the pre-harvest stand; it counts salvage cuts as regeneration cuts if the dead trees removed composed most of the stand.
[f] The Bureau of Forestry counts salvage cuts as improvement cuts or shelterwood cuts if the dead trees removed composed less than half of the pre-harvest stand; it counts salvage cuts as shelterwood cuts overstory removals if the dead trees removed composed most of the stand; however, the acres are over-and-above the harvests reported in Table 2-4 and Table 2-5.
PGC = Pennsylvania Game Commission; DCNR = Pennsylvania Department of Conservation and Natural Resources; BoF = Bureau of Forestry

Timber harvesting involves tree felling and skidding. Felling is done using either chainsaws or mechanized fellers. Larger trees are usually processed into logs for transport to roadside landings by skidders or forwarders, where they are loaded onto trucks. Skidders drag logs or entire trees along skid trails, confining the area on which logs are moved and reducing the area potentially affected by soil compaction from heavy equipment use. Forwarders, which are used in combination with mechanized fellers, are vehicles with beds that carry logs clear of the ground, further reducing the potential for soil compaction. Motorized equipment is used to cut, move, chip, and haul trees during forest management, and the State Lands Forestry HCP covers operation of that equipment for forest management activities. Equipment operators acting as agents of PGC or DCNR occasionally remove individual stems to ensure operator safety. This activity occurs on all covered lands.

Timber harvests on State Lands occur through third-party contractors who implement timber sale contract instructions and requirements in a designated area in accordance with PGC or DCNR instructions (Appendix N, *Timber Sale Process on Pennsylvania State Lands*). The State Lands Forestry HCP covers these harvest activities when they are conducted for and under the direct jurisdiction of PGC and DCNR. Typically, PGC or DCNR will identify the silvicultural methods, harvesting intensities, species to be harvested, and infrastructure improvements (e.g., road construction or reconstruction) for the area and will estimate the volume or tonnage of logs of each species that will result from the harvest. Contracts to harvest standing timber are obtained in one of the following ways: standard bid contracts, locally bid contracts, or special permits. In all cases, PGC and DCNR provide specific instructions on how the timber is harvested for each sale. Once the permit is issued, all instructions provided by PGC and DCNR for future sales will reflect the commitments and restrictions contained in the HCP.

As described above, three main types of timber harvest occur on State Lands: regeneration cuts, intermediate cuts, and salvage cuts. Each technique has the potential to affect Indiana bats and northern long-eared bats in different ways. These techniques are described in the following sections.

2.3.1.1 Regeneration Cuts

Timber harvest for regeneration is a covered activity with the potential to affect Indiana bats and northern long-eared bats. This activity is done to promote tree regeneration, balance forest age classes, provide habitat for widlife, and extract useable timber. Regeneration cuts occur in forest stands that are either even-aged (consisting of one or two age classes) or uneven-aged (consisting of three or more age classes) to regenerate the stand. Because of historical, widespread clear cutting and abandonment and reversion of farm fields, most of Pennsylvania's currently managed forests consist of even-aged stands roughly 70 to 90 years old.

Even-Aged Stands

Techniques that regenerate even-aged stands typically include **clear cutting, shelterwood harvests,** and **seed tree harvests**. Seed tree and shelterwood harvests often include two phases of cutting: the first or preparatory cut and the second or final removal. The preparatory harvest typically removes all trees except overstory trees selected to provide a seed source for the next stand and (in the shelterwood case) microclimate conditions conducive to establishment of a new stand. In some cases, two shelterwood preparatory cuts are applied, usually 10 to 15 years apart. Note that PGC classifies the first cut of a shelterwood harvest as an intermediate cut (described below), not as a regeneration cut. The final harvest in these systems, called overstory removal, removes all or nearly all remaining overstory trees after a new stand has been regenerated. In some instances, the first step of a shelterwood or seed tree cut is not necessary due to naturally occurring regeneration, and an overstory removal is performed as both the initial and final treatment of a stand.

Even-aged management can promote early- to mid-seral species such as black cherry, oaks, and hickories, which are often particularly valuable for wildlife. Two-aged stand structures, which qualify as even-aged, typically have both young and old trees, often in woodland or savannah habitats with relatively low canopy cover. These structures are often highly valuable for wildlife.

Clear cuts remove all or nearly all trees from the stand in a single harvest. Unlike the shelterwood and seed tree preparatory cuts, clear cutting usually does not follow advanced regeneration. Clear cuts implemented by PGC and DCNR retain some trees, either in clumps or as individuals, for wildlife habitat; they are referred to as clear cuts with residuals. The Bureau of Forestry implements reservation guidelines during the final canopy removal treatment. Clear cutting with residuals emphasizes retaining genetic, species, and structural diversity. In even-aged stands, an average basal area of 10 to 20 square feet is retained. Clear cuts are usually regenerated by a combination of seedlings from the harvest area's seed bank or seed trees adjacent to the harvest area, sprouting from stumps or roots of cut trees, and plantings of seedlings. Regeneration of clear cuts might require site preparation and subsequent control of weeds or animal predators. Even-aged stands are projected to eventually grow at least 80 square feet (with an average of 120 square feet) per acre of basal area (the cumulative cross-sectional area of stems measured 4.5 feet above ground), with most trees in the 12-inch to 20-inch diameter-at-breast-height size class.

Uneven-Aged Stands

Techniques that can regenerate uneven-aged stands (stands with at least three age classes) include **group selection** and **individual tree selection**.

Uneven-aged management is implemented by selectively removing individual trees or small groups of trees from a stand, thereby mimicking the natural disturbances that kill one or a few trees. Some wildlife species require older forest conditions rarely found in even-aged stands.

In a group selection, the maximum width of the group is approximately twice the height of the mature trees. Individual tree selection creates new age classes in uneven-aged stands by removing individual trees throughout the stand to achieve the desired stand structure. With either technique, the removal must be large enough to allow regeneration of new trees, as opposed to the promotion of trees from the subcanopy, which can result in an even-aged stand dominated by shade-tolerant species such as sugar maple and American beech. Selection harvesting can be combined with techniques such as prescribed fire or herbicide application to remove undesirable species.

2.3.1.2 Intermediate Cuts

Stand improvement activities are implemented to enhance the long-term value of commodities such as saw timber, or ecosystem services such as wildlife habitat, or both. These cuts are also called intermediate cuts because they occur between regeneration events. Common stand improvement activities include **crop tree releases, cleaning**, **thinning, and improvement cuts**. Intermediate cuts can occur as either commercial or precommercial manipulations (Section 2.3.1.4, *Timber Harvest Amounts, State Forests* for information on commercial and precommercial harvest practices and amounts).

Crop tree release activities involve promoting trees selected to be in the overstory when the stand matures by removing adjacent trees whose crowns directly compete with the crop tree's crown. This activity is typically carried out in young stands with tree diameters less than 4 inches at breast height. Cleaning, sanitation, and thinning activities also occur as part of forest management. Tree cleaning removes invasive or undesired species from the stand. Sanitation cuts preemptively remove trees that are prone to a disease. Thinning removes selected trees from a forest stand to reduce the overall tree density, competition, and mortality, and to improve structural habitat diversity.

2.3.1.3 Salvage Cuts

Salvage cuts remove dead or dying trees while the tree is still merchantable. Salvage cuts are done in response to forest pest outbreaks and weather-related damage that impair forest health. This activity occurs on all covered lands, but only sporadically, and is reported by the three agencies in different ways. Both PGC and the Bureau of Forests typically report timber salvage as a regenerative harvest, such as salvage shelterwood or salvage clear cut, that is used to establish desired regeneration conditions. Salvage harvests can account for up to 50 percent of the harvest in a year with severe damage (Table 2-3). For example, much of the recent regeneration harvests reported by PGC in the Northwest Region were salvage harvests that resulted from gypsy moth defoliation. Salvage harvests in State Forests are not part of the regularly scheduled forest management activities and therefore represent up to 4,000 acres of manipulations above planned and reported activities (Section 2.3.1.4, *Timber Harvest Amounts, State Forests*). Salvage harvests also occur in State Parks and can use any technique from the selection of individual trees to the cutting of a large patch of trees (although this is rare). Eleven salvage cuts resulting from storm damage or hazardous tree removal have occurred in select State Parks since 2004.

2.3.1.4 Timber Harvest Amounts

State Game Lands

For each of the 8 years from 2007 to 2014, PGC harvested an average of 5,499 acres of trees across the six regions of State Game Lands (Table 2-3), or 0.4 percent of State Game Lands. Most PGC harvests are aimed at managing the age and successional class of forest as opposed to converting forest into nonforested habitat. However, a small proportion of these harvests are designed to convert forest into early successional habitats such as old fields. These numbers provide an historic average; they do not provide an estimate of current or future impacts, which are summarized below and in Chapter 4, *Effects of Covered Activities*. As outlined in Table 2-1, PGC uses the term "regeneration cut" to include clear cuts and the removal cut of a shelterwood or seed tree harvest. PGC uses the term "improvement cut" to indicate the preparatory cut of a shelterwood or seed tree harvest as well as single-tree and group-tree selections. Salvage is reported according to the silvicultural technique used to complete the harvest.

Based on a review of harvest activities since 2012, and future desired conditions, PGC seeks to increase forest management activities so that approximately 12,600 acres of commercial timber are harvested each year. Much of the increase is projected to occur in the Northeast Region, where approximately 2,000 acres per year will be harvested. Precommercial harvests are expected to occur on 1,400 acres per year.

Table 2-3. Yearly and 8-Year Average Timber Harvests (acres) for the Six Regions of State Game Lands

		Year								Annual
Region	**Cuts**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**Average**
Northwest	Regeneration	158	29	293	687	596	533	1,032	352	460
	Improvement	1,008	1,185	899	834	512	807	704	1,025	872
	Total	**1,166**	**1,214**	**1,192**	**1,521**	**1,108**	**1,340**	**1,736**	**1,377**	**1,332**
Southwest	Regeneration	311	422	339	235	235	299	169	234	281
	Improvement	318	467	334	310	353	139	200	186	288
	Total	**629**	**889**	**673**	**545**	**588**	**438**	**369**	**420**	**569**
Northcentral	Regeneration	790	597	1,667	956	1,824	889	1,212	553	1,061
	Improvement	364	13	88	182	462	532	429	694	346
	Total	**1,154**	**610**	**1,755**	**1,138**	**2,286**	**1,421**	**1,641**	**1,247**	**1,407**
Southcentral	Regeneration	222	307	388	352	395	387	166	451	334
	Improvement	649	426	482	267	283	200	224	189	340
	Total	**871**	**733**	**870**	**619**	**678**	**587**	**390**	**640**	**674**
Northeast	Regeneration	117	146	362	328	440	385	545	281	326
	Improvement	398	631	553	439	553	658	526	317	509
	Total	**515**	**777**	**915**	**767**	**993**	**1,043**	**1,071**	**598**	**835**
Southeast	Regeneration	262	641	441	415	299	389	361	579	423
	Improvement	305	59	312	390	221	405	243	147	260
	Total	**567**	**700**	**753**	**805**	**520**	**794**	**604**	**726**	**683**
Total	Regeneration	1,860	2,142	3,490	2,973	3,789	2,884	3,485	2,450	2,884
	Improvement	3,042	2,781	2,668	2,422	2,384	2,741	2,326	2,558	2,615
	Total	**4,902**	**4,923**	**6,158**	**5,395**	**6,173**	**5,625**	**5,811**	**5,008**	**5,499**

State Forests

Pennsylvania's State Forests yield abundant high-quality forest products, an integral part of the materials base of the state's $19 billion per year forest products industry, which employs nearly 58,000 people (Commonwealth of Pennsylvania 2016). State Forests are managed to provide a sustained yield of high-quality timber and other wood products. Each year, the Bureau of Forestry sustainably harvests approximately 15,000 acres across the State Forest system, or 0.7 percent of State Forests. Harvesting serves multiple goals, including providing a steady flow of wood products to the economy, creating wildlife habitat, and enhancing forest health and diversity. The successful and timely regeneration of diverse forest communities is promoted on State Forests.

Each State Forest district is considered its own management unit for the purposes of silvicultural operations and harvest regulation. The 20 State Forest districts are further divided into landscapes that average between 2,000 and 4,000 acres each. Landscapes are defined by topographic features such as uplands (e.g., mountains, hills, plateaus) and valleys. Typically, a forester is assigned to manage and coordinate activities across multiple landscapes within a forest district. A landscape may contain 100 or more forest stands. These forest stands are the Bureau of Forestry's primary land management unit for silvicultural activities. Foresters schedule landscape examinations and make management recommendations based on stand condition.

In 2003, the Bureau of Forestry, in conjunction with the Pennsylvania State University School of Forest Resources, created a timber harvest allocation model to develop timber harvest goals for the 20 forest districts (Table 2-4 and Table 2-5). This model allows the Bureau of Forestry to project landscape conditions that will provide a balance of forest age classes and ensure retention of sufficient areas of older forest. By maintaining mosaics of habitat types in each State Forest, the Bureau of Forestry will provide habitat for a variety of sensitive species, including Indiana bats and northern-long eared bats. Varying the age classes of a forest is desirable because most eastern U.S. forests are dominated by even-aged stands established during the 1920s and 1930s. DCNR occasionally retains the overstory indefinitely to develop an uneven-aged stand of diverse age classes that benefit many species, including Indiana bats and northern-long eared bats. The model provides a projection of future harvest regimes, but these may change over time. The potential effects of harvest on Indiana bats and northern-long eared bats are quantified in Chapter 4, *Effects of Covered Activities*.

For the period ending in 2006, the yearly harvest goal was 14,056 acres (Table 2-4). The model allows for year-to-year variations of up to 25 percent of baseline harvest levels to provide management flexibility in case any year's goal is not met. Harvests are anticipated from all timber types, across all districts, with the goal of balancing the age class structure. The harvest goal increased slightly for the period from 2007 to 2013 to 14,337 acres per year and peaked at 14,776 acres for the period from 2014 to 2016. A similar harvest of 14,699 acres per year is projected for the period from 2017 to 2023 (Table 2-5). The goal then falls to 14,356 from 2024 to 2026 and remains relatively steady at 14,296 acres per year from 2027 to 2033. The harvest goal continues to remain relatively stable through 2046 (14,243 from 2034 to 2036, 14,231 from 2037 to 2043, and 14, 211 from 2044 to 2046). Many of these harvests are aimed at improving wildlife habitat, and it should be noted that this includes a relatively large amount of area that is receiving the initial cut of a shelterwood.

These harvest projections exclude salvage cutting because it is sporadic and depends on unpredictable conditions. In addition to these projected acres, it is likely that up to 4,000 acres of salvage cutting will be required per year; it is assumed that 60 percent of these will require the entire overstory to be removed. Finally, the projections in Table 2-4 and Table 2-5 are based on commercial timber sales and do not include precommercial activities, which typically are performed at a cost to the agency, and thus have proven more difficult to track.

When the rates of planned sales from Table 2-4 and Table 2-5 are combined with the expected rates of salvage and precommercial activities the Bureau of Forestry predicts 21,100 acres per year of timber harvest on DCNR properties. This estimate is summarized in Chapter 4, *Effects of Covered Activities*.

Table 2-4. Modeled Yearly Timber Harvest Goals on State Forests (2004–2016)

	2004–2006				2007–2013				2014–2016			
	Regeneration				Regeneration				Regeneration			
District	Shelter-wood	Overstory Removal	Intermediate	Buffer[a]	Shelter-wood	Overstory Removal	Intermediate	Buffer[a]	Shelter-wood	Overstory Removal	Intermediate	Buffer[a]
1	107	471	43	225	107	471	43	225	123	439	43	225
2	117	234	67	70	117	234	67	70	189	232	67	70
3	235	218	61	50	235	218	61	50	212	264	61	50
4	285	115	20	50	285	115	20	50	200	285	20	50
5	191	218	67	90	191	218	67	90	172	258	67	90
6	71	51	15	15	71	51	15	15	74	80	15	15
7	257	156	0	162	257	156	0	162	13	415	0	162
8	81	83	40	21	81	83	40	21	80	81	40	21
9	973	200	370	74	973	200	370	74	535	990	370	74
10	848	467	96	125	848	467	96	125	409	874	96	125
11	0	41	0	18	0	41	0	18	0	38	0	18
12	509	317	69	161	153	520	37	125	153	520	37	125
13	512	507	22	25	512	507	22	25	460	552	22	25
14	0	10	0	0	0	10	0	0	0	10	0	0
15	756	1,100	337	331	756	1,100	337	331	681	1,100	337	331
16	377	500	299	254	377	500	299	254	383	483	299	254
17	0	0	0	0	0	0	0	0	0	0	0	0
18	0	110	0	24	0	183	0	25	0	183	0	25
19	0	238	55	64	0	238	55	64	0	226	55	64
20	0	301	0	82	33	621	0	155	33	621	0	155
Total	**5,319**	**5,335**	**1,561**	**1,841**	**4,996**	**5,933**	**1,529**	**1,879**	**3,717**	**7,651**	**1,529**	**1,879**
Annual Total	**14,056**				**14,337**				**14,776**			

Data collected by the Bureau of Forestry as of 2014 indicated that they were on schedule at 99% of projected harvest goals.

[a] Buffer management as defined by the Bureau of Forestry includes two-aged management, uneven management, or group selection.

Table 2-5. Modeled Yearly Timber Harvest Goals on State Forests (2017–2046)

	2017–2023				2024–2026				2027–2033			
	Regeneration				Regeneration				Regeneration			
District	Shelter-wood	Overstory Removal	Intermediate	Buffer[a]	Shelter-wood	Overstory Removal	Intermediate	Buffer[a]	Shelter-wood	Overstory Removal	Intermediate	Buffer[a]
1	123	439	43	225	142	436	43	225	142	436	43	225
2	189	232	67	70	172	228	67	70	172	228	67	70
3	212	264	61	50	221	279	61	50	221	279	61	50
4	200	285	20	50	240	234	20	50	240	234	20	50
5	172	258	67	90	189	248	67	90	189	248	67	90
6	74	80	15	15	70	76	15	15	70	76	15	15
7	13	415	0	162	15	396	0	162	15	396	0	162
8	80	81	40	21	82	80	40	21	82	80	40	21
9	535	990	370	74	589	795	370	74	589	795	370	74
10	409	874	96	125	491	729	96	125	491	729	96	125
11	0	38	0	18	0	37	0	18	0	37	0	18
12	160	458	37	125	160	458	37	125	168	462	37	125
13	460	552	22	25	414	539	22	25	414	539	22	25
14	0	10	0	0	0	10	0	0	0	10	0	0
15	681	1,100	337	331	633	1,100	337	331	633	1,100	337	331
16	383	483	299	254	355	500	299	254	355	500	299	254
17	0	0	0	0	0	0	0	0	0	0	0	0
18	0	165	0	25	0	165	0	25	0	154	0	25
19	0	226	55	64	0	215	55	64	0	215	55	64
20	114	536	0	155	114	536	0	155	101	488	0	155
Total	3,805	7,486	1,529	1,879	3,887	7,061	1,529	1,879	3,882	7,006	1,529	1,879
Annual Total	**14,699**				**14,356**				**14,296**			

Table 2-5. Continued

	2034–2036				2037–2043				2044–2046			
	Regeneration				Regeneration				Regeneration			
District	Shelter-wood	Overstory Removal	Intermediate	Buffer[1]	Shelter-wood	Overstory Removal	Intermediate	Buffer[1]	Shelter-wood	Overstory Removal	Intermediate	Buffer[1]
1	121	438	43	225	121	438	43	225	115	471	43	225
2	179	235	67	70	179	235	67	70	141	252	67	70
3	243	252	61	50	243	252	61	50	218	260	61	50
4	216	240	20	50	216	240	20	50	229	220	20	50
5	170	271	67	90	170	271	67	90	185	259	67	90
6	69	72	15	15	69	72	15	15	65	70	15	15
7	17	421	0	162	17	421	0	162	20	477	0	162
8	76	82	40	21	76	82	40	21	79	76	40	21
9	641	788	370	74	641	788	370	74	688	782	370	74
10	589	692	96	125	589	692	96	125	636	639	96	125
11	0	37	0	18	0	37	0	18	0	36	0	18
12	168	462	37	125	177	445	37	125	177	445	37	125
13	380	503	22	25	380	503	22	25	391	469	22	25
14	0	10	0	0	0	10	0	0	0	10	0	0
15	571	1,100	337	331	571	1,100	337	331	514	1,100	337	331
16	345	500	299	254	345	500	299	254	336	500	299	254
17	0	0	0	0	0	0	0	0	0	0	0	0
18	0	154	0	25	0	150	0	25	0	150	0	25
19	0	204	55	64	0	204	55	64	0	204	55	64
20	101	488	0	155	106	483	0	155	106	483	0	155
Total	3,886	6,949	1,529	1,879	3,900	6,923	1,529	1,879	3,900	6,903	1,529	1,879
Annual Total	**14,243**				**14,231**				**14,211**			

[a] Buffer management as defined by the Bureau of Forestry includes two-aged management, uneven management, or group selection.

State Parks

DCNR Bureau of State Parks' timber harvest program is restricted to occasional salvage sales (typically one or two per year throughout the State Park system). Salvage sales include pine plantation thinning and other regeneration or intermediate cuttings. Table 2-6 lists recent salvage sales as examples. In addition, individual trees are removed if they pose an immediate hazard to people using campgrounds and day-use areas.

Table 2-6. Timber Harvest (salvage sales only) in State Parks (2004–2017)

Year	Park	Acres	Comments
2004	Caledonia	NA—Individual stems	Hazardous tree removal
2005	Whipple Dam	NA—Individual stems	Removing storm damage from hurricane Ivan
2005	Oil Creek	22	Removing storm damage
2005	Chapman	NA—Individual stems	Removing storm damage
2006	Tyler	NA—Individual stems	Hazardous tree removal
2007	Promised Land	35	Removing storm damage from 1998 tornado
2007	Worlds End	NA—Individual stems	Hazardous tree removal
2008	Kings Gap	NA—Individual stems	Hazardous tree removal
2008	Black Moshannon	NA—Individual stems	Hazardous tree removal
2009	Cowans Gap	NA—Individual stems	Hazardous tree removal
2009	Laurel Hill	5	Hazardous tree removal
2010	Denton Hill	44	Removing storm damage and blow downs
2012	Nolde Forest	NA—Individual stems	Removing storm damage from 2011 storms
2013	Worlds End	1	Helicopter LZ
2013	Reeds Gap	8.2	Hazardous tree removal
2013	Cowans Gap	NA—Individual stems	Removing storm damage
2013	Poe Paddy	NA—Individual stems	Hazardous tree removal (EAB-damaged ash)
2013	Worlds End	26	Hazardous tree removal (EAB-damaged ash)
2013	Worlds End	25	Hazardous tree removal (EAB-damaged ash)
2014	Black Moshannon	12	Site restoration
2015	French Creek	81	Hazardous tree removal
2015	Bald Eagle	NA—Individual stems	Hazardous tree removal (EAB-damaged ash)
2015	Hyner Run	NA—Individual stems	Hazardous tree removal (EAB-damaged ash)
2016	Laurel Hill	NA—Individual stems	Hazardous tree removal (EAB-damaged ash)
2016	Prince Gallitzin	78	Hazardous tree removal
2016	Worlds End	NA—Individual stems	Hazardous tree removal (EAB-damaged ash)
2016	Tyler	NA—Individual stems	Hazardous tree removal (EAB-damaged ash)
2016	Nochamixon	NA—Individual stems	Hazardous tree removal (EAB-damaged ash)
2017	S. B. Elliot	1	Building Site
2017	Denton Hill	NA—Individual stems	Hazardous tree removal (EAB-damaged ash)
2017	Ridley Creek	NA—Individual stems	Hazardous tree removal (EAB-damaged ash)

NA = not applicable; EAB = emerald ash borer

2.3.2 Operations

2.3.2.1 Fencing

Fences are installed on all covered lands, primarily to exclude white-tailed deer from areas where forest regeneration is in progress. However, fences might also be installed to exclude recreationists from designated areas. Fence installation and maintenance requires occasional tree cutting.

Two types of fencing (high-tensile electric and woven wire) are used on covered lands, although little to no electric fencing remains because it has been removed or replaced with woven wire. Fencing installation and repair involves the use of small trucks to transport materials, a tractor with an augur to dig postholes or a self-propelled fence builder, and manual labor to install the posts and wire. Gateposts are set in concrete. Repairing badly damaged fencing can involve using the same equipment and techniques as installation. In most cases, however, maintenance and repair of fences is done with manual labor.

Standard practice is to remove all dead or leaning trees that could fall on the fence and to clear enough space to allow an ATV loaded with maintenance supplies to pass around the perimeter of the fence. This typically requires at least 5 feet of clearance, with partial tree removal throughout a wider area. Once the fence has outlived its usefulness, the agency or a fencing contractor removes it. Fences are uninstalled by removing the staples and pulling the fence off posts. During this process, no dominant, codominant, midstory, or overstory trees are removed. The only trees removed would be saplings that had grown up into or through the fence.

Woven wire fences are constructed by attaching two 47-inch sections of fencing material together and creating a fence between 7 and 8 feet high, depending on site conditions. Woven wire fences are walked periodically and as soon after severe weather as possible.

There are approximately 375 miles of woven wire fences on State Game Lands, and the net miles of woven wire are projected to remain stable throughout the permit term (Table 2-7). This will include some tree removal each year to install fences. Approximately 1.2 acres of land are affected per mile of fence. There are approximately 1,019 miles of woven wire fence and 194 miles of high-tensile fence on State Forest Lands. DCNR constructs 40 miles of new fence each year on State Forest Lands and will continue to do so in the future. As DCNR does not conduct widespread regeneration efforts on State Parks, there is minimal need for fencing on State Parks.

Table 2-7. Projected Quantity of Fencing on State Lands in Pennsylvania (Annual and over Permit Term)

	All State Lands		State Game Lands		State Forests		State Parks	
Fencing Type	Quantity of Fencing (miles)	Affected Land (acres)	Quantity of Fencing (miles)	Affected Land (acres)	Quantity of Fencing (miles)	Affected Land (acres)	Quantity of Fencing (miles)	Affected Land (acres)
Maintained	1,588	1,906	375	450	1,213	1,456	0	0
New (annual)	40	48	0	0	40	48	0	0
Total annual	1,628	1,954	375	450	1,253	1,504	0	0
30-year total	48,840	58,620	11,250	13,500	37,590	45,120	0	0

2.3.2.2 Firewood

DCNR designates hazardous dead or live trees along public roads in State Forests and State Parks that may be cut for firewood, subject to obtaining a permit. Individuals may obtain such a permit to collect firewood only if the harvest is advantageous for State Forests and State Parks. Select situations where permits may be obtained include efforts to reduce or eliminate hazards, post-storm cleanup, timber-stand improvement, habitat improvement, and sanitation (i.e., removal of trees infested with a disease or insect). When these situations occur, DCNR staff are authorized to make the wood available to the public at the fee established by regulations. Firewood may only be removed from within a designated cutting area that has been established by DCNR personnel, subject to specific guidelines established in the permit application (Appendix O, *Firewood Program*). Only dead material or live trees specifically designated for removal by authorized DCNR personnel can be removed on State Forest land. Firewood cutting is prohibited in areas marked for timber sales, denoted by State Forest Timber Sale Boundary signs, or where trees are marked with paint or within fenced enclosures, wild areas, and natural areas. On State Park land, tree cutting for firewood is not permitted; only wood on the ground is allowed to be collected by permit. Firewood cutting is rare on State Game Lands but is conducted in limited instances (e.g., to maintain public safety by removing hazardous trees) by PGC staff.

2.3.3 Roads and Trails

2.3.3.1 Construction

Earth-moving activities associated with the construction and maintenance of roads for motorized travel, trails for nonmotorized travel, and landings (i.e., log staging areas) are covered under this activity. The construction of new roads would provide access for forest management and for public use. Only existing roads on State Lands and new roads constructed for forestry purposes are included as covered activities in the State Lands Forestry HCP. Construction of roads for other purposes (e.g., mineral extraction) is not a covered activity under this HCP. Earth-moving activities associated with the construction of new roads and landings would entail the use of bulldozers and other equipment. Heavy equipment would be confined to designated alignments selected to minimize soil, water, and residual tree damage. This activity would be done in accordance with the approved erosion and sedimentation plan (Appendix F, *Erosion and Sedimentation Plan*). Equipment used for this activity would be confined to the approved routes specified in the erosion control plan.[3] State law requires a copy of the plan to be on site at all times for all timber harvesting operations.

PGC manages approximately 3,000 miles of roads and 300 to 500 miles of trails (trail maintenance does not include large tree cutting or canopy disturbance) (Table 2-8). DCNR manages 5,122 miles of roads and 4,668 miles of trails in State Forests, and 1,302 miles of roads (these include sections of local, state, and federally maintained roads through parks) and 1,433 miles of trails in State Parks. An expansion of the road and trail system is underway, and over the duration of the permit, roads and trails are expected to increase by 10 miles of roads per year on State Game Lands, and 15 miles

[3] Chapter 102, Erosion Control Rules and Regulations of the Clean Streams Law, requires that an erosion control plan be developed, implemented, and maintained for every activity that would disturb 5,000 square feet or more of earth.

of roads and 300 miles of trails per year in State Forests. Increases to roads and trails are not anticipated in State Parks.

Nonmotorized trails are designed for hiking, biking, horseback riding, and handicap access. The width of new nonmotorized trails ranges from 1 to 5 feet. Roads for ATVs and snowmobiles would be stand-alone trails or co-located with existing rights-of-way or roads. The width of roads ranges from 5 to 10 feet for ATVs and 5 to 20 feet for snowmobile trails. PGC and DCNR construction and maintenance activities on roads and trails are covered under the State Lands Forestry HCP.

Table 2-8. Projected Quantity of Roads and Trails on State Lands (Annual and over Permit Term)

	All State Lands		State Game Lands		State Forests		State Parks	
	Annual Maint. (miles)	Annual New Construct. (miles)	Annual Maint. (miles)	Annual New Construct. (miles)	Annual Maint. (miles)	Annual New Construct. (miles)	Annual Maint. (miles)	Annual New Construct. (miles)
Roads	9,424	28	3,000	13	5,122	15	1,302	0
Trails	6,601	310	500	10	4,668	300	1,433	0
Total Annual	16,025	338	3,500	23	9,790	315	2,735	0
30-Year Total	480,750	10,140	105,000	690	293,700	9,450	82,050	0

2.3.3.2 Maintenance and Use

Roads and trails are maintained as needed to allow use, limit sedimentation delivery to adjacent water features, and prevent deterioration of the road system. The impact estimates for the creation of roads (Section 2.3.3.1, *Construction*) assumes a permanent impact in the roadbed and the road shoulder. Therefore, impacts from the subsequent maintenance and repair of new roads are assessed at the time of construction by quantifying all impacts from new road construction, including the maintained shoulders, as permanent.

Road maintenance typically consists of patching potholes, cleaning or repairing culverts and ditches, installing rock (spot-rocking), repaving, repairing or replacing v-ditches, resculpting, sealing cracks, and minor grading. Road maintenance can be performed with a grader, a dump truck to distribute road base rock, and a roller to compact it. Grading can be performed along a stretch of road 20 feet to several miles long at a time. When needed, a bulldozer is used to clear roads that a grader cannot access or where the road exceeds the grader's capability. Work at stream crossings is commonly accomplished with a backhoe or excavator to install or modify culverts or other drainage structures. Measures to avoid, minimize, and mitigate potential impacts on water quality and aquatic species will be implemented during the installation and replacement of stream crossings. In general, roadside-maintenance activities can involve parking and/or soil disturbance in a strip with an average width of 4 feet on either side of the road.

Culvert upgrades, cleaning (manually and mechanically), and replacement are required to reduce the risk of problems related to structural, hydrologic, and durability failure. Culvert maintenance, repairs, and replacement are performed as needed. Hand labor and backhoes are used to maintain culverts. Culvert upgrading, repair, and maintenance could affect areas up to 25 feet from the edge of the road.[4]

Road maintenance occurs with greater frequency in some locations than in others. Some parts of the road system might not undergo maintenance during the permit term, while other parts of the system might undergo frequent maintenance. Trail maintenance and repair includes vegetation maintenance and minimal grading to maintain the designated trail width.

The State Lands Forestry HCP covers normal road use, including driving on roads and walking on trails. Road use includes trips in and out of State Lands by all users,[5] including (but not limited to) PGC and DCNR staff, timber operators, visitors, and contractors working in the area. Trips include all motorized vehicles (commercial trucks, passenger cars and trucks, and ATVs).

2.3.4 Prescribed Fire

Prescribed fire as a forest management practice is governed by the 2009 Pennsylvania Prescribed Burn Practices Act. In accordance with this act, proper training in the purpose, use, and application of prescribed burning is provided to ensure maximum benefits and protection of the public. Furthermore, the act mandates that prescribed fire is to be carried out under specific conditions following appropriate precautionary measures to accomplish forest land management objectives that are in compliance with the Pennsylvania Prescribed Fire Standards.

2.3.4.1 Firebreaks

A firebreak is a permanent or temporary strip of bare or vegetated land planned to retard and prevent fire from moving out of a burn area. Firebreaks are used to address prescribed burning or wildfire prevention as part of the PGC and DCNR system to manage grasslands, woodland, and wildlife resources. Firebreaks can be temporary or permanent and consist of fire-resistant vegetation, nonflammable materials, bare ground, or a combination (Natural Resources Conservation Service 2009). Firebreaks can be barriers such as streams, lakes, ponds, rock cliffs, roads, field borders, skid trails, landings, drainage canals, railroads, utility rights-of-way, and cultivated land, or can be created.

Prior to any prescribed burning, a firebreak would be in place. If an existing feature (e.g., a road) that could serve as a firebreak is not present, then one would be created. These types of firebreaks can be bare soil, which are firebreaks that are plowed or disked until all vegetation is removed, or vegetated firebreaks, which are maintained by mowing as close to the ground as possible with rotary or sickle mowers (Natural Resources Conservation Service 2009). On State Game Lands, most firebreaks through wooded areas avoid disturbance to trees, and removal of trees over 10 inches diameter at breast height is rare. Firebreaks are narrow (no more than 8 feet wide) and shallow (do not exceed plow depth or 18 inches). For the most part, firebreaks do not result in a significant disturbance to the forest canopy. Firebreaks usually are made up of previously established breaks such as streams, roads, or fence lines. Any new firebreaks involve hand-cutting the herbaceous layer

[4] Culverts that involve drainage of more than 100 acres fall under Pennsylvania Department of Environmental Protection Programmatic General Permit. Culverts that have drainage of less than 100 acres do not. However, such culverts typically do not require tree removal on State Game Lands, as PGC primarily maintains and repairs existing roads as opposed to building new roads.

[5] Roads on State Lands built soley for the purpose of oil and gas exploration or other extractive activities are excluded from coverage under this HCP. Only multiuse roads are included.

or a dozer line that exposes the soil layer. New firebreaks are temporary and revegetate quickly. There are approximately 17 miles of firebreaks on State Game Lands, with 25 miles added yearly. The Bureau of Forestry does not maintain data on miles of firebreaks. State Parks create and maintain negligible firebreak miles for their burns each year.

2.3.4.2 Burning

In keeping with the Prescribed Fire Standards, each fire requires that both the Pennsylvania Department of Environmental Protection and DCNR be notified.[6] Each fire is also governed by a prescribed fire plan, which must contain 24 elements designed to address the following factors.

- **Location—**Describes the township, county, management unit, and ownership.
- **Description—**Describes how, when, and why the fire is being set, including narrative and tabular descriptions of the plan and a map.
- **Justification—**Describes why fire was chosen for the specific management goals of the site and objective standards that can be used to measure the effectiveness of the fire. Describes the conditions under which a specified burn is being conducted.
- **Acceptable conditions—**Identifies the issues that must be considered both in advance of and during prescribed fire, because fire simultaneously and instantaneously responds to multiple weather factors. Such measurements are essential to safe and effective burns because relatively minor changes in conditions can lead to a fire that burns too hot or too cool to obtain management objectives or one that escapes control.
- **Fire behavior—**Defines acceptable fire behavior parameters to ensure safety and the achievement of desired fire effects. These include minimum and maximum values for flame length, flame height, and rate of spread.
- **Smoke plan—**Addresses smoke management because smoke from prescribed fires can create a variety of problems, including obscuring vision and respiratory distress among both humans and wildlife (including bats).

Prescribed fires occur on all categories of State Lands covered by the State Lands Forestry HCP.

Although on average only 2,000 to 3,000 acres of State Game Lands were burned between 2009 and 2015, PGC's goal is to increase the level of prescribed burning to 15,000 to 20,000 acres annually within 8 years and to have this level continue throughout the permit duration. The agency's typical burn windows for forested habitat are March 1 through May 30 and August 15 through November 15. The burn window for scrub oak barrens is March 1 through November 15.

DCNR has significantly increased the amount of burning on its properties since the passage of the Pennsylvania Prescribed Burning Practices Act in 2009. The Bureau of Forestry is responsible for conducting prescribed fires in both State Forests and State Parks. From 2010 to 2013, there were an average of 11 burns covering 194 acres each year. However, during 2013 to 2018, the acreage burned increased dramatically to more than 1,200 acres per year in 2017. Most of the burns currently conducted by the Bureau of Forestry are aimed at removing unwanted species or promoting regeneration. A goal of the State Lands Forestry HCP is to allow continued expansion of Bureau of Forestry burns over the next several decades. Prescribed burns are less frequently used in

[6] Notification for a burn is standardized statewide and set forth in the Burn Plan under element #20 Notifications.

State Parks, with regular burns occurring in non-forested habitat at Canoe Creek, Jennings, and Moraine State Parks. Additional burns within forested habitat are conducted in direct association with Bureau of Forestry staff. It is estimated that burning on State Forests and State Parks will encompass 100 or more burns each year reaching a maximum of 10,000 acres per year in year 25 of the permit term.

2.3.5 Implementation of the Conservation Program

2.3.5.1 Conservation Measures for Habitat Restoration

Conservation measures, described in Chapter 5, *Conservation Program*, will be implemented to improve habitat for Indiana bats and northern long-eared bats. Such measures include gating of hibernacula, enhancement of potential hibernacula, and installation of artificial roost structures. While these conservation measures will be implemented in such a way as to minimize effects on covered bats (e.g., gating will be conducted when bats are not hibernating), implementation of these measures could temporarily affect covered bats. The disturbance attributed to these activities is not estimated in Chapter 4, *Effects of Covered Activities*, because it would be relatively small in area, would be temporary in duration, and ultimately, would result in improved habitat conditions and long-term beneficial effects for covered species.

2.3.5.2 Monitoring

PGC and DCNR personnel will regularly perform surveys for Indiana bats and northern long-eared bats and other resources on State Lands for the purposes of monitoring, research, and adaptive management. These surveys may require physical capture and inspection of specimens to determine identity, mark individuals, or measure physical features; such activities could constitute harm under the ESA. All such survey activity consistent with the State Lands Forestry HCP is proposed for coverage by the Section 10(a)(1)(B) permit. This activity also covers research conducted by PGC and DCNR personnel or their contractors on State Lands, as necessary for monitoring or implementation of the HCP, as long as the research projects are performed by individuals with the qualifications specified in the most current USFWS survey guidelines and survey personnel have appropriate handling permits from PGC or USFWS for covered species. If research projects do not meet these guidelines, approval by USFWS and PGC is required before research can be performed. Research by outside individuals (e.g., academic scientists for their own purposes) is not covered by the permit because the nature and impacts of these future research projects cannot be predicted. Decisions whether and how to issue collection or scientific permits for such individuals shall be made on a case-by-case basis by PGC, DCNR, and USFWS, and if issued, will be conditioned so that any such research does not interfere with this HCP's conservation strategy or violate any conditions or limitations imposed by it or the permit.

2.4 Lands and Activities Not Covered by the State Lands Forestry HCP

This section discusses activities on State Lands not covered by the State Lands Forestry HCP and the reasons for exclusion (Table 2-9.).

This HCP is focused on forestry and forestry-related activities because these activities enable PGC and DCNR to meet multiple objectives, including the improvement of habitat for wildlife, enhancement of recreational opportunities, the maintenance of healthy and safe forests, and economic contributions toward the respective programs and goals of each agency. This HCP does not address other activities on State Lands, such as oil and gas development, coal mining, and renewable energy development. These activities undergo their own environmental compliance process, separately from timber operations, that includes ESA compliance. Although some of these activities do result in tree cutting, often the clearing is permanent (i.e., vegetation conversion) and represents fundamentally different activities from those covered by this HCP.

Table 2-9. Examples of Activities Related to Tree Cutting on State Lands Not Covered by this HCP

Activities	Description	Reason for Exclusion
Invasive plant control using herbicides or pesticides	Application of herbicides and pesticides. The objective of this activity is to increase the regeneration and survival of native or merchantable trees through the control or eradication of invasive plants. Subcategories of this activity include broadcast spraying (spraying all or large parts of a stand), basal application (application to the base of targeted stems), and cut stump application (application to the stump of a freshly cut plant).	All herbicides and pesticides applied on PGC and DCNR lands under the direction of a licensed applicator are conducted in compliance with labels. PGC and DCNR avoid take of listed species when conducting these activities through the Pennsylvania Natural Diversity Inventory (PNDI) review process (see Section A-2 in Appendix A, *Species Evaluation* for more information). PGC and DCNR will continue to use this process to avoid effects on listed species under this State Lands Forestry HCP.
Right-of-way management	Use of rights-of-way to access, maintain, or build infrastructure or access roads on State Lands	PGC and DCNR requires easement owner or licensee to comply with all applicable state and federal laws, including the ESA.
Energy exploration and development	Exploration for and extraction of natural gas and minerals found beneath most State Forests and has the potential to impact Indiana bats and northern long-eared bats. Similarly, changing technology may introduce a wide variety of other resources (wind, solar, smaller-scale hydroelectric); all such future energy efforts are excluded from coverage by the State Lands Forestry HCP.	PGC and DCNR requires energy developers to comply with all applicable state and federal laws, including the ESA.

HCP = habitat conservation plan; USFWS = U.S. Fish and Wildlife Service; EPA = U.S. Environmental Protection Agency; PGC = Pennsylvania Game Commission; DCNR = Pennsylvania Department of Conservation and Natural Resources: ESA = Endangered Species Act

Chapter 3
Environmental Setting

3.1 Introduction and Environmental Setting

This chapter presents an overview of the physical and biological setting for the State Lands Forestry HCP. The chapter describes baseline conditions for the entire plan area (State of Pennsylvania), where conservation actions, monitoring, and future acquisitions might take place; and the permit area (State Lands), where covered activities occur (Section 2.2, *State Lands*). The effects analyses (Chapter 4, *Effects of Covered Activities*) and conservation strategy (Chapter 5, *Conservation Program*) are based, in part, on the information in this chapter.

The physical components of the plan area's environmental setting influence the distribution of Indiana bats and northern long-eared bats and provide context for evaluating effects and developing conservation actions for the State Lands Forestry HCP.

The biological setting of the permit area is described in terms of the ecosystems, vegetation types, and the specific distribution and habitat requirements of covered bat species. The sections on the ecology and distribution of the Indiana bat and northern long-eared bat include a discussion of habitat models for both species in Pennsylvania during summer, fall/spring, and winter. These models vary by habitat type and range from a simple set of assumptions to a complex analysis. The habitat models are then used to estimate species densities throughout the permit area.

The physical components of Pennsylvania's environmental setting influence the distribution of Indiana bats and northern long-eared bats and provide a context for evaluating effects and developing conservation actions for the State Lands Forestry HCP. The following sections describe the physical attributes of the plan area.

3.1.1 Location

The permit area comprises State Game Lands (1.5 million acres), State Forests (2.2 million acres), and State Parks (approximately 300,000 acres) throughout Pennsylvania (Chapter 1, *Introduction*, Figure 1-1). State Game Lands and State Parks are interspersed throughout much of Pennsylvania, while most State Forests are in the central part of the state.

State Game Lands are present in 65 of Pennsylvania's 67 counties. State Forests are present in 48 counties and account for 12 percent of the forested area in the state (Commonwealth of Pennsylvania 2007). State Parks are present in 60 of the 67 counties.

3.1.2 Topography

Pennsylvania has a diverse topography, ranging from low-relief areas near the cities of Philadelphia and Erie to rugged mountains in the center associated with the eastern continental divide (Figure 3-1). In general, elevations increase from the southeast (near Philadelphia) to the northwest, peaking along the Allegheny Front and Allegheny Mountains, and descending into the Ohio River in the southwest or into Lake Erie in the northwest. These mountains partition the state into the Gulf of

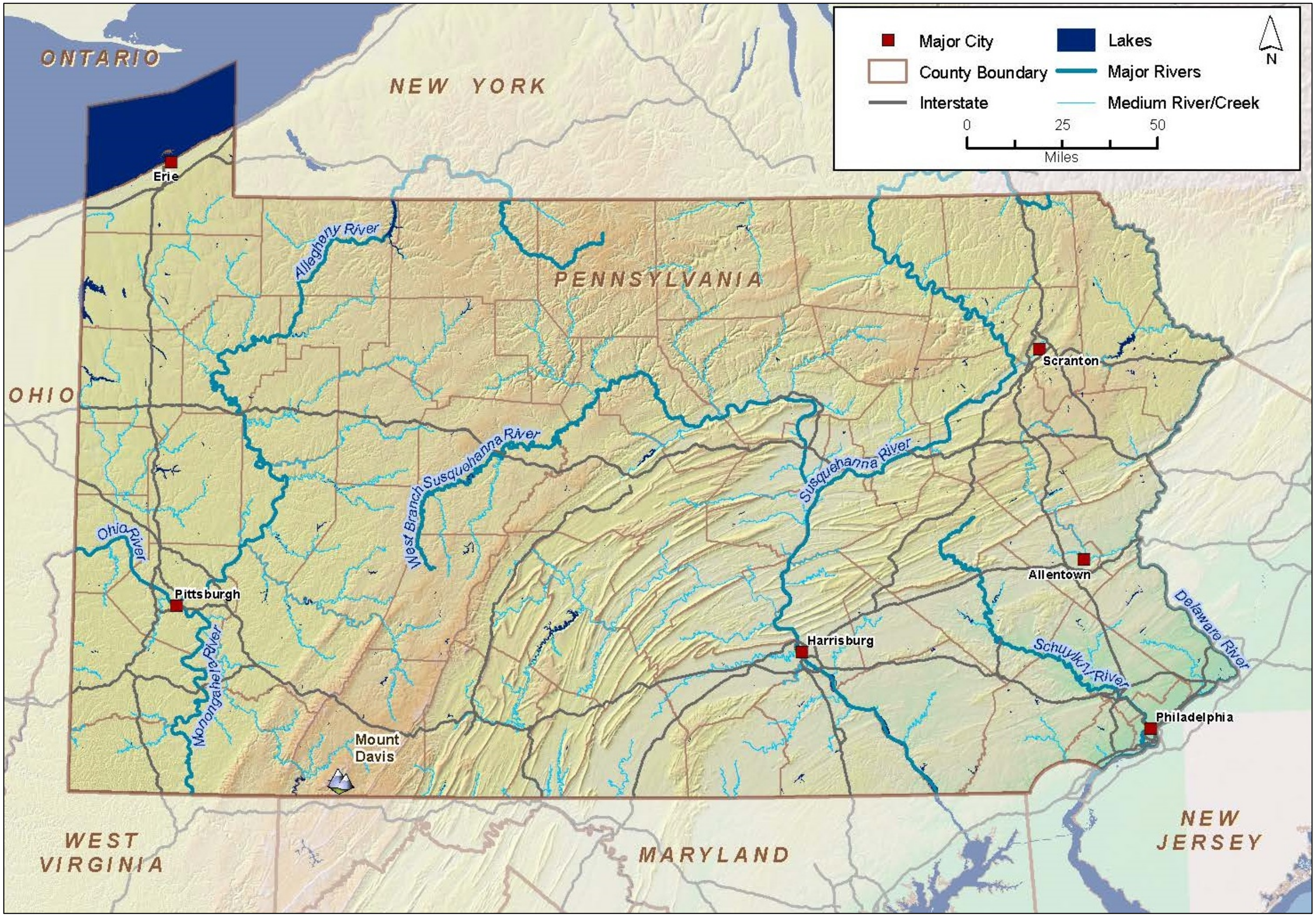


Figure 3-1. Topography and Major Water Features of Pennsylvania

Mexico watershed in the west and the Atlantic Seaboard watershed in the east. The lowest elevations are those along the Delaware River in eastern Pennsylvania, which reach sea level just south of Philadelphia. The highest point in Pennsylvania is Mount Davis at 3,213 feet, which is in Forbes State Forest in Somerset County near the Garrett County, Maryland, border.

3.1.3 Geology and Physiography

Physiographic provinces are geographic regions with similar subsurface rock types and terrain and that have been shaped by a common geologic history. Pennsylvania has six major physiographic provinces (Figure 3-2): the Atlantic Coastal Plain, Central Lowlands, Piedmont, Ridge and Valley, New England, and Appalachian Plateaus. Table 3-1 lists acres of State Lands for each province.

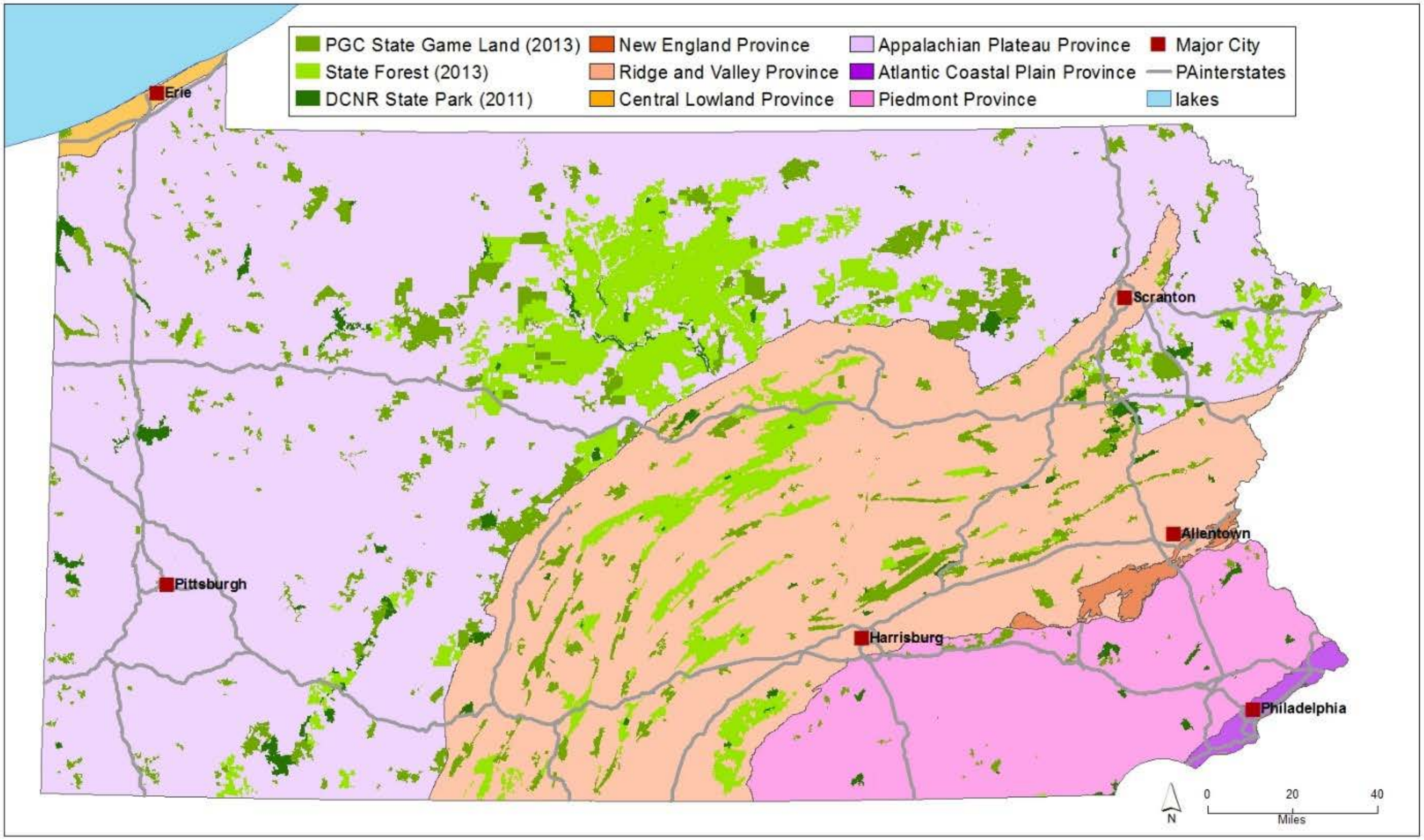
Table 3-1. Acres of State Lands within the Six Physiographic Provinces

Province	State Game Lands	State Forests	State Parks
Atlantic Coastal Plain	0	96	627
Central Lowland	3,444	0	2,126
Piedmont	35,275	677	32,270
Ridge and Valley	470,249	618,479	61,778
New England	627	33	47
Appalachian Plateaus	1,026,282	1,541,415	200,498
Total Acres	**1,535,877**	**2,160,700**	**297,346**

Source: Pennsylvania Department of Conservation and Natural Resources 2010a

3.1.3.1 Atlantic Coastal Plain Province

A small portion of the Atlantic Coastal Plain Province follows the Delaware River from Woodside in Bucks County to the Delaware/Pennsylvania border in extreme southeastern Pennsylvania. In Pennsylvania, this province is a flat terrace split by short streams in narrow, steep-sided valleys. The surface is underlain by gravel and sand associated with a previous history of inundation. Elevations in the province range from sea level to 200 feet. Most of this landscape is heavily affected by urban uses associated with the Philadelphia metropolitan area. Therefore, the area has few natural habitats for bats during summer and underground resources for winter are restricted to storm and sanitary sewers. The province has no State Game Lands, 627 acres of State Parks, and 96 acres of State Forests.



Source: Pennsylvania Department of Conservation and Natural Resources 2010a.

Figure 3-2. Physiographic Provinces in Pennsylvania

3.1.3.2 Central Lowland Province

A similar area of depositional structures is present in a narrow strip bordering Lake Erie in the northwest portion of the State. This beachfront area is part of the Eastern Lake Section of the Central Lowlands Province. Elevations range from 570 to 1,000 feet. The area is characterized by low-relief ridges made of sand and gravel. Much like the Atlantic Coastal Plain, this province is heavily affected by urbanization associated with the Erie metropolitan area. Urbanization, combined with a lack of caves and mines in the area, results in little potential for use by Indiana bats except during migration. Northern long-eared bats may be present during summer, and underground infrastructure (such as storm sewers) may provide limited winter habitat. The province has 3,444 acres of State Game Lands, 2,126 acres of State Parks, and no State Forests.

3.1.3.3 Piedmont Province

The Piedmont Province comprises the Piedmont Upland, Piedmont Lowland, and Gettysburg-Newark Lowland Sections. The Piedmont Upland Section consists of broad, gently rolling hills and valleys. This section rests on metamorphic rock called schist. Elevations in this section range from 100 to 1,220 feet. The Piedmont Lowland Section consists of broad, moderately dissected valleys separated by broad low hills. This section rests on limestone and dolomite. Elevations in this section range from 60 to 700 feet. The Gettysburg-Newark Lowland Section consists of rolling, low hills, and valleys rested on red, sedimentary rock. Elevations in this section range from 20 to 1,355 feet. This province has dendritic drainage patterns, creating floodplains and wetlands. The Piedmont Province is also part of the Chesapeake Bay drainage basin. Due to its proximity to Philadelphia, the human population in this province is high. Some counties are less densely populated than others are, but as a whole, this is one of the most populous areas in the state. Areas not urbanized are heavily farmed. The province has 35,275 acres of State Game Lands, 32,270 acres of State Parks, and 677 acres of State Forests. State Lands in heavily developed or farmed landscapes can play a critical role as a migratory stopover for multiple bat species.

In this region, colonies of Indiana bats have been found associated with areas dominated by agriculture. This includes colonies found at the edges of agricultural fields, and colonies of bats occurring in woodlands surrounded by agriculture similar to those found in New York state (Watrous et al. 2006) and the agricultural Midwest (Weber and Sparks 2013).

Few summer surveys have been completed in this region for northern long-eared bats; however, limited survey data indicate that northern long-eared bats were once relatively common in remaining woodlands scattered throughout the Province, as illustrated by captures of reproductive bats at 1,293 locations. Modeled high quality habitat discussed in Section 3.5.4.3, *Summer,* and Appendix H, *Habitat Distribution Modeling Using MaxEnt*, indicates unsuitable mixed agricultural land cover surrounding patches of highly suitable woodland. The area contains many karst features that may serve as hibernacula for northern long-eared bats. There are seven known hibernacula for the species within the region.

3.1.3.4 Ridge and Valley Province

The Ridge and Valley Province comprises seven sections: South Mountain, Great Valley, Blue Mountain, Anthracite Upland, Anthracite Valley, Appalachian Mountain, and the Susquehanna Lowland Sections. Elevations in the province range from 140 feet in the Great Valley Section to 2,775 feet in the Appalachian Mountain Section. As the name implies, the province consists of a series of ridges separated by valleys. In general, the ridges are primarily forested, with agricultural and urban development more common in the valleys. The Ridge and Valley Province is rich in karst features and contains Pennsylvania's anthracite region. Therefore, the province provides numerous caves and abandoned anthracite mines, including several that bats are known to use. The province has 470,249 acres of State Game Lands, 61,778 acres of State Parks, and 618,479 acres of State Forests.

Known Indiana bat hibernacula are present in the Appalachian Mountain and Anthracite Valley Sections. Although summer colonies of Indiana bats have rarely been discovered in the region, there is abundant forest for roosting and areas with more open land classes that could be used for foraging. Section 3.5.4.3, *Summer,* provides a model of potential Indiana bat distribution illustrating that colder, rainier areas (including ridge-top portions of this province) are less suitable for the species. Urban and suburban land classes in the Scranton/Wilkes-Barre population centers also provide less-suitable summer habitat. However, the scarcity of summer records might also indicate that Indiana bats were never at carrying capacity in the entire state even before WNS.

Northern long-eared bats are regularly captured along the forested ridges of the Ridge and Valley Region. Numerous summer occurrences have been recorded from this area, which contains abundant forest for roosting, as well as areas with more open land classes that could be used for foraging. The habitat distribution model outlined in Section 3.5.4.3, *Summer,* and Appendix H, *Habitat Distribution Modeling Using MaxEnt*, indicates substantial suitable habitat along the ridges with lower-quality areas in the developed valleys. The region contains many karst features which may serve as hibernacula. There are 69 known hibernacula for the species within the Ridge and Valley Region.

3.1.3.5 New England Province

Sandwiched between the Piedmont and the Ridge and Valley provinces of southeastern Pennsylvania is a small segment of the New England Province called the Reading Prong Section. The New England Province in Pennsylvania consists of rounded, low hills or ridges that typically rise 300 to 600 feet above the surrounding landscape and are underlain by granodiorite and quartzite. The province has 627 acres of State Game Lands, 47 acres of State Parks, 33 acres of State Forests.

The area has many small caves, but no known Indiana bat hibernacula. The presence of forest on the ridges provides potential roosting habitat for Indiana bats during summer or migration.

Based on the Habitat Distribution Tool outlined in Section 3.5.4.3, *Summer,* and Appendix H, *Habitat Distribution Modeling Using MaxEnt*, a good deal of highly suitable habitat occurs in the region, interspersed with low-suitability habitat. Limited historic information regarding northern long-eared bats is available from this region, with no captures recorded since 2000. Two hibernacula are recorded on the easternmost edge of the region. The area contains many karst features which may serve as undocumented hibernacula.

3.1.3.6 Appalachian Plateaus Province

Approximately three-fifths of the state is in the Appalachian Plateaus Province, which is further divided into 10 sections: Glaciated Pocono Plateau, Glaciated Low Plateau, Glaciated High Plateau, Allegheny Front, Allegheny Mountain, Deep Valleys, Pittsburgh Low Plateau, Waynesburg Hills, High Plateau, and Northwestern Glaciated Plateau Sections. Across these sections, elevations range from 660 to 3,213 feet. The Appalachian Plateau is essentially an erosional plain underlain by a wide variety of sedimentary rocks, including sandstone, shale, and conglomerate rocks. There are multiple areas of karst terrain, and the province provides an important source of energy (coal, natural gas, and oil). The province has 1,026,282 acres of State Game Lands, 200,498 acres of State Parks, and 1,541,415 acres of State Forests.

Indiana bats are known to hibernate in naturally occurring caves and abandoned limestone mines in the region. The presence of coal under much of the Appalachian Plateau is an important resource for bats because there are also known hibernacula associated with abandoned coal mines in this province. Summer habitat is widely distributed through the region, which contains five of the 15 counties in the state with known summer occurrences of Indiana bats.

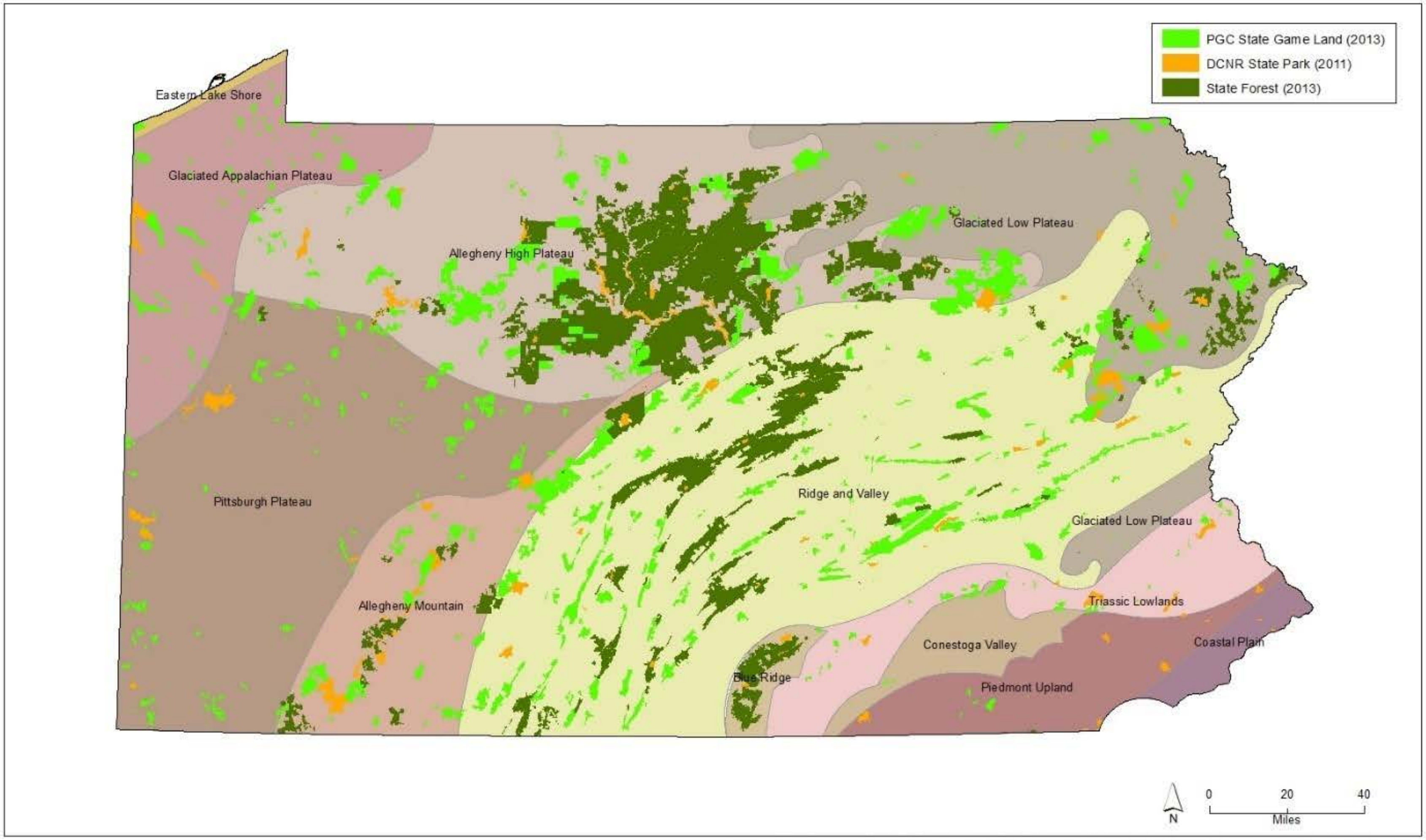
Northern long-eared bats are regularly captured along the forested areas of the region. Numerous historic summer occurrences have been recorded there, where abundant forest can be used for roosting, and areas with more open land classes could be used for foraging. The Habitat Distribution Tool outlined in Section 3.5.4.3, *Summer,* and Appendix H, *Habitat Distribution Modeling Using MaxEnt*, indicates a good deal of abundant, highly suitable forest in the region, with moderate amounts of low-suitability habitat. As noted, the area contains many karst features, limestone, and coal mines that may serve as hibernacula. The region contains 41 known hibernacula for the species, many occurring in the central to west-central area.

3.1.4 Soils

Pennsylvania has 12 soil regions (Figure 3-3): Eastern Lake Shore, Glaciated Appalachian Plateau, Allegheny High Plateau, Glaciated Low Plateau, Pittsburgh Plateau, Allegheny Mountain, Ridge and Valley, Blue Ridge, Triassic Lowlands, Conestoga Valley, Piedmont Uplands, and Coastal Plain. Soil types affect bats primarily by rendering an area suitable or unsuitable for agricultural purposes. While Indiana bats and northern long-eared bats can exist in heavily farmed landscapes, extensive expanses between woodlots can inhibit travel between roosting sites. Wooded fencerows and streams linking these remnants can provide adequate travel corridors for increased use by both species. Remnant forests on State Lands can provide valuable refugia in these areas.

Eastern Lake Shore Region soils are found on the shores of Lake Erie. They developed into beach sand and lacustrine silts and clays. The beach sand is mostly sandy and gravelly, with rapid drainage. The lacustrine soils have few rock fragments, and have moderate root zone water-holding capacity. This region has a mild climate due to its proximity to Lake Erie. This area historically produced many fruits and vegetables, including truck-garden produce. Cultivation of grapes has replaced diversified farming. The area has also been extensively developed by the Erie Pennsylvania metroplex.

Glaciated Appalachian Plateau soils are derived from glacial till. Water percolates slowly through the soil. Fragipans can be present, which results in no penetration of roots and slow water movement. These conditions have a tendency to create wetland soils. Rock fragments can be present, depending on the proximity of the glacial till to the surface. Soils in this area are highly productive when drained; therefore, it is typical in this region to find extensively farmed areas adjacent to wetland and forest complexes.



Source: Digitized by hand from Duiker 2017.

Figure 3-3. Soil Regions in Pennsylvania

Allegheny High Plateau soils are developed primarily from sandstone. Soils in this region are sandy loam in texture, and well drained because of the abundant sand, shallow soil, steep terrain, and many rock fragments, all challenges to agriculture. High elevation also presents two other challenges to agriculture: the region has a short growing season and soils are highly erodible. The region is extensively forested, with only occasional agricultural activity focused on potato and pastoral production.

Glaciated Low Plateau soils are derived from glacial till. Soil texture here is mostly silt loam. Some soils have a fragipan at shallow depth, resulting in poorly drained soils. Rock fragments are common. Root zones can be very low, which makes water-holding capacity low. The growing season is short, and agriculture consists of grassland and pastoral areas.

Pittsburgh Plateau soils were developed in acid clay shale and interbedded shale and sandstone. Soils in this region contain more clay and silt than those derived from sandstone. Soil texture in this region is mostly silt loam. The soils usually are well drained. Erosion is a concern due to steep slopes. Rock fragments are common in the soil. Root zone water-holding capacity is moderate. Soils in the southwestern section of the region tend to be deeper, with higher water-holding capacity. Agriculturally, the most productive area is in the southwest of this region and includes a mix of row crops and pasture.

Allegheny Mountains soils were developed in sandstone. The soil texture is sandy loam to loamy sand. Drainage is good, and erosion is high due to steep slopes. Root zone water-holding capacity is low due to rock fragments. Much of this area is under forest vegetation, although there are some important agricultural areas in the valleys.

Ridge and Valley soils were developed in a landscape of sandstone ridges, shale footslopes, and shale and limestone valleys. Sandy loam soils are present on the ridgetops. Colluvial soils, a mixture of sandstone and shale, are present on the slopes. Limestone-derived soils are present in the valleys, along with some shale-derived soils. Limestone soils are very productive, are usually deep and well drained, and have high root zone water-holding capacity due to few rock fragments. Shale soils are less productive due to acidity, steep slopes, and low root zone water-holding capacity. The valley soils are used intensively for agriculture.

Blue Ridge soils were derived from igneous and metamorphic rocks. These soils are well drained and silt loam in texture. Rock fragments are common, and root zone water-holding capacity is moderate. Steep slopes provide high erosion potential. The high elevations in this region mean the growing season is short and ensures that much of this land remains as forest.

The Piedmont is the most heavily farmed region of Pennsylvania, partly because of its relatively mild climate, abundant water resources, low topography, and three regions of fertile soils. Triassic Lowlands soils developed in reddish sandstone, shale, and siltstone. The texture of these soils is usually silt loam on slopes and is well drained. Some soils are on level land and poorly drained. Water-holding capacity is moderate. Rock fragments are substantial. The Conestoga Valley soils are predominately limestone derived. Soil textures are silt loam at the surface and clayey underneath. Erosion potential is low, rock fragments are rare, soils are well drained, and the root zone water-holding capacity is moderate to high. The Piedmont Upland soils are derived from metamorphic rock. Soils are well drained and silt loam in texture. Slopes are steep, making erosion potential moderately high. Rock fragments are scarce and water-holding capacity is moderate to high. The entire Piedmont Section of Pennsylvania is heavily farmed; row crops and hay are common products.

Coastal Plain soils developed from coastal sands. Soils are well drained and sandy in texture. Erosion potential is low, rock fragments are few, and root zone water-holding capacity is moderate due to sandy soils. Most of this area is occupied by Philadelphia and its suburbs.

3.1.5 Climate

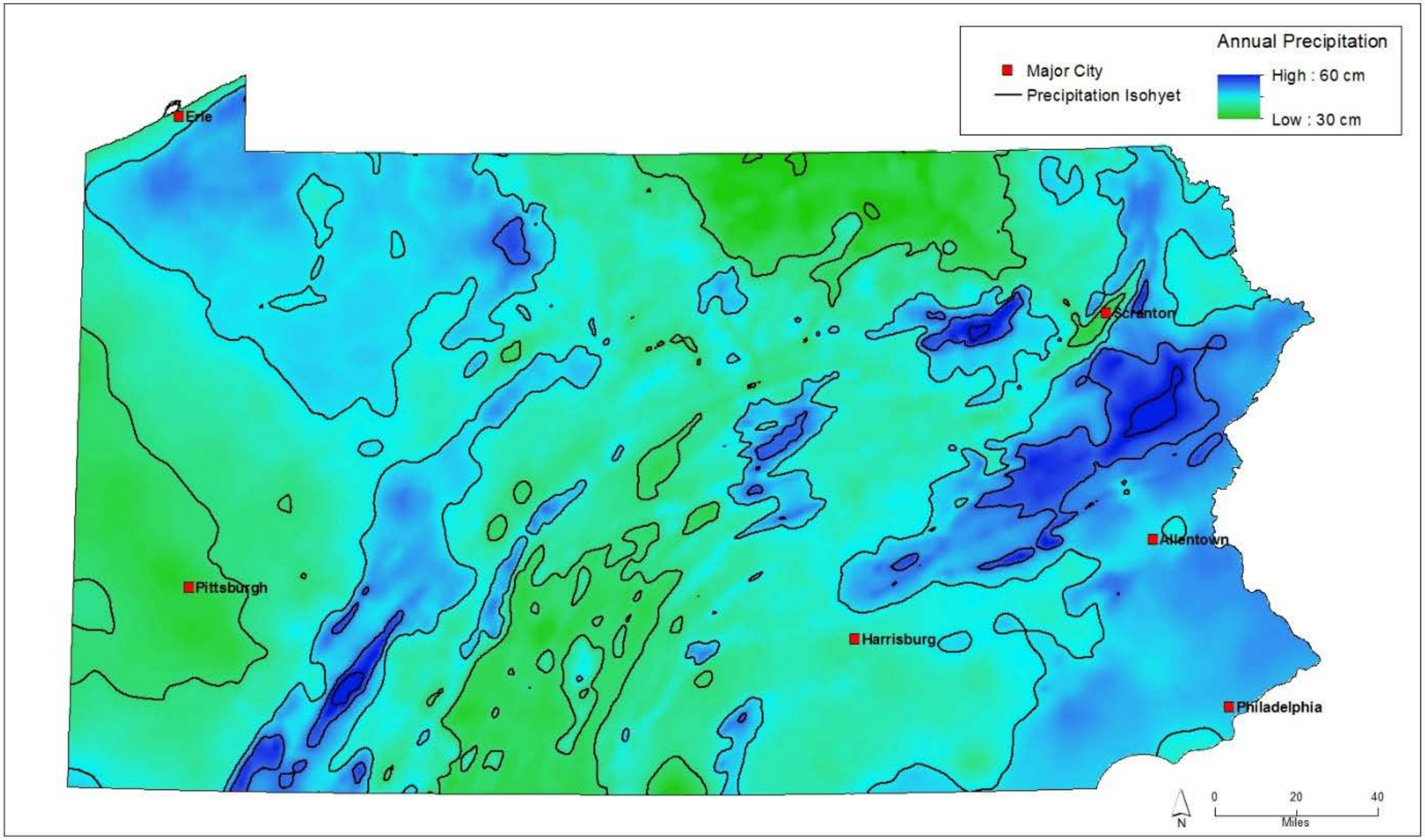
The climate of Pennsylvania can generally be considered humid continental, but physiographic features affect weather and climate in various sections of the state. Humid continental is a climatic region defined by large seasonal differences in temperature, with hot summers and cold winters (The Pennsylvania State Climatologist Undated). Prevailing westerly winds cause most of the weather disturbances from the interior of the continent. The Atlantic Ocean has a limited effect on the climate of the state; some coastal storms affect day-to-day weather, especially in the eastern regions.

Temperatures typically range from 0 to 100°F. In the mountains, 47°F is the yearly average, with warmer temperatures of approximately 57°F in the extreme southeast. The highest recorded temperature was 111°F in 1936; the lowest was -42°F in 1904. Summers average 68°F along Lake Erie, 74°F in the southeast. Highs of 90°F or above occur an average of 15 days a year for most of the state, up to 35 days in the southeast, and as few as 3 days in the northwest. Freezing temperatures average 100 or more days per year. Annual average precipitation ranges from 34 to 52 inches, with most—38 to 46 inches—in spring and summer. Thunderstorms average 30 to 35 per year. Most snow comes from northeastern-moving storms. Snow can be 20 inches or more, sometimes up to 100 inches or more in the north and mountains. Twenty inches per year is the average snowfall in the southeast, whereas 90 inches is the average for McKean County in the northwest. Pennsylvania averages 16 tornadoes per year (National Oceanic and Atmospheric Administration 2010).

Pennsylvania has four climatic areas: Southeastern Coastal Plain and Piedmont Plateau, Ridge and Valley Province, Allegheny Plateau, and Lake Erie Plain. The Southeastern Coastal Plain and Piedmont Plateau area has long summers that are uncomfortable at times. Winters are generally mild, averaging less than 100 days with above-freezing temperatures. Average precipitation is 30 inches in lower Susquehanna County to 46 inches in Chester County, with an average of 30 inches of snow per year. The Ridge and Valley area has mountains that cause a flux in extremes. The Susquehanna Valley has the longest growing season in the state. Average precipitation is 3 to 4 inches more than in the Southeastern Coastal Plain area. Snow can range from an average of 88 inches in Somerset County to 37 inches as the other extreme. The Allegheny Plateau area exhibits typical continental climate. Precipitation averages 41 inches, with 54 inches of snow. The Lake Erie Plain area averages 34.5 inches of precipitation, and snow exceeds 72 inches per year (Figure 3-4).

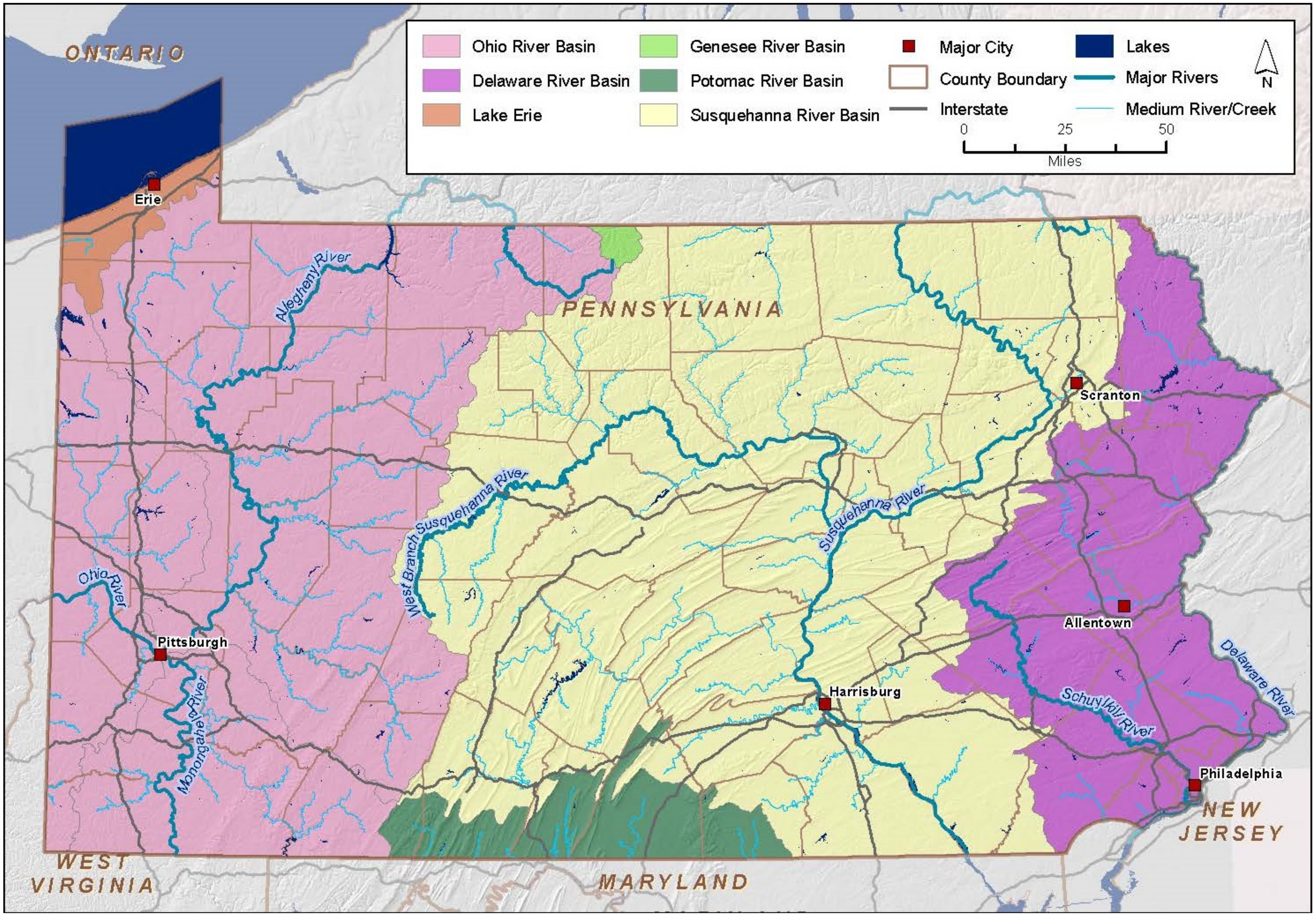
3.1.6 Hydrology

Pennsylvania has an estimated 86,000 miles of rivers and streams and 161,455 acres of lakes (Figure 3-5). The state has 63 miles of Lake Erie shoreline and 403,924 acres of freshwater wetlands, and an additional 412 acres of tidal wetlands and 10,880 acres of the Delaware Estuary. The six major river basins in Pennsylvania are the Delaware, Susquehanna, Genesee, Potomac, Ohio, and Lake Erie basins (Pennsylvania Department of Conservation and Natural Resources 2014). Hydrology is important to the ecology of all species of bats because it influences and shapes habitats of wetlands, floodplains, and waterways used by roosting, foraging, and traveling bats (Carter 2006).



Source: PRISM Climate Group 2013

Figure 3-4. Precipitation Isohyets for Pennsylvania, 1981–2010



Source: Pennsylvania Department of Conservation and Natural Resources 2014

Figure 3-5. Streams, Rivers, and Lakes in Pennsylvania

3.1.6.1 Delaware River Basin

The Delaware River basin in eastern Pennsylvania extends 13,539 square miles over four states, with 6,422 square miles in Pennsylvania (Pennsylvania Department of Conservation and Natural Resources 2010b). The 330-mile river starts at the confluence of the east and west branches in Hancock, New York. Important tributaries in Pennsylvania include the Schuylkill, Lackawaxen, and Lehigh Rivers, and the basin includes the following major cities in Pennsylvania: Allentown, Bethlehem, Easton, Philadelphia, Pottsville, Pottstown, and Reading. Water from the Delaware River is used for agriculture, industry, power generation, recreation, tourism, resource extraction, fishing, shipping, discharge of treated wastewater, and especially drinking water. The Delaware River basin is home to 7.8 million people (including 4.9 million Pennsylvanians), but water from the Delaware River basin is the primary source of drinking water for 15 million people.

3.1.6.2 Susquehanna River Basin

The Susquehanna River basin is in the center of Pennsylvania (Figure 3-5). The Susquehanna River starts at Otsego Lake in Cooperstown, New York, ends in the Chesapeake Bay, and drains approximately one-half (20,960 square miles) of Pennsylvania (Pennsylvania Department of Conservation and Natural Resources Undated (a)). Water drawn from the Susquehanna is used for many purposes with 79 percent being used for thermoelectric, 13 percent for public drinking water, 5 percent for industrial purposes, and 3 percent for agriculture, mining, and commercial purposes (Pennsylvania Department of Conservation and Natural Resources Undated (a)). There are 110.5 miles of designated scenic rivers within the Susquehanna River basin, including parts of Pine Creek, Lick Run, Stony Creek, Yellow Breeches Creek, LeTorte Spring Run, Tucquan Creek, and Octoraro Creek (Pennsylvania Department of Conservation and Natural Resources Undated (a)).

3.1.6.3 Genesee River Basin

The headwaters of the Genesee River are in Potter County Pennsylvania, and the river flows northward through New York State into Lake Ontario (Pennsylvania Department of Conservation and Natural Resources Undated(b)). Most of the river is in New York, with only approximately 100 square miles of drainage in Pennsylvania. As such, the river is little used in Pennsylvania.

3.1.6.4 Potomac River Basin

Portions of southern Pennsylvania are within the Potomac River basin (Figure 3-5). The Potomac River itself flows from West Virginia to Maryland without entering Pennsylvania, but many of the small streams of southern Pennsylvania eventually drain into the Potomac River (Pennsylvania Department of Conservation and Natural Resources 2010c). The basin encompasses 1,584 square miles, including the basins of Antietam and Conococheague Creeks. Water from the Potomac River and its tributaries is used for drinking water (especially in the District of Columbia), recreation, industry, and agriculture (Pennsylvania Department of Conservation and Natural Resources 2010c).

3.1.6.5 Ohio River Basin

The Ohio River basin is in the western portion of Pennsylvania (Figure 3-5). It starts at the confluence of the Allegheny and Monongahela Rivers in Pittsburgh, Pennsylvania, is 981 miles long, and drains 203,940 square miles over 15 states before joining the Mississippi River near Cairo, Illinois (Pennsylvania Department of Conservation and Natural Resources Undated (b)). It is the second largest basin in Pennsylvania, encompassing 15,614 square miles. Approximately 25 million people live in the Ohio River basin, including 3.5 million in Pennsylvania. Waters from the Ohio River and its tributaries are among the most heavily used in the country, with 43 billion dollars of material being transported on the river each year and 121 companies located directly on the river in Pennsylvania (Pennsylvania Department of Conservation and Natural Resources Undated (b)). Other important uses include utility and thermoelectric production, industry, public consumption, agriculture, commercial, and mining (Pennsylvania Department of Conservation and Natural Resources Undated (b)).

3.1.6.6 Lake Erie Basin

The Lake Erie basin is in the northwestern corner of Pennsylvania and contains 511 square miles of land along with 750 square miles of Lake Erie itself (Pennsylvania Department of Conservation and Natural Resources 2010d). This area is home to approximately 240,000 people and includes the metropolitan area of Erie, Pennsylvania. There are no major rivers in the Pennsylvania portion of the drainage, although it is home to multiple smaller streams, including Conneaut Creek, Crooked Creek, Elk Creek, Mill Creek, Six Mile Creek, Sixteen Mile Creek, and Walnut Creek that drain into Lake Erie (Pennsylvania Department of Conservation and Natural Resources 2010d). Important water uses include shipping, commercial and sport fishing, recreation, and drinking water. The Erie water treatment plant treats approximately 30 to 40 million gallons of wastewater daily, all of which is discharged into Lake Erie (Pennsylvania Department of Conservation and Natural Resources 2010d).

3.2 Ecosystems and Vegetation Types

State Lands account for almost 14 percent of Pennsylvania's 29,475,200-acre area. As land management agencies, both PGC and DCNR have developed and are striving to maintain an updated inventory of habitats across their parks, game lands, and forests. At present, highly detailed data are available for the entire DCNR system and for approximately half the State Game Lands; however, large-scale projects such as the State Lands Forestry HCP require data at the landscape level. For this reason, data on ecosystems and vegetation types for the State Lands Forestry HCP are based on the Northeast Terrestrial Habitat Classification System (Classification System) (Gawler 2008), a product of the Northeast Terrestrial Habitat Mapping Project undertaken in 2008 by the Northeast Association of Fish and Wildlife Agencies.

The Classification System covers 13 states in the northeast Atlantic coastal region of the United States, and its main goal is to provide a common and consistent framework for habitat and ecosystem classifications at multiple scales across the region.

The Habitat Systems component of this dataset is based on the ecosystem classifications originally created by NatureServe, with the addition of classes used to describe highly developed and altered lands. There are 143 Habitat Systems in the Classification System, but they are grouped into 35 broader-scale "macro-groups" based on the U.S. National Vegetation Classification standard.

The Terrestrial Habitat Map is a 30-meter grid map of the upland and wetland wildlife habitats/ecological systems for the Northeastern region of the country. This classification scheme is primarily based on the occurrence of plant community types within the landscape with similar ecological processes (Comer et al. 2003), rather than the common classification scheme based on land cover type. This is achieved by combining the many existing and currently used classification and mapping products. The National Land Cover Database and the U.S. Geological Survey Gap Analysis Program data were used in conjunction with the National Vegetation Classification System to generate a more detailed classification scheme.

This data set is consistent across the entire plan area and will allow a standardized geographic metric for analysis. Table 3-2 lists the vegetation types in Pennsylvania based on the Classification System. The Classification System used in the State Lands Forestry HCP is at a coarser (30-meter pixel) scale than data obtained and field-verified by the agencies. As a result, very small habitat features cannot be resolved within the Classification System. For the purposes of understanding the relationship between DCNR Bureau of Forestry data and the Classification System used by the State Lands Forestry HCP, Table G-1 (Appendix G, *Vegetation Crosswalk*) crosswalks the two data sets.

Table 3-2. Acres of Vegetation Types and Miles of Mapped Streams on State Lands in Pennsylvania (2013)[a]

Habitat Type	State Game Lands	State Forests	State Parks
Agriculture[b]	37,177	3,571	11,078
Swamps and marsh	55,332	19,992	11,170
Oak/pine forest	687,397	1,120,989	108,339
Rocky outcrops	15,672	111,040	11,285
Grasslands	16,665	9,488	1,714
Northern hardwoods/ coniferous forest	666,256	850,903	106,560
Open water	22,608	2,792	33,175
Developed urban	34,781	41,955	14,540
Total Acres	**1,535,888**	**2,160,730**	**297,861**
Streams & rivers (miles)	3,869	4,895	1,005

[a] Source: Gawler 2008
[b] Due to the scale of the land cover dataset, some mapping errors (e.g., lands calculated as agriculture) are expected.

According to the Classification System, there are 15 habitat macro-groups in Pennsylvania:

- Agricultural
- Central hardwood swamp
- Central oak-pine
- Cliff and talus
- Coastal grassland and shrubland
- Coastal plain swamp
- Emergent marsh
- Glade and savanna
- Northern hardwood and conifer
- Northern peatland

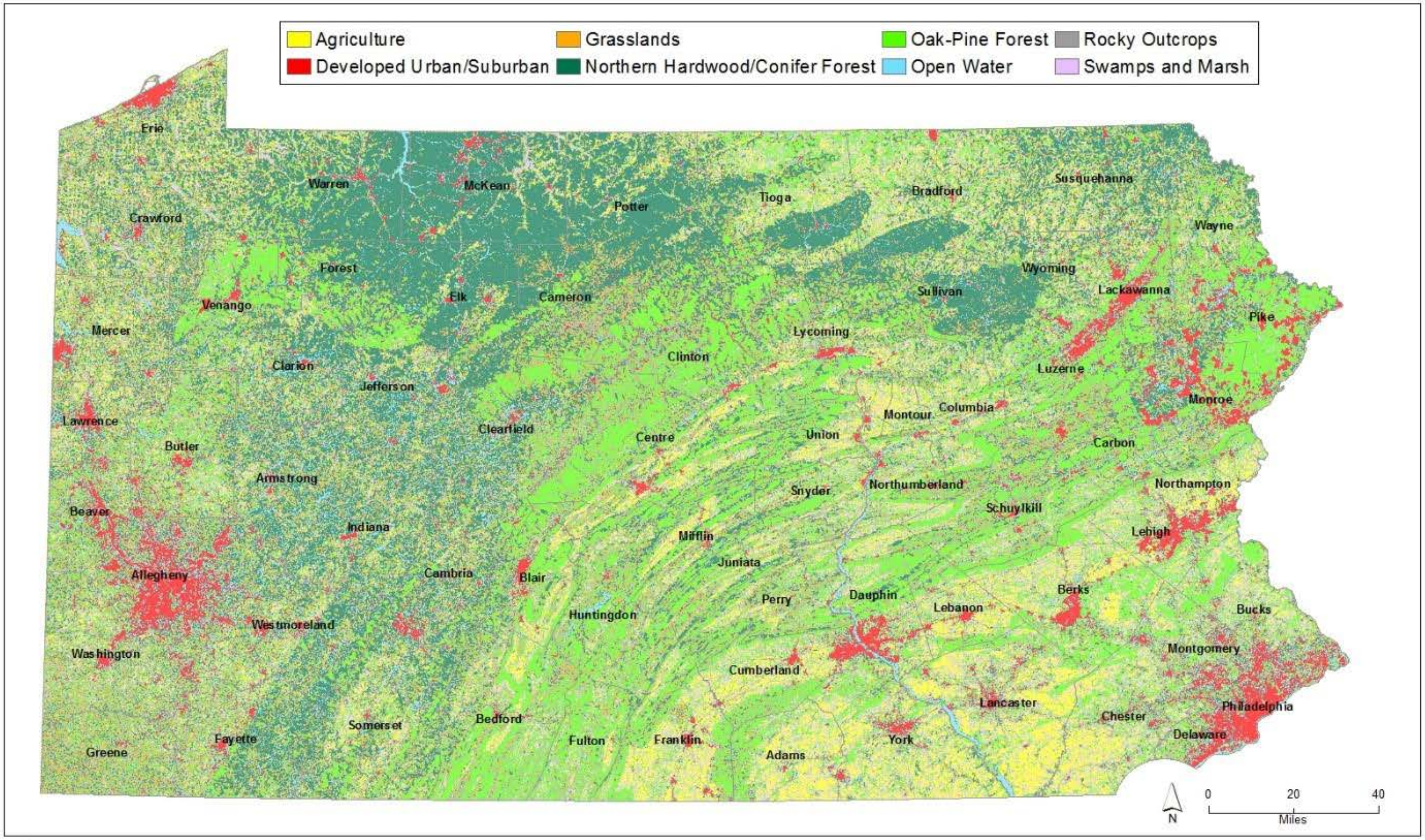
- Northern swamp
- Ruderal shrubland and grassland
- Urban/suburban built
- Water
- Wet meadow/shrub marsh

Based on similarities of structure and use by bats, these were further condensed into eight macro-groups for the purposes of the State Lands Forestry HCP (Table 3-3, Figure 3-6). In most cases, categories that were combined are relatively small components of the Pennsylvania landscape. In some cases (i.e., rocky outcrops and oak/pine forest) names were simplified to make the category more intuitive.

The State Lands Forestry HCP refers to these macro-groups as vegetation types (Table 3-4). They are used in the habitat distribution model developed for summer habitat for Indiana bats and northern long-eared bats.

Table 3-3. Crosswalk of HCP Vegetation Macro-Groups and Comer et al. 2003

HCP Vegetation Macro-Groups	Original Macro-Groups (Comer et al. 2003)
Agriculture	Agriculture
Developed urban/suburban	Developed urban/suburban
Grasslands	Coastal grassland and shrubland Glade and savanna Ruderal shrubland and grassland
Northern hardwoods/coniferous forest	Northern hardwood/conifer forest
Oak/pine forest	Central oak-pine
Open water	Open water
Rocky outcrops	Cliff and talus
Swamps and marsh	Central hardwood swamp Coastal plain swamp Northern peatland Northern swamp Emergent marsh Wet meadow/shrub marsh



Source: Adapted from Gawler 2008

Figure 3-6. Vegetation Types in Pennsylvania

Table 3-4. Vegetation Types in Pennsylvania and State Lands

	Pennsylvania		State Lands	
Vegetation Type	**Acres**	**Percent**	**Acres**	**Percent**
Agriculture	7,176,042	25	51,826	1
Developed Urban	3,406,753	12	91,276	2
Grasslands	278,854	1	27,867	1
Northern Hardwoods/Coniferous Forest	8,906,636	31	1,623,719	41
Oak/Pine Forest	8,148,872	28	1,916,725	48
Open Water	391,736	1	58,575	12
Rocky Outcrops	214,763	1	137,997	3
Swamps and Marsh	468,021	1	86,494	2
Totals	**28,991,677**	**100**	**3,994,479**	**100**

Note: Due to rounding to the nearest whole number, discrepancies may appear in the table.

3.2.1 Agriculture

Agriculture covers approximately 25 percent (7,176,041 acres) of Pennsylvania. This vegetation macro-group includes all cultivated crops, including annual-cycle crops (corn, potatoes, small grains, oilseed crops, other vegetables, and flowers) and perennial or more stable land cover crops such as orchards, vineyards, nurseries, and Christmas tree farms. Hayfields and livestock pastures are also included in this macro-group as a perennial, herbaceous land cover type. Hayfields and pastures are distinguished from natural grasslands based on the obvious signs of management such as fencing or enrollment in the Conservation Reserve Program. This voluntary program, initiated by the U.S. Department of Agriculture Farm Service Agency, allows agricultural producers to set aside environmentally sensitive land for conservation in exchange for rental payments and cost-share assistance from the Farm Service Agency.

Large areas of agriculture fragment the landscape, which reduces suitability for Indiana bats (U.S. Fish and Wildlife Service 2007; Weber and Sparks 2013). Murray and Kurta (2004) argued that Indiana bats moved long distances to avoid crossing open agricultural fields. However, Indiana bats have also been observed foraging along the edges of agricultural fields adjacent to forested land (Humphrey et al. 1977; LaVal et al. 1977; Brack 1983; Sparks et al. 2004; Menzel et al. 2005; Sparks et al. 2005a; Tuttle et al. 2006; Watrous et al. 2006). Thus, the value of agricultural lands to Indiana bats is likely a function of the way the agricultural site interacts with the surrounding landscape.

While northern long-eared bats will forage along the edge of agricultural land, this species more commonly forages under forest canopy. Woodlots can be valuable for this species; however, very small and very sparse woodlots with limited connectivity are of diminished value to northern long-eared bats.

3.2.2 Developed Urban/Suburban

Nearly 12 percent (3,406,752 acres) of Pennsylvania falls into the developed urban/suburban macro-group and includes areas used for low- to high-intensity residential, commercial, industrial, extraction (e.g., quarries, pits, and strip mines), and recreation.

Indiana bats avoid large blocks of development (Carter et al. 2002; Menzel et al. 2005; Sparks et al. 2005a; Sparks et al. 2005b; Weber and Sparks 2013). However, they are occasionally found occupying woodland habitat that abuts developed land and have been observed roosting in artificial structures such as buildings (Butchkoski and Hassinger 2002a; ESI 2006) and bat boxes (Butchkoski and Hassinger 2002b; Carter 2002; Butchkoski 2005; Ritzi et al. 2005; Whitaker et al. 2006) at the edge of developed areas.

Similarly, northern long-eared bats have been observed roosting in artificial structures, such as buildings and bat boxes at the edge of developed areas (Whitaker et al. 2004; Whitaker et al. 2006; Sparks et al. 2009) but they also tend to avoid large blocks of development. Areas of remnant forest within urban areas, especially areas where homes are scattered amongst forest and that are considered-low-density residential development (i.e., houses on lots greater than 1 acre) or edge, can provide adequate or even high quality roosting and foraging areas, especially when they occur near riparian zones.

3.2.3 Grasslands

The grasslands vegetation type covers less than 1 percent (278,853 acres) of the state and is a combination of the coastal grassland and shrub, ruderal grassland and shrub, and glade/savanna macro-groups. Habitats range from highly disturbed coastal grasslands and maintained utility rights-of-way to the rarely disturbed fallow fields and shrublands overrun with exotic, invasive species such as honeysuckles (*Lonicera* sp.) and multiflora rose (*Rosa multiflora*). Halfway between those extremes are the glades, oak barrens, and savannas, characterized as open-tree systems dominated by oaks with understories dominated by graminoids and shrubs. The following sections describe the primary grassland vegetation subtypes for the state.

3.2.3.1 Coastal Grassland and Shrub—Great Lakes Dune and Swale

This system occurs across the shorelines of the Great Lakes, reaching into western New York. It consists of a foredune, followed by a series of low to high dunes (uplands) and swales (wetlands). The system is often best developed where post-glacial streams entered an embayment and provide a dependable sand source. The combination of along-shore currents, waves, and winds forms foredunes along the shoreline. The foredunes of most dune-and-swale complexes are commonly 3.3 to 6.6 feet high, with beachgrass (*Ammophila* sp.), willow (*Salix* sp.), and balsam poplar (*Populus balsamifera*) most common. The swale immediately behind the foredune is influenced by short-term variation in lake levels and can be partially or occasionally completely filled by dune sands following major storm events. These swales are usually graminoid-dominated. A low dune field with more advanced plant succession often follows the first open dunes and swales. Jack pine (*Pinus banksiana*), white pine (*Pinus strobus*), and red pine (*Pinus resinosa*) often form a scattered overstory canopy, while juniper (*Juniperus* sp.) and, on a rare occasion, bearberry (*Arctostaphylos uva-ursi*) form a dwarf shrub layer. Partly forested swales (red maple [*Acer rubrum*], alder [*Alnus* sp.], willow, northern white cedar [*Thuja occidentalis*]) can be interspersed with the back-dune ridges.

3.2.3.2 Ruderal Grassland and Shrub

Introduced shrublands are dominated by aggressive exotic species including fescue (*Festuca* sp.) honeysuckles, multiflora rose, autumn olive (*Alaeagnus umbellata*), barberry (*Berberis* sp.), privet (*Ligustrum* sp.), Russian olive (*Elaeagnus angustifolia*), and oriental bittersweet (*Celastrus* *orbiculatus*). They are primarily upland but can occur in seasonally wet situations, and most typically develop on disturbed former agricultural fields where soil structure and chemistry have been altered. Return to native species dominance requires intensive and prolonged intervention.

Powerline rights-of-way contain shrub-dominated or graminoid-dominated vegetation, with occasional areas of herb-dominated vegetation. Species composition is variable and exotic, but depends on contents of the contractor's seed mix and subsequent disturbance regimes. Some of these rights-of-way mimic early successional phases of the natural systems through which they cut, although they are artificially maintained.

Ruderal upland or old-field shrubland results from succession following virtually complete removal of native woody cover of an area, primarily on lands cleared for coal strip mining, agriculture, or pasture. Soils often show a plow layer, which alters the successional pathway and can increase the likelihood of invasions by exotic species. Lands might have been cleared decades ago or more recently, but have been maintained in a non-forested state (at least until relatively recently) and might still be annually mowed to control tree incursion. Ruderal upland or old-field shrubland is generally characterized by unnatural combinations of native and alien species. In Pennsylvania, they most commonly take the form of fields dominated by pasture grasses plus early-successional native or introduced forbs, including goldenrods (*Solidago* sp.), asters (*Aster* sp.), Queen Anne's lace (*Daucus carota*), black-eyed Susan (*Rudbeckia hirta*), hawkweeds (*Hieracium* sp.), and teasel (*Dipsacus* sp.), usually with some shrub component of raspberries (*Rubus* sp.), spiraea (*Spiraea* spp.), shrub dogwoods (*Cornus* sp.), or viburnums (*Viburnum* sp.); poison ivy (*Toxicodendron radicans*) is a common vine. Compared to the Agriculture system (which contains the pasture/hay subgroup), this type has more forbs (excluding legumes that might be a pasture component) and more shrubs, and does not produce useable hay.

While Indiana bats have been documented foraging in areas (especially old-fields) with extensive growth of honeysuckles and multiflora roses (Brack 1983), it is likely such clutter reduces roosting and foraging potential (Brack 1983).

While northern long-eared bats have been documented foraging along forest edges, they are more commonly found foraging under the forest canopy (Sheets et al. 2013a). Northern long-eared bats are also likely to forage in woodlands in which the understory has been overrun by invasive shrub such as multiflora rose (*Rosa multiflora*) or bush honeysuckle (*Lonicera mackii*) (Brack 1983).

3.2.3.3 Glade and Savanna

This system occurs at low to moderate elevations from the Central Appalachians down into the Ridge and Valley. It consists of woodlands and open glades on thin soils over limestone, dolostone, or similar calcareous rock. In some cases, the woodlands grade into closed-canopy forests. Red cedar (*Juniperus virginiana*) is a common tree, filling in in the absence of fire, and chinquapin oak (*Quercus muehlenbergii*) is indicative of the limestone substrate. Prairie grasses are the dominant herbs (big bluestem [*Andropogon gerardii*], Indian grass [*Sorghastrum nutans*], little bluestem [*Schizachyrium scoparium*], and grama); forb richness is often high. Fire is sometimes an important natural disturbance vector but open landscapes can also be maintained by drought and landslides.

Much of the core range of the Indiana bat was historically a mix of savannas, open prairies, and small woodlands. At one point this vegetation type was considered important enough for Indiana bats that the species was referred to as a savanna species in the 1999 draft recovery plan (U.S. Fish and Wildlife Service 1999).

Northern long-eared bats have been documented roosting in isolated trees in cow pastures (Sparks 2003). These areas are likely to provide habitat of limited value to the species.

3.2.4 Northern Hardwood and Conifer Forest

The northern hardwood and conifer forest vegetation type occurs primarily in the north central region of Pennsylvania and is the largest vegetation type in terms of acreage, covering approximately 31 percent (8,906,636 acres) of the state. It is the second-largest vegetation type on State Lands. The following forests are in this vegetation type:

- Laurentian-Acadian northern hardwoods
- Laurentian-Acadian northern pine-oak forests
- Laurentian Acadian pine-hemlock-hardwood forests
- Appalachian hemlock-northern hardwood forests
- North-central interior beech-maple forests
- South-central interior mesophytic forests

This variable category includes a mix of forest types that range from oak/hickory and mixed mesophytic complexes thought to be most valuable to Indiana bats (Menzel et al. 2001; Gardner and Cook 2002) to less-suitable cooler, moister types (Brack et al. 2002).

All habitats within this highly variable category are likely suitable for use by northern long-eared bats (Sasse and Pekins 1996; Foster and Kurta 1999; Lacki and Schwierjohann 2001; Sparks 2003; Carter and Feldhamer 2005; Johnson et al. 2012), which are much more likely to use dense forests than Indiana bats.

3.2.4.1 Laurentian-Acadian Northern Hardwoods

These forests occur from low to moderate elevations (generally less than 2,000 feet) across the glaciated northeast. Sugar maple (*Acer saccharum*), beech (*Fagus* sp.), and yellow birch (*Betula alleghaniensis*) are the dominant tree species, with hemlock (*Tsuga canadensis*) as the sub-dominant canopy tree species. Blow-downs or snow and ice loading, with subsequent gap regeneration, are the most frequent forms of natural disturbance.

3.2.4.2 Laurentian-Acadian Northern Pine-Oak Forests

This is a pine or pine-oak forest system found in a variety of topographic settings. Red pine is present although not necessarily dominant. Soils are loamy to sandy, varying from thin soil over bedrock to deeper soils, sometimes sandy. Sites are dry, but less so than barrens and sand plains. Boreal conifers such as red spruce can occasionally be present. Conifers typically dominate the canopy, but sub-dominants can include hardwoods such as red oak (*Quercus rubra*) or red maple, and aspen (*Populus* sp.).

3.2.4.3 Laurentian Acadian Pine-Hemlock-Hardwood Forests

These dry forests typically occur on low-nutrient soils at lower elevations, mostly less than 2,000 feet. White pine, hemlock, and red oak are the dominant tree canopy species. Red maple (or various species of birch) is often subdominant. Oaks (*Quercus* sp.), other than red oak, are essentially absent from this system. This is a widespread, matrix forest type in the glaciated northeast. Gap replacement and infrequent fire are the major acts of natural regeneration.

3.2.4.4 Appalachian Hemlock-Northern Hardwood Forests

This forested system is one of the matrix forest types of the northeast, ranging from central New England west to Lake Erie and south to the higher elevations of Virginia and West Virginia. Northern hardwoods such as sugar maple, yellow birch, and beech are characteristic, either forming a deciduous canopy or mixed with hemlock (or in some cases white pine). Other common and sometimes dominant trees include red oak, tulip tree (*Liriodendron tulipifera*), black cherry (*Prunus serotina*), and black birch (*Betula lenta*). Fire suppression appears to have increased the extent of this system.

3.2.4.5 North-Central Interior Beech-Maple Forests

This system is found primarily along the southern Great Lakes, extending into the northeast in extreme western Pennsylvania, through north-central Pennsylvania, and into New York. It is typically found on flat to rolling uplands or in stream valleys with rich loam soils over glacial till. This system is characterized by a dense tree canopy that forms a thick layer of humus and leaf litter, leading to a dense and rich herbaceous layer. Sugar maple and beech comprise most of the canopy. Subdominants can include red oak, basswood (*Tilia americana*), hornbeam (*Carpinus caroliniana*), and hop-hornbeam (*Ostrya virginiana*). The herbaceous layer is very diverse and typically includes spring ephemerals. The primary natural influence on this system is wind-driven gap dynamics that result from gaps created by disturbances in the forest. Conversion to agriculture has significantly decreased the range of this system, and very few large stands remain intact.

3.2.4.6 South-Central Interior Mesophytic Forests

The core distribution of this system lies in the Cumberland and Allegheny plateaus, extending into northeast West Virginia and southwestern Virginia, with very limited occurrence in western Pennsylvania and New York. These high-diversity, predominantly deciduous forests occur on deep and enriched soils, in non-montane settings, and usually in somewhat protected landscape positions such as coves or lower slopes. Dominant species include sugar maple, beech, tulip tree, red oak, cucumber tree (*Magnolia acuminata*), and black walnut (*Juglans nigra*). Hemlock can be a component of some stands. Trees can grow very large in undisturbed areas. The herb layer is very rich, often with abundant spring ephemerals.

3.2.5 Oak-Pine Forest

The oak-pine forest vegetation macro-group covers approximately 28 percent of Pennsylvania. It is second to the Northern Hardwood and Conifer Forest macro-group in terms of acreage and largest on State Lands. This macro-group is best described by summarizing the primary sub-groups in this vegetation type within Pennsylvania:

- Eastern serpentine woodland
- Appalachian shale barrens
- Central Appalachian dry oak-pine forest
- Central Appalachian pine-oak rocky woodland

- Northeastern interior dry-mesic oak forest
- Northeastern interior pine barrens
- Southern Appalachian oak forest

Because Indiana bats make extensive use of oaks and hickories (*Carya* sp.) as roosts, this vegetation type is widely perceived as being highly valuable to the species (Gardner and Cook 2002; U.S. Fish and Wildlife Service 2007).

As northern long-eared bats also make regular use of oaks and hickories (*Carya* sp.) as roosts, this vegetation type is highly valuable to the species (Sasse and Pekins 1996; Foster and Kurta 1999; Lacki and Schwierjohann 2001; Sparks 2003; Carter and Feldhamer 2005; Johnson et al. 2012).

3.2.5.1 Eastern Serpentine Woodland

This vegetation type consists of distinctive vegetation associated with serpentine rock substrates in Maryland, southern Pennsylvania, and Virginia (rarely southward). Most are open woodlands with pitch pine (*Pinus rigida*), Virginia pine (*Pinus virginiana*), white oak (*Quercus alba*), post oak (*Quercus stellata*), and blackjack oak (*Quercus marilandica*) in the often-stunted canopy. Extreme edaphic conditions (influences of soil rather than climate) lead to extremely dry growing conditions, resulting in relatively open canopies and a ground cover dominated by prairie grasses and a variety of forbs. The unusual and extreme soil chemistry determines the distinctive flora of the type, but fire frequency determines the physiognomy of particular examples over time, and many have succeeded to forest cover because of fire suppression.

3.2.5.2 Appalachian Shale Barrens

This habitat system encompasses the distinctive shale barrens of the central Appalachians at low to mid elevations. The exposure, steep slopes, unstable shale scree, and lack of soil create extreme conditions for plant growth. The barrens are usually a mosaic of woodlands and large open areas of sparse vegetation. Dominant trees are primarily chestnut oak (*Quercus prinus* = *montana*) and Virginia pine, although on higher-pH substrates the common trees include red cedar and white ash (*Fraxinus americana*). Shale barren endemics are diagnostic in the herb layer. The substrate includes areas of solid rock and shale scree, usually steeply sloped.

3.2.5.3 Central Appalachian Dry Oak-Pine Forest

These oak and oak-pine forests cover large areas in the Central Appalachians and northern Piedmont, with a more limited range in New England and north to the Champlain Valley. The low- to mid-elevation setting ranges from rolling hills to steep slopes, with occasional occurrences on more level, ancient alluvial fans. The soils are coarse and infertile; they can be deep (on glacial deposits in the northern part of the system's range), or, more commonly, shallow, on rocky slopes of acidic rock. The well-drained soils and exposure create dry conditions. The forest is mostly closed-canopy but can include patches of more open woodlands. It is dominated by a variable mixture of dry-site oak species such as chestnut oak, white oak, red oak, black oak (*Quercus velutina*), scarlet oak (*Quercus coccinea*); and pine species (*Pinus* sp.) such as pitch pine and white pine. The system can include areas of oak forest, pine forest (usually small), and mixed oak-pine forest. A heath shrub layer (e.g., hillside blueberry [*Vaccinium pallidum*], huckleberry [*Gaylussacia* sp.], and mountain laurel [*Kalmia latifolia*]), often dense, is characteristic. Small hillslope pockets with impeded drainage can support small isolated wetlands with red maple and black gum (*Nyssa sylvatica*) characteristic. Disturbance agents include fire, wind-throw, and ice damage. Increased site disturbance generally leads to secondary forest vegetation with a greater proportion of weedy hardwoods such as red maple. In the absence of fire, this system is believed to succeed to northern hardwood and hemlock forests.

3.2.5.4 Central Appalachian Pine-Oak Rocky Woodland

This system of the Central Appalachians encompasses open or sparsely wooded hilltops and outcrops or rocky slopes, mostly at lower elevations, but occasionally up to 4,000 feet in West Virginia. The substrate rock is granitic or of other acidic lithology, including trap rock in New England. The vegetation is patchy, with woodland and open portions. Pitch and table mountain pine (*Pinus pungens*) are dominant and often are mixed with dry-site oaks (including black oak and scarlet oak) and sprouts of chestnut (*Castanea dentata*) and hickory (*Carya* spp.). Some areas have a fairly well developed heath shrub layer, others a graminoid layer. Conditions are dry and nutrient-poor, and at many, if not most, sites, a history of fire is evident.

3.2.5.5 Northeastern Interior Dry-Mesic Oak Forest

These oak-dominated, mostly closed-canopy forests are one of the matrix forest systems in the northeast south of New England and New York. They cover large expanses at low to mid elevations, where the topography is flat to gently rolling, to occasionally steeper slopes. Soils are mostly acidic and relatively infertile, but not very dry. Local areas of limy bedrock, or colluvial pockets, can support forests typical of richer soils. Oak species characteristic of dry-mesic conditions (e.g., red oak, white oak, black oak, and scarlet oak) and hickory dominate mature stands. Chestnut oak can be present but is generally less important than the other oak species. Chestnut was formerly a prominent tree. Red maple, black birch, and yellow birch can be common associates. With a long history of human habitation, many of these forests are mid-successional, where white pine, Virginia pine, or tuliptree can be dominant or co-dominant; however, the appropriate oak or hickory species are present in enough abundance to recognize it as this type. In these forests, hill-slope pockets with impeded drainage can support small isolated wetlands, including non-forested seeps. See also Southern Appalachian Oak Forest, found in the southernmost portions of the region, and characterized by southern Appalachian species.

3.2.5.6 Northeastern Interior Pine Barrens

These pine barrens occur on glacial sand plains in the inland regions of New England and New York, and in the coastal plain north of Cape Cod and the Long Pond area in the Poconos. Substrates include outwash plains, stabilized sand dunes, and glacial till. The soils are consequently coarse-textured, acidic, well drained to xeric, and low in nutrients. Pitch pine is the usual dominant; open woodland is the typical cover, but some areas include patches of closed-canopy forest. Red maple is common and chestnut and scarlet oak are occasional associates. A tall-shrub layer of dwarf chinquapin oak (*Quercus prinoides*) is rare if present. A well-developed low-shrub layer is typical, with lowbush blueberry (*Vaccinium angustifolium*), huckleberry, rhodora (*Rhododendron canadense*) and sweetfern (*Comptonia peregrina*) characteristic. The barrens are often a physiognomic patchwork, ranging from nearly closed-canopy forest to open pine woodlands, to scrub oak shrublands, to herbaceous/dwarf-shrub frost pockets. Small changes in elevation can create pockets with saturated soil, where shrubs such as hazelnut (*Corylus* sp.), buttonbush (*Cephalanthus occidentalis*), highbush blueberry (*Vaccinium corymbosum*), and alder can form dense cover. Grassy areas dominated by little bluestem, with bushclover (*Lespedeza* sp.), and other forbs provide habitat for several rare invertebrates and vertebrates including sallow moth (*Chaetaglaea cerata*), barrens buckmoth

(*Hemileuca maia*), New Jersey chorus frog, (*Pseudacris feriarum kalmi*), and golden-winged warbler (*Vermivora chrysoptera*). These barrens have a history of recurrent fires, and fire is required to maintain them.

3.2.5.7 Southern Appalachian Oak Forest

Southern Appalachian Oak Forests are relatively dry-to-mesic forests common on open and exposed topography sites at lower to mid elevations in the Southern Blue Ridge and Southern Ridge and Valley ecoregions and the southern half of the Central Appalachians ecoregion. As the name suggests, these woodlands are dominated by oaks including chestnut oak, northern red oak, white oak, and scarlet oak. Various hickories co-occur in the stands along with red maple. When cleared, these sites tend to be reforested by communities dominated by tulip poplar, pines, and black locust.

3.2.6 Open Water

Open water covers a little more than 1 percent (391,736 acres) of Pennsylvania and includes streams, rivers, ponds, and lakes. Large bodies of open water serve as barriers to daily movement (Sparks et al. 2005a; Sparks et al. 2005b) and contain few to no trees for roosting. Smaller patches of open water (such as ponds) and the edges of large patches of open water provide Indiana bats and northern long-eared bats with a source of hydration and access to aquatic insects (Brack 1983; Brown and Brack 2003). Both species will roost along the edge of areas of open water.

3.2.7 Rocky Outcrops

The rocky outcrops vegetation macro-group comprises less than 1 percent (214,762 acres) of the state. Rocky outcrops provide important habitat for eastern small-footed bats (*Myotis leibii*), timber rattlesnakes (*Crotalus horridus*), Allegheny woodrat (*Neotoma magister*), and the rock vole (*Microtus chrotorrhinus*). The following sparsely vegetated rock habitat systems are in this group:

- North-central Appalachian acidic cliff and talus
- North-central Appalachian circumneutral cliff and talus
- Northeastern erosional bluff

Trees along the edges or contained within such areas can receive significant solar warming and therefore provide high-suitability roosts to both species. In addition, it is not known where many northern long-eared bats hibernate. Because northern long-eared bats occur in areas of Kansas where there are no caves, Sparks et al. (2011) hypothesized that the species hibernates in the abundant local rock fissures. It is likely that they also use rock faces in Pennsylvania.

3.2.7.1 North-Central Appalachian Acidic Cliff and Talus

These sparsely vegetated to partially wooded cliffs and talus slopes in the Central Appalachians occur at low to mid elevations from central New England south to Virginia, and up to 4,500 feet in West Virginia. This system consists of vertical or near-vertical cliffs and the talus slopes below, formed on hills of granitic, sandstone, or otherwise acidic bedrock. In some cases, especially in periglacial areas, this system can take the form of upper-slope boulder fields without adjacent cliffs, where talus forms from freeze/thaw action on the bedrock. Most of the substrate is dry and exposed, but small (and occasionally large) areas of seepage are often present. The vegetation is patchy and often sparse, punctuated with patches of small trees. Red cedar, hickories, sweet birch, and chestnut oak are characteristic tree species, Virginia creeper a characteristic woody vine, and rock polypody (*Polypodium virginianum*) a characteristic fern. Virginia pine is often present (within its range).

3.2.7.2 North-Central Appalachian Circumneutral Cliff and Talus

This cliff system occurs at low to mid elevations from central New England south to Virginia and West Virginia. It consists of vertical or near-vertical cliffs and steep talus slopes where weathering and bedrock lithology produce circumneutral to calcareous pH and enriched nutrient availability. Substrates include limestone, dolomite, and other rocks. The vegetation varies from sparse to patches of small trees, in places forming woodland or even forest vegetation. Basswood, ash (*Fraxinus* sp.), and bladdernut (*Staphylea* sp.) are woody indicators of the enriched setting. The herb layer is typically not extensive but includes at least some species that are indicators of enriched conditions.

3.2.7.3 Northeastern Erosional Bluff

These steep, linear cliffs form where erosion in deep glacial or alluvial deposits has left tall (more than 9 feet), nearly vertical banks of sand, silt, clay, or a mixture. They typically develop in landscapes that are otherwise of rather low relief. The substrate is unconsolidated, and provides habitat for some animals that burrow into steep banks, such as bank swallows (*Riparia riparia*) and certain invertebrates. Vegetation is very sparse, mostly herbaceous, and variable in composition. Known examples are in the Chesapeake Bay, some areas of the northern Atlantic coast, the Lake Erie and Lake Ontario coastline, and some of the larger northeastern rivers.

3.2.8 Swamps and Marsh

The swamps and marsh vegetation type covers approximately 1.6 percent (468,021 acres) of Pennsylvania. The following vegetation types are considered swamps and marsh:

- Central hardwood swamps
- Coastal plain swamps
- Emergent marsh
- Northern peatland
- Northern swamps
- Wet meadow/shrub marsh

Indiana bats feed extensively on aquatic insects (Belwood 1979; Brack 1983; Kurta and Whitaker 1998; Murray and Kurta 2002; Tuttle et al. 2006), so wetlands often provide high-quality roosting areas for the species (Kurta et al. 1993; Kurta and Whitaker 1998; Kurta 2004a; Kurta 2004b; Carter 2006). Wet forests that contain ashes (*Fraxinus* spp.), cottonwood (*Populus deltoides*), or elms (*Ulmus* sp.) are especially valuable for Indiana bats because these trees are frequently used as roosts.

Wetlands often provide northern long-eared bats with high-quality roosting areas, especially in the confines of forest canopy. Wet forests that contain ashes (*Fraxinus* spp.), American sycamores (*Platanus occidentalis*), cottonwood, hackberry (*Celtis occidentalis*), or elms are especially valuable for northern long-eared bats because these trees are frequently used as roosts (Sparks 2003; Whitaker et al. 2004).

3.2.8.1 Central Hardwood Swamps

Central Hardwood Swamps occur on poorly drained soils, with surface water remaining for extended periods. They rarely become entirely dry, although they are subject to periods of seasonal fluctuation and drought. Soils can be deep (3 feet), consisting of peat or muck, with parent material of peat, muck, or alluvium. The Central Hardwood Swamps are typically dominated by oak species, green ash (*Fraxinus pennsylvanica*), and red maple. More open areas typically have greater shrub and herbaceous cover. Common species of understory consist of buttonbush, winterberry (*Ilex verticillata*), alder, and sedges (*Carex* sp.).

3.2.8.2 Coastal Plain Swamps

The Northern Atlantic Coastal Plain Basin Swamp and Wet Hardwood Forest system consists of non-riverine hardwood swamps of seasonally flooded Coastal Plain habitats. Pennsylvania contains only a few remnants near Philadelphia. Characteristic tree species include red maple, sweet gum (*Liquidambar styraciflua*), black gum, willow oak (*Quercus phellos*), and green ash.

3.2.8.3 Emergent Marsh

The Emergent Marsh type consists of three sub-types in Pennsylvania: the Laurentian-Acadian Freshwater Marsh, the Great Lakes Freshwater Estuary and Delta system (which is limited to areas in and around Presque Isle), and the North Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh. The system, best developed on the Chesapeake and Delaware Bay drainages, extends northeast. In general, these swamp types are associated with surrounding rivers and tributaries, lakes, ponds, and streams, and are subject to local water regimes. All of the types of emergent marsh are characterized by poor soil drainage and may have coarser substrates on occasion due to greater flooding force associated with local water sources. Vegetation at these marshes can be highly diverse. Typical plants in the Laurentian-Acadian Freshwater Marsh include cattails (*Typha* sp.), marsh fern (*Thelypteris palustris*), touch-me-nots (*Impatiens* sp.), pondweeds (*Potamogeton* sp.), water lilies (*Nymphaea tuberosa*), pickerelweed (*Pontederia cordata*), and tall rushes (*Juncus* sp.). The North Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh are populated by tall grasses such as wild rice (*Zizania palustris*) and forbs such as water hemp (*Amaranthus rudis*) and rosemallow (*Hibiscus* sp.).

3.2.8.4 Northern Peatland

Laurentian-Acadian Alkaline Fens and North Central Interior and Appalachian Acidic Peatland are distributed across the Northeast in glacial areas and their boundaries. Shore fens, which are peatlands that are occasionally flooded along stream and lakeshores, are also included here because flooding tends to create moderately alkaline conditions. These marsh types are typically nutrient poor and readily form peat and peatland vegetation. The vegetation can be graminoid dominated, shrub dominated, or a patchwork of the two, with patches of sedges and marshland forbs. The herbaceous flora is usually species rich. Peat moss and similar species dominate the substrate. Some peatlands can have a sparse tree layer. Although these are often called bogs, in most cases they are technically fens (albeit nutrient-poor ones), as the vegetation remains in contact with the groundwater.

3.2.8.5 Northern Swamps

The Northern Appalachian-Acadian Conifer-Hardwood Acidic Swamps and North Central Appalachian Acidic Swamps are forested wetlands common in the glaciated Northeast from central New England through the Central Appalachians south to Virginia and west to Ohio. They are found at low to mid elevations (generally less than 2,000 feet) in poorly drained depressions. They occur on mineral soils (sometimes with a thin-to-moderate upper layer of peat) that are nutrient poor; if peat is present, it usually forms a thin layer over the mineral soil rather than a true peat substrate. These basin wetlands remain saturated for all or nearly all of the growing season and can have standing water seasonally. Red maple, red spruce, and balsam fir (*Abies balsamea*) are the most typical trees; ash is common in some locations. The herbaceous and shrub layers tend to be fairly species poor; catberry (*Ilex mucronata*), tall ferns (cinnamon [*Osmunda cinnamomea*], interrupted [*Osmunda claytoniana*], sensitive [*Onoclea sensibilis*]), and wetland sedges are typical and can be extensive. Hemlock is usually present and can be dominant. Basin swamps tend to be more nutrient poor than seepage swamps; in some settings, the two occur adjacent to each other, with the basin swamp vegetation surrounded by seepage swamp vegetation on its upland periphery.

North Central Interior and Appalachian Rich Swamps are also forested wetlands and are scattered throughout the Northeast from southern New England south, at low to mid elevations. They are found in basins where higher pH and nutrient levels are associated with a rich flora. Species include red maple and black ash, as well as calcium-loving herbs. Conifers can include larch (*Larix* sp.), but typically not northern white cedar, which is characteristic of more northern wetlands. There can be shrubby or herbaceous openings in the swamp. The substrate is primarily mineral soil, but there can be some peat development.

3.2.8.6 Wet Meadow/Shrub Marsh

The Laurentian-Acadian Wet Meadow-Shrub Swamp system encompasses shrub swamps and wet meadows on mineral soils of the northeast. They are most characteristic of the glaciated regions but can be found in more scattered areas southward. They are often associated with lakes and ponds but are also found along streams, where the water level does not fluctuate greatly. They are commonly flooded for part of the growing season but generally do not have standing water throughout the season. The size of occurrences ranges from small pockets to extensive acreages. The system can have a patchwork of shrub and graminoid dominance; typical species include willow, red-osier dogwood (*Cornus sericea*), alder, meadowsweet (*Spiraea* sp.), bluejoint grass (*Calamagrostis canadensis*), tall sedges, and rushes. Trees, if present, are scattered.

3.3 Forest Trends

Ecological succession is an important process influencing the type of habitat that currently exists on State Lands. There are three facts concerning the forests of the eastern United States that drive current forest management practices. First, virtually all forests east of the Rocky Mountains are regrowth on sites that were cleared at least once during or before the Industrial Revolution. For example, at European settlement, Pennsylvania contained approximately 27 million acres of forest, which were reduced to 9 million acres by 1907 (Price and Sprague 2011). At present, Pennsylvania has approximately 17 million acres of forest, indicating a net increase of 8 million acres in little over a century (Price and Sprague 2011). Much of this increase occurred on abandoned agricultural lands. Second, the forests that existed at the time of settlement were heavily manipulated by Native

American land practices, which included techniques similar to those used by modern foresters such as prescribed fire, planting of preferred tree species, and selective removal of less-desirable species (Denevan 1992). Third, disease has changed and continues to change vegetation patterns dramatically. Perhaps the best example is the American chestnut, which once dominated many forests throughout the Appalachians. The American chestnut was eliminated from the forest overstory by the chestnut blight of the 1940s. Even the most productive, diverse forests in Pennsylvania today are quite different from presettlement forests.

Pennsylvania forests reflect the long-term effects of these three historical realities. Activities of native people likely were responsible for the extensive oak, pine, and chestnut forest that previously covered much of the southern half of the state. Similarly, the pre-settlement landscape included many relatively open woodland types often dominated by large, widely spaced trees. By the turn of the last century, most of these woodlands had been removed—cut for timber, firewood, or in later years converted into charcoal to fuel iron furnaces. By the 1920s, north-central Pennsylvania was so denuded of forest it was colloquially known as the Pennsylvania Desert. Today, this area is the most extensively forested in the state, but like most forests in Pennsylvania, consists of trees that began to grow in the 1920s and 1930s. Finally, American chestnut was likely a dominant tree throughout southern Pennsylvania but now only exists as an understory shrub (the species sprouts extensively from the roots). Several factors influence present-day evolution of forested lands in Pennsylvania. Both Indiana bats and northern long-eared bats generally prefer forested landscapes for habitat; however, not all forested environments exhibit preferred habitat characteristics. Accordingly, the suitability of habitat can change from not only loss of forested lands, but through modifications in average tree type, abundance, size, and other habitat variables. The following present-day factors, among others, influence forest changes.

- Successional dynamics and disturbance regimes favor the red maple. This species comprises 90 percent of the current forest regeneration, which differs from historical regeneration of the forests in the state and likely portends a future maple-dominated forest (Price and Sprague 2011). An important goal of the covered activities is to manage and maintain a diversity of forest communities on State Lands.
- Forests today tend to be younger, uniform stands, as opposed to the mature, diverse stands of the past.
- Approximately two-thirds of Pennsylvania forests are privately owned. Timber harvest is far less structured on private lands and may include a variety of harvest practices that may or may not address the goals of long-term sustainable forestry. Private land supports most summer colonies of Indiana bats and northern long-eared bats. The following activities in privately owned forests can affect Indiana bats and northern long-eared bats.
    - Removing trees for timber, firewood, and development. During periods of economic difficulty, there is an increased likelihood that landowners will be forced to harvest timber for financial gain, sell land to developers, or become more reliant on firewood.
    - Managing land for wildlife, especially game animals.
    - Leaving land for natural succession. Landowners often have the goal of preserving the existing landscape without understanding the role of ecological succession.
- Pennsylvania's climate is getting warmer and wetter; therefore cooler-climate species such as sugar maple, black cherry, white ash (*Fraxinus americana*), northern red oak (*Quercus rubra*), and American beech are expected to retreat northward. These stands might be replaced by

oak/hickory complexes (which are favorable to Indiana bats), but the current dominance of red maples in the understory will likely prevent such a transition. Other southern species such as eastern red cedar and shortleaf pine (*Pinus echinata*) are also expected to become more prevalent.

- Logging practices on private lands often are characterized by the selection of those trees with the greatest economic value (i.e., high grading) a practice that leads to an increase of red maple, black birch, and other less valuable species over time. Such harvests often occur without the input of foresters who understand how to guide successional dynamics within a stand. As with public lands, the type of harvest can dramatically affect the species regime of that area. Selective cuts (single or group tree selection) can favor beech and maple regeneration because those species are shade tolerant. Clear-cuts, shelterwood cuts, and fire favor oak and hickory regeneration.

- Invasive nonnative species, both plants and animals, have a large effect on forest diversity and health. Some invasive species in Pennsylvania that influence forest dynamics are the small hemlock woolly adelgid (*Adelges tsugae*), emerald ash borer (*Agrilus planipennis*), Asian long-horned beetle (*Anoplophora glabripennis*), tree of heaven (*Ailanthus altissima*), and oriental bittersweet (*Celastrus orbiculatus*). The small hemlock wooly adelgid beetle consumes eastern hemlock (*Tsuga canadensis*) and has reduced the prevalence of hemlocks from 20 percent of the Pennsylvania forest to approximately 5 percent (Price and Sprague 2011). The emerald ash borer bores its way down the trunk of ash trees, causing them to die from the inside out. The Asian long-horned beetle found in New York is a potential future threat, because it preys on many hardwood species, including maple (*Acer* spp.), birch (*Betula* spp.), poplar (*Populus* spp.), and sycamore (*Platanus* spp.). Insects and diseases that cause mass mortality of trees can produce a short-term boom of potential roost trees, but at the expense of long-term roosting habitat. Tree of heaven is allelopathic (generates a toxin that inhibits growth of other species), grows rapidly, and takes over areas that would have been dominated by native species. Neither Indiana bats nor northern long-eared bats are known to use this species (Kurta 2004a; U.S. Fish and Wildlife Service 2013). Oriental bittersweet blocks out light, girdles plants, topples trees with its weight, and produces highly cluttered environments rarely used by Indiana bats (Price and Sprague 2011) but similar to areas used by northern long-eared bats in suburban Indianapolis (Sparks 2003; Whitaker et al. 2004).

- Browsing by abundant white-tailed deer can have a substantial damaging effect on regenerating woodlands—especially those dominated by early successional species (Russell et al. 2001; Rooney and Waller 2003; Wakeland and Swihart 2009). White-tailed deer are selective foragers (Russell et al. 2001; Rooney and Waller 2003; Wakeland and Swihart 2009) and can have an effect on tree species observed in forest regeneration. On State Lands, fencing is used to reduce the effects of deer browse on succession, but this is often not true on private lands. While a few deer help maintain an open understory, deer overpopulation can eliminate the understory of a forest and prevent regeneration.

Combined, these factors suggest that within the next 30 years the forests of Pennsylvania will become heavily dominated by red maples (Price and Sprague 2011). Indiana bats and northern long-eared bats will use red maples for roosting; however, these trees do not typically provide the type of roosting habitat bats prefer until the trees reach the end of their life.

In total, the forests of Pennsylvania are changing. The factors described previously create a complicated scenario for predicting availability of suitable summer Indiana bat and northern long-eared bat habitat. Some of these factors bring rapid change to forestscapes, while others will create change over a long period. In addition, some of these factors are the result of previous anthropogenic actions (e.g., introduction of invasive species and forestry practices) that have created a ripple effect on the landscape that will likely continue. Future state, local, or private activities have the potential to create additional change and stresses on the state's forests. Conversely, the goal of PGC and DCNR's covered activities is to ensure those forests under their jurisdiction retain their value as habitat for covered bats.

3.4 Indiana Bats

3.4.1 Ecology

The Indiana bat is listed as an endangered species by the U.S. Fish and Wildlife Service and the State of Pennsylvania. Thirteen caves and mines in Illinois, Indiana, Kentucky, Missouri, Tennessee, and West Virginia are designated critical habitat for the Indiana bat. No designated critical habitat occurs in Pennsylvania, but some of the bats covered by the State Lands Forestry HCP are known to hibernate in Hellhole Cave, West Virginia, which is designated critical habitat.

3.4.1.1 Range

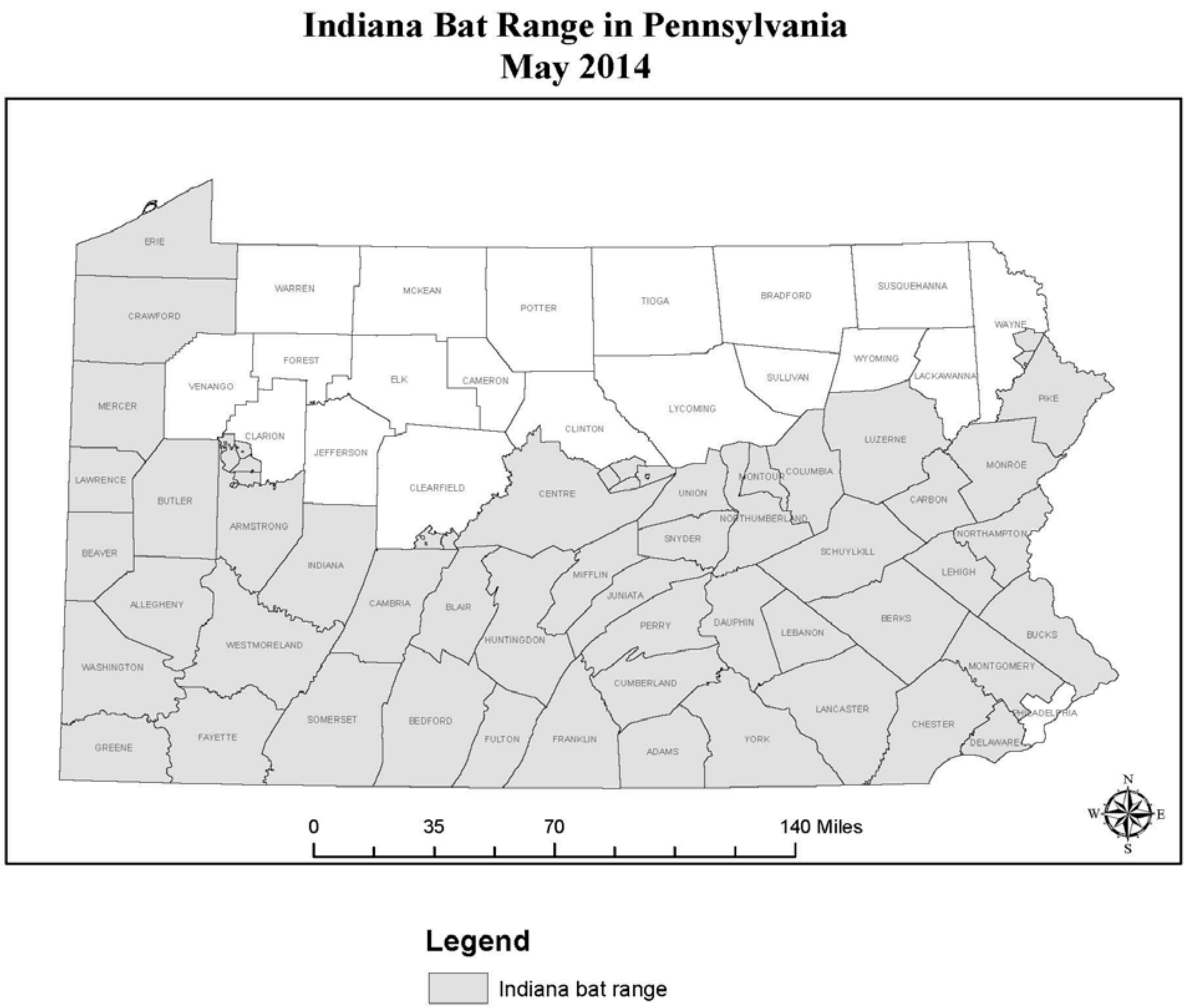
The summer range of the Indiana bat is large and includes much of the eastern deciduous forestlands between the Appalachian Mountains and Midwest prairies. During summer, the species is more abundant in its core range of the agricultural Midwest, including Indiana, northern Missouri, western Ohio, and southern portions of Iowa, Michigan, and Illinois. The species is relatively rare in the northeastern United States, including Pennsylvania (Figure 3-7).

The winter range of the Indiana bat was historically restricted to regions of well-developed limestone caves, and most of the population winters in Indiana, Kentucky, and Missouri (more than 73 percent of the known population). Human-created sites (e.g., mines) are an important source of habitat for Indiana bats. Most hibernacula in Pennsylvania are mines, and many of the bats that summer in Pennsylvania are migrants from West Virginia (Appendix B, *Species Accounts*, for additional detail on species range overall and in Pennsylvania).

Data made available by the Pennsylvania Natural Heritage database indicated that Indiana bats have been documented on State Lands at the following locations.

- PGC State Game Lands 051, 105, 147, 260, and 302
- Canoe Creek State Park
- Shawnee State Park
- Michaux State Forest

See Appendix B, *Species Accounts*, for occurrence information. These, along with climatic and environmental data, were used to develop a Habitat Distribution Tool that predicts summer occurrences across much of the southern and western portions of Pennsylvania.



Source: U.S. Fish and Wildlife Service 2014

Figure 3-7. Distribution of the Indiana Bat by County in Pennsylvania

3.4.1.2 Life History

The Indiana bat lives in trees during summer and caves during winter. There are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction. Appendix B, *Species Accounts*, includes a detailed description of Indiana bat ecology. A brief overview of Indiana bat biology and its presence in Pennsylvania is provided in this section.

Winter Hibernation

Hibernation is key to surviving winter for many species of bats, including the Indiana bat. During winter, insects (food) are relatively unavailable, water may be frozen, and the energetic cost of remaining euthermic (i.e., producing its own body heat) is very high. During hibernation, body temperature cools to ambient and metabolic processes are radically reduced. This results in energy savings as high as 112 times that when active.

The best hibernacula have a predictable range of temperatures starting at freezing or colder at the cave entrance to about 56°F (13°C), with portions of the cave that are relatively stable at 41 to 50°F (5 to 10°C). In Pennsylvania, average temperatures of hibernacula are 50 to 52°F (10 to 11°C), with low humidity.

The movement of bats into the hibernaculum in autumn seems to be driven by the timing, length, and severity of cold and wet weather systems moving through the area (Cope and Humphrey 1977; Parsons et al. 2003; Brack 2006). Nevertheless, populations of Indiana bats in hibernacula often do not peak until late January (Hassell 1967; Daan 1973; Clawson 1980), and bats can sometimes be found moving in and out of hibernacula during winter (Mumford 1958; Daan 1973; Whitaker and Rissler 1992a).

Autumn Swarming and Spring Staging

Before and after entering hibernation, Indiana bats spend significant periods near the entrance of the hibernaculum. During spring, this is known as staging and likely represents a period when any unbred females mate, and some bats forage extensively to recuperate from hibernation (U.S. Fish and Wildlife Service 2007). During fall, however, bats may assemble around the entrances of caves and mines in large groups known as swarms (Fenton 1972; Humphrey and Cope 1976; Humphrey et al. 1977). This is the period when most mating occurs.

While some bats may fly 20 miles or more from the entrance of the hibernaculum, swarming activity is typically restricted to an area within 5 miles of the entrance (Gumbert et al. 2002; Rommé et al. 2002; Chenger and Sanders 2007). Across all available studies, 89 of 107 bats (83 percent) tracked during fall and spring have remained within 5 miles of a known hibernaculum. Sites where Indiana bats flew farther can be explained by the presence of multiple hibernacula, presence of both summer and winter habitat, the absence of geographic boundaries that limited movement, and areas where many bats share the same landscape.

Summer Season of Reproduction

Outside of hibernation, Indiana bats most frequently roost under the exfoliating bark of dead trees, although the species has also been found using cracks and crevices on trees, buildings, and bat boxes. Detailed reviews of summer roosting are available (Menzel et al. 2001; Kurta 2004b), as are a series of studies based on bats in Pennsylvania (Butchkoski and Hassinger 2002a, 2002b; Butchkoski 2003; Butchkoski and Turner 2006, 2007, 2008; Butchkoski 2009; Butchkoski 2010a; Butchkoski 2010b). Females and their dependent young form maternity colonies and are occasionally joined by males and non-reproductive females. In Pennsylvania these colonies are usually formed within 100 miles of the hibernaculum, but distances in the core range can exceed 300 miles (Gardner and Cook 2002; Winhold and Kurta 2006). As is the case across much of the range, maternity colonies in Pennsylvania are relatively loyal to an area, although the bats might move between roosts in this area every few days (Butchkoski and Hassinger 2002b; ESI 2012).

Females are pregnant when they arrive at maternity roosts in spring and typically produce one young per year (Asdell 1964; Hayssen et al. 1993). Parturition usually occurs between late June and early July, with lactation being recorded in Pennsylvania as early as 17 May. Juveniles become volant between early July and early August with the earliest capture record for Pennsylvania being 4 July.

3.4.1.3 Foraging

The diet of Indiana bats includes a wide variety of insects, such as Lepidoptera (moths), Coleoptera (beetles), Diptera (true flies), Trichoptera (caddisflies), and Hymenoptera (wasps and ants) (Tuttle et al. 2006). Indiana bats forage in and adjacent to a variety of woodland settings throughout their range (Sparks et al. 2004). Data collected in Pennsylvania are similar in most regards to data collected in other portions of the range (Butchkoski and Hassinger 2002b; ESI 2012). The species makes extensive use of forested habitat for commuting and foraging. Foraging habitat for the colony at Canoe Creek State Park has been described as a large block of relatively flat, upland forest, and all foraging occurred within 2.8 miles of the primary roost. Long-term studies of the Greene County Colony have revealed that the bats foraged extensively in woodlands within 3.1 miles of known roosts. Indiana bats avoid areas of residential development and large areas of open water when habitat is available within 3.1 miles of all known roosts.

3.4.1.4 Threats

White-Nose Syndrome

The greatest current threat to the survival of Indiana bats is WNS. Indiana bats were among the first species to be observed with signs of WNS in 2006. By winter 2008-2009, the disease had arrived in Pennsylvania and was state-wide within four years (Heffernan and Turner 2016). Since then, populations of Indiana bats in Pennsylvania have declined substantially (Butchkoski and Bearer 2016, USFWS 2017a); however, at the regional level, the level of decline is much lower than that seen for little brown bats and northern long-eared bats (Turner et al. 2011). Unfortunately, as the Indiana bat is already endangered, these population declines may still be severe enough to cause extirpation over large parts of its range (Thogmartin et al. 2013). Thogmartin et al. (2013) anticipated a total loss of 86 percent of the population with only 4 percent remaining after 50 years. A more recent study asserts that of 468 winter colonies within the northeast, only 17 percent have gone extinct (Frick et al. 2015). In addition, the probability of extinction of colonies declines to zero in colony sizes greater than approximately 200 bats (Frick et al. 2015). Bat species such as the

Indiana bat that are found in large groups during both summer and winter are the most likely to be infected by the disease, and also the most likely to reach population levels at which colonies are no longer viable (Brack et al. 2010) (i.e., such highly social organisms may suffer an Allee effect[1]).

Other Threats

The greatest danger to Indiana bats at the time of their listing in 1967 was a variety of man-made and natural threats to winter hibernacula (USFWS 2007). Documented man-made threats to winter habitats include disturbance and vandalism, improper cave gates and structures, indiscriminate collecting, and flooding of caves from reservoir construction. Natural hazards include flash flooding of hibernacula (Brack et al. 2005), ceiling collapse of mines and caves (Elliot 2007), and colder or warmer than average winters. Natural and/or human-caused changes in the microclimate of caves and mines used as hibernacula can adversely affect the species (Richter et al. 1993). An important new source of mortality is the potential for Indiana bats to be killed at wind energy facilities that are now common on the ridgelines of Pennsylvania. Possible interactions between mortality of Indiana bats at wind energy sites and WNS raises serious concerns about the ability of the species to survive in those areas where both sources of mortality interact (Erickson et al. 2016).

3.4.2 Habitat Preferences

The Indiana bat uses a variety of habitat types. Its general habitat preferences, need for ecological disturbance, and specific habitat features are described in this section.

The well-documented ability of this species to migrate hundreds of miles between summer and winter habitats prompts consideration of habitat at a variety of scales (Gardner and Cook 2002). Suitable habitat is characterized first as habitat within the known migratory range (Gardner and Cook 2002) of the species, which is currently known to be 357 miles (Winhold and Kurta 2006). Habitat within this distance must also meet the climatic needs of the species, and much of the northeastern United States appears to be too cold and damp for the Indiana bat at present (Brack et al. 2002; Loeb and Winters 2013; Weber and Sparks 2013). Climate appears to be an important force behind the current distribution in Pennsylvania.

Second, areas with suitable climate within the home range must also provide landscapes that include suitable foraging and roosting opportunities for the species. The Indiana bat is most abundant in the upper Midwest, a region in which agricultural landscapes are broken by scattered woodlands and riparian corridors (U.S. Fish and Wildlife Service 2007). Within this landscape where forest is limited, multiple studies have documented the importance of forested habitat (Butchkoski and Hassinger 2002b; Carter et al. 2002; Menzel et al. 2005; Sparks et al. 2005b; ESI 2012; Weber and Sparks 2013; Womack et al. 2013) for both foraging and roosting.

Many of these same studies also document the importance of other land classes to Indiana bats—especially during foraging (Carter et al. 2002; Menzel et al. 2005; Sparks et al. 2005b; ESI 2012; Weber and Sparks 2013). Data suggest a mosaic of habitats may be critically important to the

[1] For most species, reproductive success increases as the density of con-specifics decreases. This is a direct result of competition. However, for highly social or gregarious species this may not be true. An Allee effect is said to occur when a species shows a positive correlation between density and reproductive success at low population densities. Bats have all the characteristics one would expect for a group to show an Allee effect. They are highly social and gregarious, with sociality directly linked to their physiological requirements. As such, very small colonies are unlikely to be viable.

Indiana bat. Two studies (Carter et al. 2002; Watrous et al. 2006) provide clear evidence of the importance of a mosaic of habitat types. Indiana bats in the Champlain Valley of New York and Vermont preferentially selected areas characterized by their patchy nature (Watrous et al. 2006). In Illinois, when roosting areas were compared to randomly centered plots, "roosting areas contained more patches of agriculture, but overall area of agriculture was less for roosting areas than for random points" (Carter et al. 2002). Similarly, a study across multiple states found evidence of selection of forests within agricultural landscapes and selection of open grounds within heavily forested regions (Weber and Sparks 2013).

Much of this need for a mosaic of habitats (as opposed to strictly forest) may be a result of the species foraging at an air/vegetation interface (Sparks et al. 2004). Direct observation techniques provide details of bat behavior at below the landscape scale. The use of chemical lights and direct observation techniques in Missouri and Indiana indicate the species routinely forages just above and just below the tree canopy as well as along the edge separating woodlands from open land classes (Humphrey et al. 1977; LaVal et al. 1977; Brack 1983). Direct observations of radio-tagged Indiana bats confirm that foraging is concentrated in "edgy" conditions as well as in interiors of fragmented forest (Hobson and Holland 1995; Murray and Kurta 2004; Sparks et al. 2004).

The value of forests for foraging Indiana bats has been demonstrated across multiple studies (Kiser and Elliott 1996; Butchkoski and Hassinger 2002b; Murray and Kurta 2004; Menzel et al. 2005; Sparks et al. 2005a; Brack 2006; Watrous et al. 2006; ESI 2012; Womack et al. 2013). Only four of these studies have been completed in forested regions (Kiser and Elliott 1996; Butchkoski and Hassinger 2002b; Brack 2006; ESI 2012). Indiana bats tracked during autumn in Virginia preferentially foraged in open forests (including some that were newly logged) and along forest edges (Brack 2006) as compared to denser forests. Indiana bats tracked in the Daniel Boone National Forest in Kentucky and near Canoe Creek State Park in Pennsylvania foraged primarily in intact forests (Kiser and Elliott 1996; Butchkoski and Hassinger 2002b). Indiana bats foraging along the Greene/Washington County Line in Pennsylvania avoided residential areas and ponds but used woodlands, pasture, and open lands in accordance with availability (ESI 2012).

Woodlands used by Indiana bats are often described as containing a degree of "openness" that ranges from small openings within a closed canopy forest, to those containing corridors (such as small roads), trees in edge habitats along roads, field margins, and along streams (Kurta 2004a). Foraging bats in northern Indiana were captured almost exclusively in woodlands with an open understory (Brack 1983).

Evidence from most of the cited studies indicates that Indiana bats prefer to forage in open, lower-density forests, forest edges, and grasslands. A mosaic of forest types that includes low-density forests, open areas, grasslands for foraging, and senescent and dead trees and snags for roosting was maintained historically by periodic disturbances such as insect outbreaks, lightning-caused and human-caused burns, and flooding. Today, many of these forest-wide disturbances have been replaced by localized and widespread disturbances that selectively harm certain tree species (e.g., hemlock killed by hemlock woolly adelgid; white-tailed deer greatly prefer to browse sugar maple). These novel and relatively recent threats can dramatically change forest structure and composition, indirectly harming Indiana bats, without active forest management.

Previous authors (Lacki et al. 2007a; Sheets et al. 2013b; U.S. Fish and Wildlife Service 2013; Pauli et al. 2015a; Pauli et al. 2015b) have concluded that sustainable forest management activities, such as those conducted by PGC and DCNR, are generally beneficial to bats because they favor the retention of large senescent trees for primary roosts and smaller trees for use as alternate roosts, maintain wooded commuting corridors through open landscapes, provide open corridors through forested landscapes, and provide open or uncluttered areas for foraging within closed-canopy forests. This research suggests that Indiana bats are capable of surviving in a managed forest; furthermore, management can create a mosaic of habitats that is beneficial to the species. Further, the dominance of red maple (a shade-tolerant species) in the understory indicates that it will form a near monoculture to the detriment of bats and most other wildlife if active management is not implemented. As illustrated in Chapter 4, *Effects of Covered Activities*, and Chapter 5, *Conservation Program*, the active management described in Chapter 2, *State Lands and Covered Activities,* will provide a long-term benefit to Indiana bat habitat, even though it does pose a small risk of take of covered bats primarily during the limited periods of time that tree removal occurs on the landscape.

3.4.2.1 Forest Dynamics

PGC and DCNR manage land for multiple uses including habitat for wildlife. Managing land of any type for the benefit of wildlife requires an understanding of how a species (or group of species) responds to a particular disturbance and successional changes in a forest system, and this is true for the Indiana bat. Further, the process of ecological succession means habitat suitability is always changing, and managing for a particular species requires managing for an appropriate habitat or mix of habitat types.

Ecological succession is the process by which habitats change in structure and species composition and abundance as they age. Classic ecological texts break succession into two categories—primary and secondary. Primary succession is the process by which newly available habitat (e.g., newly emergent islands) is inhabited by organisms and encompasses the changes produced by these organisms and their successors. Secondary succession occurs following a disturbance. Practitioners of wildlife management and forestry are trained to manage succession in either direction (i.e., to "set back" or "speed up" succession). All of the forest management practices described in the following sections represent well-established techniques designed to change long-term successional dynamics. Ecologically, these efforts can be viewed as disturbance events.

Disturbance is a critical component of Indiana bat habitat and was historically accomplished through fire, insect outbreaks, tree senescence, and flooding that provided the species with places to roost (dead and dying trees) and feed (open forests and "edgy" areas). For the Indiana bat to thrive on a landscape, disturbance must happen frequently enough to provide a constant supply of open areas for feeding, but infrequently enough to retain at least a few large, dead trees for roosting. Alternatively, individual or groups of trees must be allowed to reach their lifespan and die, typically aided by diseases, insects, and other stressors. In addition, the process of killing and leaving trees to serve as wildlife trees through girdling is now commonly used as a tool to provide habitat for bats in Pennsylvania and surrounding states.

3.4.3 Habitat Features

3.4.3.1 Snags

Primary maternity roosts of Indiana bats are often found under the loose bark of large, dead trees (snags) with substantial solar exposure (Humphrey et al. 1977; Brack 1983; Kurta et al. 1993; Kurta et al. 1996; Callahan et al. 1997; Kurta et al. 2002; Whitaker and Brack 2002; Kurta 2004b; Kurta 2004a; Barclay and Kurta 2007; Whitaker and Sparks 2008; Timpone et al. 2010). Partially dead and live trees are also used on occasion. Roost trees are often exposed to the sun 10 hours per day and are present in areas with 20 to 80 percent canopy closure (Humphrey et al. 1977; Gardner et al. 1991; Kurta et al. 1993; Kurta et al. 1996; Kurta et al. 2002; Carter 2003; Carter and Feldhamer 2005), but the need for solar exposure may vary with latitude. High temperatures inside bat roosts are associated with rapid growth of both fetal and juvenile bats, and are likely the reason why climate is such an important driver of Indiana bat distribution. It is noteworthy that dead trees heat up and cool off quickly and unevenly due to solar exposure, whereas live trees change temperature slowly and thus can retain heat for longer periods (Bakken 1989).

Females form nursery colonies under exfoliating bark of snags in a variety of habitat types, including upland and riparian habitats. A wide variety of tree species (Kurta 2004b), occasionally including pines (Britzke et al. 2003), are used for nursery colonies, indicating that it is tree form, not species, that is important for roosts (Kurta 2004b; Winhold 2007; Whitaker and Sparks 2008). Because many roosts are in dead or dying trees, they are often ephemeral.

Nursery colonies often use several roost trees (Kurta et al. 1993; Foster and Kurta 1999; Kurta and Murray 2002; Whitaker and Sparks 2008), moving among roosts within a season. Most members of a colony coalesce into one or a few roost trees about the time of parturition. Once young are volant, the bats spend less time in these major roosts and more time in minor roosts—often roosting alone under the bark of live trees (Section 3.4.3.2, *Other Preferred Roost Trees*). Numerous suitable roosts may be needed to support a single nursery colony, possibly about 45 stems per hectare (20 per acre) (Gardner et al. 1991; Miller et al. 2002; Carter 2003).

3.4.3.2 Other Preferred Roost Trees

In addition to large primary roosts, Indiana bats also make extensive use of smaller-diameter trees with sloughing bark and crevices, and live trees—especially shell- and shag-bark hickories. Alternate roosts may contain only a portion of the colony but may still be an important resource (Callahan et al. 1997) and thus viable habitat for the species. Male roosts are similar to female roosts although they tend to be more shaded and smaller (Kurta 2004a). Males also tend to be found closer to hibernacula (Gumbert et al. 2002).

Some species of trees make better roosts. For example, it has been recommended that Indiana bats would benefit from management regimes that favored cottonwoods in riparian areas and oaks and hickories in upland areas (Whitaker and Brack 2002). These recommendations were based on the perceived ability of cottonwoods to become very high-quality roosts for 1 to 2 years, and the ability of oaks and hickories to remain viable for use across a decade or more. Many of the roosts observed are in elms presumably killed by Dutch elm disease, but these roosts are highly ephemeral as the bark swiftly falls off. Trees with high roost value for Indiana bats are presented in Table 3-5.

Table 3-5. Tree Species with High Value for Indiana Bat Roosts

Common Name	Scientific Name
Shagbark hickory	*Carya ovata*
Shellbark hickory[1]	*Carya lacinosa*
Bitternut hickory	*Carya cordiformis*
Mockernut hickory	*Carya tomentosa*
Pignut hickory	*Carya glabra*
Other hickories	*Carya* spp.
Green ash	*Fraxinus pennsylvanica*
White ash	*Fraxinus americana*
Eastern cottonwood	*Populus deltoids*
Northern red oak	*Quercus rubra*
Scarlet oak	*Quercus coccinea*
Black oak	*Quercus velutina*
White oak	*Quercus alba*
Chestnut oak	*Quercus prinus*
Slippery elm	*Ulmus rubra*
American elm	*Ulmus americana*
Black locust	*Robinia pseudoacacia*

[a] This species is a Pennsylvania Plant Species of Concern with a state rank of S3 (vulnerable).

3.4.3.3 Caves and Mines

Caves and mines are important to Indiana bats because the species depends on hibernation to survive winter. Indiana bats are known to hibernate in 20 sites in 11 counties[2]. Of Pennsylvania's 20 known Indiana bat hibernacula, 13 are abandoned mines, six are limestone caves, and one is an abandoned railroad tunnel. Three current hibernacula are caves formerly abandoned by Indiana bats and to which they returned shortly after gates preventing human access were installed. In addition, many bats that summer in Pennsylvania winter in caves and mines in adjacent states—especially Hellhole Cave West Virginia. Prior to European settlement, it is likely that few Indiana bats hibernated in Pennsylvania. Indiana bats begin entering mine tunnels and caves in mid-September, with most in hibernation by early November, through mid-May.

Indiana bats are selective about the caves they use. Temperatures within the cave must be cold enough to ensure that bats survive the winter, ideally from 41 to 50°F, the point at which costs of metabolic depression are balanced with the benefits of a lower metabolic rate (see Section 3.5.1.2, *Life History*, for additional details about ideal hibernacula).

WNS, a recent serious threat to bat populations (Section 3.5.1.4, *Threats*), thrives in cold and humid conditions characteristic of the caves and mines in which bats hibernate (Gargas et al. 2009).

Protecting and managing hibernacula was the primary target of conservation efforts aimed at the Indiana bat prior to the emergence of WNS. This approach was beginning to allow recovery of some

[2] The locations of these sites are not mapped or otherwise disclosed in the State Lands Forestry HCP to help protect them from trespass and unlawful disturbance.

portions of the population (Richter et al. 1993; Currie 2002; Johnson et al. 2002; Currie 2004; Kath 2002).

3.4.3.4 Barrens

Naturally occurring open habitats, or barrens, are unique assemblages of plant communities that support many rare and threatened plant and animal species. In Pennsylvania, there are four major barrens community complexes (ridgetop acidic barrens, mesic-till barrens, serpentine barrens, and shale barrens) and several minor shrubland community types. These habitat types are sub-categories of the grasslands described in Section 3.2.3, *Grasslands*. Such areas are often relatively small open habitats that, combined with surrounding woodlands, provide the mix of open and forested landscapes often associated with Indiana bats.

Most barrens habitat occurs on ridgetops where soils are well drained, sandy, and acidic. Ridgetop barrens are found in the Northern Ridge and Valley, Allegheny Plateau, Pocono Plateau, Northern Great Valley, and Allegheny Deep Valley Ecoregions of Pennsylvania. The area encompasses 132 State Game Land tracts (Pennsylvania Game Commission and Pennsylvania Fish and Boat Commission 2005).

The mesic-till barrens, located on the southern edge of the Pocono Plateau in northeastern Pennsylvania, include the largest areas of barrens vegetation in Pennsylvania. These barrens contain the highest concentration of globally rare plant and animal species in Pennsylvania (Davis et al. 1991).

The serpentine barrens are located along the Pennsylvania and Maryland border in Lancaster and Chester counties. There are eight sites, seven in Pennsylvania, totaling 2,100 acres, the largest expanse of serpentine vegetation in eastern temperate North America. These barrens represent areas where serpentine bedrock is exposed or is near enough to the surface to influence soil properties and contain many rare plant and animal species.

The shale barrens are located in south-central Pennsylvania, specifically Fulton, Bedford, and Huntingdon counties. A shale barren is a steep, south-facing slope where the bedrock is composed of shale; the rocky, dark, shale soils can reach temperatures of 140°F when the sun is shining full strength. Despite the dry living conditions, many species have become adapted to this habitat including the Pennsylvania shale barrens evening primrose, cat’s paw ragwort, fence lizards, and many rare moth species. Shale barrens are only found from southern Pennsylvania through West Virginia to southern Virginia, leaving many of the species dependent on them listed as threatened and endangered.

Fire plays an integral role in the conservation of barrens. Barrens were maintained for thousands of years by lightning-induced and native-set fires that promoted berries and improved hunting grounds. More recently, fires were lit by settlers and sparks from locomotives that carried coal and timber. Fire suppression was initiated in the early 1900s to stem the uncontrolled wildfires. In the absence of fire, trees that were minor components in healthy barrens expanded and changed habitat structure from early successional to closed canopy forest. Without fire, understory diversity was lost to the shading effect of trees and overly dense shrubs. Scattered oaks and hard pines (pitch or table mountain pine) are desirable; however, beyond about 15 trees per acre, barrens become savannas or woodlands (Pennsylvania Game Commission and Pennsylvania Fish and Boat Commission 2005).

The value of open areas such as glades is illustrated by studies of Indiana bats conducted during autumn swarming in 2000 near a hibernaculum in Bland County, Virginia. Bats were active in several habitats, but preferred open habitat for foraging. Glade and barren areas may provide important foraging areas within heavily forested landscapes.

3.4.3.5 Savannas

Much like glades, savannas provide trees for roosting and open areas for foraging. Black oak savannas are found along the coast of Lake Erie and are one of the rarest communities in Pennsylvania. These communities exist on sandy soils of ancient dunes and beach ridges, remains of when the Great Lakes water level was higher. Historically, wind and fire combined with well-drained, nutrient-poor, sandy soils to prevent these areas from developing into forests. Savannas share features of both prairie and forests ecosystems, and are characterized by widely spaced trees interspersed with sparsely vegetated sandy openings (sand barrens) with low-growing shrubs and herbs. Historically, black oak savannas were found from Ohio and into western Pennsylvania, along the Erie Coast and on glacial sand beach ridges and dunes. It is estimated that only 2 percent of the black oak savanna that once was in Pennsylvania remains. Land use changes outside of Pennsylvania have contributed to the decline of black oak savanna. Presently, oak savanna is found in two protected areas along the Erie coastline in northwestern Pennsylvania, in Presque Isle and Erie Bluffs State Parks (Pennsylvania Department of Conservation and Natural Resources 2010a).

Savanna habitats adjacent to riparian corridors have probably been historically important for roost sites, as bats prefer sun-exposed trees for maximum warmth, especially in the cooler portion of their range.

3.4.3.6 Other

Indiana bats have been found roosting in utility poles (ESI 2004; Hendricks et al. 2004), buildings (Butchkoski and Hassinger 2002a; ESI 2006), and bat boxes (Butchkoski and Hassinger 2002b; Carter 2002; Butchkoski 2005; Ritzi et al. 2005; Whitaker et al. 2006). The colony of bats near the Indianapolis Airport has used both natural roosts (trees) and bat boxes every year since 2003 (Sparks 2008; O'Keefe pers. comm.). However, use of human-made structures appears to be rare.

3.4.4 Seasonal Habitat Types in Pennsylvania

There are several relevant periods in the life history of the Indiana bat. Annually, these are winter hibernation, spring migration, spring staging, summer reproduction, autumn swarming, and autumn migration. Differential habitat use across time necessitates the calculation of effects at different times of year. As such, the State Lands Forestry HCP assesses effects based on the following life-cycle components:

- **Winter**: Indiana bats hibernate in the winter, when they are largely confined to the cave (or mine) environment.
- **Fall/Spring**: Indiana bats are active at or near the hibernaculum before and after winter hibernation. In the spring, this is where a period of staging takes place, in the fall a period of swarming and mating. During these times, the areas around the hibernaculum are used heavily.
- **Summer**: Within Pennsylvania, this is the broadest habitat category, reflecting the summer period of reproduction (pregnancy and lactation), when bats use the forest for both roosting and

foraging. At this time of year, many males are found near hibernacula, but some wander widely and may occur in suitable habitat throughout the state. Before and after the summer, bats migrate between the hibernaculum and areas of summer habitat.

These categories are used to quantify effects (Chapter 4, *Effects of Covered Activities*) and to guide conservation (Chapter 5, *Conservation Program*). For winter and fall/spring, when habitat is largely correlated with the location of the hibernaculum, the methods for modeling habitat are straightforward. For summer, where distance to the hibernaculum is only a partial predictor of occurrence, the habitat distribution model, a species-specific statistical tool, was developed to aid in the identification of suitable habitat (Appendix H, *Habitat Distribution Modeling Using MaxEnt*). Species distribution models are often employed in conservation planning efforts and utilize well-tested modeling algorithms. These models use known locations of a species coupled with information on environmental conditions to predict species distributions and map habitat suitability (Sofaer et al. 2019).

Habitat is quantified in acres to provide context for the State Lands Forestry HCP and because the effects analysis is based on the number of acres of suitable habitat present and the effects of covered activities on the quality of this habitat. As such, the environmental baseline for the permit is based on the number of acres of suitable habitat associated with winter habitat (i.e., buffers around known hibernacula (Section 3.5.4.1, *Winter*), fall/spring habitat (Section 3.5.4.2, *Fall/Spring*), and summer habitat (Section 3.5.4.3, *Summer*). Chapter 4, *Effects of Covered Activities,* estimates the number of bats present each season as a means for understanding the potential effects of covered activities. However, these population estimates are not tied to the State Land Forestry HCP take limits because of the difficulty of monitoring losses of individual bats because of covered activities (described in Chapter 4).

3.4.4.1 Winter

Bats hibernate during the winter months, beginning as early as September and extending as late as April. Based on records of the same bat appearing in two or more hibernacula during the same winter, the movement of individuals during the winter is considered rare. However, some individuals likely do not enter a hibernaculum until as late as January (Hassell 1967; Daan 1973; Clawson 1980) and occasional winter movements outside hibernacula do occur for many species (Mumford 1958; Daan 1973; Whitaker and Rissler 1992a, b). For the purposes of defining winter habitat and subsequently analyzing risk, Indiana bats are assumed to be entirely within the hibernaculum. Winter habitat is modeled as the known hibernaculum and adjacent lands within 0.25 mile of all entrances of known hibernacula. This distance is larger than the 0.09-mile (150-meter) exclusion zone recommended by (Bearer et al. 2016), is based on the application of an identical size buffer in multiple U.S. Fish and Wildlife Service biological opinions (U.S. Fish and Wildlife Service 2015; 2016a, 2016b), and is intended to protect the bats within from surface-level disturbance. This also accounts for the relatively low accuracy of some of the data points.

Indiana bats are known to hibernate at 20 sites in the state of Pennsylvania, with some hibernacula receiving much greater use. The two most important sites (South Penn Tunnel and Hartman Mine) contained 25 of the 28 bats counted in winter 2014-2015. The remaining 18 other smaller hibernacula contained only three bats. Of these 20 sites, seven (including Hartman Mine) are located on State Lands (including Canoe Creek State Park, and State Game Lands 51, 105, 224, 147, 148, and 260), and the 0.25-mile buffer associated with one of the 12 remaining hibernacula extends onto Bald Eagle State Forest. Winter habitat for Indiana bats is therefore defined as the land within 0.25

mile of all hibernacula on State Lands and all State Lands within 0.25 mile of the entrance(s) to a known hibernaculum. Winter habitat on State Lands for Indiana bats is mapped in Figure 3-8 and the distribution of these bats is described in Table 3-6.

3.4.4.2 Fall/Spring

During the fall and spring, most Indiana bats are found near the hibernaculum as they prepare for hibernation (September 1 to November 1) or emerge from hibernation (April 1 to May 15). As described in Section 3.5.1.2, *Life History*, 83 percent of staging and swarming activities occur within 5 miles of hibernacula. As a result, this distance was used to delineate fall/spring habitat for most hibernacula in Pennsylvania (Chenger and Sanders 2007; Gumbert et al. 2002; Rommé et al. 2002; ESI 2005). Sites where Indiana bats flew farther than 5 miles can be explained by the presence of multiple hibernacula, presence of both summer and winter habitat, geographic boundaries that limited movement, and areas where many bats share the same landscape. In particular, studies at the South Penn Tunnel (Sanders and Chenger 2000) provided site-specific data indicating bats were regularly traveling beyond the 5-mile radius in the fall and spring. This site is uniquely constrained by Allegheny Mountain (a major biogeographic boundary), and the Pennsylvania Turnpike. During radio-telemetry studies at the site, only a single bat approached, and no bats crossed the top of Allegheny Mountain. Thus, site-specific data was used to identify the fall-spring habitat for bats at this site (Figure 3-9).

In addition, studies of bats throughout the active period of the year (Kiser and Elliott 1996; Sanders and Chenger 2000; Rommé et al. 2002; Sparks et al. 2005a; Brack 2006), indicate that large blocks of agricultural fields, open water, and developed areas are of little or no value for Indiana bats. These vegetation types are considered unsuitable as fall/spring habitat, whereas all other vegetation types within 5 miles of known hibernacula are considered to have high suitability for habitat (Table 3-7). Therefore, for the purposes of the State Lands Forestry HCP, Indiana bat fall/spring habitat is defined as all high suitability habitat on State Lands within 5 miles of a known Indiana bat hibernaculum (Table 3-8). As with Indiana bat winter habitat, the 5-mile buffer associated with several of the 14 hibernacula not found on State Lands extends onto State Lands. Fall/spring habitat for all sites is mapped on Figure 3-10.

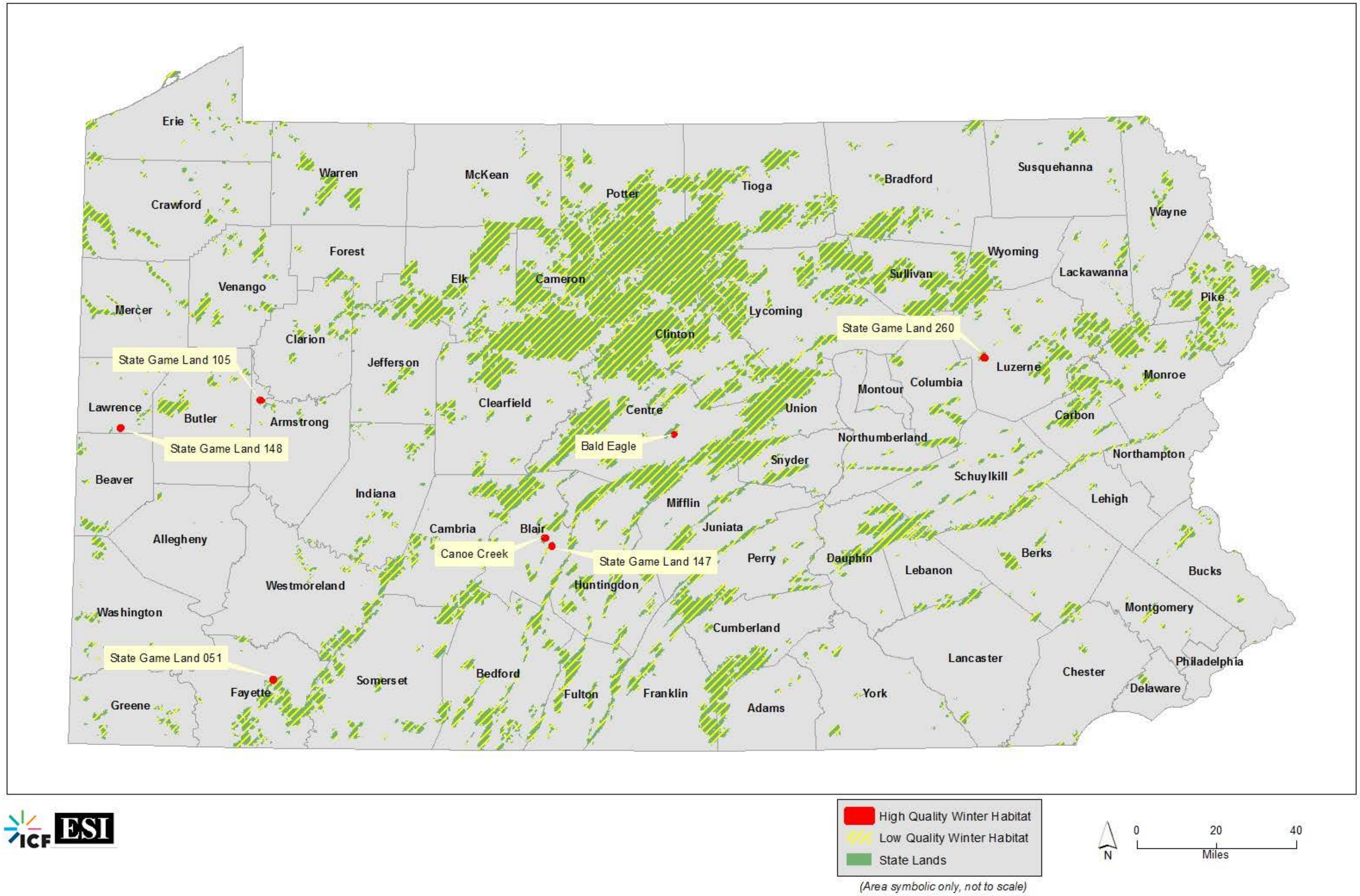
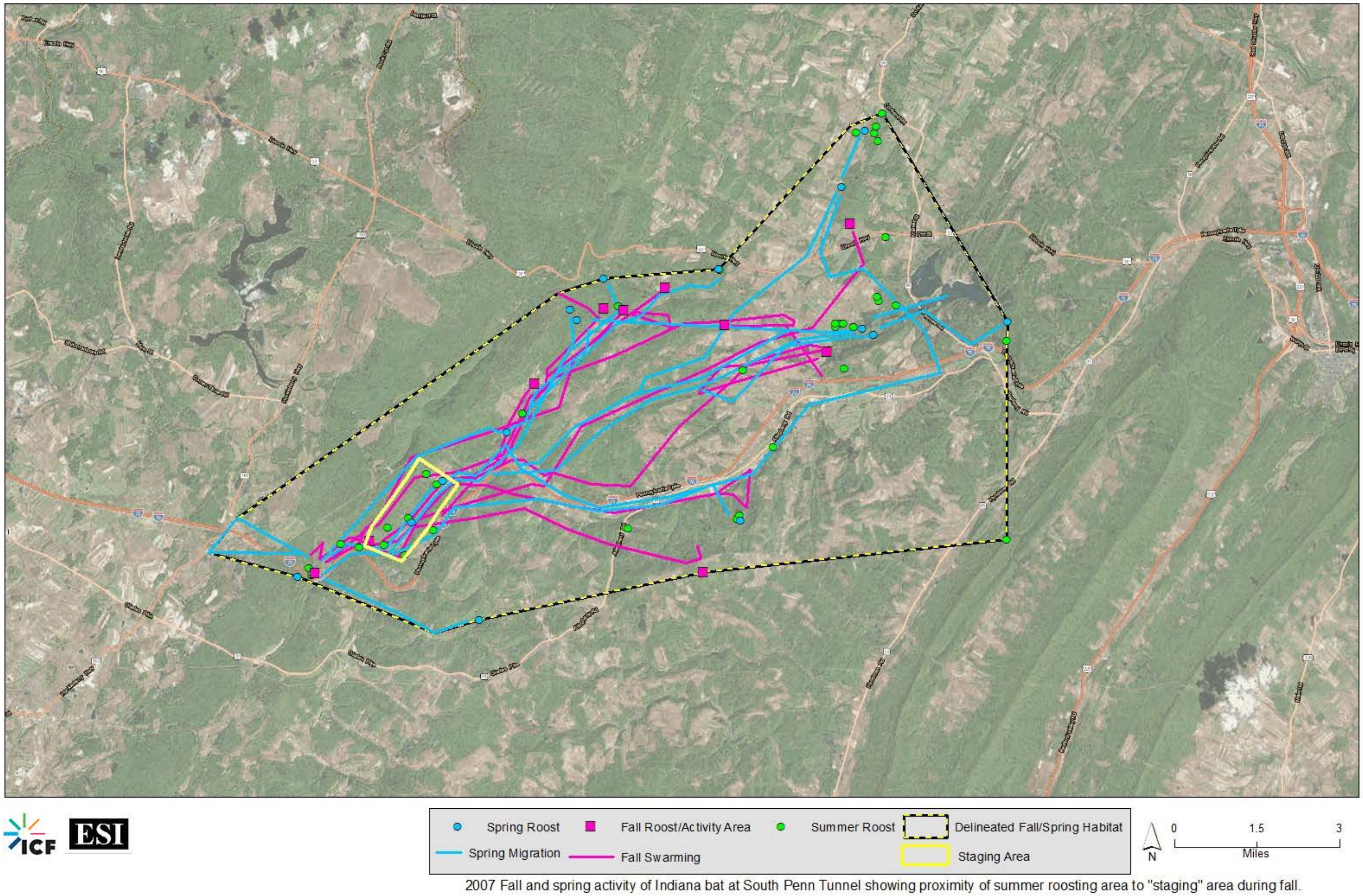


Figure 3-8. Modeled Winter Habitat for Indiana Bats on State Lands

Table 3-6. Modeled Acres of Indiana Bat Winter Habitat in Pennsylvania and on State Lands[a]

Location of Hibernacula	Statewide (all lands)		State Game Lands		State Forests		State Parks		State Lands (Total)	
	Acres of Winter Habitat	Percent of Land Area in State	Acres of Winter Habitat	Percent of State Game Lands	Acres of Winter Habitat	Percent of State Forests	Acres of Winter Habitat	Percent of State Parks	Acres of Winter Habitat	Percent of State Lands
South Penn Tunnel (PA Turnpike Authority)[b,c]	126	<0.1	0	0	0	0	0	0	0	0
Hartman Mine (Canoe Creek State Park)[b,c]	126	<0.1	0	0	0	0	78	<0.1	78	<0.1
6 Hibernacula[c] on State Game Lands	756	<0.1	524.91	<0.1	0	0	0	0	524.91	<0.1
Hibernacula Adjacent to Bald Eagle State Forest	126	<0.1	0	0	2.65	<0.1	0	0	2.65	<0.1
11 Other Hibernacula on Private Lands	1386		0	0	0	0	0	0	0	0
Total	2,520	<0.10	524.91	<0.10	2.65	<0.10	78	<0.10	605.56	<0.10

[a] Based on June 3, 2016 Pennsylvania Game Commission data (Pennsylvania Game Commission pers. comm.).
[b] These hibernacula contain 25 of 27 bats counted during the last survey and are a focus of Chapters 4 and 5.
[c] The natural heritage data contains a single point, but multiple entrances need to be mapped and buffered.

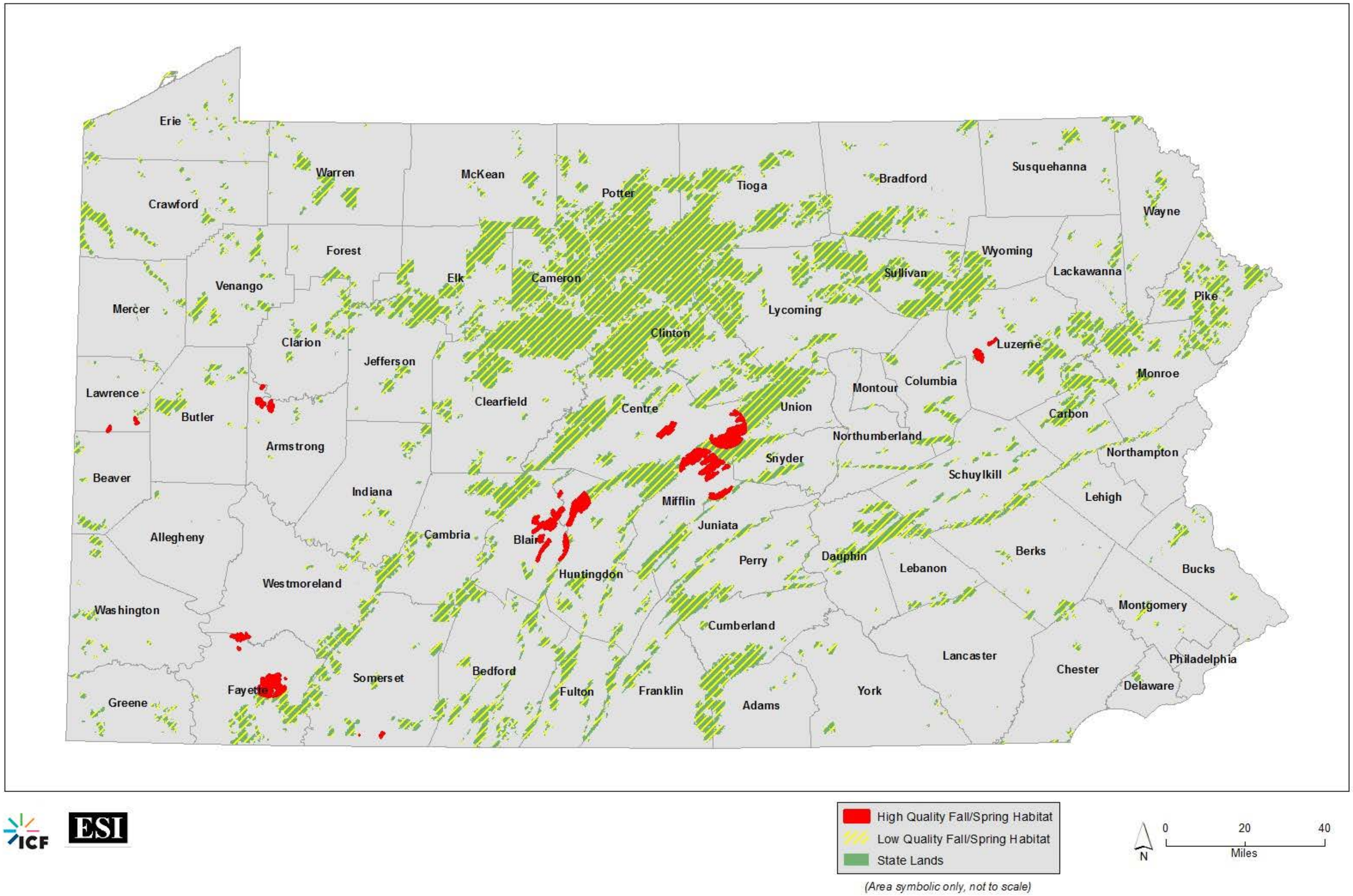


Source: Digitized from Sanders and Chenger 2000

Figure 3-9. Delineation of Fall/Spring Habitat for Indiana Bats at the South Pennsylvania Tunnel

Table 3-7. Assigned Habitat Value of Vegetation Types to Indiana Bats Active near Hibernacula in Fall and Spring

Vegetation Type	Habitat Value Rank	Notes and Citations
Agriculture	Low	Agricultural areas were avoided during studies of fall/spring bats (Brack 2006; Kiser and Elliot 1996; Rommé et al. 2002; Chenger and Sanders 2007)
Developed Urban	Low	Developed areas have consistently been avoided by Indiana bats at other times of the year (Sparks et al. 2005a; Menzel et al. 2005), and have been rare or absent from studies conducted during fall/spring activities.
Grasslands	High	This is likely size-dependent, but more open forests and grassy areas have been documented as valuable foraging areas (Brack 2006) or as neutral areas (Sparks et al. 2005a) during nocturnal activities.
Northern Hardwoods/ Coniferous Forest	High	Forested areas have proven valuable for Indiana bats during studies of both foraging and roosting by spring and fall Indiana bats (Gumbert et al. 2002; Brack 2006; Sanders and Chenger 2000; Rommé et al 2002; Kiser and Eliot).
Oak/Pine Forest	High	Forested areas have proven valuable for Indiana bats during studies of both foraging and roosting by spring and fall Indiana bats (Gumber et al. 2002; Brack 2006; Sanders and Chenger 2000; Rommé et al. 2002; Kiser and Eliot).
Open Water	Low	Large areas of open water are avoided by Indiana bats (Sparks et al. 2005).
Rocky Outcrops	High	Rocky outcrops often contain scattered trees and may contain mine and cave entrances.
Swamps and Marsh	High	Unlike large expanses of open water, smaller, contained wetlands are valuable for all in many ways for Indiana bats (Kurta et al. 2002; Murray and Kurta 2002; Murray and Kurta 2004; Carter 2006).



Source: Digitized from Sanders and Chenger 2000

Figure 3-10. Modeled Fall/Spring Habitat for Indiana Bats on State Lands

Table 3-8. Modeled Indiana Bat Fall/Spring Habitat in Pennsylvania and on State Lands and Estimated Numbers of Indiana Bats[a]

	Statewide (all lands)		State Game Lands		State Forests		State Parks		State Lands (Total)	
Location of Hibernacula (Affected State Lands)	**Acres of Fall/Spring Habitat**	**Percent of Land Area in State**	**Acres of Fall/Spring Habitat**	**Percent of State Game Lands**	**Acres of Fall/Spring Habitat**	**Percent of State Forests**	**Acres of Fall/Spring Habitat**	**Percent of State Parks**	**Acres of Fall/Spring Habitat**	**Percent of State Lands**
South Penn Tunnel[b]	31,684	0.1%	0	0	0	0.0%	1,905	0.6%	1,905	0.6%
Hartman Mine (Canoe Creek State Park)[b,c]	36,614	0.1%	7,600	0.2%	0	0.0%	511	0.2%	8,111	0.4%
6 Hibernacula[c] on State Game Lands	215,071	0.7%	22,536	0.6%	56	<0.1%	2050	0.7%	24,642	1.3%
9 Other Hibernacula[c] whose habitat extends onto State Lands	238,272	0.8%	13,517	0.3%	50,192	2.3%	684	0.2%	64,393	2.8%
Total (20 Hibernacula)[d]	**521,641**	**1.7%**	**43,653**	**1.1%**	**50,248**	**2.3%**	**5,150**	**1.7%**	**99,051**	**5.1%**

[a] Based on June 3, 2016 Pennsylvania Game Commission data (Pennsylvania Game Commission pers. comm.).

[b] These hibernacula contain 25 of 27 bats counted during the last survey1 and are a focus of Chapters 4 and 5.

[c] The natural heritage data contains a single point, but multiple entrances need to be mapped and buffered.

[d] Fall/Spring buffer overlaps another hibernaculum. The overlap is not tallied for the total acres.

3.4.4.3 Summer

Male and female Indiana bats typically live apart during summer. Females congregate in maternity colonies for most of the summer. Members of these colonies occupy multiple roosts during a summer, and it is in these colonies that female bats gestate and subsequently raise their young. During the summer, males live alone or in small groups. During this time, both males and females use habitat that provides warm roosting conditions and good foraging. During summer, bats are widely distributed in areas that may be subject to timber harvest and thus the risk of direct take is likely highest at this time.

Unlike hibernacula, which are relatively well known, most summer roosts are widely distributed and not clearly identified (U.S. Fish and Wildlife Service 2007). For this reason, it is difficult to predict the distribution of summering bats. To do so for the State Lands Forestry HCP, a model was created to delineate areas of high suitability for summer habitat. This model was created using MaxEnt, a statistical-based software package (Phillips et al. 2004, 2006), and is tailored to predict species distributions based on presence-only data using a procedure known as maximum entropy. Maximum entropy works by determining the environmental variables in the landscape that are most influential in predicting species occurrence and the relative probability of species occurrence for each landscape unit (i.e., a pixel in a raster-based image/map). MaxEnt has been used globally to model distributions of a variety of species (Elith et al. 2011), including Indiana bats (Loeb and Winters 2013; Weber and Sparks 2013) and is used in numerous HCPs. MaxEnt predicts species distribution across a geographic area of interest by comparing point location data (e.g., capture locations) to a suite of environmental variables. For the State Lands Forestry HCP, the following variables were found to predict bat occurrence and were integrated into the model: precipitation, distance to hibernacula, land cover type, temperature, distance to streams, distance to roads, aspect, and slope. Additional information on the modeling approach, including the limitations of MaxEnt, the model settings, and the methods for selecting model variables, can be found in Appendix H, *Habitat Distribution Modeling Using MaxEnt*.

Migratory habitat was not quantified due to the fact it is largely unknown and used on a temporary basis. The main migratory route is between West Virginia (e.g., Hellhole Cave) and southwestern Pennsylvania. During migration individual bats may pass through a variety of habitats (including areas that are otherwise unsuitable), but most of the known routes pass through high suitability summer habitat.

Model Summary

Analysts used over 90 occurrence locations and nine environmental variables to model habitat for the Indiana bat in Pennsylvania. The Jenks natural-breaks method (Jenks 1967) was used to create two categories of habitat suitability (high and low). Approximately 17 percent of the state was modeled as high suitability habitat for summering Indiana bats, the remainder is considered low suitability habitat. It is likely that bats make occasional use of the areas of low suitability habitat (especially when juxtaposed with areas of high suitability habitat), but such use is relatively rare.

Results from the model suggest that most high suitability summer habitat is concentrated in the southern half of the state, whereas the northern half of Pennsylvania contains only small, isolated patches of higher-quality habitat. The overall pattern is consistent with data presented in Figure 3-7, which is used by the U.S. Fish and Wildlife Service for other Endangered Species Act consultations. The preponderance of bats in the southern portion of the state could also be, in part, a result of migrant bats entering the state from West Virginia. Most areas of summer habitat are within the Ridge and Valley physiographic province and within the west-central to southwest portion of the State. Overall, the northern half of the state has a lower potential for use than the southern half. Higher-quality areas for potential use are generally found where historic prairies occurred.

The fit of the occurrence data to the model was high - the average likelihood of locating a bat occurrence within high suitability habitat is approximately four times higher than that of a random location.

Results

Based on the modeling results, Indiana bat summer habitat is defined as all State Lands modeled as high suitability summer habitat (Figure 3-11 and Table 3-9). Individual Indiana bats may occur in areas of low suitability when they are migrating or when these areas abut areas of high suitability. Maternity colonies are unlikely to occur in low-suitability habitat.

Table 3-9. Modeled Indiana Bat Summer Habitat in Pennsylvania and on State Lands

Statewide (all lands)		State Game Lands		State Forests		State Parks		State Lands (Total)	
Acres of Summer Habitat	% Land Area in State	Acres of Summer Habitat	% State Game Lands	Acres of Summer Habitat	% State Forests	Acres of Summer Habitat	% State Parks	Acres of Summer Habitat	% State Lands
5,003,042	17.0	252,290	16.4	169,452	7.8	57,890	19.5	479,632	12.0%

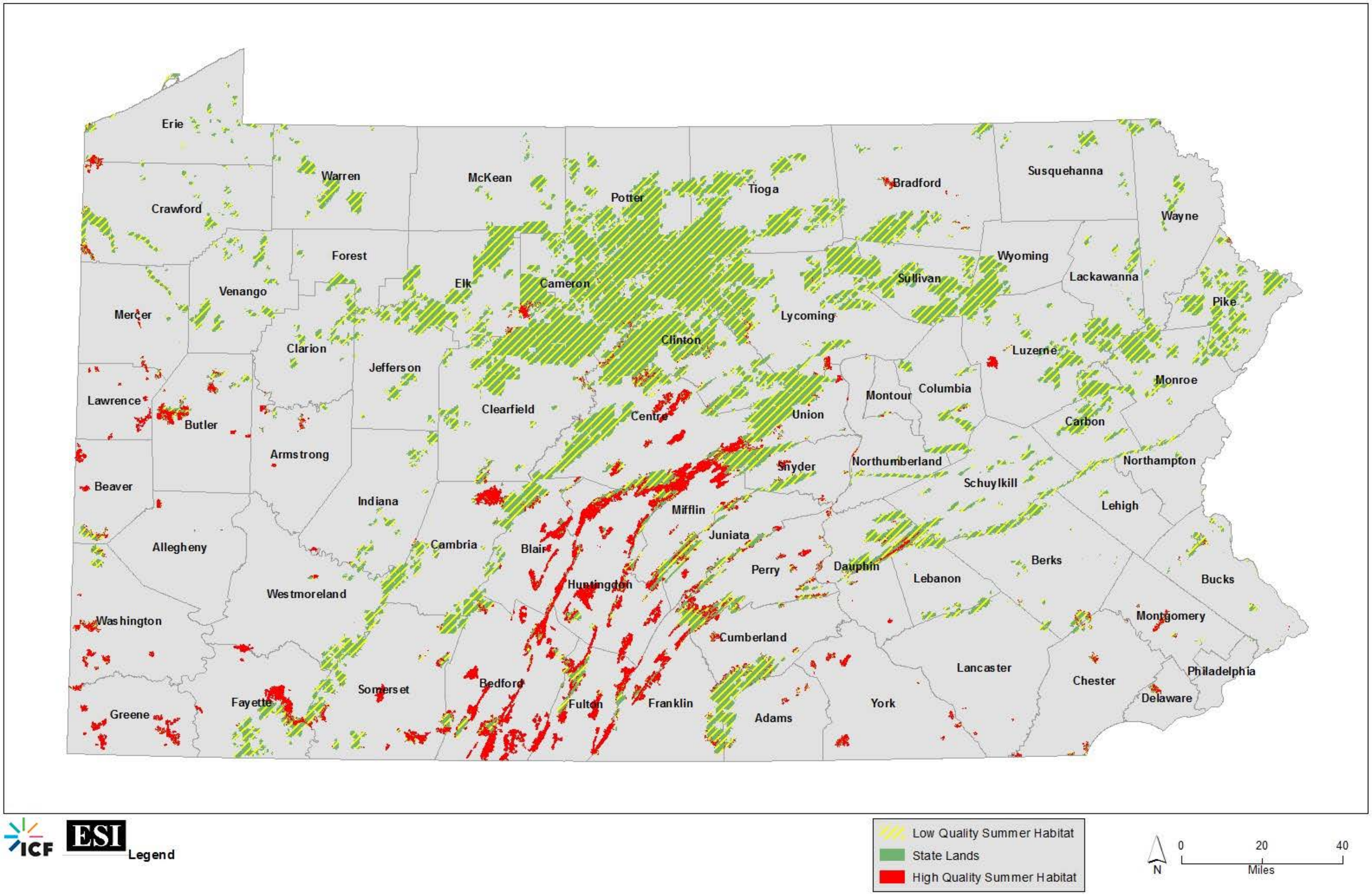


Figure 3-11. Modeled Summer Habitat for Indiana Bats on State Lands

Using these assumptions in combination with the habitat distribution model described previously, it was possible to estimate the number of Indiana bats that summer in the state based on three different source populations (Table 3-10): bats that hibernate in Pennsylvania or surrounding states other than West Virginia, male migrants from West Virginia, and female migrants from West Virginia.

The smallest source populations consist of 27 Indiana bats that are considered year-round residents in the state. The second source population consists of 71 male Indiana bats that summer in Pennsylvania and hibernate in West Virginia. Most Indiana bats that summer in Pennsylvania are females that migrate between hibernacula in West Virginia and maternity colonies in southern Pennsylvania. As described in Appendix M, *Estimating Summer Densities of Indiana Bats in Pennsylvania,* this number is estimated at 280.

Table 3-10. Estimated Numbers of Indiana Bats on Summer Habitat in State Lands

	Statewide	
Source Population	**Est. Number of Bats[a]**	**Number of Bats Per 100,000 Acres Summer Habitat[a]**
Bats that hibernate in Pennsylvania or surrounding states other than West Virginia	28	0.56
Male migrants from West Virginia	71	1.42
Female migrants from West Virginia	280	5.6
Total	**379**	**--**

[a] Based on Pennsylvania Game Commission June 3, 2016 data (Pennsylvania Game Commission pers. comm.) and U.S. Fish and Wildlife Service 2015

Number of Colonies

It is important to remember that the distribution model is based on distributional data collected prior to and in the early days of the WNS epidemic. In the absence of other data, the working assumption is that surviving Indiana bats may still be found within these areas of suitable habitat.

Included in the distributional data used to create the model are maternity roosts and capture sites associated with three maternity colonies on State Lands: Canoe Creek State Park, Shawnee State Park, and State Game Lands (SGL) #302 located in Greene County. Four additional maternity colonies have roosts within 2.5 miles of SGL# 232 in Washington County, SGL#249 in Adams County, SGL#315 in Berks County, and SGL#316 in Pike Counties. As such, there are seven colonies of Indiana bats known from State Lands. The 2.5-mile known habitat buffer (USFWS 2017b) for these colonies contains 78,288 acres of suitable habitat with an average colony occupying 11,184 suitable acres spread between State Lands and other ownerships. The 479,632 suitable acres across State Lands and the 5,003,042 acres of suitable habitat across the Commonwealth provides an estimated 43 colonies on State Lands and 447 colonies across the state. This is likely an over-estimate because the distribution model is highly conservative (i.e., includes areas of relatively low habitat suitability).

As noted above, Indiana bats that summer in Pennsylvania are drawn from a larger regional pool, but most of the bats hibernate in Pennsylvania and West Virginia. Between 2009 (when WNS arrived in Pennsylvania) and 2015, the winter population in these states has declined by 87 percent. If this decline in individuals is reflected by a decline in the number of colonies, then at the time of publication of this HCP there are 5 colonies on State Lands and 56 spread across the rest of the state.

3.5 Northern Long-Eared Bats

3.5.1 Ecology

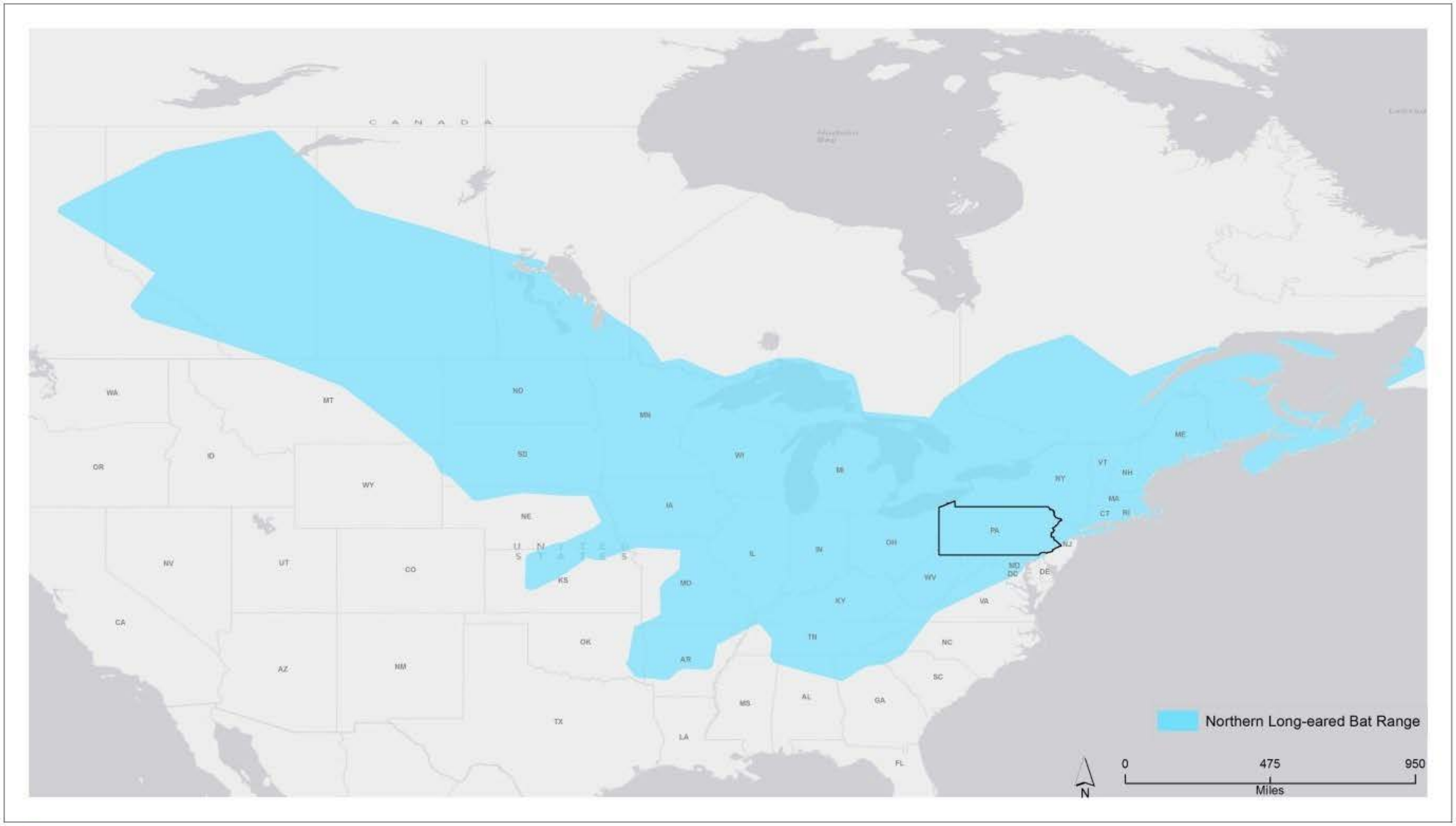
The northern long-eared bat is listed as a threatened species by the U.S. Fish and Wildlife Service and the Commonwealth of Pennsylvania. Much like the Indiana bat, the northern long-eared bat roosts in underground structures (caves, mines, and possibly rock outcroppings) during the winter and in trees in summer. The U.S. Fish and Wildlife Service has determined that designation of critical habitat is not prudent for this species (81 *Federal Register* 24707-24714 [April 27, 2016]); as a result, none has been designated for northern long-eared bats. As with the Indiana bats, there are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction.

3.5.1.1 Range

The northern long-eared bat ranges from the northern border of Florida north and west to Saskatchewan, and east to Labrador (Figure 3-12). This bat is common to a variety of forest types ranging from intact forest to small remnants. Although primarily an eastern species, the northern long-eared bat can be found as far west as Montana and is relatively common on the High Plains. Historically, the northern long-eared bat was abundant throughout a majority of Pennsylvania.

Captures within the Piedmont and Coastal Plain Regions are less common but do occur in forested habitat.

Unlike the Indiana bat, the northern long-eared bat does not show a marked preference for different habitat types for summer and winter ranges. This broader habitat distribution reduces the distance bats must migrate to find suitable summer and winter habitats.



Source: England 2003

Figure 3-12. Range-Wide Distribution of the Northern Long-Eared Bat

3.5.1.2 Life History

Much like the Indiana bat, northern long-eared bats lives in trees during summer and caves during winter. There are four ecologically distinct components of the annual life cycle: winter hibernation, spring staging and autumn swarming, spring and autumn migration, and the summer season of reproduction. Appendix B, *Species Accounts*, includes a detailed description of northern long-eared bat ecology; the following sections provide an overview of northern long-eared bat biology.

Winter Hibernation

Northern long-eared bats primarily hibernate in caves and mines (Whitaker and Mumford 2009); however, the species has been known to use other human-made structures including the spillway of a hydroelectric dam (Kurta and Teramino 1994). They are known to use cracks and crevices in caves and mines, evidenced by the presence of clay and mud debris on their fur during cave emergence (Caire et al. 1979; Whitaker and Mumford 2009). The species is also known from areas of the High Plains where caves and mines are absent but rock faces are abundant, suggesting that the species also likely uses such rocky habitats as hibernacula (Sparks et al. 2011). Several unpublished reports indicate the species regularly hibernates in coastal rocky outcrops. Prior to WNS, many more bats were captured in summer than could be accounted for given the limited numbers observed during the winter in traditional hibernacula (i.e., caves and mines).

Northern long-eared bats select areas within hibernacula that are relatively stable with a mean temperature of 48.4°F (9.1°C) (Brack 2007). They prefer high humidity conditions with little to no airflow (van Zyll de Jong 1979).

Autumn Swarming and Spring Staging

Like Indiana bats, northern long-eared bats spend significant periods near the entrance of the hibernaculum before and after entering hibernation. During spring, this is known as staging and likely represents a period when any unbred females mate, and some bats forage extensively to recuperate from hibernation (U.S. Fish and Wildlife Service 2007). During fall, however, bats may assemble around the entrances of caves and mines in large groups known as swarms (Fenton 1972; Humphrey and Cope 1976; Humphrey et al. 1977). This is the period when most mating occurs.

Typical of most bat species in the eastern United States, northern long-eared bats migrate between winter hibernacula and summer roosting habitat. The distance and routes traveled from winter hibernacula to summer roosting areas are not well known for this species, but are likely shorter than for the Indiana bat (U.S. Fish and Wildlife Service 2014) because their seasonal habitat preferences are not as specific. Overall, this species is not regarded as a long-distance migrant, usually covering only 40 to 50 miles (U.S. Fish and Wildlife Service 2014). Spring migration from winter hibernacula usually occurs between mid-March and mid-May, while fall migration from summer roosting areas back to winter hibernacula occurs from mid-August through mid-October.

Rangewide Roosting Ecology

Maternity colonies are typically found in hollow trees and under bark, although they sometimes use bat-houses, buildings, and other anthropogenic structures. After parturition, pups usually achieve volancy (i.e., capability of flight) by 21 days (Kunz 1971; Krochmal and Sparks 2007). As the offspring become volant the average number of bats (Amelon and Burhans 2006) using a maternity roost declines (Lacki and Schwierjohann 2001; Sparks 2003). Once young are weaned, a colony may spread out and occupy multiple roosting locations.

Pennsylvania-Specific Roosting Data

Stauffer (2016) reported on roosts used by 28 northern long-eared bats captured on State Forests in May to August of 2010 and 2011 by consultants. These data represent the best available science on the habitat used by northern long-eared bats on State Lands, and are broadly similar to observations throughout the range. The 28 bats (9 pregnant females, 6 post-lactating females, 7 lactating females, 5 non-reproductive females, and 1 juvenile male) were tracked to 70 different roost trees on and adjacent to State Lands including 44 snags and 26 live trees. Roost trees averaged 13.2 inches (± 6.9 inches) in diameter and 67.9 feet (± 33.8 feet) in height and received an average of 4.5 hours of direct sunlight per day (± 3.2 hours). Bats were found roosting under loose bark at 17 roost sites and 29 roosts were in cavities or crevices. Surveyors could not determine the exact locations in the tree (bark or cavity) for 24 of the roost locations. As many as 46 bats were counted emerging from one tree, although counts averaged 10.3 bats (± 13.1). Bats frequently changed roosts with as many as six different roosts being used during an 8-day period. Fifteen species of trees were documented:

- American beech
- Black birch
- Black cherry
- Black locust
- Chestnut oak
- Paper birch
- Pignut hickory
- Red maple
- Red oak
- Sassafras
- Shellbark hickory
- Silver maple
- White ash
- White oak
- White pine

3.5.1.3 Foraging

The northern long-eared bat typically emerges from roosting near dusk to forage over forested ponds and streams and in wooded areas before returning to a night roost (Kunz 1973). Northern long-eared bats often emerge a second time in early morning for another short bout of foraging before returning to their day roosts (Kunz 1973; Brack and Whitaker 2001). The northern long-eared bat has been documented as using both hawking and gleaning foraging strategies (picking up food in flight or from a substrate) (Griffith and Gates 1985; Faure et al. 1993; Brack and Whitaker 2001; Feldhamer et al. 2009).

Unpublished studies in suburban Indianapolis and along the Wabash River near Terre Haute, Indiana indicate that this species forages almost exclusively in forested areas within 0.6 mile of the roost (Sparks pers. comm.). This coincides with studies from New Hampshire, showing an average distance from roosting areas to foraging areas of 0.37 mile (Sasse and Pekins 1996). Henderson and Broders (2008) found that foraging areas on Prince Edward Island were comparatively more cluttered than roosting areas, although foraging areas were also found to be predominately forested. If a bat was found to forage in an open area, it was within 85 yards of a forest feature.

3.5.1.4 Threats

White-Nose Syndrome

The primary reason for the listing of northern long-eared bats is catastrophic population declines due to WNS. As noted in Appendix B, *Species Accounts*, the fungus grows readily in cool areas used by hibernating bats and coincides with a time when bats have reduced immune function (Carey et al. 2003), which may further predispose them to infection by *P. destructans* (Meteyer et al. 2009).

Northern long-eared bats are in a period of rapid decline associated with WNS. At the time of listing, (U.S. Fish and Wildlife Service 2016b) winter observations in Pennsylvania had declined by 99 percent and summer captures had declined by 76 percent. Available data suggest that capture rates for northern long-eared bats declined by 77 percent in West Virginia and adjacent portions of Pennsylvania within 2 years of the arrival of WNS in the state (Francl et al. 2012). Similarly, observations in regularly monitored hibernacula declined by 98 percent in the 5 years following the arrival of WNS (Turner et al. 2011). Available data provide no indication that cave-hibernating populations of this species are stabilizing or rebounding (Frick et al. 2015).

Other Threats

The northern long-eared bat uses a variety of wooded summer habitats, from large tracts of woodlands to riparian strips and woodlots on an anthropogenic landscape. Summer habitat losses include tree removal or land clearing for a variety of land uses. Removing standing dead trees, especially during summer months, is potentially harmful. Removing riparian forest along streams and ditches also degrades summer habitat. Loss of wooded lands can lead to increased forest fragmentation, and a compounding of adverse effects. In many portions of their core range, northern long-eared bats use forested habitats with trees of multiple sizes and a more cluttered understory than Indiana bats. Urbanization removes potential roosting and foraging habitat and some bat species may not cross developed areas to access otherwise suitable foraging habitat (Duchamp et al. 2004; Sparks et al. 2005a). However, northern long-eared bats may also be able to occupy very small remnant forests within a developed landscape if such habitat contains suitable roosts (Whitaker et al. 2004; Damm et al. 2016).

Because northern long-eared bats use a wide variety of hibernacula and are often difficult to detect, efforts to close abandoned mines may have killed many individuals prior to the widespread use of bat-friendly gates (Whitaker and Stacy 1996). This species likely also suffers from problems documented for other species, including flash flooding of hibernacula (Brack et al. 2005), ceiling collapse of mines and caves (Elliot 2007), colder or warmer than average winters, and severe summer storms. Natural or human-caused changes in the microclimate of caves and mines used as hibernacula can adversely affect bats hibernating within the structure (Richter et al. 1993).

3.5.2 Habitat Preferences

The northern long-eared bat uses a much greater variety of habitat types than Indiana bats. Within a bat's home range, there must be suitable roosting and foraging habitat. The northern long-eared bat is primarily a forest bat in the summer. The species makes extensive use of contiguous forests, although maternity colonies may occupy much smaller woodland fragments than Indiana bats. Forest edges are used for foraging and commuting, but this bat is capable of existing in unbroken forest (Lacki et al. 2007b; Sheets et al. 2013b; U.S. Fish and Wildlife Service 2013).

3.5.2.1 Forest Dynamics

Previous authors (Lacki et al. 2007a; Sheets et al. 2013b; U.S. Fish and Wildlife Service 2013) have noted that forest management activities could benefit bats, in general, if they favored the retention of large, senescent trees for primary roosts, smaller trees for use as alternate roosts, wooded commuting corridors through open landscapes, open corridors through forested landscapes, and open or uncluttered areas for foraging within closed-canopy forests. Such generalized guidance would also benefit northern long-eared bats, but this species may be negatively affected by increased edge (which creates opportunities for competitors) or a decrease in clutter. Alternatively, the widely held belief that northern long-eared bats are specialists of interior forest may simply reflect the lack of suitability of such interior forests for other species.

3.5.2.2 Use of Multiple Landscape Types

Northern long-eared bats are found in a wide variety of landscape conditions. At one extreme, the species is often reported as being abundant in large expanses of woodland throughout the range (Sasse and Pekins 1996; Sparks et al. 1998; Cryan et al. 2001; Lacki and Schwierjohann 2001; Brack 2009; Timpone et al. 2010; Timpone et al. 2011; Johnson et al. 2012; Sheets et al. 2013b). Conversely, the species is also one of the most abundant in strips of riparian vegetation on the High Plains (Benedict et al. 2000; Sparks and Choate 2000; Benedict 2004) and in "postage-stamp" woodlots in both urban and rural settings of the Midwest (Sparks et al. 1998; Foster and Kurta 1999; Whitaker et al. 2004; Damm et al. 2016). Abundance of the species in heavily forested landscapes has been interpreted as evidence such sites are optimal (U.S. Fish and Wildlife Service 2014), but the observations of the species roosting and reproducing in more "patchy" forests calls this assumption into question. The species may simply be able to use a wide variety of habitats but is competitively inferior to other species (perhaps including the Indiana bat). As such, it may be relegated to habitat types such as unbroken forest or "postage stamp woodlands" where other species are less effective competitors. Having a very broad realized niche may thus allow northern long-eared bats to occupy a wide variety of more marginal habitat types as opposed to specializing in a very narrow habitat type. As such, efforts to identify suitable habitat within Pennsylvania (described in the following sections) included efforts to examine habitat selection at a variety of scales.

3.5.3 Habitat Features

3.5.3.1 Roost Trees

Northern long-eared bats use a much wider variety of roost trees than do Indiana bats (Sasse and Pekins 1996; Foster and Kurta 1999; Lacki and Schwierjohann 2001; Sparks 2003; Whitaker et al. 2004; Carter and Feldhamer 2005; Timpone et al. 2010; Johnson et al. 2012; Silvis et al. 2012). Roost size can vary with individual bats being tracked to smaller trees (mean diameter at breast height 4.8 inches) (Lacki and Schwierjohann 2001). Colonial bats are associated with much larger trees with average diameters ranging between 11.5 and 24.8 inches (Sasse and Pekins 1996; Foster and Kurta 1999; Lacki and Schwierjohann 2001; Sparks 2003; Whitaker et al. 2004; Carter and Feldhamer 2005; Timpone et al. 2010; Johnson et al. 2012; Silvis et al. 2012). Large, live trees are commonly used as roosts, and these may be in use for many years (Sparks 2003). In some cases, the species also makes extensive use of large, dead trees, but some authors have noted that this may be a result of competition with other similar species, including the Indiana bat (Cryan et al. 2001; Timpone et al. 2010). In addition to the regular use of both live and dead trees, northern long-eared bats routinely use trees with variable canopy cover, other roost types (i.e., cracks, crevices, and exfoliating bark), and occasionally much smaller roosts.

3.5.3.2 Anthropogenic Roosts

Another illustration of the breadth of habitat used by northern long-eared bats is the extensive list of anthropogenic structures used as roosts. During summer, these include buildings, bat boxes, bridges, and even utility poles (Sparks and Choate 1995; Sparks et al. 1998; Sparks 2003; Farrell Sparks et al. 2004; Whitaker et al. 2004).

3.5.3.3 Caves and Mines

The ability to use a wide variety of habitat types also extends to winter habitat, with 322 hibernacula in Pennsylvania listed as known occupied sites by the U.S. Fish and Wildlife Service.[3] These include naturally occurring caves, as well as a variety of mines ranging from large limestone mines to small mines from which iron or coal have been extracted.

Northern long-eared bats are selective about the caves they use, with temperatures ideally between 41 and 50°F (5 and 10°C), where costs of metabolic depression are balanced with the benefits of a lower metabolic rate. At temperatures above 50°F, the costs of more frequent and prolonged arousal are excessive. Cold and freezing temperatures require an increase in metabolism for thermoregulation during torpor and result in a substantial decrease in torpor bout duration (Geiser and Broome 1993) or result in death.

An important issue for biologists is whether sites where this or other species have been extirpated should be considered as viable habitat. Initial consideration of such sites as habitat seems warranted based on 1) evidence the species once used these sites, and 2) the potential that recovery efforts may discover a means to eliminate *P. destructans* from the sites. Conversely, continuing to focus conservation efforts on such habitats may also result in the protection of ecological sinks.

3.5.4 Seasonal Habitat Types in Pennsylvania

Seasonal habitat for the northern long-eared bats is broken into the following components:

- **Winter**: Bats hibernate in the winter when they are largely confined to the cave (or mine) environment. For northern long-eared bats, this includes the 322 sites in Pennsylvania where the species has been observed either during interior surveys or during entrance trapping. It is

[3] The locations of these sites are not mapped or otherwise disclosed in the HCP to help protect them from trespass and unlawful disturbance.

particularly difficult to count individual northern long-eared bats because they secret themselves in cracks and crevices within hibernacula.

- **Fall/Spring**: Northern long-eared bats are active at or near the hibernaculum before and after winter hibernation. In the spring, this is where a period of staging takes place, in the fall a period of swarming and mating. During these times the areas around the hibernaculum are used heavily.
- **Summer**: Within Pennsylvania this is the broadest habitat category, reflecting the summer period of reproduction (pregnancy and lactation), when bats use the forest for both roosting and foraging. At this time of year many males are found near hibernacula, but some wander widely and may occur in suitable habitat throughout the state. Before and after the summer, bats migrate between the hibernaculum and areas of summer habitat.

These categories will be used to quantify effects (Chapter 4, *Effects of Covered Activities*) and to guide conservation (Chapter 5, *Conservation Program*). For winter and fall/spring, when habitat is largely a product of the location of the hibernaculum, the methodologies for modeling habitat are straightforward. For summer, where distance to the hibernaculum is only a partial predictor of occurrence, a habitat distribution model, a species-specific statistical tool, was developed to estimate the extent of suitable habitat (Appendix H, *Habitat Distribution Modeling Using MaxEnt*).

As stated in Section 3.5.4, *Seasonal Habitat Types in Pennsylvania*, for Indiana bats, the number of bats present during each season was estimated using hibernacula surveys. However, for northern long-eared bats, the best available data on the number of bats present on State Lands is associated with historic summer bat records when the species was relatively easy to capture. Therefore, these summer bat numbers were used as the starting point for this species, and the ratio of capture records to estimated total bats for Indiana bats was used develop an estimate of northern long-eared bats on State Lands (Table 3-12).

3.5.4.1 Winter

Northern long-eared bat use of hibernacula mirrors that for Indiana bats described in Section 3.5.4.1, *Winter*. Northern long-eared bats have been documented at 322 sites in the state of Pennsylvania. Of these 322 sites, 34 are located on State Lands, and the 0.25-mile buffer associated with 59 entrances of the remaining hibernacula extends onto State Lands. Winter habitat for northern long-eared bats is therefore defined as all hibernacula occurring on State Lands and all State Lands within a 0.25-mile buffer of known hibernacula. Winter habitat on State Lands for northern long-eared bats is mapped in Figure 3-13 and the distribution of these bats is described in Table 3-11.

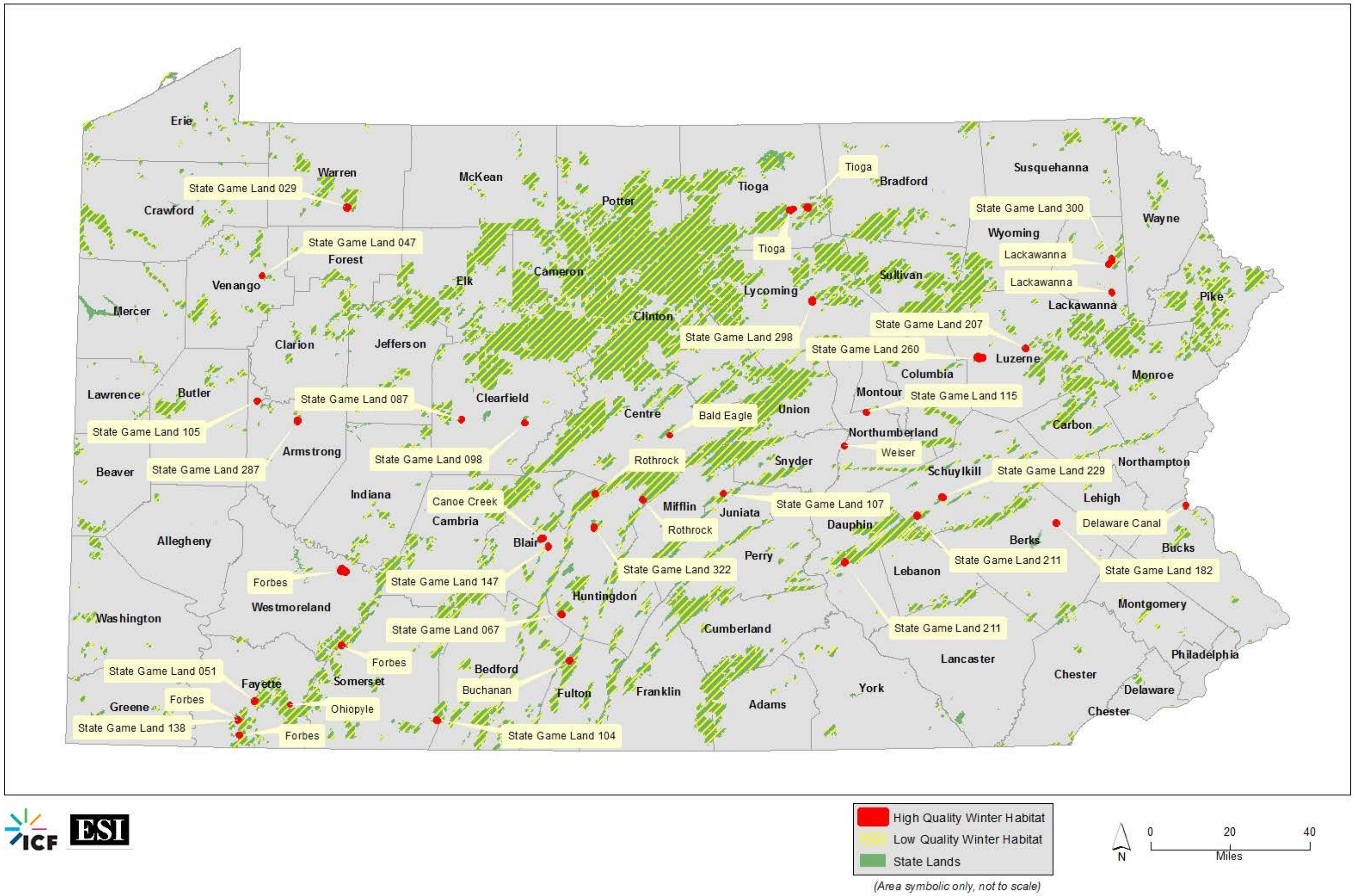


Figure 3-13. Modeled Winter Habitat for Northern Long-Eared Bats within State Lands

Table 3-11. Modeled Northern Long-Eared Bat Winter Habitat Statewide and on State Lands and Estimated Numbers of Northern Long-Eared Bats Statewide

		Statewide (all lands)		State Game Lands		State Forests		State Parks		State Lands (Total)	
Hibernacula Location	**Number of Hibernacula**	**Acres of Winter Habitat**	**Percent of Land Area in State**	**Acres of Winter Habitat**	**Percent of State Game Lands**	**Acres of Winter Habitat**	**Percent of State Forests**	**Acres of Winter Habitat**	**Percent of State Parks**	**Acres of Winter Habitat**	**Percent of State Lands**
Appalachian Region	89	10,031	0.1%	1,037	0.1%	832	<0.1%	35	<0.1%	1,904	<0.1%
Game Lands	9	-	-	1,037	0.1%	0	0.0%	0	0.0%	1,037	0.1%
State Forests	6	-	-	0	0.0%	832	<0.1	0	0.0%	832	<0.1%
State Parks	0	-	-	0	0.0%	0	0.0%	35	<0.1	35	<0.1%
Private Lands	74	8,127	<0.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%

Capture data indicate that northern long-eared bat populations in the eastern portion of the state (where WNS first appeared) have been more affected than populations in the western part of the state. To distinguish between the lower population density in the east and the higher population density in the west, northern long-eared bat populations are broken into two populations for context: the Appalachian Plateau (which includes the Appalachian Plateau Physiographic Province and the adjacent portion of the Central Lowland Provinces) and a Southeastern Region (all other Provinces). While professional judgment indicates that northern long-eared bats are not equally distributed among known hibernacula; they are assumed to be equally distributed for the purpose of analysis in the State Lands Forestry HCP.

3.5.4.2 Fall/Spring

As with Indiana bats, most northern long-eared bats spend fall and spring near the hibernaculum (within 5 miles) as they prepare for hibernation (September 1 to November 1) or emerge from hibernation (April 1 to May 15). Within this distance, northern long-eared bats also preferentially use the habitat types outlined in Table 3-6.

For the purposes of the State Lands Forestry HCP, northern long-eared bat fall/spring habitat is defined as all high-suitability habitat on State Lands within 5 miles of a known northern long-eared bat hibernaculum. Many hibernacula (284) are located on private lands near State Lands and thus the 5-mile buffer associated with these hibernacula extends onto State Lands. Northern long-eared bats are assumed to be distributed across State Lands in proportion to habitat suitability; as a result, more bats are assumed present in areas with more high suitability habitat. Fall/spring habitat for northern long-eared bats is mapped on Figure 3-14 and summarized in Table 3-12.

3.5.4.3 Summer

Ecologically, the northern long-eared bat is very similar to the Indiana bat, allowing most of the same parameters to be used to generate a model of summer habitat for this species (Appendix H, *Habitat Modeling using MaxEnt*). To account for some additional parameters thought to influence habitat preference in northern long-eared bats, the following variables were also incorporated into the habitat distribution model for northern long-eared bats:

- Sensitivity to changes in forest connectivity
- Association with geologic features indicative of the presence of caves or underground mines
- Differences in habitat preference between adult males and maternity colonies (females and juveniles).

3.5.4.4 Model Summary

More than 1,200 occurrences of reproductive female and juvenile northern long-eared bats and 11 environmental variables were used to model high suitability habitat for northern long-eared bats in Pennsylvania. Results from this model suggest that most high suitability summer habitat is scattered throughout the state in areas with forest patches of 22 acres or greater and within 0 to 40 miles of a hibernaculum or swarming site used from the years 2000 to 2012. Due to settlement and agricultural practices, these also tend to be in areas of moderate to high elevation.

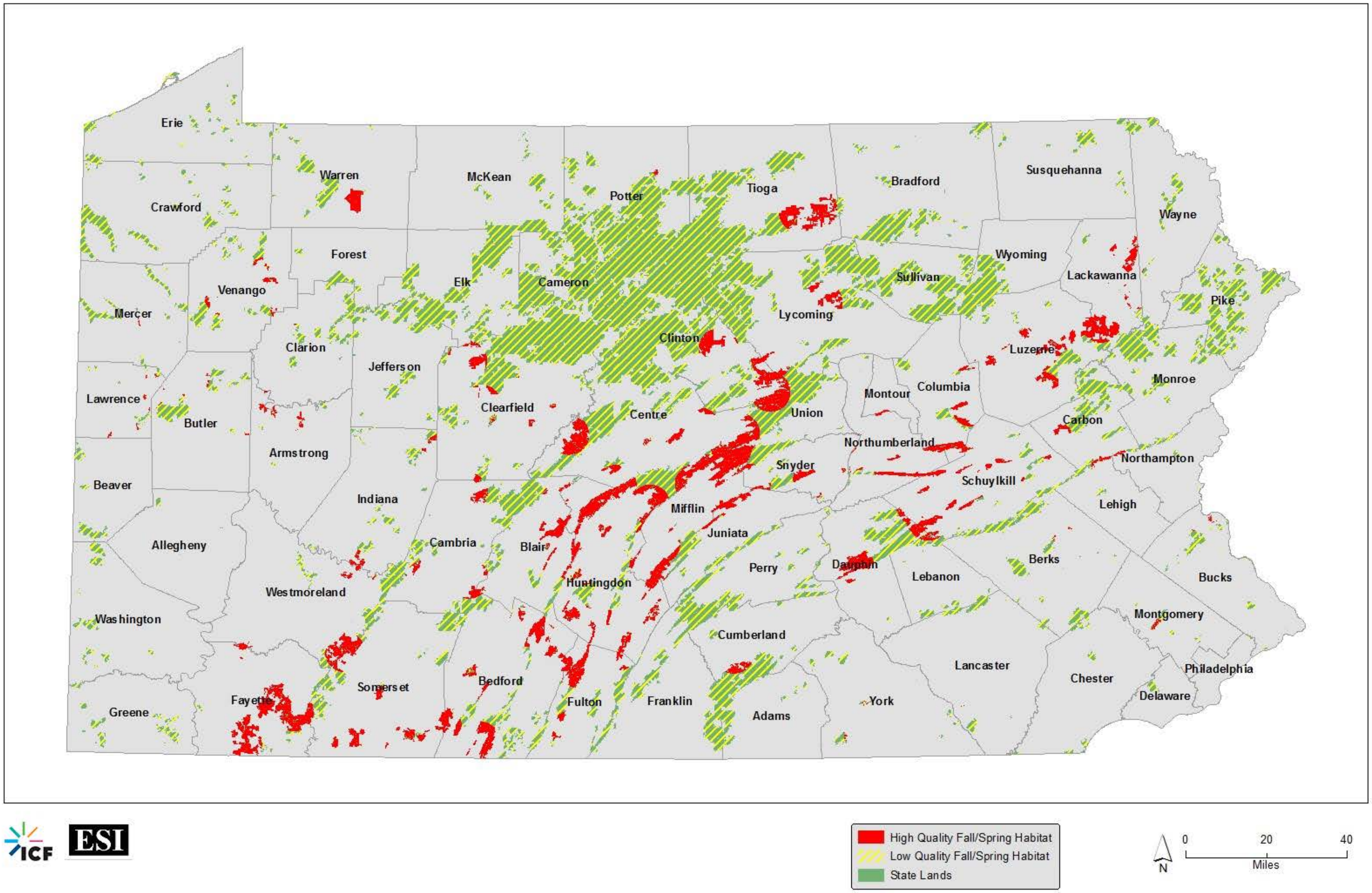


Figure 3-14. Modeled Fall/Spring Habitat for Northern Long-Eared Bats on State Lands

Table 3-12. Modeled Northern Long-Eared Bat Fall/Spring Habitat Statewide and on State Lands and Estimated Number of Northern Long-Eared Bats Statewide

		Statewide (all lands)		State Game Lands		State Forests		State Parks		State Lands (Total)	
Hibernacula Location	Number of Hibernacula	Acres of Fall/ Spring Habitat	% Land Area in State	Acres of Fall/ Spring Habitat	% State Game Lands	Acres of Fall/ Spring Habitat	% State Forests	Acres of Fall/ Spring Habitat	% State Parks	Acres of Fall/ Spring Habitat	% State Lands
Appalachian Region	89	1,738,270	5.9%	116,268	7.6%	111,499	5.2%	20,914	7.0%	248,681	6.2%
Game Lands	9	-	-	116,268	7.6%	0	0.0%	0	0.0%	116,268	2.9%
State Forests	6	-	-	0	0.0%	111,499	5.2%	0	0.0%	111,499	2.8%
State Parks	0	-	-	0	0.0%	0	0.0%	20,914	7.0%	20,914	0.5%
Private Lands	74	1,489,589	5.1%	-	-	-	-	-	-	-	-
Southeast Region	233	2,091,958	7.1%	170,702	11.1%	230,283	10.7%	15,513	5.2%	416,498	10.4%
Game Lands	15	-	-	170,702	11.1%	0	0.0%	0	0.0%	170,702	4.3%
State Forests	2	-	-	0	0.0%	230,283	10.7%	0	0.0%	230,283	5.8%
State Parks	2	-	-	0	0.0%	0	0.0%	15,513	5.2%	15,513	0.4%
Private Lands	214	1,675,460	5.7%	-	-	-	-	-	-	-	-
TOTAL	322	**3,830,228**	**13.0%**	**286,970**	**18.7%**	**341,782**	**15.9%**	**36,427**	**12.3%**	**665,179**	**16.6%**

As with the Indiana bat model, the Jenks natural-breaks method was used to create two categories of habitat suitability (high and low). Approximately 54 percent of the state was modeled as high suitability habitat for summering northern long-eared bats. Forested regions throughout the state were rated as the most valuable, with the largest concentration of high suitability habitat occurring in more rugged portions of the Ridge and Valley and Appalachian Plateaus physiographic provinces. However, significant areas of high suitability habitat were also recorded in forested portions of the Piedmont and New England physiographic provinces. Little contiguous forest and thus little high suitability habitat is found in the Central Lowlands or Atlantic Coastal Plain.

As with the Indiana bat model, individual northern long-eared bats may occur in areas of low suitability during migration or when these areas abut areas of high suitability. Maternity colonies are unlikely to occur in low-suitability habitat.

The fit of the occurrence data to the model was high - the average likelihood of locating a bat occurrence within high suitability habitat is approximately four times higher than that of a random background location.

Variable Contributions

The basic sensitivity of the variables used in the model is captured by an analysis of variable contributions, displayed in Table 3-13.

Table 3-13. Analysis of Variable Contribution

Variable	Percent Contribution	Permutation Importance
Forest cover within 300 meters (985 feet)	39.0	28.9
Distance to hibernaculum	20.7	15.8
Distance to streams	8.1	8.4
Elevation	7.8	8.7
Mean minimum temperature	7.8	21.5
Mean maximum temperature	7.7	2.8
Land cover	3.3	3.4
Distance to major roads	2.5	3.2
Slope	1.6	5.0
Distance to coal mined/karst area/carbonate rock	1.4	2.3

Model results for two of these variables are displayed in Figure 3-15 and 3-16. Consistent with the known ecology of the species (U.S. Fish and Wildlife Service 2013), northern long-eared bats tend to be found in areas with at least some contiguous woodlands (Figure 3-15) within 40 miles of a known hibernaculum (Figure 3-16). It is noteworthy that the probability of occupancy appears to reach a maximum in a landscape that is not quite entirely forested. Based on the size of grid used in the analysis, a landscape with at least one habitat patch containing 22 acres of forest is suitable. This is indicative that small-scale forest disturbance (including timber harvest) in a heavily forested landscape is beneficial to northern long-eared bats—which is consistent with recent publications on the species (Silvis et al. 2012; Pauli et al. 2015a; Pauli et al. 2015b; Silvis et al. 2016).

Distance to streams, elevation, and weather conditions have a relatively minor effect on habitat suitability. Northern long-eared bats tend to be found at higher slopes in areas that are cool year-round, likely because these areas are also most likely to be forested.

Land cover, distance to major roads, slope, and distance to karst or coal beds contributed little to the predicted areas of highly suitable habitat. Finally, model results showed little difference between adult male bats and maternity colonies.

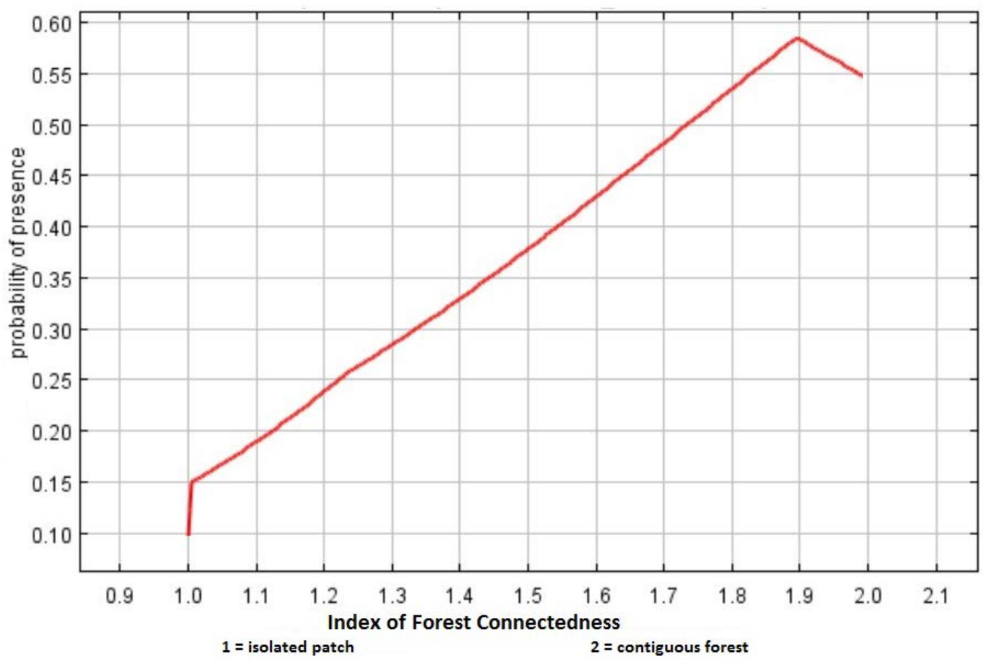


Figure 3-15. Distribution of Northern Long-Eared Bats Relative to Patches of Contiguous Forest in a 300- by 300-Meter Grid

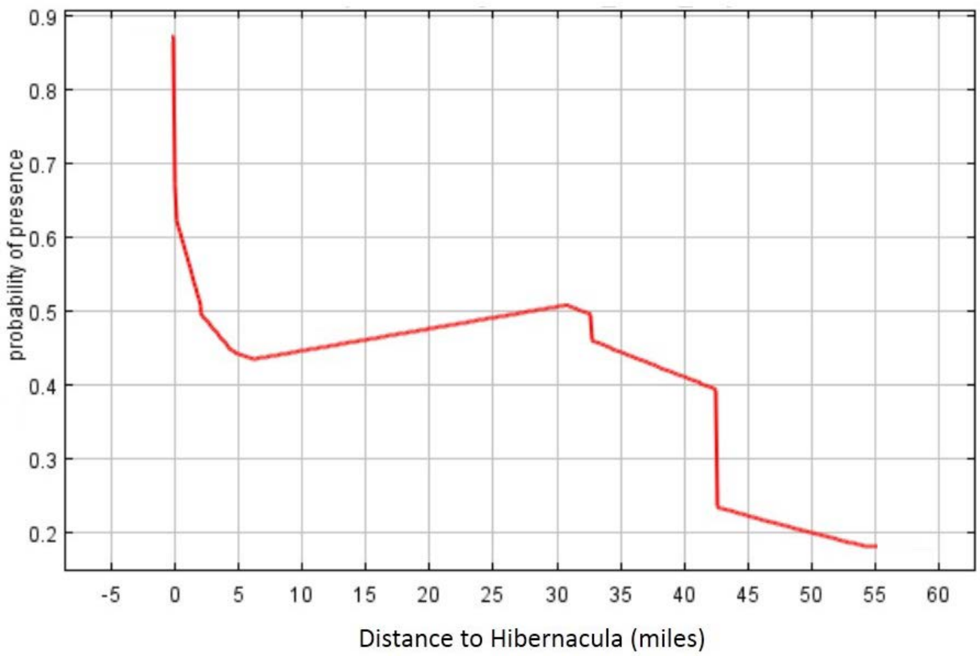


Figure 3-16. Distribution of Northern Long-Eared Bats Relative to Known Hibernacula

Results

Based on the modeling results, northern long-eared bat summer habitat is defined as all State Lands modeled as high suitability summer habitat (Figure 3-17 and Table 3-14). Because northern long-eared bats are not known to migrate long distances between summer and winter habitat, the 45,661 population estimate, which is most applicable for the summer population, is used to estimate the winter and fall/spring population of northern long-eared bats in Pennsylvania as well.

Table 3-15 shows the estimate of northern long-eared bats on summer habitat statewide. Table 3-16 shows the estimate of northern long-eared bats on summer habitat in State Lands.

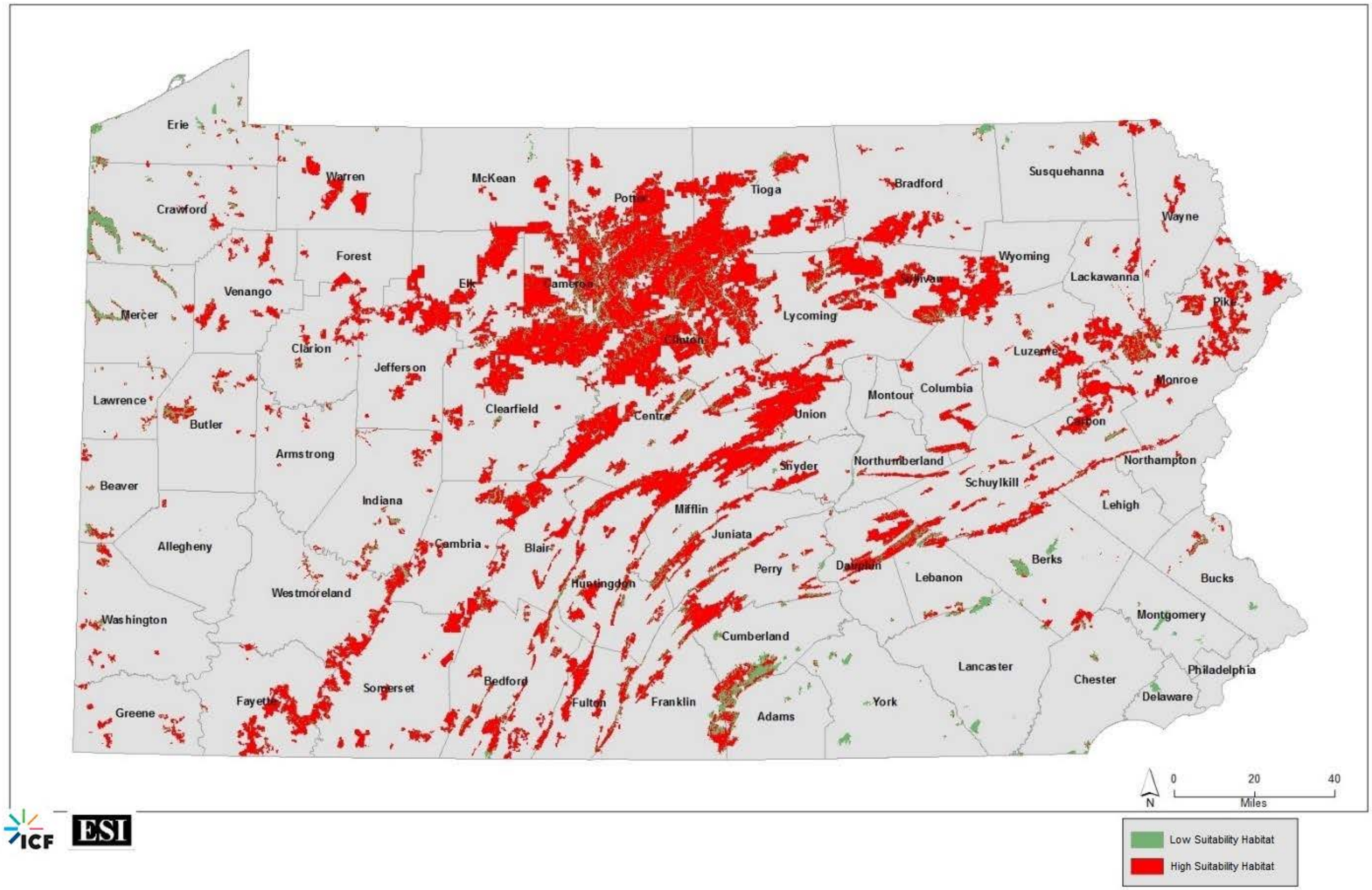


Figure 3-17. Modeled Summer Habitat for Northern Long-Eared Bats on State Lands

Table 3-14. Modeled Northern Long-Eared Bat Summer Habitat Statewide and on State Lands

	Statewide (all lands)		State Game Lands		State Forests		State Parks		State Lands (Total)	
Region	**Acres of Summer Habitat**	**Percent of Land Area in State**	**Acres of Summer Habitat**	**Percent of State Game Lands**	**Acres of Summer Habitat**	**Percent of State Forests**	**Acres of Summer Habitat**	**Percent of State Parks**	**Acres of Summer Habitat**	**Percent of State Lands**
Appalachian Plateau	11,569,847	39.3%	896,285	58.4%	1,358,464	62.9%	143,749	48.3%	2,398,498	60.1%
Southeastern Region	4,269,292	14.5%	391,641	25.5%	535,687	24.8%	53,662	18.0%	980,990	24.6%
Total	**15,839,139**	**53.8%**	**1,287,926**	**83.9%**	**1,894,151**	**87.7%**	**197,411**	**66.3%**	**3,379,488**	**84.7%**

Table 3-15. Estimate of Northern Long-Eared Bat Numbers on Summer Habitat Statewide

Region	Indiana Bats		Northern Long-Eared Bats	Indiana Bat Capture Multiplier (see text)	Estimated Number of Northern Long-Eared Bats[a]
	Captures	Estimated Numbers	Captures		
Appalachian Plateau	48	171	8,068	3.56	28,722
Southeastern Region	23	208	1,867	9.04	16,876

[a] Northern long-eared bat captures multiplied by Indiana bat capture multiplier. Discrepancies may appear in the table due to rounding.

Table 3-16. Estimated Numbers of Northern Long-Eared Bats on Summer Habitat in Pennsylvania

Source Population	Estimated Number of Northern Long-Eared Bats Statewide[a]	Number of Bats Per 100,000 Acres Summer Habitat
Appalachian Plateau	28,722	249
Southeastern Region	16,876	395
Total	**45,598**	**644**

[a] See Table 3-15.

Number of Colonies

USFWS calculated that there were 5,130 maternity colonies in Pennsylvania in 2016 (USFWS 2016b). As with the Indiana bat, it is likely that the number of maternity colonies has declined since 2016 due to WNS.

3.5.4.5 Summary of Seasonal Habitat on State Lands

State Lands provide habitat for both covered bat species throughout the year. All lands within 0.25 mile of an entrance to a known hibernaculum are considered winter habitat for the species within that hibernaculum. Similarly, during fall/spring, both species are usually concentrated within 5 miles of the hibernaculum. An important exception to this pattern is provided by telemetry data collected at the South Penn Tunnel, which shows that landscape features cause Indiana bats to shift their activity to the north and east of the hibernaculum, but these telemetry data also provide a means of estimating the area of activity for Indiana bats. Thus, fall/spring habitat is based on lands within 5 miles of a known hibernaculum or within the area delineated by these telemetry data. All land classes within these activity areas are considered highly suitable with the exception of those habitat types known to be avoided by bats at a landscape-scale (i.e., open water, agriculture, and developed lands). Summer habitat was estimated for both species using a probabilistic habitat suitability tool. Table 3-6 summarizes these seasonal habitat types on State Lands for both species.

Chapter 4
Effects of Covered Activities

4.1 Introduction

An HCP submitted in support of an ITP must describe the effects likely to result from the taking of the species for which permit coverage is requested (50 CFR §§ 17.22(b)(1) and 17.32(b)(1)). This chapter addresses the effects of covered activities on Indiana bats and northern long-eared bats from timber harvest and related activities, including fencing, firewood harvest, roads and trails, and prescribed fire. **These effects are analyzed absent avoidance, minimization, and mitigation measures**, which are described in Chapter 5, *Conservation Program*, to allow for comparison. Subsequent sections of this chapter describe the calculation of requested incidental take and the level of incidental take.

Estimates of take can be made in a variety of ways, including numbers of individuals, numbers of populations, or the amount of suitable habitat. Because the State Lands Forestry HCP occurs over a very large area and over a long timeframe, it will be impractical to track the number of individual bats taken by covered activities, particularly as numbers decline because of white-nose syndrome. Instead, in this HCP, habitat serves as a surrogate for the take of individuals or assemblages of bats: the requested take is expressed in terms of the amount of suitable habitat (in acres) removed or modified. Acres of habitat are a suitable metric for take because acres can be easily tracked during implementation. Bats use essential habitat features in forests (e.g., roost trees) at predictable times of year and thus acres of these seasonal habitats affected when bats are present provide a reasonable proxy for the number of individuals taken.

Several factors make it difficult to calculate the number of bats impacted by a given covered activity. First, because this plan is programmatic, the exact location of planned activities is unknown. PGC and DCNR may adjust the exact location of activities throughout the permit term to respond to changing environmental conditions. Second, the exact location of bats remains unknown—the estimates of habitat suitability contained in Chapter 3*, Environmental Setting,* represent the best available information on where these bats are located during different times of year. However, within this larger range, the location of bats at any given time is unknown. Both covered species are migratory and move between summer and winter habitats on a cycle that is only generally known. During summer and migration, covered species are highly secretive—hiding in tree cavities and under bark during the day and moving between trees every few days. During summer, these species also have a fission/fusion social system where the number of individuals sharing a roost varies by day—as a result, the number of occupied roosts also varies across a season. Finally, both populations are in a period of rapid decline, and thus any effort to estimate the number of bats taken is complicated by a rapidly changing baseline. PGC and DCNR have used the best available science to derive an estimate (Appendix J, *Supplemental Effects Analysis*). At its core, however, this approach relies on estimating the number of bats within a seasonal habitat type and assuming those bats are evenly distributed. For these reasons, PGC and DCNR determined that using the number of acres of seasonal habitat affected would be the most appropriate means of estimating take of covered species.

Using habitat to estimate take is common in HCPs and has been upheld by the courts in instances where it is impractical to estimate or track the number of individuals taken. USFWS's HCP Handbook (2016) underscores this approach (Handbook at Sec. 8.2.2). The USFWS Section 7 regulations also describe when the use of surrogates is appropriate in the context of inter- and antra-agency consultations. See 50 CFR § 402014(i)(1)(i).[1] Therefore, for the purpose of the permit and tracking during implementation, anticipated take is expressed in terms of acres of habitat that will be affected by each covered activity.

The habitat estimates presented in this chapter will also serve as hard limits (caps) to be included in the USFWS-issued permit, identifying the maximum allowable take authorized under the State Lands Forestry HCP. Additionally, the anticipated effects on individuals, also expressed as a proportion of the estimated species' populations, are quantified in Appendix J, *Supplemental Effects Analysis*. These individual and population level effects, along with the anticipated benefits of habitat maintenance and enhancement, are provided for context only when later evaluating the "impact of the taking" around which the agencies have designed the Plan's conservation strategy.

As described in Chapter 3, *Environmental Setting*, and Appendix H, *Habitat Distribution Modeling Using MaxEnt*, winter, fall/spring, and summer habitat were modeled. These models were used to determine and partition the level of take. The effects assessment outlined in this chapter is programmatic and provides relative estimates of the acres of habitat affected for each covered activity. Both the take analysis approach (definitions and methods) and the take analysis results (without conservation measures) are described in this chapter.

This approach provides a conservative estimate of take, as the analysis quantifies the effects of each activity separately, even if the activities take place on the same geographic parcel. In other words, the effect on the bats and/or their habitat would be counted twice, but the effect would occur only once. This approach overestimates take but ensures that all possible take is captured.

4.2 Take Analysis Approach

4.2.1 Definitions

Section 10(a)(1)(B) of the ESA authorizes the U.S. Fish and Wildlife Service, under some circumstances, to permit the taking of fish and wildlife otherwise prohibited under Section 9 of the ESA if such taking is "incidental to, and not the purpose of carrying out otherwise lawful activities." Under 50 CFR §§ 17.22 and 17.32, nonfederal parties may apply for a Section 10 ITP to incidentally take threatened or endangered species. For the purposes of the State Lands Forestry HCP, the following definitions were used to assess the effects and level of take without the benefit of conservation measures.

- **Take.** As described in Section 3(18) of the ESA, *take* means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."

[1] This regulation states: A surrogate (*e.g.,* similarly affected species or habitat or ecological conditions) may be used to express the amount or extent of anticipated take provided that the biological opinion or incidental take statement: Describes the causal link between the surrogate and take of the listed species, explains why it is not practical to express the amount or extent of anticipated take or to monitor take-related impacts in terms of individuals of the listed species, and sets a clear standard for determining when the level of anticipated take has been exceeded.

- **Harm.** Under federal regulation (50 CFR § 17.3), *harm* in the definition of take includes "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." Therefore, habitat modification or destruction, to the extent these effects occur, constitutes take.

- **Direct effects.** *Direct effects* are the immediate effects of the covered activities on bats or their habitat. 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.
- **Indirect effects.** *Indirect effects* are the effects of the covered activities that manifest later in time and are reasonably certain to occur (e.g., trees killed by a prescribed fire could become viable bat roosts after several years and may remain in use for several years thereafter) (50 CFR § 402.02). Indirect effects can occur outside the area directly affected by the action.
- **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 plan area (50 CFR § 402.02). Cumulative effects will be addressed in the USFWS's NEPA document and ESA Section 7 intra-Service biological opinion.

4.2.2 Methods

The covered activities are reasonably certain to cause incidental take of both Indiana bats and northern long-eared bats over the course of the permit term. To meet the ITP issuance criteria and fully offset take to the maximum extent practicable, the effects must be identified and, where possible, quantified.

Estimates of take will be measured by the amount of suitable summer and fall/spring habitat that will be affected by covered activities (winter habitat is not included because covered activities will not occur during the winter when bats are hibernating). The numbers of individual bats on State Lands and effects on bat populations as a whole are derived from these habitat associations (Appendix J, *Supplemental Effects Analysis*). For the purposes of the ITP, the measure of take is the amount of affected Indiana bat and northern long-eared bat habitat by season. Effects on bats using winter habitat could be catastrophic and will be avoided with existing and future buffers around hibernacula. Effects in fall/spring and summer habitat, on the other hand, assume that avoidance, minimization, and mitigation measures have not been applied prior to the analysis. **In other words, the results reflect effects without the contribution of the conservation strategy presented in Chapter 5*, Conservation Program*.**

4.2.2.1 Quantifying Effects on Habitat

Effects on bat habitat were quantified using the following steps.

- **Model bat habitat.** The habitat models outlined in Chapter 3, *Environmental Setting*, and Appendix H, *Habitat Distribution Modeling Using MaxEnt*, were used to quantify the acreage of each habitat type (summer, fall/spring, and winter) on State Lands.
- **Determine covered activities footprint.** The acreage of State Lands potentially affected by each covered activity was estimated (Chapter 2, *State Lands and Covered Activities*). For context, only a small portion of State Lands is actively managed at any given time. For example, during a typical year, management activities would be expected to affect 3.2 percent or 127,479 acres of

State Lands annually.[2] Note that over the course of a year, some State Lands may be manipulated multiple times while other lands are impacted only one time and others will not be manipulated.

- **Estimate area of overlap**. The acreage where covered activities overlap with modeled bat habitat was estimated. For short-term projects with well-defined areas of effects, the areas where activities occur can be overlaid in a geographic information system (GIS) with the areas of modeled bat habitat to identify overlap. However, the distribution of covered activities in the State Lands Forestry HCP is not spatially explicit over the 30-year permit term; as a result, a relative measure of the area of overlap is determined. For example, if a covered activity occurs across 100 acres of State Parks and 20 percent of State Parks are considered suitable habitat, an overlap of 20 acres is assumed.

An estimate of overlap was generated for summer and fall/spring habitat (no effects on active winter habitat are permitted under this HCP). The annual take estimate is used to calculate a cap for the purposes of this HCP. The cap is calculated as a 5-year rolling average for all covered activities as described in Section 4.3.4.3, *Five-Year Rolling Take Limits*.

4.2.2.2 Integrating Effects of Forestry Practices

The State Lands Forestry HCP integrates the relative effects of different forest practices on Indiana bats and northern long-eared bats.

To simplify the analysis, multiple types of timber harvest were grouped together to reflect their ecological effects on northern long-eared and Indiana bats. These resulting categories of harvest are named for the ecological processes that Sheets et al. (2013c) described as occurring within the stand. For a more detailed description of Sheets et al. (2013c) and other supporting papers, see Appendix J, *Supplemental Effects Analysis*. This approach recognizes that multiple silvicultural techniques have similar effects on bats. The categories are as follows.

- **Seral diversification**. Timber harvests create seral diversification when stands dominated by large trees are replaced by stands dominated by smaller trees (the harvests change the seral stage and return the stand to an early successional state). Within stands, these activities significantly decrease clutter and maximize sunlight to residual tree boles and trunks, when they are retained. After harvest, residual trees remain, with a scattering of large trees in a relatively open matrix. Trees that survive are likely of improved quality because they now receive extensive solar radiation. Much of the initial (direct) negative effects on roosting habitat are overcome by a direct positive effect on foraging habitat and long-term (indirect) improvements in habitat quality related to improvements in roosting habitat following harvest. See Appendix J, *Supplemental Effects Analysis*, for additional details on direct and indirect effects of seral diversification.
- **Horizontal diversification.** Timber harvests cause horizontal diversification when they affect some canopy and subcanopy trees, decrease clutter (relevant to foraging), and allow increased solar radiation (relevant to roosting). These activities retain many canopy-dominant trees in the stand, which retains many more potential roosts after a harvest than seral diversification harvests. Horizontal diversification has a lower direct effect on Indiana bat habitat compared to harvests that result in seral diversification or early seral improvement. A horizontal

[2] Data presented in Table 4-17.

diversification harvest has a negligible effect on roosting habitat because fewer trees are cut overall. In fact, MacGregor et al. (1999) documented radio-tagged bats moving into a stand while harvest activities were in progress. For additional details on the direct and indirect effects of horizontal diversification see Appendix J, *Supplemental Effects Analysis*.

- **Early seral improvement.** Timber harvests in the early stages of forest development cause early seral improvement, normally during early canopy closure and competitive exclusion. These activities, typically in small stands that provide limited roosting habitat for bats, are specifically intended to remove some trees to increase the growth rate of the remaining trees and push the stand toward a desired future condition. Early seral improvement harvests occur in patches with relatively small trees (average diameter at breast height of 6 to 10 inches) that have marginal potential for use by Indiana bats because they are too small, shaded, and cluttered. Further, these harvests target live trees, and dead trees are specifically retained to provide habitat. These activities are performed at a cost, and PGC, the Bureau of Forestry, and the Bureau of State Parks do not report them as a commercial timber harvest. The goal of early seral improvement harvests is to increase the growth of surviving trees and speed succession and forest regeneration—which can result in a faster return to high quality roosting habitat. For additional details on the direct and indirect effects of early seral improvement, see Appendix J, *Supplemental Effects Analysis*.

Seral and horizontal diversification remove large trees that can serve as primary roosts, and early seral improvements affect trees that are typically too small to be used as primary roosts. These categories encompass the timber harvest activities described in Chapter 2, *State Lands and Covered Activities*. These terms combine multiple forestry practices that have similar effects on bats and recognize the fact that PGC, Bureau of Forestry, and Bureau of State Parks use different terminology to describe timber harvest. The types of timber harvests and descriptive terminology are summarized in Table 4-1.

Table 4-1. Crosswalk of Timber Harvest Terminology to Categories Used in Effects Analysis

	Terminology				
	Society of American Foresters Handbook[a]	Pennsylvania Game Commission	Bureau of Forestry	Bureau of State Parks	Effects Category
Regeneration Harvest					
Even-Aged Stands	Clear-cut	Regeneration cut[2]	Overstory removal[b]	N/A[c]	Seral diversification
	Shelterwood or seed tree preparatory cut	Improvement cut	Shelterwood, or seed tree cut	N/A	Horizontal diversification
	Shelterwood or seed tree removal	Regeneration cut	Overstory removal	N/A	Seral diversification
Uneven-Aged Stands	Group selection	Improvement cut	Buffer management	N/A	Horizontal diversification
	Single-tree selection	Improvement cut	Buffer management	N/A	Horizontal diversification

	Terminology				
	Society of American Foresters Handbook[a]	**Pennsylvania Game Commission**	**Bureau of Forestry**	**Bureau of State Parks**	**Effects Category**
Intermediate Harvests					
All Stands	Release cut	Improvement cut	Intermediate cut	N/A	Horizontal diversification
	Commercial thinning	Improvement cut	Intermediate cut	Salvage	Horizontal diversification
	Sanitation cut	Improvement cut	Intermediate cut	Salvage	Horizontal diversification
	Salvage cut	Improvement or Regeneration Cut[d]	Improvement, overstory removal, or shelterwood cut[e]	Salvage	Horizontal diversification
	Precommercial thinning	Timber stand improvement	Timber stand improvement	Salvage	Early seral improvement

a Society of American Foresters 1984.

b Clear-cuts on State Lands involve retention of selected individual trees or clumps of trees and are referred to as clear-cuts with residuals.

c N/A = technique not used.

d PGC counts salvage cuts as improvement cuts if the dead trees removed composed less than half of the pre-harvest stand; it counts salvage cuts as regeneration cuts if the dead trees removed composed most of the stand.

e The Bureau of Forestry counts salvage cuts as improvement cuts if the dead trees removed composed less than half of the preharvest stand; it counts salvage cuts as shelterwood cuts if the dead trees removed composed most of the stand; however, the acres are over and above the harvests reported in Tables 2-4 and 2-5.

Certain conservation measures covered under the HCP may result in temporary ground disturbance; however, the disturbance footprint from these activities is not estimated because it would be relatively small in area, would be temporary in duration, and ultimately would result in improved habitat conditions and long-term beneficial effects for covered species (i.e., self-mitigating).

4.3 Take Analysis Results

4.3.1 Summer

Summer Habitat

- Used June to August
- Modeled using MaxEnt

This section describes the effects of different covered activities on summer habitat for Indiana bats and northern long-eared bats. Maternity colonies are dispersed across suitable habitat in the summer, and the locations of individual bats shift frequently within their home ranges. Individual males and nonreproductive females may be even more dispersed at this time. Effects during the summer are likely higher in relation to other times of year when bats are aggregated closer to hibernacula. This analysis models summer habitat using MaxEnt (Appendix H, *Habitat Distribution Modeling Using MaxEnt*) and assumes that bats use summer habitat from April to October. This analysis uses acres of forest as a proxy for take of individual bats and/or maternity colonies. Note that annual estimates of take for similar activities are then rolled together and used to generate a 5-year rolling average which then serves as the cap of permitted activities (Section 4.3.4.3, *Five-Year Rolling Take Limits*).

4.3.1.1 Timber Harvest Effects on Covered Species' Habitat

Indiana bats and northern long-eared bats spend much of the year roosting in trees, and they frequently forage in forested areas. Timber harvest operations have the potential to affect both species, particularly in the summer when bats are not necessarily congregating around hibernacula but are rearing pups that are not volant part of the year. Timber harvest practices have a wide variety of effects on the two species, and these effects have different frequencies, durations, and intensities (Sheets et al. 2013c). At one end of the spectrum, cutting and immediately removing an occupied primary roost could alter how a maternity colony functions. At the opposite extreme, timber harvest can be used to create and improve essential habitat for either species over long periods. This analysis is focused on the potential for immediate negative effects from tree removal. Chapter 5, *Conservation Program,* and Appendix J, *Supplemental Effects Analysis*, address the positive, long-term consequences of forest practices.

The effects on habitat were calculated for each of the identified forest practice types. Effects on summer habitat are the result of estimating the amount of harvest on State Lands relative to the proportion of those lands in modeled summer habitat for bats. The results for Indiana bat are shown in Table 4-2 and the results for northern long-eared bat are shown in Table 4-3.

Table 4-2. Effects of Timber Harvest on Summer Habitat for Indiana Bats (acres annually)

Harvest Category	Total Harvested	Summer Habitat Harvested
State Game Lands		
Seral diversification	5,600	920
Horizontal diversification	7,000	1,150
Early seral improvement	1,400	230
Totals	**14,000**	**2,300**
State Forests		
Seral diversification	9,100	714
Horizontal diversification	8,900	698
Early seral improvement	3,100	243
Totals	**21,100**	**1,655**
State Parks		
Seral diversification	10	2
Horizontal diversification	10	2
Early seral improvement	—	—
Totals	**20**	**4**
All State Lands	**35,120**	**3,959**
Note: Some rows will not sum due to rounding.		

State Game Lands. PGC anticipates harvesting timber using seral diversification, horizontal diversification, and early seral improvement harvests. State law (i.e., complying with the requirements of Article 1, Section 27 of the Pennsylvania Constitution), agency policies (including management plans), and the logistical constraints of having staff and loggers spread across the state mean these harvests are distributed evenly across State Game Lands. Based on the proportion of habitat suitability reported in Chapter 3, *Environmental Setting* (Table 3-10), harvest activities will affect an estimated 2,300 acres of modeled summer habitat for the Indiana bat per year (Table 4-2).

State Forests. The Bureau of Forestry anticipates harvesting timber in commercially viable stands and unplanned salvage harvests. Early seral improvements will also occur annually. Timber harvest activities will affect an estimated 1,655 acres of modeled summer habitat for the Indiana bat per year (Table 4-2).

State Parks. The Bureau of State Parks anticipates annual salvage cuts, which will affect an estimated 4 acres of modeled summer habitat for the Indiana bat per year (Table 4-2).

All State Lands. Across all State Lands, harvest activities will affect an estimated 3,958 acres of summer habitat for the Indiana bat per year. This estimate functions as a cap for the purposes of the State Lands Forestry HCP. The cap will be calculated as a 5-year rolling average as described in Section 4.3.4.3, *Five-Year Rolling Take Limits*.

Table 4-3. Effects of Timber Harvest on Summer Habitat for Northern Long-Eared Bats (acres annually)

Agency	Total Harvested	Summer Habitat Harvested
State Game Lands		
Seral Diversification	**5,600**	**4,697**
Southeastern Region	1,848	1,420
Appalachian Region	3,752	3,277
Horizontal Diversification	**7,000**	**5,871**
Southeastern Region	2,310	1,775
Appalachian Region	4,690	4,096
Early Seral Improvement	**1,400**	**1,174**
Southeastern Region	462	357
Appalachian Region	938	817
Totals	**14,000**	**11,742**
State Forests		
Seral Diversification	**9,100**	**7,977**
Southeastern Region	2,608	2,256
Appalachian Region	6,492	5,721
Horizontal Diversification	**8,900**	**7,802**
Southeastern Region	2,551	2,206
Appalachian Region	6,349	5,596
Early Seral Improvement	**3,100**	**2,718**
Southeastern Region	888	769
Appalachian Region	2,212	1,949
Totals	**21,100**	**18,497**

Agency	Total Harvested	Summer Habitat Harvested
State Parks		
Seral Diversification	**10**	**7**
Southeastern Region	3	2
Appalachian Region	7	5
Horizontal Diversification	**10**	**7**
Southeastern Region	3	2
Appalachian Region	7	5
Early Seral Improvement	—	—
Southeastern Region	—	—
Appalachian Region	—	—
Totals	**20**	**14**
All State Lands	**35,120**	**30,253**
Note: Some rows will not sum due to rounding.		

State Game Lands. PGC anticipates annual planned harvests, salvage activities, and early seral improvements. Harvest activities will affect an estimated 11,742 acres of modeled summer habitat for the northern long-eared bat per year (Table 4-3).

State Forests. The Bureau of Forestry anticipates harvesting in commercially viable stands, unplanned salvage harvests, and in early seral improvements. Harvest activities will affect an estimated 18,497 acres of modeled summer habitat for the northern long-eared bat per year (Table 4-3).

State Parks. The Bureau of State Parks anticipates annual salvage cuts, which will affect an estimated 13 acres of modeled summer habitat for the northern long-eared bat per year (Table 4-3).

All State Lands. Across all State Lands, harvest activities will affect an estimated 30,253 acres of modeled summer habitat for the northern long-eared bat per year (Table 4-3).

4.3.1.2 Operations Effects on Covered Species' Habitat

As described in Chapter 2, *State Lands and Covered Activities*, operations include installation and maintenance of fencing and firewood harvest. Because both activities can lead to tree cutting and habitat disturbance, they have the potential to affect Indiana bats and northern long-eared bats. Operations activities vary between PGC and the Bureau of Forestry; the Bureau of State Parks does not conduct such activities. As such, the sections that follow only apply to habitat on PGC and Bureau of Forestry lands.

During construction, the operation of machinery used to install fences could cause temporary negative effects. Noise, vibration from machinery, and dust could temporarily affect habitat quality in or adjacent to an area where fencing is being installed. Once installed, fencing would have positive effects on Indiana bat and northern long-eared bat habitat because the exclusion of deer from designated areas would encourage forest regeneration. Further, because Indiana bats preferentially forage at the air/vegetation interface, the cleared space around fences creates the kind of vertical structure used by foraging Indiana bats in Illinois (Menzel et al. 2005). Additional details on the beneficial effects of operations activity on bat habitat are provided in Chapter 5, *Conservation Program,* and Appendix J, *Supplemental Effects Analysis*.

Fencing

Effects of fencing are caused by the fence itself and the area cleared to install and maintain the fence. Existing fences and new construction will occur on State Lands annually, affecting summer habitat for Indiana bats (Table 4-4).

Table 4-4. Effects of Fencing on Summer Habitat for Indiana Bats (acres annually)

Agency	Total Affected	Summer Habitat Affected
State Game Lands		
Fence maintenance	450	74
Fence construction	—	—
State Forests		
Fence maintenance	1,408	110
Fence construction	48	4
State Parks		
Fence maintenance	—	—
Fence construction	—	—
Totals	**1,906**	**188**

Existing fences and new construction will occur on State Lands annually, affecting summer habitat for northern long-eared bats (Table 4-5).

Table 4-5. Effects of Fencing on Summer Habitat for Northern Long-Eared Bats (acres annually)

Agency	Total Affected	Summer Habitat Affected
State Game Lands		
Fence Maintenance	**451**	**376**
Southeastern Region	149	114
Appalachian Region	302	262
Fence Construction	—	—
Southeastern Region	—	—
Appalachian Region	—	—
State Forests		
Fence Maintenance	**1,407**	**1,234**
Southeastern Region	408	355
Appalachian Region	999	879
Fence Construction	**48**	**42**
Southeastern Region	14	12
Appalachian Region	34	30
Totals	**1,906**	**1,652**
Note: Some rows will not sum due to rounding.		

Firewood Harvest

Firewood harvest could affect habitat by removing potential roost trees. Dust, emissions, noise, and vibration from operations equipment could temporarily affect habitat quality.

Firewood harvest will occur on State Lands annually, affecting summer habitat for Indiana bats (Table 4-6) and northern long-eared bats (Table 4-7). Foresters estimate that, based on the size and condition of the trees being harvested, it takes two trees to make a cord of wood, the standard unit of sale. Similarly, based on the number of dead, broken, hollow, and cull trees identified in the state forest resources report, a typical acre contains 21 such trees. Thus, 10,000 cords of firewood harvested each year on state forests remove 20,000 trees or the equivalent of 952 acres.

Table 4-6. Effects of Firewood Harvest on Summer Habitat for Indiana Bats (acres annually)

Agency	Total Affected	Summer Habitat Affected
State Game Lands (informal estimate)	5	1
State Forests	952	77
Totals	**957**	**78**

Table 4-7. Effects of Firewood Harvest on Summer Habitat for Northern Long-Eared Bats (acres annually)

	Per Year	
Agency	**Total Affected**	**Summer Habitat Affected**
State Game Lands (informal estimate)		
Southeastern Region	2	1
Appalachian Region	3	3
Totals	**5**	**4**
State Forests		
Southeastern Region	276	240
Appalachian Region	676	595
Totals	**952**	**835**
All State Lands	**957**	**839**
Note: Some rows will not sum due to rounding.		

Summary

Table 4-8 summarizes the effects of fencing and firewood harvest (operations) on both species of bats in summer habitat.

Table 4-8. Summary of Effects of Operations on Summer Habitat (acres annually)

Agency	Total Affected	Summer Habitat Affected
Indiana Bats		
State Game Lands	455	75
State Forests	2,408	191
Totals	**2,863**	**266**
Northern Long-Eared Bats		
State Game Lands	456	380
State Forests	2,407	2,111
Totals	**2,863**	**2,491**

4.3.1.3 Road and Trail Effects on Covered Species' Habitat

As described in Chapter 2, *State Lands and Covered Activities,* projects associated with the construction and maintenance of roads are covered under this activity.

Roads

Road construction, maintenance, and use can permanently affect Indiana bats and northern long-eared bats by converting suitable habitat. Trees removed from road sites are no longer available as roosts. In addition, Indiana bats are known to avoid foraging in developed areas (Sparks et al. 2005), and bats might avoid even small clusters of homes (ESI 2013). Changes in habitat connectivity and habitat fragmentation can reduce habitat quality for Indiana bats, and this may be true for northern long-eared bats.

While this analysis addresses the direct effects on bat habitat from roads and trails, these activities can have indirect effects. Contaminants from construction vehicles and equipment and soil erosion from construction activities can degrade nearby waterways and thereby affect the insect forage base. Roads and road use can generate pollution that enters the air or water and degrades habitat (Campbell and Doeg 1989; Trombulak and Frissell 2000). Spills, although infrequent and often related to accidents, can transfer contaminants directly from vehicles or cargo into the environment. Dust and emissions from internal combustion engines and noise and vibration from road use could affect the insect prey base. Negative effects of roadways on bat habitat are primarily associated with larger, busier roads (Bennett et al. 2013; U.S. Fish and Wildlife Service 2016). Smaller roads within a forested matrix (such as the ones addressed under this HCP) create vertical structure that may attract insects and bats (Menzel et al. 2005). Smaller roads in forested systems are important commuting corridors for bats (Sheets et al. 2013a; Sheets et al. 2013b), a role that has led the U.S. Fish and Wildlife Service to recognize these sites as important sampling locations during presence/absence surveys for the covered species (U.S. Fish and Wildlife Service 2017).

For consistency, all habitat effects were converted to acres. Thus, a 20-foot-wide road 1 mile in length is equivalent to 2.4 acres. Similarly, a 5-foot-wide trail 1 mile in length is equivalent to 0.6 acre.

Existing and planned roads will occur on State Lands annually, affecting summer habitat for Indiana bats (Table 4-9) and northern long-eared bats (Table 4-10).

Table 4-9. Effects of Roads on Summer Habitat for Indiana Bats (acres annually)

Agency	Total Affected	Summer Habitat Affected
State Game Lands		
Existing road maintenance	**7,200**	**1,183**
Future road maintenance	**720**	**118**
Road construction	**24**	**4**
Totals	**7,944**	**1,305**
State Forests		
Existing road maintenance	**12,293**	**964**
Public use	5,230	410
Drivable trails	1,058	83
Administrative roads	6,005	471
Future road maintenance	**1,080**	**90**
Road construction	**36**	**3**
Totals	**13,409**	**1,057**
State Parks		
Existing road maintenance	**3,125**	**607**
Totals	**3,125**	**607**
Combined Totals	**24,478**	**2,969**
Note: Some rows will not sum due to rounding.		

Table 4-10. Effects of Roads on Summer Habitat for Northern Long-Eared Bats (acres annually)

Agency	Total Affected	Summer Habitat Affected
State Game Lands		
Existing Road Maintenance	**7,200**	**6,027**
Southeastern Region	2,376	1,830
Appalachian Region	4,824	4,197
Future Road Maintenance	**720**	**603**
Southeastern Region	238	183
Appalachian Region	482	420
Road Construction	**24**	**20**
Southeastern Region	8	6
Appalachian Region	16	14
Totals	**7,944**	**6,650**
State Forests		
Existing Road Maintenance	**12,293**	**10,782**
Public use	**5,230**	**4,586**
Southeastern Region	1,517	1,319
Appalachian Region	3,713	3,267
Drivable Trails	**1,058**	**928**
Southeastern Region	307	267
Appalachian Region	751	661
Administrative Roads	**6,004**	**5,267**
Southeastern Region	1,741	1,515

Agency	Total Affected	Summer Habitat Affected
Appalachian Region	4,263	3,752
Future road maintenance	**1,080**	**930**
Southeastern Region	300	270
Appalachian Region	780	660
Road Construction	**36**	**31**
Southeastern Region	10	9
Appalachian Region	26	22
Totals	**13,409**	**11,743**
State Parks		
Existing Road Maintenance	**3,125**	**2,077**
Southeastern Region	1,000	554
Appalachian Region	2,125	1,523
Road Construction	—	—
Totals	**3,125**	**2,077**
All Road Maintenance	**24,418**	**20,419**
All Road Construction	**60**	**51**
Totals	**24,478**	**20,470**
Note: Some rows will not sum due to rounding.		

Trails

Maintenance and construction of existing and planned trails will occur on State Lands annually, affecting summer habitat for Indiana bats (Table 4-11) and northern long-eared bats (Table 4-12).

Table 4-11. Effects of Trails on Summer Habitat for Indiana Bats (acres annually)

Agency	Total Affected	Summer Habitat Affected
State Game Lands		
Existing trail maintenance	300	49
State Forests		
Existing trail maintenance	2,801	220
New trail maintenance	5,400	420
Trail construction	180	14
State Parks		
Existing trail maintenance	860	167
Totals	**9,541**	**870**

Table 4-12. Effects of Trails on Summer Habitat for Northern Long-Eared Bats (acres annually)

Agency	Total Affected	Summer Habitat Affected
State Game Lands		
Existing Trail Maintenance	**300**	**251**
Southeastern Region	99	76
Appalachian Region	201	175

Totals	**300**	**251**
State Forests		
Existing Trail Maintenance	**2,801**	**2,457**
Southeastern Region	812	707
Appalachian Region	1,989	1,750
New Trail Maintenance	**5,400**	**4,710**
Southeastern Region	1,560	1,350
Appalachian Region	3,840	3,360
Trail Construction	**180**	**157**
Southeastern Region	52	45
Appalachian Region	128	112
Totals	**8,381**	**7,324**
State Parks		
Existing Trail Maintenance	**860**	**572**
Southeastern Region	275	152
Appalachian Region	585	419
Totals	**860**	**571**
Combined Totals	**9,541**	**8,146**
Note: Some rows will not sum due to rounding.		

Summary

Tables 4-13 and 4-14 summarize the potential annual effects of road and trail construction and maintenance by agency on Indiana bats and northern long-eared bats, respectively.

Table 4-13. Summary of Effects of Roads and Trails on Summer Habitat for Indiana Bats (acres annually)

Agency	Total Affected	Summer Habitat Affected
State Game Lands	8,244	1,354
State Forests	21,790	1,711
State Parks	3,985	774
Total	**34,019**	**3,839**
Note: Some rows will not sum due to rounding.		

Table 4-14. Summary of Effects of Roads and Trails on Summer Habitat for Northern Long-Eared Bats (acres annually)

Agency	Total Affected	Summer Habitat Affected
State Game Lands	8,244	6,901
State Forests	21,790	19,067
State Parks	3,985	2,648
Total	**34,019**	**28,616**
Note: Some rows will not sum due to rounding.		

4.3.1.4 Prescribed Fire Effects on Covered Species' Habitat

The use of fire to manage wildlife dates to presettlement times, when native people routinely used fire to manage both wildlife and their habitats (Trefethen 1975). Modern prescribed fires in Pennsylvania are primarily used to maintain or restore fire-dependent climax communities and to encourage regeneration of oaks and hickories after timber harvest (because oak-dominated forests are often fire dependent). A number of studies have addressed the 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; Ford 2016). These studies suggest 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. In most cases, prescribed fires have relatively short-term effects on individual bats, such as forcing a bat to change roosts (and thereby potentially exposing it to predators) or temporarily rendering parts of the site unsuitable for foraging (e.g., due to a temporary decrease in prey abundance). The beneficial effects of prescribed fire are described in Chapter 5, *Conservation Program,* and Appendix J, *Supplemental Effects Analysis*.

During the permit term, the agencies' fire programs are expected to grow significantly, affecting summer habitat for Indiana bats (Table 4-15) and northern long-eared bats (Table 4-16).

Table 4-15. Effects of Prescribed Fire on Summer Habitat for Indiana Bats (acres annually)

	Prescribed Fire			Summer Habitat Affected		
Year	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined
1	15,500	1,548	17,048	2,546	121	2,667
2	18,000	1,885	19,885	2,957	148	3,105
3	20,000	2,222	22,222	3,285	174	3,459
4	25,000	2,559	27,559	4,107	201	4,308
5	28,000	2,896	30,896	4,599	227	4,826
6	30,000	3,233	33,233	4,928	254	5,182
7	33,000	3,570	36,570	5,421	280	5,701
8	35,000	3,907	38,907	5,749	306	6,055
9	40,000	4,244	44,244	6,571	333	6,904
10	45,000	4,581	49,581	7,392	359	7,751
11	50,000	4,918	54,918	8,213	386	8,599
12	55,000	5,255	60,255	9,034	412	9,446
13	60,000	5,592	65,592	9,856	439	10,295
14	60,000	5,929	65,929	9,856	465	10,321
15	60,000	6,266	66,266	9,856	491	10,347
16	60,000	6,603	66,603	9,856	518	10,374
17	60,000	6,940	66,940	9,856	544	10,400
18	60,000	7,277	67,277	9,856	571	10,427
19	60,000	7,614	67,614	9,856	597	10,453
20	60,000	7,951	67,951	9,856	624	10,480
21	60,000	8,288	68,288	9,856	650	10,506
22	60,000	8,625	68,625	9,856	676	10,532

	Prescribed Fire			Summer Habitat Affected		
Year	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined
23	60,000	8,962	68,962	9,856	703	10,559
24	60,000	9,299	69,299	9,856	729	10,585
25	60,000	9,636	69,636	9,856	756	10,612
26	60,000	10,000	70,000	9,856	784	10,640
27	60,000	10,000	70,000	9,856	784	10,640
28	60,000	10,000	70,000	9,856	784	10,640
29	60,000	10,000	70,000	9,856	784	10,640
30	60,000	10,000	70,000	9,856	784	10,640
Total	**1,474,500**	**189,800**	**1,664,300**	**242,210**	**14,884**	**257,094**
Prorated Annual	**49,150**	**6,327**	**55,477**	**8,074**	**496**	**8,570**

Note: some rows may not add up due to rounding.

Table 4-16. Effects of Prescribed Fire on Summer Habitat for Northern Long-Eared Bats (acres annually)

	Prescribed Fire			Summer Habitat Affected		
Year	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined
1	15,500	1,548	17,048	12,974	1,358	14,332
2	18,000	1,885	19,885	15,066	1,653	16,719
3	20,000	2,222	22,222	16,740	1,949	18,689
4	25,000	2,559	27,559	20,925	2,244	23,169
5	28,000	2,896	30,896	23,436	2,540	25,976
6	30,000	3,233	33,233	25,110	2,836	27,946
7	33,000	3,570	36,570	27,621	3,131	30,752
8	35,000	3,907	38,907	29,295	3,427	32,722
9	40,000	4,244	44,244	33,480	3,722	37,202
10	45,000	4,581	49,581	37,665	4,018	41,683
11	50,000	4,918	54,918	41,850	4,314	46,164
12	55,000	5,255	60,255	46,035	4,609	50,644
13	60,000	5,592	65,592	50,220	4,905	55,125
14	60,000	5,929	65,929	50,220	5,200	55,420
15	60,000	6,266	66,266	50,220	5,496	55,716
16	60,000	6,603	66,603	50,220	5,791	56,011
17	60,000	6,940	66,940	50,220	6,087	56,307
18	60,000	7,277	67,277	50,220	6,383	56,603
19	60,000	7,614	67,614	50,220	6,678	56,898
20	60,000	7,951	67,951	50,220	6,974	57,194
21	60,000	8,288	68,288	50,220	7,269	57,489

	Prescribed Fire			Summer Habitat Affected		
Year	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined
22	60,000	8,625	68,625	50,220	7,565	57,785
23	60,000	8,962	68,962	50,220	7,861	58,081
24	60,000	9,299	69,299	50,220	8,156	58,376
25	60,000	9,636	69,636	50,220	8,452	58,672
26	60,000	10,000	70,000	50,220	8,771	58,991
27	60,000	10,000	70,000	50,220	8,771	58,991
28	60,000	10,000	70,000	50,220	8,771	58,991
29	60,000	10,000	70,000	50,220	8,771	58,991
30	60,000	10,000	70,000	50,220	8,771	58,991
Total	**1,474,500**	**189,800**	**1,664,300**	**1,234,157**	**166,473**	**1,400,630**
Prorated Annual	**49,150**	**6,327**	**55,477**	**41,139**	**5,549**	**46,688**
Note: some rows may not add up due to rounding.						

4.3.1.5 Summary of Summer Habitat Effects

Effects of covered activities on the summer habitat for Indiana and northern long-eared bats are summarized in Table 4-17. The total annual effects of covered activities occur on 3.2 percent of all State Lands with 3.5 percent of Indiana bat and 3.2 percent of northern long-eared bat summer habitat acres affected. By the end of the 30-year permit term, more than 3.8 million acres across State Lands will be affected. However, as detailed in Section 4.2.2.1, *Quantifying Effects on Habitat*, the location of covered activities will often overlap with areas manipulated in previous years—resulting in some areas being manipulated regularly to create and maintain younger seral states and other areas manipulated a maximum of one time (for older stands). Most manipulations only affect some of the potential roost trees. While there is overlap of suitable summer habitat between the two species where covered activities may occur, these overlaps are displayed as independent totals for summer habitat acres affected in Table 4-17.

Table 4-17. Summary of Effects on Summer Habitat for Indiana and Northern Long-Eared Bats (acres annually)

Activity	Total Affected	Summer Habitat Affected
Indiana Bats		
Timber Harvest	35,120	3,959
Operations	2,863	266
Roads and Trails	34,019	3,839
Prescribed Fire (annualized)	55,477	8,570
Total	**127,479**	**16,634**
30-Year Total	**3,824,360**	**499,014**

Activity	Total Affected	Summer Habitat Affected
Northern Long-Eared Bats		
Timber Harvest	35,120	30,253
Operations	2,863	2,491
Roads and Trails	34,019	28,616
Prescribed Fire (annualized)	55,477	46,688
Total	**127,479**	**108,048**
30-Year Total	**3,824,360**	**3,241,430**

4.3.2 Fall/Spring

Fall/Spring Habitat

- Used August to November and March to May
- Within 5 miles of known hibernaculum

This section describes the potential effects of covered activities on fall/spring habitat. As described in Chapter 2, *State Lands and Covered Activities*, and in Appendix B, *Species Accounts*, during fall (August to November) and spring (March to May), Indiana bats and northern long-eared bats are concentrated near (often within 5 miles) of a hibernaculum (U.S. Fish and Wildlife Service 2007; Brack 1983; Gardner and Cook 2002; Hobson and Holland 1995; Rommé et al. 2002; Whitaker and Brack 2002; U.S. Fish and Wildlife Service 2014). The analysis for this chapter is described relative to known hibernacula. Other than being near the hibernaculum, bats forage and roost as they do in the summer. Therefore, the effects analysis for fall/spring habitat is identical in approach to that of summer habitat.

4.3.2.1 Indiana Bats

Effects on Indiana bats are assessed in association with a given hibernaculum. As noted in Chapter 3, *Environmental Setting,* and Appendix M, *Estimating Summer Densities of Indiana Bats in Pennsylvania*, there are marked differences in the number of bats associated with the three categories of hibernacula currently found in Pennsylvania. Following the arrival of WNS, the relative value of hibernacula changed markedly. The three classes of hibernacula as they currently exist are as follows.

- **South Penn Tunnel** is now the largest and thus most important hibernaculum in the state.
- **Hartman Mine** was historically treated as a Priority 2 hibernaculum but now contains 10 bats.
- **18 smaller hibernacula** contain scattered individuals.

Recognizing that once-important Indiana bat sites are now defunct (or nearly so) provides a realistic understanding of potential effects and a means to recognize future conservation opportunities.

Timber Harvest Effects on Indiana Bat Habitat

South Penn Tunnel Hibernaculum

South Penn Tunnel is located on property owned and managed by the Pennsylvania Turnpike Authority. The Bureau of State Parks manages 1,905 acres of fall/spring habitat associated with South Penn Tunnel. Annual salvage sales conducted by the Bureau of State Parks and their impacts on fall/spring habitat for Indiana bats at this hibernaculum are summarized in Table 4-18.

Table 4-18. Effects of Timber Harvest on Fall/Spring Habitat for Indiana Bats Associated with South Penn Tunnel (acres annually)

Harvest Types	Total Harvested	Fall/Spring Habitat Harvested
State Parks		
Seral diversification	10	<1
Horizontal diversification	10	<1
Early seral improvement	—	—
Totals	**20**	**<1**

Hartman Mine Hibernaculum

PGC and the Bureau of State Parks manage fall/spring habitat for Indiana bats associated with Hartman Mine. The hibernaculum is located in Canoe Creek State Park, although the modeled habitat extends onto PGC lands. The modeled habitat associated with Hartman Mine does not encompass any Bureau of Forestry lands.

Annual timber harvest conducted by PGC and the Bureau of State Parks will affect fall/spring habitat for Indiana bats near this hibernaculum (Table 4-19).

Table 4-19. Effects of Timber Harvest on Fall/Spring Habitat for Indiana Bats Associated with Hartman Mine (acres annually)

Harvest Type	Total Affected	Fall/Spring Habitat Affected
State Game Lands		
Seral diversification	5,600	28
Horizontal diversification	7,000	35
Early seral improvement	1,400	7
Subtotal	**14,000**	**70**
State Parks		
Seral diversification	10	< 1
Horizontal diversification	10	< 1
Early seral improvement	—	—
Subtotal	20	< 1
Combined Totals	**14,020**	**70**
Note: rows may not sum due to rounding		

Smaller Hibernacula

PGC, the Bureau of Forestry, and the Bureau of State Parks manage 89,035 acres of fall/spring habitat for Indiana bats near the 18 remaining hibernacula. This land area accounts for 0.9 percent of State Game Lands, 2.4 percent of State Forests and 0.9 percent of State Parks. Annual timber harvests conducted by all three agencies will affect fall/spring habitat for Indiana bats near these hibernacula (Table 4-20).

Table 4-20. Effects of Timber Harvest on Fall/Spring Habitat for Indiana Bats Associated with 18 Smaller Hibernacula (acres annually)

Agency	Total Harvested	Fall/Spring Habitat Harvested
State Game Lands		
Seral diversification	5,600	131
Horizontal diversification	7,000	164
Early seral improvement	1,400	33
Totals	**14,000**	**328**
State Forests		
Seral diversification	9,100	212
Horizontal diversification	8,900	207
Early seral improvement	3,100	72
Totals	**21,100**	**491**
State Parks		
Seral diversification	10	< 1
Horizontal diversification	10	< 1
Early seral improvement	—	—
Totals	**20**	**< 1**
All State Lands	**35,120**	**819**
Note: Some rows will not sum due to rounding.		

Operations Effects on Indiana Bat Habitat

South Penn Tunnel Hibernaculum

No effects on Indiana bats or their fall/spring habitat at South Penn Tunnel are anticipated from operations activities. Any operations activities near South Penn Tunnel will be associated with down and dead woody vegetation that is not suitable for use by Indiana bats. A few trees could be felled within the habitat buffer as part of the salvage effort. No deer fences will be constructed.

Hartman Mine Hibernaculum

PGC is anticipated to maintain fencing that will affect fall/spring Indiana bat habitat associated with Hartman Mine (Table 4-21).

Table 4-21. Effects of Operations on Fall/Spring Habitat for Indiana Bats Associated with Hartman Mine (acres annually)

Agency	Total Affected	Fall/Spring Habitat Affected
State Game Lands		
Fence maintenance	450	2

Smaller Hibernacula

PGC and the Bureau of Forestry are expected to conduct a variety of operations activities that will affect fall/spring habitat for Indiana bats near the 18 smaller hibernacula (Table 4-22).

Table 4-22. Effects of Operations Activities on Fall/Spring Habitat for Indiana Bats Associated with 18 Smaller Hibernacula (acres annually)

State Forests	Total Affected	Fall/Spring Habitat Affected
State Game Lands		
Existing fence maintenance	450	11
Public harvest of firewood	5	< 1
State Forests		
Existing fence maintenance	1,408	33
New fence maintenance	48	1
Public harvest of firewood	952	22
Totals	**2,863**	**67**

Road and Trail Effects on Indiana Bat Habitat

South Penn Tunnel Hibernaculum

The Bureau of State Parks will continue to maintain existing roads and trails, affecting fall/spring habitat for Indiana bats near South Penn Tunnel (Table 4-23).

Table 4-23. Effects of Roads and Trails on Fall/Spring Habitat for Indiana Bats Associated with South Penn Tunnel (acres annually)

Activity	Total Affected	Fall/ Spring Habitat Affected
State Parks		
Road maintenance	3,125	20
Trail maintenance	860	5
Totals	**3,985**	**25**

Hartman Mine Hibernaculum

PGC and the Bureau of State Parks will construct and maintain new roads and trails, affecting fall/spring habitat for Indiana bats (Table 4-24).

Table 4-24. Effects of Roads and Trails on Fall/Spring Habitat for Indiana Bats Associated with Hartman Mine (acres annually)

Agency	Total Affected	Fall/Spring Habitat Affected
State Game Lands		
Road maintenance	7,200	36
Road construction	24	< 1
Trail maintenance	300	1
State Parks		
Road maintenance	3,125	5
Trail maintenance	860	1
Totals	**11,509**	**43**

Smaller Hibernacula

PGC, the Bureau of State Parks, and Bureau of Forests will construct and maintain roads and trails, affecting fall/spring habitat for Indiana bats near the 18 minor Indiana bat hibernacula (Table 4-25).

Table 4-25. Effects of Roads and Trails on Fall/Spring Habitat for Indiana Bats Associated with 18 Smaller Hibernacula (acres annually)

Agency	Total Affected	Falls/Spring Habitat Affected
State Game Lands		
Existing road maintenance	7,200	169
Road construction	24	1
Existing trail maintenance	300	7
State Forests		
Existing road maintenance	12,293	282
Public use	5,230	122
Drivable trails	1,058	25
Administrative roads	6,005	140
Road construction	36	1
Existing trail maintenance	2,801	64
Trail construction	180	4
State Parks		
Existing road maintenance	3,125	29
Existing trail maintenance	860	8
Grand Total	**26,819**	**565**

Prescribed Fire Effects on Indiana Bat Habitat

The effects of prescribed fire on the fall/spring habitat for Indiana bats are summarized in Table 4-26 and for each hibernaculum.

South Penn Tunnel Hibernaculum

Prescribed fire in Shawnee State Park is limited to nonforested habitat and is not expected to result in take of bat habitat associated with South Penn Tunnel.

Hartman Mine Hibernaculum

Both PGC and the Bureau of State Parks will conduct prescribed fires in fall/spring habitat associated with Hartman Mine. The amount of prescribed fire associated with Hartman Mine will increase over time, affecting fall/spring habitat for the Indiana bat (Table 4-26).

The Bureau of State Parks will conduct annual fires in the immediate vicinity of the mine, but these will include rigorous smoke plans (see example smoke plan in Appendix K, *Canoe Creek State Park Prescribed Fire Plan*) designed to prevent smoke from entering the hibernaculum. The fires are used to maintain warm-season grass plantings, which provide suitable foraging habitat but no roosting habitat for Indiana bats either before or during a burn. Therefore, the fires at Hartman Mine are essentially maintenance activities that do not change habitat value for Indiana bats.

Smaller Hibernacula

Prescribed fire associated with the 18 smaller hibernacula will increase over time, affecting fall/spring habitat for Indiana bats (Table 4-26). Beneficial effects of prescribed burning are described in Chapter 5, *Conservation Program,* and Appendix J, *Supplemental Effects Analysis*.

Table 4-26. Effects of Prescribed Fire on Fall/Spring Habitat for Indiana Bats (acres)

				Fall/Spring Habitat Affected						
	Prescribed Fire			Hartman Mine			18 Smaller Hibernacula			
Year	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined	Total
1	15,500	1,548	17,048	77	0	77	364	36	400	477
2	18,000	1,885	19,885	89	0	89	423	44	467	556
3	20,000	2,222	22,222	99	0	99	469	52	521	620
4	25,000	2,559	27,559	124	1	125	587	60	647	772
5	28,000	2,896	30,896	139	1	140	657	67	724	864
6	30,000	3,233	33,233	148	1	149	704	75	779	928
7	33,000	3,570	36,570	163	1	164	775	83	858	1,022
8	35,000	3,907	38,907	173	1	174	822	91	913	1,087
9	40,000	4,244	44,244	198	1	199	939	99	1038	1,237
10	45,000	4,581	49,581	223	1	224	1,056	107	1163	1,387
11	50,000	4,918	54,918	247	1	248	1,174	114	1288	1,536
12	55,000	5,255	60,255	272	1	273	1,291	122	1413	1,686
13	60,000	5,592	65,592	297	1	298	1,408	130	1538	1,836
14	60,000	5,929	65,929	297	1	298	1,408	138	1546	1,844
15	60,000	6,266	66,266	297	1	298	1,408	146	1554	1,852
16	60,000	6,603	66,603	297	1	298	1,408	154	1562	1,860
17	60,000	6,940	66,940	297	1	298	1,408	161	1569	1,867
18	60,000	7,277	67,277	297	2	299	1,408	169	1577	1,876
19	60,000	7,614	67,614	297	2	299	1,408	177	1585	1,884
20	60,000	7,951	67,951	297	2	299	1,408	185	1593	1,892
21	60,000	8,288	68,288	297	2	299	1,408	193	1601	1,900
22	60,000	8,625	68,625	297	2	299	1,408	201	1609	1,908
23	60,000	8,962	68,962	297	2	299	1,408	208	1616	1,915
24	60,000	9,299	69,299	297	2	299	1,408	216	1624	1,923

				Fall/Spring Habitat Affected						
			Prescribed Fire	Hartman Mine			18 Smaller Hibernacula			
Year	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined	Total
25	60,000	9,636	69,636	297	2	299	1,408	224	1632	1,931
26	60,000	10,000	70,000	297	2	299	1,408	233	1641	1,940
27	60,000	10,000	70,000	297	2	299	1,408	233	1641	1,940
28	60,000	10,000	70,000	297	2	299	1,408	233	1641	1,940
29	60,000	10,000	70,000	297	2	299	1,408	233	1641	1,940
30	60,000	10,000	70,000	297	2	299	1,408	233	1641	1,940
Total	**1,474,500**	**189,800**	**1,664,300**	**7,298**	**40**	**7,338**	**34,605**	**4,417**	**39,022**	**46,360**
Prorated Annual	**49,150**	**6,327**	**55,477**	**243**	**1**	**245**	**1,154**	**147**	**1,301**	**1,545**

Note: some rows may not add up due to rounding.

Summary of Fall/Spring Habitat Effects

During the next 30 years, PGC, the Bureau of Forestry, and the Bureau of State Parks plan to implement activities that will affect high suitability fall/spring habitat for Indiana bats near each of their 20 hibernacula in Pennsylvania (Table 4-27). The annual effects of covered activities occur on 3.2 percent of Indiana bat fall/spring habitat acres affected. By the end of the 30-year permit term, 94,090 acres will be affected, but as detailed in Section 4.2.2.1, *Quantifying Effects on Habitat*, the location of covered activities can overlap areas where another permitted activity has already occurred. This is especially likely to happen in areas that are being managed for disturbance-mediated habitats such as grasslands, shrublands, and open forests. Conversely, lands managed for older timber may be manipulated once or not at all. Additionally, while suitable fall/spring habitat for Indiana and northern long-eared bats may overlap where covered activities may occur, these overlaps are displayed as independent totals for fall/spring habitat acres affected in Tables 4-27 and 4-34.

Table 4-27. Summary of Effects on Fall/Spring Habitat for Indiana Bats (acres)

Activity	Total Affected	Fall/Spring Habitat Affected
Timber harvest	49,160	889
Operations	3,313	69
Roads and trails	42,313	633
Prescribed fire (annualized)	55,477	1,545
Total	**150,263**	**3,136**
30-Year Total	**4,507,880**	**94,090**

4.3.2.2 Northern Long-Eared Bats

Unlike Indiana bats, which are highly associated with specific known hibernacula in Pennsylvania, northern long-eared bats can be found in a variety of hibernacula throughout the state. The effects analysis for northern long-eared bats is, therefore, not specific to hibernacula but is segregated by region.

Timber Harvest Effects on Northern Long-Eared Bat Habitat

Northern long-eared bats roost in trees during the spring staging and fall swarming seasons when timber harvest operations have the potential to affect the species.

Annual timber harvests on State Game Lands, State Forests, and State Parks are expected to affect fall/spring habitat for northern long-eared bats (Table 4-28).

Table 4-28. Effects of Timber Harvest on Fall/Spring Habitat for Northern Long-Eared Bats (acres annually)

Agency	Total Affected	Fall/Spring Habitat Affected
State Game Lands		
Seral Diversification	**5,600**	**1,044**
Southeastern Region	1,848	619
Appalachian Region	3,752	425
Horizontal Diversification	**7,000**	**1,305**
Southeastern Region	2,310	774
Appalachian Region	4,690	531
Early Seral Improvement	**1,400**	**261**
Southeastern Region	462	155
Appalachian Region	938	106
Totals	**14,000**	**2,610**
State Forests		
Seral Diversification	**9,100**	**1,440**
Southeastern Region	2,608	970
Appalachian Region	6,492	470
Horizontal Diversification	**8,900**	**1,407**
Southeastern Region	2,551	948
Appalachian Region	6,349	459
Early Seral Improvement	**3,100**	**490**
Southeastern Region	888	330
Appalachian Region	2,212	160
Totals	**21,100**	**3,337**
State Parks		
Seral Diversification	**10**	**2**
Southeastern Region	3	1
Appalachian Region	7	1
Horizontal Diversification	**10**	**2**
Southeastern Region	3	1
Appalachian Region	7	1
Early Seral Improvement	—	—
Southeastern Region	—	—
Appalachian Region	—	—
Totals	**20**	**4**
All State Lands	**35,120**	**5,951**
Note: some rows may not add up due to rounding.		

Operations Effects on Northern Long-Eared Bat Habitat

Operations activities on State Lands will affect fall/spring habitat for northern long-eared bats. These activities include fencing (Table 4-29) and firewood harvest (Table 4-30).

Table 4-29. Effects of Fencing on Fall/Spring Habitat for Northern Long-Eared Bats (acres annually)

Agency	Total Affected	Fall/Spring Habitat Affected
State Game Lands		
Fence Maintenance	**451**	**84**
Southeastern Region	149	34
Appalachian Region	302	50
State Forests		
Fence Maintenance	**1,407**	**224**
Southeastern Region	408	72
Appalachian Region	999	152
Fence Construction	**48**	**7**
Southeastern Region	34	5
Appalachian Region	14	2
All State Lands	**1,906**	**315**
Note: some rows may not add up due to rounding.		

Table 4-30. Effects of Firewood Harvest on Fall/Spring Habitat for Northern Long-Eared Bats (acres annually)

	30-Year Totals	
Agency	Total Affected	Fall/Spring Habitat Affected
State Game Lands	**5**	**1**
Southeastern Region	2	<1
Appalachian Region	3	1
State Forests	**952**	**152**
Southeastern Region	276	103
Appalachian Region	676	49
All State Lands	**957**	**153**
Note- some rows may not add up due to rounding.		

Road and Trail Effects on Northern Long-Eared Bat Habitat

Road construction and maintenance on State Lands will affect fall/spring habitat for northern long-eared bats (Table 4-31). Additionally, trail construction and maintenance will affect fall/spring habitat for northern long-eared bats (Table 4-32).

Table 4-31. Effects of Roads on Fall/Spring Habitat for Northern Long-Eared Bats (acres annually)

Agency	Total Affected	Fall/Spring Habitat Affected
State Game Lands		
Existing Road Maintenance	**7,200**	**1,343**
Southeastern Region	2,376	796
Appalachian Region	4,824	547
Future Road Maintenance	**720**	**150**
Southeastern Region	238	90
Appalachian Region	482	60
State Forests		
Existing Road Maintenance	**12,293**	**1,957**
Public use	5,230	833
Drivable trails	1,058	168
Administrative roads	6,005	956
Future Road Maintenance	**1,080**	**180**
Road Construction	**36**	**6**
State Parks		
Existing Road Maintenance	**3,125**	**382**
Road Construction	**—**	**—**
Totals	**24,454**	**4,038**
Note- some rows may not add up due to rounding.		

Table 4-32. Effects of Trails on Fall/Spring Habitat for Northern Long-Eared Bats (acres annually)

Agency	Total Affected	Fall/Spring Habitat Affected
State Game Lands		
Existing Trail Maintenance	**300**	**56**
Southeastern Region	99	33
Appalachian Region	201	23
State Forests		
Existing Trail Maintenance	**2,801**	**446**
Southeastern Region	812	302
Appalachian Region	1,989	144
New Trail Maintenance	**5,400**	**840**
Southeastern Region	1,566	570
Appalachian Region	3,834	270
Trail Construction	**180**	**28**
Southeastern Region	52	19
Appalachian Region	128	9

Agency	Total Affected	Fall/Spring Habitat Affected
State Parks		
Existing Trail Maintenance	**860**	**224**
Southeastern Region	275	72
Appalachian Region	585	152
Totals	**9,541**	**1,594**
Note: some rows may not add up due to rounding.		

Prescribed Fire Effects on Northern Long-Eared Bat Habitat

The effects of prescribed fires on the fall/spring habitat for of northern long-eared bats are summarized in Table 4-33.

Table 4-33. Effects of Prescribed Fire on Fall/Spring Habitat for Northern Long-Eared Bats (acres)

	Prescribed Fire			Fall/Spring Habitat Affected						
				Southeast Region			Appalachian Region			
Year	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined	Total
1	15,500	1,548	17,048	1,713	150	1,863	1,177	125	1,302	3,165
2	18,000	1,885	19,885	1,990	183	2,173	1,366	152	1,518	3,691
3	20,000	2,222	22,222	2,211	216	2,427	1,518	179	1,697	4,124
4	25,000	2,559	27,559	2,764	249	3,013	1,898	206	2,104	5,117
5	28,000	2,896	30,896	3,095	281	3,376	2,125	233	2,358	5,734
6	30,000	3,233	33,233	3,316	314	3,630	2,277	260	2,537	6,167
7	33,000	3,570	36,570	3,648	347	3,995	2,505	287	2,792	6,787
8	35,000	3,907	38,907	3,869	380	4,249	2,657	314	2,971	7,220
9	40,000	4,244	44,244	4,422	412	4,834	3,036	341	3,377	8,211
10	45,000	4,581	49,581	4,974	445	5,419	3,416	368	3,784	9,203
11	50,000	4,918	54,918	5,527	478	6,005	3,795	396	4,191	10,196
12	55,000	5,255	60,255	6,080	510	6,590	4,175	423	4,598	11,188
13	60,000	5,592	65,592	6,633	543	7,176	4,554	450	5,004	12,180
14	60,000	5,929	65,929	6,633	576	7,209	4,554	477	5,031	12,240
15	60,000	6,266	66,266	6,633	609	7,242	4,554	504	5,058	12,300
16	60,000	6,603	66,603	6,633	641	7,274	4,554	531	5,085	12,359
17	60,000	6,940	66,940	6,633	674	7,307	4,554	558	5,112	12,419
18	60,000	7,277	67,277	6,633	707	7,340	4,554	585	5,139	12,479
19	60,000	7,614	67,614	6,633	740	7,373	4,554	612	5,166	12,539
20	60,000	7,951	67,951	6,633	772	7,405	4,554	640	5,194	12,599
21	60,000	8,288	68,288	6,633	805	7,438	4,554	667	5,221	12,659
22	60,000	8,625	68,625	6,633	838	7,471	4,554	694	5,248	12,719
23	60,000	8,962	68,962	6,633	871	7,504	4,554	721	5,275	12,779
24	60,000	9,299	69,299	6,633	903	7,536	4,554	748	5,302	12,838
25	60,000	9,636	69,636	6,633	936	7,569	4,554	775	5,329	12,898

				Fall/Spring Habitat Affected						
	Prescribed Fire			Southeast Region			Appalachian Region			
Year	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined	State Game Lands	Parks and Forests	Combined	Total
26	60,000	10,000	70,000	6,633	971	7,604	4,554	804	5,358	12,962
27	60,000	10,000	70,000	6,633	971	7,604	4,554	804	5,358	12,962
28	60,000	10,000	70,000	6,633	971	7,604	4,554	804	5,358	12,962
29	60,000	10,000	70,000	6,633	971	7,604	4,554	804	5,358	12,962
30	60,000	10,000	70,000	6,633	971	7,604	4,554	804	5,358	12,962
Total	**1,474,500**	**189,800**	**1,664,300**	**163,003**	**18,435**	**181,438**	**111,917**	**15,266**	**127,183**	**308,621**
Prorated Annual	**49,150**	**6,327**	**55,477**	**5,433**	**615**	**6,048**	**3,731**	**509**	**4,239**	**10,287**

Summary of Fall/Spring Habitat Effects

During the next 30 years, PGC, the Bureau of Forestry, and the Bureau of State Parks plan to implement activities that will affect fall/spring habitat for northern long-eared bats near each of their 322 hibernacula in Pennsylvania (Table 4-34). The annual effects of covered activities occur on 3.4 percent of northern long-eared bat fall/spring habitat acres affected. By the end of the 30-year permit term, 669,551 acres will be affected, but as described in Section 4.2.2.1, *Quantifying Effects on Habitat*, the location of covered activities can overlap areas where another permitted activity has already occurred. This is especially likely to happen in areas that are being managed for disturbance-mediated habitats such as grasslands, shrublands, and open forests. Conversely, lands managed for older timber may be manipulated once or not at all. Additionally, suitable fall/spring habitat for Indiana and northern long-eared bats may overlap where covered activities may occur; however, these overlaps are displayed as independent totals for fall/spring habitat acres affected in Tables 4-27 and 4-34.

Table 4-34. Summary of Effects on Fall/Spring Habitat for Northern Long-Eared Bats (acres annually)

Type of Activity	Total Acres	Fall/Spring Habitat Affected
Timber Harvest	**35,120**	**5,951**
Seral diversification	14,710	2,486
Horizontal diversification	15,910	2,714
Early seral improvement	4,500	751
Operations	**2,863**	**468**
Fencing	1,906	315
Firewood	957	153
Roads and Trails	**33,995**	**5,632**
Roads	24,454	4,038
Trails	9,541	1,594
Prescribed Fire	**55,477**	**10,287**
Total	**127,455**	**22,318**
30-Year Total	**3,823,640**	**670,151**
Note: Some rows may not add up due to rounding.		

4.3.3 Winter

An estimated 425 acres of State Lands are within modeled winter habitat for Indiana bats along with 3,459 acres for northern long-eared bats. This represents less than 1 percent of the nearly 4 million acres of State Lands. Considered solely based on area and probability, the potential for covered activities to directly affect one of these areas is small. However, prorating activities is not appropriate for assessing effects on winter habitat because of the potential magnitude of any single event (one event could affect most bats wintering in Pennsylvania). In addition, effects can be avoided because the hibernacula are known. PGC and DCNR will avoid all

Winter Habitat

- Used between October and May
- Lands within 0.25 mile of a known hibernaculum
- No effects anticipated

negative effects within this buffer and thus avoid effects on wintering bats. This section does not assess effects on winter habitat (those will not occur). However, a brief discussion of effects absent any conservation measures is provided below.

Without appropriate avoidance and minimization measures, any covered activity could have the direct effect of killing or disturbing all bats within a hibernaculum if the activity occurs when the bats are present. If Indiana bats or northern long-eared bats are not present, the hibernaculum could be degraded to the point that it is not usable. Worse yet, the hibernaculum could attract bats to a site where they cannot survive the winter. A variety of activities could affect bats and hibernacula:

- Trees removed near a hibernaculum entrance can alter airflow into the hibernaculum, affecting winter temperature regimes and humidity, and thus the suitability of the hibernaculum for over-wintering bats.
- Altered entrances or rocks in the interiors can affect the temperature regime (which can have both positive and negative effects). An altered entrance can divert water and immediately flood the hibernaculum or cause debris (including silt) to accumulate so that the water backs up into the hibernaculum, or could change airflow regimes, making portions of the hibernacula inaccessible. These issues are important considerations when gates are installed on caves with the intent of protecting bats.
- Large or loud equipment can create noise and vibrations that could disturb hibernating bats, thereby depleting fat stores and causing fatalities or lessening reproductive fitness.
- Trees removed or roads can make remote areas more accessible, increasing human disturbance that would make those areas less suitable for hibernating bats.
- Spilled contaminants, such as vehicle and equipment fuels, lubricants, and hydraulic fluids, can create an above-ground or subterranean path to a hibernaculum and adversely affect bats through inhalation, ingestion (in drinking water), or dermal absorption.
- Smoke from a variety of sources, including vehicle exhaust, recreational fires, prescribed fires, wildfires, or fires set as deliberate acts of vandalism, can enter hibernacula and arouse or kill bats within.

The 0.25-mile buffer used to identify winter habitat (Chapter 3, *Environmental Setting*) is designed to protect both the physical structure of the hibernaculum and portions of the surrounding landscape from which noise, vibration, and contaminants could affect the hibernaculum.

4.3.4 Effects Summary

4.3.4.1 Indiana Bats

Table 4-35 summarizes the annual effects of covered activities on Indiana bat habitat as a prorated average (effects from prescribed fire grow over time). Areas near hibernacula that provide both fall/spring and summer habitat are counted twice because effects can occur during either period, and habitat effects occur across multiple years. The 19,770 acres expected to be affected annually accounts for less than 1 percent of all State Lands. Moreover, the affected habitat will regenerate over time providing a benefit, while subsequent year's covered activities could occur in other areas. By operating in such a manner, PGC and DCNR's goal is to maintain and enhance a mosaic of suitable habitat across their lands. Agency practices already protect winter habitat at all of the 20 hibernacula in Pennsylvania.

Table 4-35. Summary of Effects of Covered Activities on Indiana Bat Habitat (acres annually)

Type of Activity, Habitat	Seasonal Habitat on State Lands
Timber Harvest	**4,848**
Summer	3,959
Fall/Spring	889
Operations	**335**
Summer	266
Fall/Spring	69
Roads and Trails	**4,472**
Summer	3,839
Fall/Spring	633
Prescribed Fire	**10,115**
Summer	8,570
Fall/Spring	1,545
Total	**19,770**

4.3.4.2 Northern Long-Eared Bats

Table 4-36 summarizes the annual effects of covered activities on northern long-eared bat habitat. The 130,366 acres expected to be affected annually accounts for 3.3 percent of all State Lands. Moreover, the affected habitat will regenerate over time providing a benefit, while subsequent year's covered activities could occur in other areas. By operating in such a manner, PGC and DCNR's goal is to maintain and enhance a mosaic of suitable habitat across their lands. Agency practices already protect winter habitat at all of the 322 hibernacula in Pennsylvania.

Table 4-36. Summary of Effects of Covered Activities on Northern Long-Eared Bat Habitat (acres annually)

Type of Activity, Habitat	Seasonal Habitat on State Lands
Timber Harvest	**36,204**
Summer	30,253
Fall/Spring	5,951
Operations	**2,959**
Summer	2,491
Fall/Spring	468
Roads and Trails	**34,248**
Summer	28,616
Fall/Spring	5,632
Prescribed Fire	**56,975**
Summer	46,688
Fall/Spring	10,287
Total	**130,386**

4.3.4.3 Five-Year Rolling Take Limits

The estimated effects of covered activities presented throughout this chapter are the basis for the limits of take coverage requested by PGC and DCNR through the State Lands Forestry HCP. These limits are based on the total effects of covered activities for both PGC and DCNR and are specific to modeled habitat for covered species. While take is calculated annually, PGC and DCNR propose a 5-year rolling average take limit during implementation to allow for flexibility in managing harvests year-to-year. The 5-year rolling average and resulting take limit is presented in Table 4-37 for those activities with relatively stable levels of activity over the permit term. As the fire program is expected to grow over the permit term, the 5-year rolling average and resulting take limit for fire is shown separately in Table 4-38.

Table 4-37. 5-Year Rolling Take Limits (in acres of bat habitat) for Relatively Stable Covered Activities over the Permit Term (All Activities other than Prescribed Fire) (acres)

Type of Activity/Habitat	Projected Annual Effects on Indiana Bats	Cap for any 5-Year Period	Projected Annual Effects on Northern Long-Eared Bats	Cap for any 5-Year Period
Timber Harvest	**4,848**	**24,240**	**36,204**	**181,020**
Summer	3,959	19,795	30,253	151,265
Fall/Spring	889	4,445	5,951	29,755
Operations	**335**	**1,675**	**2,959**	**14,795**
Summer	266	1,330	2,491	12,455
Fall/Spring	69	345	468	2,340
Roads and Trails	**4,472**	**22,360**	**34,248**	**171,140**
Summer	3,839	19,195	28,616	143,080
Fall/Spring	633	3,165	5,632	28,060
Total	**9,655**	**48,275**	**73,411**	**366,955**

Table 4-38. 5-Year Rolling Take Limit for Prescribed Fire (acres) in Bat Habitat

	Indiana Bat				Northern Long-Eared Bat			
	Summer		Fall/Spring		Summer		Fall/Spring	
Year	Annual Projection	Cap for Last 5 Years	Annual Projection	Cap for Last 5 Years	Annual Projection	Cap for Last 5 Years	Annual Projection	Cap for Last 5 Years
1	2,667	—	477	—	14,331	—	3,165	—
2	3,105	—	556	—	16,719	—	3,691	—
3	3,460	—	621	—	18,689	—	4,124	—
4	4,307	—	771	—	23,169	—	5,116	—
5	4,826	18,365	864	3,289	25,976	98,884	5,735	21,831
6	5,181	20,879	929	3,741	27,946	112,499	6,168	24,834
7	5,701	23,475	1,022	4,207	30,752	126,532	6,787	27,930
8	6,056	26,071	1,086	4,672	32,722	140,565	7,219	31,025
9	6,903	28,667	1,236	5,137	37,202	154,598	8,212	34,121
10	7,751	31,592	1,386	5,659	41,683	170,305	9,204	37,590
11	8,599	35,010	1,536	6,266	46,164	188,523	10,196	41,618
12	9,447	38,756	1,687	6,931	50,644	208,415	11,188	46,019
13	10,294	42,994	1,837	7,682	55,125	230,818	12,180	50,980
14	10,321	46,412	1,844	8,290	55,420	249,036	12,240	55,008
15	10,347	49,008	1,852	8,756	55,716	263,069	12,300	58,104
16	10,374	50,783	1,860	9,080	56,011	272,916	12,359	60,267
17	10,400	51,736	1,868	9,261	56,307	278,579	12,419	61,498
18	10,426	51,868	1,876	9,300	56,603	280,057	12,479	61,797
19	10,453	52,000	1,884	9,340	56,898	281,535	12,539	62,096
20	10,479	52,132	1,892	9,380	57,194	283,013	12,599	62,395
21	10,506	52,264	1,900	9,420	57,489	284,491	12,659	62,695
22	10,532	52,396	1,908	9,460	57,785	285,969	12,718	62,994
23	10,559	52,529	1,916	9,500	58,081	287,447	12,778	63,293
24	10,585	52,661	1,923	9,539	58,376	288,925	12,838	63,592
25	10,611	52,793	1,931	9,578	58,672	290,403	12,898	63,891

	Indiana Bat				Northern Long-Eared Bat			
	Summer		Fall/Spring		Summer		Fall/Spring	
Year	Annual Projection	Cap for Last 5 Years	Annual Projection	Cap for Last 5 Years	Annual Projection	Cap for Last 5 Years	Annual Projection	Cap for Last 5 Years
26	10,640	52,927	1,940	9,618	58,991	291,905	12,963	64,195
27	10,640	53,035	1,940	9,650	58,991	293,111	12,963	64,440
28	10,640	53,116	1,940	9,674	58,991	294,021	12,963	64,625
29	10,640	53,171	1,940	9,691	58,991	294,636	12,963	64,750
30	10,640	53,200	1,940	9,700	58,991	294,955	12,963	64,815

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Chapter 5
Conservation Program

5.1 Introduction

The conservation program for the State Lands Forestry HCP is designed to avoid, minimize, and mitigate forest management effects on Indiana bats and northern long-eared bats. The program meets the regulatory requirements of the ESA and Pennsylvania State laws and streamlines compliance with other applicable environmental regulations (Chapter 1, *Introduction*). The conservation program was developed using the best science available at the time of preparation, including the following analyses and data:

- Indiana bat and northern long-eared bat species accounts (Appendix B, *Species Accounts*).
- Ecosystems and vegetation data (Chapter 3, *Environmental Setting*).
- Indiana Bat (*Myotis sodalis*) Draft Recovery Plan: First Revision (U.S. Fish and Wildlife Service 2007)
- Indiana Bat (*Myotis sodalis*) 5-Year Review: Summary and Evaluation (U.S. Fish and Wildlife Service 2009).
- Northern Long-Eared Bat Interim Conference and Planning Guidelines (U.S. Fish and Wildlife Service 2014).
- A National Plan for Assisting States, Federal Agencies, and Tribes in Managing White-Nose Syndrome in Bats (U.S. Fish and Wildlife Service 2011).
- Habitat models created for summer, winter, and fall/spring habitat (Chapter 3, *Environmental Setting,* and Appendix H, *Habitat Distribution Modeling Using MaxEnt*).
- Input from resource specialists, PGC, DCNR, and USFWS staff.

In this chapter, Section 5.3, *Biological Goals and Objectives*, provides the basis for the conservation program. Sections 5.4, *Avoidance and Minimization Measures*, and 5.5*, Mitigation Measures,* (collectively, the *conservation measures*) outline the actions that will help accomplish the goals and objectives. The conservation measures are designed to have enough detail and specificity to allow for implementation, yet are flexible enough to allow for the statewide scale of the State Lands Forestry HCP and the 30-year permit term. Section 5.6, *Summary of Effects*, quantifies the estimated effect of permitted covered activities *after* the conservation program is in place. All conservation measures will be implemented using an adaptive management approach that is closely tied to long-term monitoring, as described in Section 5.7, *Adaptive Management*, and Section 5.8, *Monitoring*.

5.2 The Impact of the Taking

The effects analysis (Chapter 4, *Effects of Covered Activities*) quantifies the potential adverse effects of covered activities on bats and bat habitat. However, both timber harvest and prescribed fire can have long-term beneficial effects on bat habitat by decreasing tree clutter and inducing successional patterns that lead to high-quality roosting and foraging habitat for bats (Sheets et al. 2013;

Pauli et al. 2015a, Pauli et al. 2015b; Pauli et al. 2017; Silvis et al. 2016). In particular, prescribed fire facilitates the development of roosting habitat by increasing roost availability and solar exposure. Prescribed fires can also change the successional stage of a forest stand by removing much of the woody understory and creating a more open forest, often dominated by forbs, which can substantially increase the quality of foraging habitat for bats. Opening the understory reduces clutter around roost trees, improving the microclimate as well as travel and foraging conditions. For example, early pole stands are usually too cluttered for regular use by foraging bats (Blakey et al. 2016), but prescribed fire or the timber harvests identified as early seral improvements can open these habitats to allow bat access and provide some limited roosting opportunities. Without periodic fire, forests can become overloaded with shrubs and saplings, resulting in a cluttered forest that inhibits bat movement and foraging. When these indirect positive effects of covered activities are considered in concert with the adverse effects described in Chapter 4, the beneficial effects of covered activities outweigh the adverse effects on summer and fall/spring habitat of both species due to the creation of foraging and roosting habitat through prescribed burning. The conservation strategy for covered bat species was designed in the context of these impacts of the taking.

The primary goal of this HCP is to permit habitat management activities undertaken for the long-term benefit of covered bats and other wildlife native to Pennsylvania. In many cases, long-term benefits are acquired at the cost of short-term negative consequences, including a risk of killing or injuring individual bats. The effects analysis in Chapter 4 presents the number of acres of each management activity that will be permitted under this HCP in areas that are suitable habitat for Indiana bats or northern long-eared bats during the summer or fall/spring. However, the goal of these activities is to accomplish a long-term management objective that may take years or decades to manifest fully. As such, this chapter and Appendix J, *Supplemental Effects Analysis* analyze the long-term effects of the covered activities on those lands where they are implemented. In the case of prescribed fire, the effects on habitat quality are nearly all positive and greatly increase habitat quality in a forest stand decades after a fire is completed. The analysis reports this change in status relative to the baseline (measured in the number of acres affected).

Proposed covered activities promote forest health, create conditions suitable for multiple users, and enhance or restore habitat for wildlife species. As such, the covered activities improve conditions for covered bats over the permit term.

Indirect, beneficial effects of timber harvest and prescribed fire on bat habitat were quantified using a modified habitat equivalency analysis. This type of analysis is widely applied in natural resource management and has survived legal challenges when based on best available science (Snyder and Desvousges 2013). This approach allows the recognition and quantification of the following attributes of the covered activities in this HCP:

- Covered activities have directional effects (they can be either good or bad for bats).
- Covered activities do not result in habitat conversion but have graduated effects.
- Covered activities have both short- and long-term effects, and these change over time.
- Covered activities affect the quality of both foraging and roosting habitat, and these effects may be directional (i.e., the same activity may reduce roosting habitat and improve foraging habitat).

A detailed discussion of the methods used to quantify effects is presented in Appendix J, *Supplemental Effects Analysis*. Table 5-1 displays the direct adverse effects of covered activities (from Chapter 4) as well as the indirect beneficial effects of covered activities (Appendix J) to derive the combined effect on bat habitat from both forestry and prescribed burning. The effects of other covered activities (positive or negative) are small and discountable relative to these larger effects for the purposes of summarizing the combined effects. As shown in Table 5-1, covered activities result in more than 35,000 acres of improved habitat annually for Indiana bats and more than 151,000 acres of improved habitat annually for northern long-eared bats.

It is expected that the unavoidable take of bats is offset by increased habitat, especially because none of the covered activities is expected to eliminate any existing summer or winter colonies. Higher-quality habitat should lead to an increased reproductive output and increased survivorship. However, it is important to note that white-nose syndrome (WNS) is the primary threat to the species and that the activities covered by this HCP are unlikely to have any bearing on the status of this species in the State of Pennsylvania. Rather, the protections provided by this HCP will ensure that effects on the species are minimized and important habitat features and conditions are present when or if the species recovers. As a result, the State Lands Forestry HCP's conservation program relies primarily on avoidance, followed by minimization, then mitigation for unavoidable effects.

Table 5-1. Annual Acres of Direct and Indirect Effects on Indiana and Northern Long-Eared Bats

	Timber Harvest Acres				Prescribed Fire Acres				Summary
Year	Seasonal Habitat Affected (Summer + Fall / Spring)	Direct Effects	Indirect Effects	Combined Effects	Seasonal Habitat Affected	Direct Effects	Indirect Effects	Combined Effects	Total Combined Effects
Indiana Bats									
1	4,847	(-) 117	(+) 130	(+) 13	3,144	(+) 1,834	(+) 5,394	(+) 7,228	(+) 7,241
2	4,847	(-) 117	(+) 130	(+) 13	3,661	(+) 2,135	(+) 6,627	(+) 8,762	(+) 8,775
3	4,847	(-) 117	(+) 130	(+) 13	4,081	(+) 2,380	(+) 7,780	(+) 10,160	(+) 10,172
4	4,847	(-) 117	(+) 106	(-) 11	5,078	(+) 2,962	(+) 9,119	(+) 12,081	(+) 12,070
5	4,847	(-) 117	(+) 130	(+) 13	5,690	(+) 3,319	(+) 10,588	(+) 13,908	(+) 13,920
6	4,847	(-) 117	(+) 55	(-) 63	6,110	(+) 3,564	(+) 12,303	(+) 15,867	(+) 15,805
7	4,847	(-) 117	(+) 55	(-) 63	6,723	(+) 3,921	(+) 14,029	(+) 17,951	(+) 17,888
8	4,847	(-) 117	(+) 55	(-) 63	7,142	(+) 4,166	(+) 15,680	(+) 19,846	(+) 19,783
9	4,847	(-) 117	(+) 55	(-) 63	8,139	(+) 4,748	(+) 17,445	(+) 22,193	(+) 22,130
10	4,847	(-) 117	(+) 17	(-) 100	9,137	(+) 5,330	(+) 19,480	(+) 24,810	(+) 24,710
11	4,847	(-) 117	(-) 27	(-) 144	10,135	(+) 5,912	(+) 21,823	(+) 27,735	(+) 27,591
12	4,847	(-) 117	0	(-) 117	11,134	(+) 6,494	(+) 24,419	(+) 30,914	(+) 30,797
13	4,847	(-) 117	0	(-) 117	12,131	(+) 7,076	(+) 27,102	(+) 34,178	(+) 34,061
14	4,847	(-) 117	0	(-) 117	12,165	(+) 7,096	(+) 30,010	(+) 37,106	(+) 36,989
15	4,847	(-) 117	0	(-) 117	12,199	(+) 7,116	(+) 32,620	(+) 39,737	(+) 39,620
16	4,847	(-) 117	0	(-) 117	12,234	(+) 7,136	(+) 34,992	(+) 42,129	(+) 42,012
17	4,847	(-) 117	0	(-) 117	12,268	(+) 7,156	(+) 37,075	(+) 44,231	(+) 44,114
18	4,847	(-) 117	0	(-) 117	12,302	(+) 7,176	(+) 38,796	(+) 45,972	(+) 45,855
19	4,847	(-) 117	0	(-) 117	12,337	(+) 7,197	(+) 40,239	(+) 47,436	(+) 47,319
20	4,847	(-) 117	(-) 160	(-) 277	12,371	(+) 7,217	(+) 41,431	(+) 48,648	(+) 48,371
21	4,847	(-) 117	(-) 65	(-) 182	12,406	(+) 7,237	(+) 42,386	(+) 49,622	(+) 49,440
22	4,847	(-) 117	(-) 42	(-) 159	12,440	(+) 7,257	(+) 43,205	(+) 50,462	(+) 50,303
23	4,847	(-) 117	(-) 65	(-) 182	12,475	(+) 7,277	(+) 43,866	(+) 51,143	(+) 50,961
24	4,847	(-) 117	(-) 42	(-) 159	12,508	(+) 7,297	(+) 44,426	(+) 51,723	(+) 51,564
25	4,847	(-) 117	(-) 128	(-) 246	12,542	(+) 7,317	(+) 44,920	(+) 52,237	(+) 51,991
26	4,847	(-) 117	(-) 42	(-) 159	12,580	(+) 7,338	(+) 45,360	(+) 52,699	(+) 52,540
27	4,847	(-) 117	(-) 65	(-) 182	12,580	(+) 7,338	(+) 45,753	(+) 53,091	(+) 52,909
28	4,847	(-) 117	(-) 42	(-) 159	12,580	(+) 7,338	(+) 46,074	(+) 53,412	(+) 53,253

	Timber Harvest Acres				Prescribed Fire Acres				Summary
Year	**Seasonal Habitat Affected (Summer + Fall / Spring)**	**Direct Effects**	**Indirect Effects**	**Combined Effects**	**Seasonal Habitat Affected**	**Direct Effects**	**Indirect Effects**	**Combined Effects**	**Total Combined Effects**
29	4,847	(-) 117	(-) 65	(-) 182	12,580	(+) 7,338	(+) 46,328	(+) 53,667	(+) 53,485
30	4,847	(-) 117	(-) 105	(-) 222	12,580	(+) 7,338	(+) 46,537	(+) 53,876	(+) 53,653
Total	**145,410**	**(-) 3,510**	**(+) 15**	**(-) 3,495**	**303,452**	**(+) 177,010**	**(+) 895,807**	**(+) 1,072,817**	**(+) 1,069,322**
Prorated Annual	**4,847**	**(-) 117**	**(+) <1**	**(-) 116**	**10,115**	**(+) 5,900**	**(+) 29,860**	**(+) 35,761**	**(+) 35,644**
Northern Long-Eared Bats									
1	36,203	(-) 8,073	(+) 6,128	(-) 1,945	17,496	(+) 7,290	(+) 29,160	(+) 36,450	(+) 34,505
2	36,203	(-) 8,073	(+) 1,578	(-) 6,495	20,410	(+) 8,504	(+) 36,450	(+) 44,954	(+) 38,460
3	36,203	(-) 8,073	(+) 1,072	(-) 7,000	22,813	(+) 9,505	(+) 40,872	(+) 50,377	(+) 43,377
4	36,203	(-) 8,073	(+) 1,578	(-) 6,495	28,285	(+) 11,785	(+) 46,295	(+) 58,080	(+) 51,585
5	36,203	(-) 8,073	(+) 918	(-) 7,155	31,711	(+) 13,213	(+) 44,862	(+) 58,075	(+) 50,920
6	36,203	(-) 8,073	(+) 1,578	(-) 6,495	34,114	(+) 14,214	(+) 51,944	(+) 66,158	(+) 59,663
7	36,203	(-) 8,073	(+) 1,072	(-) 7,000	37,539	(+) 15,641	(+) 60,880	(+) 76,521	(+) 69,521
8	36,203	(-) 8,073	(+) 1,578	(-) 6,495	39,941	(+) 16,642	(+) 68,365	(+) 85,007	(+) 78,513
9	36,203	(-) 8,073	(+) 1,072	(-) 7,000	45,414	(+) 18,922	(+) 75,865	(+) 94,787	(+) 87,787
10	36,203	(-) 8,073	(+) 1,423	(-) 6,650	50,887	(+) 21,203	(+) 84,794	(+) 105,996	(+) 99,347
11	36,203	(-) 8,073	0	(-) 8,073	56,360	(+) 23,483	(+) 93,924	(+) 117,407	(+) 109,335
12	36,203	(-) 8,073	(+) 506	(-) 7,567	61,832	(+) 25,763	(+) 104,775	(+) 130,538	(+) 122,971
13	36,203	(-) 8,073	0	(-) 8,073	67,305	(+) 28,044	(+) 116,669	(+) 144,713	(+) 136,640
14	36,203	(-) 8,073	(+) 506	(-) 7,567	67,660	(+) 28,192	(+) 129,923	(+) 158,114	(+) 150,547
15	36,203	(-) 8,073	(-) 155	(-) 8,228	68,016	(+) 28,340	(+) 141,227	(+) 169,566	(+) 161,339
16	36,203	(-) 8,073	(+) 506	(-) 7,567	68,370	(+) 28,488	(+) 153,020	(+) 181,508	(+) 173,941
17	36,203	(-) 8,073	0	(-) 8,073	68,726	(+) 28,636	(+) 163,324	(+) 191,960	(+) 183,887
18	36,203	(-) 8,073	(+) 506	(-) 7,567	69,082	(+) 28,784	(+) 171,986	(+) 200,770	(+) 193,202
19	36,203	(-) 8,073	0	(-) 8,073	69,437	(+) 28,932	(+) 179,158	(+) 208,090	(+) 200,017
20	36,203	(-) 8,073	(+) 351	(-) 7,722	69,793	(+) 29,080	(+) 185,574	(+) 214,655	(+) 206,932
21	36,203	(-) 8,073	0	(-) 8,073	70,148	(+) 29,228	(+) 191,235	(+) 220,463	(+) 212,391
22	36,203	(-) 8,073	(+) 155	(-) 7,918	70,503	(+) 29,376	(+) 196,140	(+)225,516	(+) 217,598
23	36,203	(-) 8,073	0	(-) 8,073	70,859	(+) 29,525	(+) 200,289	(+) 229,814	(+) 221,741
24	36,203	(-) 8,073	(+) 155	(-) 7,918	71,214	(+) 29,673	(+) 203,683	(+) 233,355	(+) 225,437
25	36,203	(-) 8,073	0	(-) 8,073	71,570	(+) 29,821	(+) 207,088	(+) 236,909	(+) 228,836

	Timber Harvest Acres				Prescribed Fire Acres				Summary
Year	**Seasonal Habitat Affected (Summer + Fall / Spring)**	**Direct Effects**	**Indirect Effects**	**Combined Effects**	**Seasonal Habitat Affected**	**Direct Effects**	**Indirect Effects**	**Combined Effects**	**Total Combined Effects**
26	36,203	(-) 8,073	(+) 155	(-) 7,918	71,954	(+) 29,981	(+) 210,505	(+) 240,486	(+) 232,568
27	36,203	(-) 8,073	0	(-) 8,073	71,954	(+) 29,981	(+) 213,946	(+) 243,927	(+) 235,854
28	36,203	(-) 8,073	(+) 155	(-) 7,918	71,954	(+) 29,981	(+) 216,656	(+) 246,637	(+) 238,719
29	36,203	(-) 8,073	0	(-) 8,073	71,954	(+) 29,981	(+) 219,389	(+) 249,370	(+) 241,297
30	36,203	(-) 8,073	(+) 155	(-) 7,918	71,954	(+) 29,981	(+) 217,276	(+) 247,257	(+) 239,339
Total	**1,086,090**	**(-) 242,190**	**(+) 20,992**	**(-) 221,198**	**1,709,255**	**(+) 712,189**	**(+) 4,055,274**	**(+) 4,767,463**	**(+) 4,546,265**
Prorated Annual	**36,203**	**(-) 8,073**	**(+) 700**	**(-) 7,373**	**56,975**	**(+) 23,740**	**(+) 135,176**	**(+) 158,915**	**(+) 151,542**

5.3 Biological Goals and Objectives

Biological goals and objectives are required elements in HCPs (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016). Biological goals and objectives describe the vision and commitments of the conservation program and articulate the conservation objectives of the State Lands Forestry HCP. Goals are broad, guiding principles based on the conservation needs of the resource. Biological objectives are conservation targets designed to achieve the biological goals. To the extent possible, objectives are written to be SMART (Specific, Measurable, Achievable, Result-Oriented, Time-Fixed).

The goals and objectives will be achieved through the collective efforts of the three implementing agencies (PGC, Bureau of Forestry, and Bureau of State Parks). In general, each agency will be responsible for implementing obligations on its own lands. However, some covered activities are not conducted by each agency (e.g., timber harvest is not conducted by the Bureau of State Parks). In such instances, the objectives and conservation measures associated with that covered activity will not apply to that agency.

The following biological goals and objectives of the conservation program will be completed by year 30 of the permit term unless otherwise noted.

Goal 1: Promote survivorship of covered bats from covered activities throughout the permit area

- **Objective 1.1** Manage and maintain conditions at a minimum of 25 active and suitable hibernacula on State Lands by year 20 and throughout the permit term.
- **Objective 1.2** Manage and maintain summer roosting habitat for each of the covered bats by minimizing effects on summer habitat and known roost trees throughout the permit term.
- **Objective 1.3** Manage and maintain 665,000[1] acres of core swarming and staging habitat for covered bats across 4 million acres[2] of State Lands and minimize effects on covered species by avoiding area(s) surrounding known hibernacula beginning in year 1 and throughout the permit term.

Goal 2: Protect and promote roosting and foraging habitat and conditions for covered bats on State Lands

- **Objective 2.1** Maintain at least 3.5 million acres of interconnected forest annually on State Lands beginning in year 1 and continuing throughout the permit term.
- **Objective 2.2** Enhance at least 7,200 acres of roosting and foraging habitat annually through forest management practices on State Lands beginning in year 1 and continuing throughout the permit term.

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[1] As discussed in Chapter 3, *Environmental Setting,* Section 3.5.4.4, there are approximately 665,179 acres of fall/spring habitat for northern long-eared bats across State Lands. As northern long-eared bats are present in all hibernacula that contains Indiana bats, this habitat overlaps with fall/spring habitat for Indiana bats.

[2] PGC and DCNR manage approximately 4 million acres as State Lands.

- **Objective 2.3** Maintain or increase healthy insect populations (the insect prey base) by protecting 9,700 miles of streams and associated riparian habitat on State Lands throughout the permit term.

Goal 3: Promote high-quality winter habitat for covered bats

- **Objective 3.1** Increase or improve winter roosting opportunities at sites throughout State Lands beginning in year 1 and continuing throughout the permit term.

Goal 4: Promote bat survivorship from white-nose syndrome (WNS)

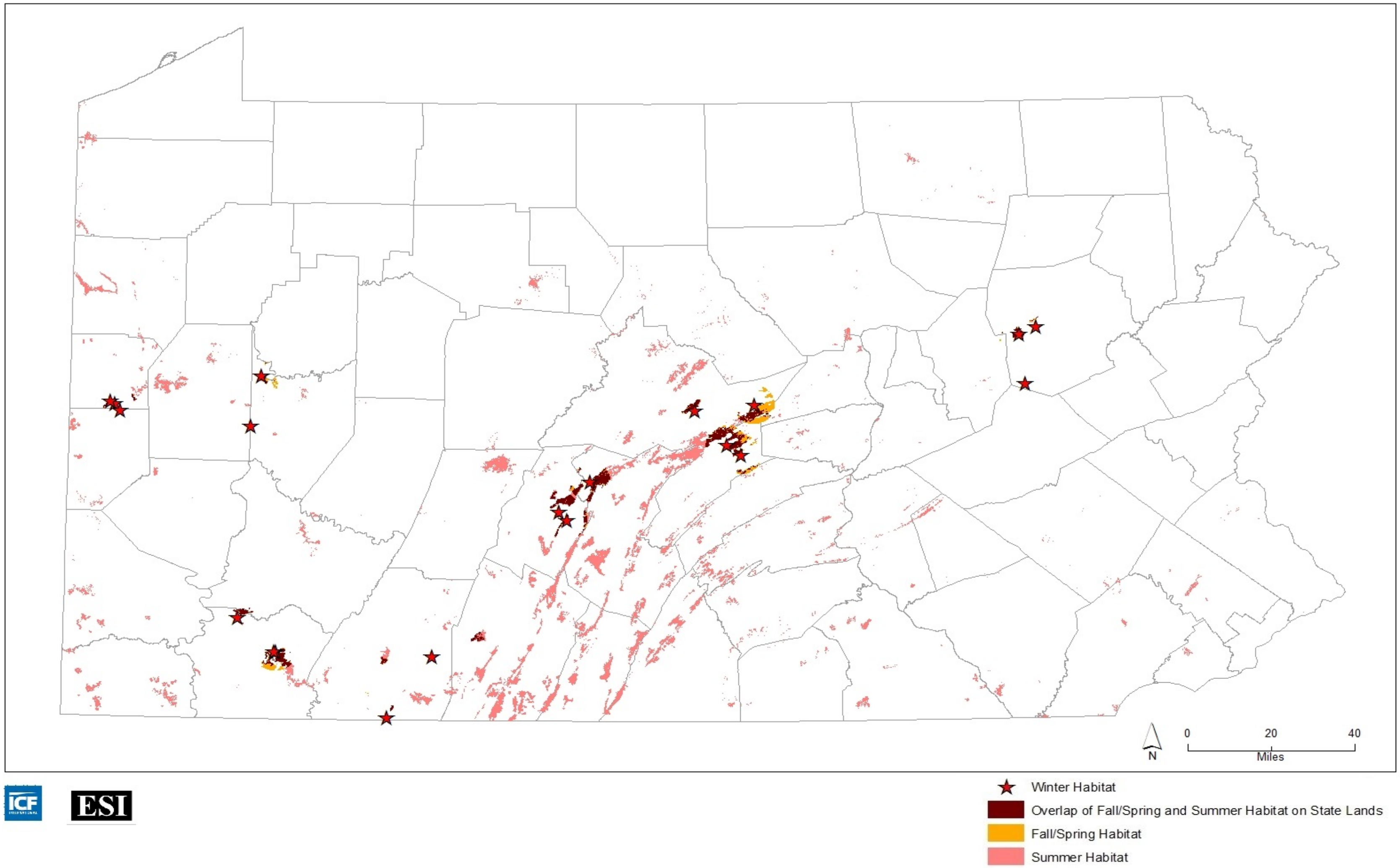
- **Objective 4.1.** Reduce potential human transmission of WNS at a minimum of 25 active and suitable hibernacula on State Lands and at all HCP-related monitoring sites throughout the permit term.

Goal 5: Increase understanding of covered bat ecology and conservation across the plan area

- **Objective 5.1.** Increase understanding of HCP conservation measures by communicating importance to relevant staff workers in PGC and DCNR.
- **Objective 5.2.** Increase understanding of covered bat species by offering at least four public speaking engagements on bat protection per year to landowners, stakeholders, or interested members of the public throughout the permit term.

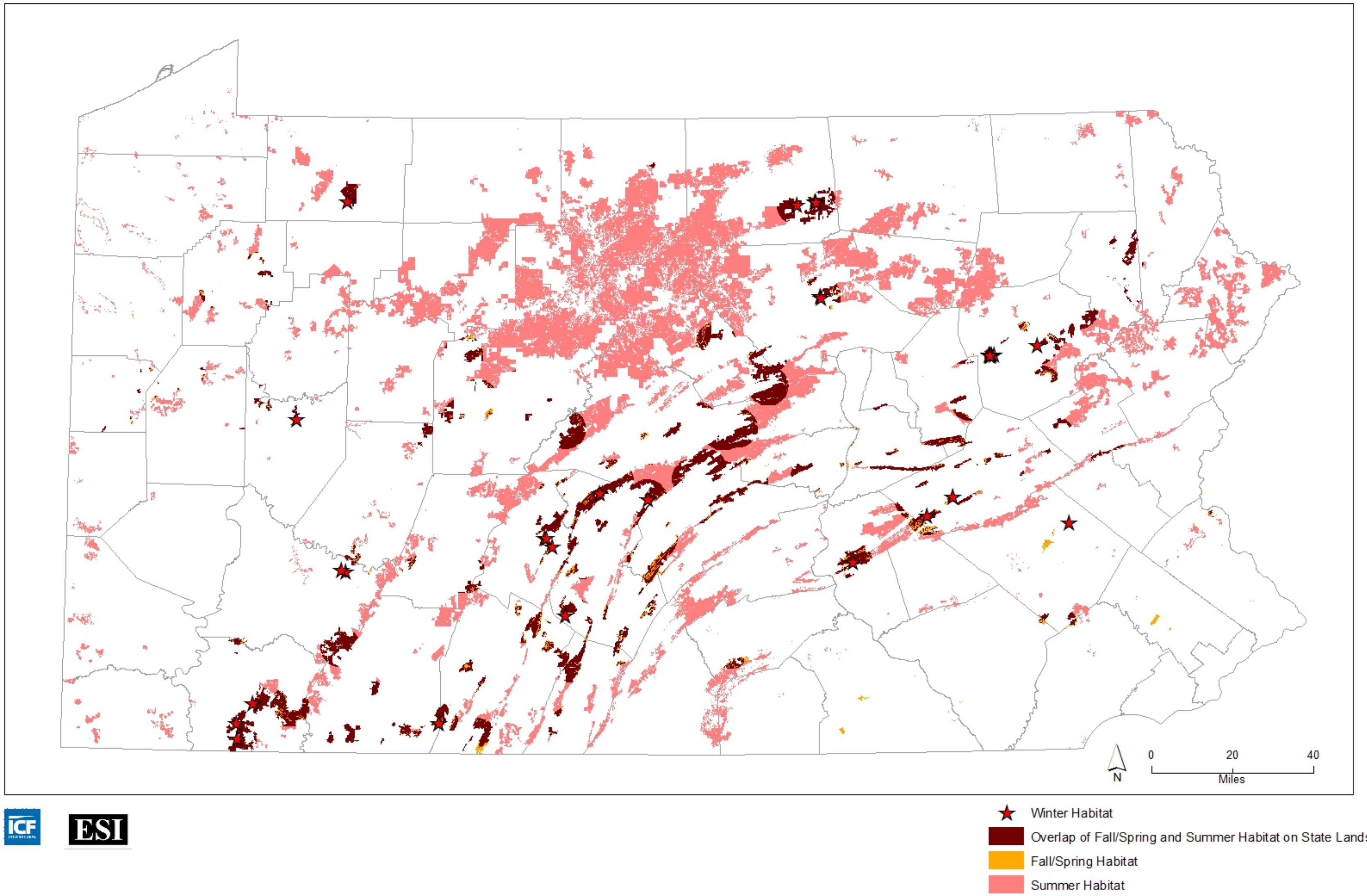
Conservation measures will be implemented to achieve the biological goals and objectives. The HCP process allows for modification of the conservation measures, while goals and objectives generally remain static. Those conservation measures that help avoid and minimize effects are described in Section 5.4, *Avoidance and Minimization Measures.* Those conservation measures that proactively support conservation of the species are described in Section 5.5, *Mitigation Measures*.

Figure 5-1 depicts habitat areas for Indiana bats on State Lands for each habitat type; Figure 5-2 depicts habitat areas for northern long-eared bats for each habitat type. The acreage of habitat in each type for each species is provided in Chapter 3, *Environmental Setting*. Table 5-2 identifies the biological goals and objectives and summarizes the conservation measures that support those goals. The relationship between covered activities, their stressors, and conservation measures is presented in Table 5-3.



Source: Habitat Distribution Model referenced in Chapter 3, *Environmental Setting.*

Figure 5-1. Seasonal Habitat Types for Indiana Bats on State Lands



Source: Habitat Distribution Model referenced in Chapter 3, *Environmental Setting.*

Figure 5-2. Seasonal Habitat Types for Northern Long-Eared Bats on State Lands

Table 5-2. Biological Goals, Objectives, and Conservation Measures

Biological Goals and Objectives	Conservation Measure	Location: State Game Lands	Location: State Parks	Location: State Forests	Target Species: I-Bat	Target Species: NLEB
Goal 1: Promote survivorship of covered bats from covered activities throughout the permit area						
Objective 1.1 Manage and maintain conditions at a minimum of 25 active and suitable hibernacula on State Lands by year 20 and throughout the permit term.	**CM-1 Install Gates at Known Hibernacula.** Restrict nonessential human entry to hibernacula on State Lands known to contain hibernating Indiana bats and northern long-eared bats following the standards provided in the *Agency Guide to Cave and Mine Gates* (American Cave Conservation Association et al. 2009).	✓	✓	✓	✓	✓
	CM-2 Remove Obstructions around Known Hibernacula. Prevent a buildup of debris at known hibernacula entrances on State Lands. Prior to fall swarming, remove vegetation and other obstructions to air or water flow around known hibernacula.	✓	✓	✓	✓	✓
	CM-3 Close Hibernacula Seasonally to Public Visitation.[a] Close all known inhabited Indiana bat hibernacula and Category 1 northern long-eared bat hibernacula from October 1 to April 30.	✓	✓	✓	✓	✓
	CM-7 Avoid Timber Harvest Effects on Winter Habitat. Restrict timber harvest and firewood collection year-round in winter habitat for both species.	✓		✓	✓	✓
	CM-12 Manage Prescribed Burns to Minimize Effects on Bats. For all burns on State Lands, prepare a smoke management plan to ensure burns occur in conditions that reduce smoke from entering known hibernacula.	✓	✓	✓	✓	✓

Biological Goals and Objectives	Conservation Measure	Location: State Game Lands	Location: State Parks	Location: State Forests	Target Species: I-Bat	Target Species: NLEB
Objective 1.2 Manage and maintain summer roosting habitat for each of the covered bats by minimizing effects on summer habitat and know roost trees throughout the permit term.	**CM-4 Minimize Effects on Trees that Provide Summer Roosting Habitat.** Limit harvest of preferred Indiana bat roost trees and retain snags and hollow trees of suitable diameter to provide roosting habitat for Indiana bats. Designate northern long-eared bat roosting activity areas for protection, and limit harvest of snags, trees with hollow cavities exfoliating bark, cracks, or crevices, in these roost areas.	✓		✓	✓	✓
	CM-5 Avoid Timber Harvest Effects on Non-Volant Pups in Maternity Colonies. Restrict harvest of snags and large trees with hollow cavities in modeled summer habitat for Indiana bats from June 1 to July 31, the time when pups are non-volant (unable to fly) and are most vulnerable. Restrict timber harvest in designated northern long-eared bat roosting activity areas during the pup season (June 1 to July 31).	✓		✓	✓	✓
	CM-6 Cease Harvest Activities when Bats Are Detected. Cease tree felling and removal activities if bats are observed within or fleeing from a felled tree or if dead bat(s) are found. This applies to timber harvest, operations (fencing and firewood), roads, trails, and firebreaks, but excludes prescribed burns.	✓	✓	✓	✓	✓
	CM-9 Limit Firewood Collection Seasonally (Summer).[b] Close areas to collection of standing dead trees for firewood on roads or road segments that are predominantly within summer habitat for Indiana bats (30% or more of their length) from May 15 to September 1.			✓	✓	
	CM-11 Restrict Prescribed Fire Seasonally (Summer). Restrict prescribed burning from May 15 to August 15 in forested Indiana bat summer habitat. Restrict prescribed burns in designated northern long-eared bat roosting activity areas during the pup season (June 1 to July 31).	✓	✓	✓	✓	✓
	CM-17 Maintain Speed Limits on Forest Roads. Maintain speed limits on roads under PGC and DCNR jurisdiction to 25 miles per hour or less throughout State Lands at all times.	✓	✓	✓	✓	✓

Biological Goals and Objectives	Conservation Measure	Location: State Game Lands	Location: State Parks	Location: State Forests	Target Species: I-Bat	Target Species: NLEB
Objective 1.3 Manage and maintain 665,000 acres of core swarming and staging habitat for covered bats across 4 million acres of State Lands and minimize effects on covered species by avoiding area(s) surrounding known hibernacula beginning in year 1 and throughout the permit term.	**CM-8 Limit Firewood Collection Seasonally (Fall/Spring).**[b] Close areas to collection of standing dead trees for firewood in Indiana bat fall/spring habitat from April 1 to May 15 and September 1 to November 15.			✓	✓	
	CM-11 Restrict Prescribed Fire Seasonally (Summer). Restrict prescribed burning from May 15 to August 15 in forested Indiana bat summer habitat. Restrict prescribed burns in designated northern long-eared bat roosting activity areas during the pup season (June 1 to July 31).	✓	✓	✓	✓	✓
Goal 2: Protect and promote roosting and foraging habitat and conditions for covered bats on State Lands						
Objective 2.1 Maintain at least 3.5 million acres of interconnected forest annually on State Lands beginning in year 1 and continuing throughout the permit term.	**CM-20 Maintain a Forested Landscape in a Variety of Seral Stages.** Protect and manage forests at the landscape scale to provide bats with a diversity of habitat types.	✓	✓	✓	✓	✓
Objective 2.2 Enhance at least 7,200 acres of roosting and foraging habitat annually through forest management practices on State Lands beginning in year 1 and continuing throughout the permit term.	**CM-21 Enhance Foraging and Roosting Habitat.** Selectively remove tree species with limited potential to grow into high-value roost trees to encourage succession toward a mature forest community.	✓	✓	✓	✓	✓
	CM-22 Install Artificial Roost Structures. Install, maintain, and monitor seven bat boxes per year in areas of overlapping Indiana bat and northern long-eared bat summer habitat during the first 10 years of the permit term.	✓	✓	✓	✓	✓

Biological Goals and Objectives	Conservation Measure	Location: State Game Lands	Location: State Parks	Location: State Forests	Target Species: I-Bat	Target Species: NLEB
Objective 2.3 Maintain or increase healthy insect populations (the insect prey base) by protecting 9,700 miles of streams and associated riparian habitat on State Lands throughout the permit term.	**CM-13 Restrict Vehicles and Equipment in Perennial Stream and Riparian Areas.**[3] Restrict vehicles or equipment used for construction and timber harvest activities near perennial streams or wetlands on property owned and managed by PGC and DCNR.	✓	✓	✓	✓	✓
	CM-14 Retain Vegetation in Perennial Stream and Riparian Areas.[c] Retain appropriate natural vegetation within 50 feet of streams and around wetlands throughout State Lands.	✓	✓	✓	✓	✓
	CM-15 Implement Erosion and Sediment Control Plans. Develop and implement erosion and sediment control plans for logging and other earth-disturbing activities to protect water quality and the bat prey base in streams and wetlands throughout State Lands.	✓	✓	✓	✓	✓
	CM-16 Implement Spill Pollution Prevention Measures. Implement spill pollution prevention measures, as needed, to protect water quality and the bat prey base in streams and wetlands throughout State Lands.	✓	✓	✓	✓	✓
Goal 3: Promote high-quality winter habitat for covered bats						
Objective 3.1 Increase or improve winter roosting opportunities at sites throughout State Lands beginning in year 1 and continuing throughout the permit term.	**CM-10 Restrict Prescribed Fire Seasonally (Winter).** Restrict prescribed burning year-round in winter habitat of both species.	✓	✓	✓	✓	✓
	CM-23 Identify, Assess, Protect, and Enhance Potential Hibernacula. Identify and assess at least 10 potential hibernacula (caves, mines, or underground habitat) for use by Indiana bats and/or northern long-eared bats. Make appropriate modifications (e.g., gating, physical modifications to improve airflow or temperature).	✓	✓	✓	✓	✓
	CM-24 Provide Artificial Roosts for Infected Bats. Create one to two artificial roosts near known WNS-infected hibernacula to allow infected bats a place to recuperate once they emerge from hibernation. This will also provide a place for bats to roost during other seasons.	✓	✓	✓	✓	✓

Biological Goals and Objectives	Conservation Measure	Location: State Game Lands	Location: State Parks	Location: State Forests	Target Species: I-Bat	Target Species: NLEB
Goal 4: Promote bat survivorship from white-nose syndrome (WNS)						
Objective 4.1 Reduce potential human transmission of WNS at a minimum of 25 active and suitable hibernacula on State Lands and at all HCP-related monitoring sites throughout the permit term.	**CM-1 Install Gates at Known Hibernacula.** Restrict nonessential human entry to hibernacula on State Lands known to contain hibernating Indiana bats and northern long-eared bats following the standards provided in the *Agency Guide to Cave and Mine Gates* (American Cave Conservation Association et al. 2009).	✓	✓	✓	✓	✓
	CM-3 Close Hibernacula Seasonally to Public Visitation. Close all known inhabited Indiana bat hibernacula and Category 1 northern long-eared bat hibernacula from October 1 to April 30.[a]	✓	✓	✓	✓	✓
	CM-24 Provide Artificial Roosts for Infected Bats. Create one to two artificial roosts near known WNS-infected hibernacula to allow infected bats a place to recuperate once they emerge from hibernation. This will also provide a place for bats to roost during other seasons.	✓	✓	✓	✓	✓
Goal 5: Increase understanding of covered bat ecology and conservation across the plan area						
Objective 5.1 Increase understanding of HCP conservation measures by communicating importance to relevant staff workers in PGC and DCNR.	**CM-18 Implement Staff Training Program.** Develop and document training program for personnel concerning HCP implementation, avoidance and minimization measures, important habitats, WNS, and management implications.	✓	✓	✓	✓	✓
Objective 5.2 Increase understanding of covered bat species by offering at least four public speaking engagements on bat protection per year to landowners, stakeholders, or interested members of the public throughout the permit term.	**CM-19 Support Public Engagement.** Educate members of the public (e.g., State Land users/visitors, private landowners, loggers) on the Indiana bat and northern long-eared bat to promote conservation efforts across the State by developing an outreach program within 6 months of permit issuance.	✓	✓	✓	✓	✓

[a] Excludes designated recreation use caves (Section 5.4.1, *Caves and Mines*).Timber harvest restrictions do not apply to State Parks because timber harvest does not occur on State Park lands.

[b] Firewood collection restrictions apply only to State Forests. PGC does not issue firewood collection permits for State Game Lands, and firewood collection is limited to downed trees in State Parks.

[c] This conservation measure only applies to perennial streams (and their associated riparian areas) identified as “blue-line” streams on U.S. Geological Survey 1:24k quadrangle topographic maps.

I-Bat = Indiana bat; NLEB = northern long-eared bat; PGC = Pennsylvania Game Commission; DCNR = Pennsylvania Department of Conservation and Natural Resources; WNS = white-nose syndrome; HCP = habitat conservation plan

Table 5-3. Covered Activities, Stressors, and Conservation Measures

		Species		
Stressor	**Contributing Covered Activity**	**I-Bat**	**NLEB**	**Addressed via Conservation Measure**
Potential disturbance of hibernacula	Timber harvest Prescribed fire HCP implementation	✓	✓	CM-1 Install Gates at Known Hibernacula CM-3 Close Hibernacula Seasonally to Public Visitation CM-7 Avoid Timber Harvest Effects on Winter Habitat CM-10 Restrict Prescribed Fire Seasonally (Winter) CM-12 Manage Prescribed Burns to Minimize Effects on Bats CM-23 Identify, Assess, Protect, and Enhance Potential Hibernacula
Quality of and access to hibernacula	Not applicable	✓	✓	CM-2 Remove Obstructions around Known Hibernacula CM-3 Close Hibernacula Seasonally to Public Visitation CM-7 Avoid Timber Harvest Effects on Winter Habitat
Removal of potential roost trees	Timber harvest Operations Prescribed fire	✓	✓	CM-4 Minimize Effects on Trees that Provide Summer Roosting Habitat CM-5 Avoid Timber Harvest Effects on Non-Volant Pups in Maternity Colonies CM-8 Limit Firewood Collection Seasonally (Fall/Spring) CM-9 Limit Firewood Collection Seasonally (Summer) CM-11 Restrict Prescribed Fire Seasonally (Summer)
Direct effects on roosting bats, including maternity colonies	Timber harvest Operations Prescribed fire	✓	✓	CM-4 Minimize Effects on Trees that Provide Summer Roosting Habitat CM-5 Avoid Timber Harvest Effects on Non-Volant Pups in Maternity Colonies CM-6 Cease Harvest Activities when Bats Are Detected CM-8 Limit Firewood Collection Seasonally (Fall/Spring) CM-9 Limit Firewood Collection Seasonally (Summer) CM-11 Restrict Prescribed Fire Seasonally (Summer)
Habitat degradation and loss	Timber harvest (PGC/DCNR land use preserves lands from development and enhances habitat for both covered species)	✓	✓	CM-18 Implement Staff Training Program CM-19 Support Public Engagement CM-20 Maintain a Forested Landscape in a Variety of Seral Stages CM-21 Enhance Foraging and Roosting Habitat CM-22 Install Artificial Roost Structures
Removal of foraging habitat	Operations Roads and trails	✓	✓	CM-13 Restrict Vehicles and Equipment in Perennial Stream and Riparian Areas CM-14 Retain Vegetation in Perennial Stream and Riparian Areas CM-15 Implement Erosion and Sediment Control Plans CM-21 Enhance Foraging and Roosting Habitat

Stressor	Contributing Covered Activity	Species I-Bat	Species NLEB	Addressed via Conservation Measure
Direct toxicity and loss of prey base (Note that small roads and trails provide travel corridors and edge benefits to bats when in the right location)	Roads and trails	✓	✓	CM-18 Implement Spill Pollution Prevention Measures
Vehicle strike	Roads and trails	✓	✓	CM-17 Maintain Speed Limits on Forest Roads
Insufficient or low-quality roosts in otherwise high-quality summer habitat	Not applicable	✓		CM-21 Enhance Foraging and Roosting Habitat CM-22 Install Artificial Roost Structures CM-23 Identify, Assess, Protect, and Enhance Potential Hibernacula
WNS	HCP implementation (monitoring)	✓	✓	CM-24 Provide Artificial Roosts for Infected Bats
Incidental effects from humans	Firewood collection (recreational use and private timber harvest – although not covered by the HCP)	✓	✓	CM-8 Limit Firewood Collection Seasonally (Fall/Spring) CM-9 Limit Firewood Collection Seasonally (Summer) CM-18 Implement Staff Training Program CM-19 Support Public Engagement

I-Bat = Indiana bats; NLEB = northern long-eared bats; HCP = habitat conservation plan; PGC = Pennsylvania Game Commission; DCNR = Pennsylvania Department of Conservation and Natural Resources

5.4 Avoidance and Minimization Measures

Implementation of conservation measures that support avoidance and minimization of effects will reduce the negative effects of covered activities on covered bat species and bat habitat. These measures support **Goal 1: Promote survivorship of covered bats from covered activities throughout the permit area.** Important components of avoidance and minimization measures are seasonal restrictions on various activities (Table 5-4). The conservation measures that act as avoidance and minimization measures are described following Table 5-4. Because some elements of the conservation program differ between Indiana bats and northern long-eared bats, the conservation measure for each species is discussed separately in this section and in Section 5.5, *Mitigation Measures*. The justification for using different conservation strategies for the two bat species is presented in Appendix P, *Justification for Indiana Bat and Northern Long-Eared Bat Conservation Programs in the State Lands Forestry Habitat Conservation Plan*.

Table 5-4. Conservation Measures by Season for Indiana Bats and Northern Long-Eared Bats

Conservation Measure	Bat Type	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
CM-1 Install Gates at Known Hibernacula	Indiana Bat												
	NLEB												
CM-2 Remove Obstructions around Known Hibernacula	Indiana Bat												
	NLEB												
CM-3 Close Hibernacula Seasonally to Public Visitation[a]	Indiana Bat												
	NLB												
CM-4 Minimize Effects on Trees that Provide Summer Roosting Habitat	Indiana Bat												
	NLEB												
CM-5 Avoid Timber Harvest Effects on Non-Volant Pups in Maternity Colonies	Indiana Bat												
	NLEB												
CM-6 Cease Harvest Activities when Bats Are Detected	Indiana Bat												
	NLEB												
CM-7 Avoid Timber Harvest Effects on Winter Habitat	Indiana Bat												
	NLEB												
CM-8 Limit Firewood Collection Seasonally (Fall/Spring)	Indiana Bat												
	NLEB												
CM-9 Limit Firewood Collection Seasonally (Summer)	Indiana Bat												
	NLEB												

Conservation Measure	Bat Type	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
CM-10 Restrict Prescribed Fire Seasonally (Winter)	Indiana Bat												
	NLEB												
CM-11 Restrict Prescribed Fire Seasonally (Summer)	Indiana Bat												
	NLEB												
CM-12 Manage Prescribed Burns to Minimize Effects on Bats	Indiana Bat												
	NLEB												
CM-13 Restrict Vehicles and Equipment in Perennial Stream and Riparian Areas	Indiana Bat												
	NLEB												
CM-14 Retain Vegetation in Perennial Stream and Riparian Areas	Indiana Bat												
	NLEB												
CM-15 Implement Erosion and Sediment Control Plans	Indiana Bat												
	NLEB												
CM-16 Implement Spill Pollution Prevention Measures	Indiana Bat												
	NLEB												
CM-17 Maintain Speed Limits on Forest Roads	Indiana Bat												
	NLEB												
CM-18 Implement Staff Training Program	Indiana Bat												
	NLEB												

Conservation Measure	Bat Type	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
CM-19 Support Public Engagement	Indiana Bat												
	NLEB												
CM-20 Maintain a Forested Landscape in a Variety of Seral Stages	Indiana Bat												
	NLEB												
CM-21 Enhance Foraging and Roosting Habitat	Indiana Bat												
	NLEB												
CM-22 Install Artificial Roost Structures	Indiana Bat												
	NLEB												
CM-23 Identify, Assess, Protect, and Enhance Potential Hibernacula[b]	Indiana Bat												
	NLEB												
CM-24 Provide Artificial Roosts for Infected Bats	Indiana Bat												
	NLEB												

[a] This represents the closure of ungated hibernacula from October 1 to April 30. Gated hibernacula are closed year-round.

[b] While some limited winter survey work may be needed to identify potential hibernacula, all enhancement work would be completed when bats have left the hibernacula.

NLEB = northern long-eared bat

5.4.1 Caves and Mines

Both Indiana bats and northern long-eared bats hibernate in caves and mines during winter. The Indiana bat's tendency to collect in relatively large numbers in relatively few sites has long been identified as one of the primary areas of conservation concern for the species (Barbour and Davis 1969) and is one of the primary reasons the species was initially listed (U.S. Fish and Wildlife Service 2007). Similarly, the northern long-eared bat has experienced a sharp decline in the northeastern part of its range since 2006, as bats hibernating in caves and mines bats have contracted WNS (78 *Federal Register* 61064 [October 2, 2013]).

As noted in Chapter 4, *Effects of Covered Activities*, activities in hibernacula could cause disturbance and mortality of all bats present, or could cause hibernacula to become unsuitable. At present, PGC and DCNR implement a number of measures to protect these crucial resources and will include them as conservation measures in the State Lands Forestry HCP.

CM-1 Install Gates at Known Hibernacula

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: Winter habitat for both species

Rationale: Human entry into hibernacula can result in the disturbance and arousal of hibernating bats; arousal from hibernation is metabolically expensive for bats and can reduce bats' abilities to retain the energy stores they need to survive the winter (U.S. Fish and Wildlife Service 2007). In addition, human activities in bat hibernacula can lead to the spread of WNS between bat colonies. PGC and DCNR have already made efforts to close known Indiana bat hibernacula to human entry; of the seven known Indiana bat hibernacula on State Lands, all but two have had gates installed to date (Turner 2016). The largest Indiana bat hibernaculum on State Lands, Hartman Mine, is closed to unauthorized entry.

Indiana bat commitment: All seven known Indiana bat hibernacula on State Lands will be protected by restricting nonessential human entry year-round through the use and maintenance of bat-friendly gates. Human entry by agency personnel for activities aimed at the recovery of the species or management of the resource (e.g., hibernacula surveys, permitted WNS monitoring activities) will be allowed.

Gates will be installed at two of the seven known Indiana bat hibernacula on State Lands as soon as possible or within the first 5 years of the permit term. Existing gates will be inspected regularly and repaired or replaced within a year of identifying a repair or replacement need. New gates will be installed within 5 years of discovery of a new Indiana bat hibernaculum, where appropriate. For example, installing gates would be inappropriate when gate installation would place workers in danger or when installing gates would not be beneficial to bats by trapping debris at the hibernaculum entrance. Gates will be installed, repaired, or replaced from May 15 to August 31, in accordance with USFWS (Appendix B in U.S. Fish and Wildlife Service 2018) when actions are least likely to disturb Indiana bats. The standards provided in the *Agency Guide to Cave and Mine Gates* (American Cave Conservation Association et al. 2009) will be followed in constructing bat-friendly gates. In general, gates will be constructed to allow adequate space for bats and other small mammals to pass through the bars but not enough space for human entry. Bars will also be constructed to maximize airflow through the gate. Gates will be locked to ensure that human entry is restricted to appropriate PGC, DCNR, and other cooperating personnel, and *No Trespassing* signs will be posted at all known entrances to the hibernacula.

Northern long-eared bat commitment: There is no conclusive list of known hibernacula available for northern long-eared bats. PGC and DCNR have assembled a list of 322 potentially occupied hibernacula for northern long-eared bats in Pennsylvania, 32 of which are on State Lands (these include the seven hibernacula on State Lands known to be used by Indiana bats). However, there is great uncertainty regarding the status of these caves and mines. In addition, these 32 sites are not considered a conclusive list of northern long-eared bat hibernacula for the following reasons.

- Hibernacula locations are treated as highly confidential information among bat biologists and the caving community. As such, one underground feature may have several different names. For example, the Hartman Mine is also known as the Canoe Creek Mine and there are several hybrid names. This uncertainty is relatively easy to resolve when the site is well known (such as the Hartman Mine) but it can be difficult to parse out in the case of smaller caves or mines with multiple entrances. As such, it is impossible to eliminate all duplicates based on the name associated with the site.
- Geographic data obtained by different survey teams or at different times has different levels of error associated with it. As a result, a single feature may appear with multiple sets of coordinates. Further, while reviewing the data, PGC and DCNR found three separate occasions when errors occurred between when the coordinates for a site were obtained and when they were entered into the database. Finally, underground features can be difficult to map using hand-held global positioning system (GPS) devices. Cave and mine entrances are often located under rocky overhangs or in areas where subsidence is a threat. Thus, data points are often obtained from a short distance away from an underground feature.
- Most of the sites recorded in the entrance-trapping data were surveyed by contractors addressing other regulatory issues. It is likely that many of these sites have already been closed or otherwise affected by construction activities. Some also have been closed or modified because they represent public safety hazards. In some cases, enough bats were captured to identify the site as a potential resource for bats and the site has already received a protective gate. While permits may have been issued to gate or close a mine, the installation may have been canceled and thus no action was taken.

Given the significant uncertainties in the status of northern long-eared bat hibernacula on State Lands, PGC and DCNR will identify and prioritize conservation of northern long-eared bat hibernacula on State Lands as follows:

Step 1: Develop a survey plan. Within 1 year of permit issuance, PGC and DCNR biologists will develop a survey plan to categorize all potential hibernacula on State Lands. As a first step, PGC and DCNR will use desktop analysis to categorize potential hibernacula as follows.

- **Category 1:** The site is either currently being used by or has a well-documented recent history of use (within the last 10 years) by northern long-eared bats. In addition, the site is determined to be a high priority for conservation based on one or more of the following criteria.
    - Site overlaps with sites for other bat species, particularly Indiana bats.
    - Estimated size of the current hibernating population of northern long-eared bats is considered sustainable.

- Northern long-eared bats have been captured at the site following the arrival of WNS.
- Site is geographically isolated.
- Site is currently gated and has a well-documented recent history of use by northern long-eared bats.

- **Category 2:** The site has been sealed for public safety or is otherwise unusable as a hibernaculum. The site will be removed from the list of northern long-eared bat hibernacula; the conservation measures outlined in the State Lands Forestry HCP will not apply to this site.
- **Category 3:** The status of the site for bat use remains unknown and will need to be determined through on-the-ground survey efforts.

The survey plan will outline the procedures the agencies will take to survey all Category 3 sites by year 10 of the permit term.

Step 2: Conduct seasonal hibernacula surveys. Following the procedures outlined in the survey plan developed under Step 1, PGC and DCNR will survey all known Category 3 sites within the first 10 years of permit issuance. Following the conclusion of survey efforts at each site, that site will be categorized as Category 1 or 2 (as described previously) or Category 4:

- **Category 4:** The site is not in active use as a hibernaculum for northern long-eared bats but has the potential to become used.

The conservation measures outlined in the State Lands Forestry HCP will not apply to Category 4 sites; however, these sites will be monitored every 5 years for bat use (beginning with 5 years following completion of initial categorization as a Category 4 hibernaculum). If the results of monitoring show that the site is in use by northern long-eared bats, it will be categorized as a Category 1 site, and the conservation measures outlined in this HCP will apply.

Using the data gathered through this effort, PGC and DCNR will gate one ungated Category 1 northern long-eared bat hibernaculum each year throughout the permit term (or 32 over the permit term). Assuming all 32 potential hibernacula are ultimately determined to be Category 1, the gating schedule would be as depicted in Table 5-5. To ensure that these resources are evenly distributed across State Lands, within the first 10 years of plan implementation, PGC and DCNR will ensure that at least one hibernaculum is protected within each of the six PGC regions.

Both PGC and DCNR will work with conservation partners such as other state and federal agencies and nongovernmental organizations that may identify high-priority sites for conservation. If this occurs over the permit term, PGC and DCNR will consult with USFWS to determine whether gating efforts should be reallocated to one of these sites.

As with Indiana bats, nonessential human entry will be restricted year-round through the use and maintenance of bat-friendly gates.[3] Human entry by agency personnel for activities aimed at the recovery of the species or management of the resource (e.g., hibernacula surveys, permitted WNS monitoring activities) will be allowed. Gates will be installed or, if needed, replaced from May 15 to August 31 when actions are least likely to disturb bats. The standards provided in the *Agency Guide to Cave and Mine Gates* (American Cave Conservation Association et al. 2009) will be followed in constructing bat-friendly gates.

[3] Designated recreation-use caves will not be closed to public use year-round (CM-3).

Table 5-5. Hibernacula Gating Schedule over the Permit Term

Year(s)	Number of Hibernacula Gated Per Year	Total No. of NLEB hibernacula gated on State Lands
0	0	5 [a]
1	1	6
2	1	7
3	1	8
4	1	9
5	1	10
6	1	11
7	1	12
8	1	13
9	1	14
10	1	15
11–20	10	25
21–27	7	32
28–30	0	32[b]

[a] Five northern long-eared bat hibernacula are known to be used by Indiana bats and are already gated.
[b] Assumes no additional Category 1 hibernacula are identified over the permit term.
NLEB = northern long-eared bat

CM-2 Remove Obstructions around Known Hibernacula

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Removals conducted from April 1 through September 14
Where: Winter habitat for both species

Rationale: The presence of vegetation and other obstructions can obscure the entrances of hibernacula or cause excessive clutter near hibernacula openings. The presence of bat gates can exacerbate the issue when debris becomes entangled in the gate. These obstructions can alter airflow into the hibernaculum, affecting winter temperature regimes and humidity and therefore the suitability of the hibernaculum for over-wintering bats. In addition, altered entrances can divert water and/or debris into the hibernaculum, leading to flooding or making some areas of the hibernaculum inaccessible. Further, bats of many species have been found impaled on thorny vegetation (e.g., burdock, multiflora rose, locusts, and hawthorns) (Sparks and Choate 2000). As a result, efforts are currently in place near Hartman Mine to remove burdock.

Indiana bat commitment: Agency staff, volunteers, or consultants certified as qualified bat surveyors (QBS) will direct the removal of vegetation and other obstructions around known gated hibernacula and will prevent a buildup of debris at hibernacula entrances. Gated Indiana bat hibernacula will be inspected annually and maintained, as necessary. Ungated sites will be checked for obstructions at least every other year. If new Indiana bat hibernacula are identified on State Lands, they will be included on the list for annual inspections and maintenance. Where appropriate and at the direction of a QBS, areas around known or potential Indiana bat hibernacula will be backfilled to create better airflow in the hibernacula. Thorny vegetation near hibernacula will be removed, as necessary. These annual inspections will take place from April 1 to September 14 so that any obstructions can be removed when bats are not hibernating at the site. If obstructions hazardous to hibernating bat colonies are identified when bats are hibernating, PGC and DCNR will coordinate with USFWS to ensure that the appropriate precautions are taken to protect hibernacula. Any removal of obstructions will take place in late summer or early fall to minimize potential effects on Indiana bats.

Northern long-eared bat commitment: As noted, PGC and DCNR will inspect gated Indiana bat hibernacula entrances annually; each of these sites is also known to contain northern long-eared bats. Any northern long-eared bat hibernaculum designated as Category 1 and gated under CM-1 *Install Gates at Known Hibernacula* will be inspected annually. Ungated sites that remain suitable will be checked for obstructions at least every other year. If obstructions are present, they will be removed, as described under the Indiana bat commitment.

CM-3 Close Hibernacula Seasonally to Public Visitation

Rationale: Human entry into hibernacula can result in the disturbance and arousal of hibernating bats. Some caves and mines may not currently act as hibernacula but may become active in the future. This action encourages establishment of new hibernacula and prevents disturbance of bats that may be using a cave or mine as a hibernaculum without the knowledge of PGC and DCNR. This seasonal closure is based on the period when these bat species are most likely to be present in hibernacula. Both species begin entering hibernacula in mid-September, with most in hibernation by early November (Appendix B, *Species Accounts*); spring emergence from hibernacula begins in mid-April, with few bats left hibernating by mid-May (U.S. Fish and Wildlife Service 2007). Entry by qualified individuals for the purposes of monitoring and research will be permitted.

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Gated hibernacula closed year-round. Ungated hibernacula of unknown status closed October 1 to April 30 through signage.
Where: Winter habitat for both species

Indiana bat commitment: Currently five of the seven known hibernacula on State Lands inhabited by Indiana bats are gated and closed to public use year-round.

Northern long-eared bat commitment: As described under CM-1 *Install Gates at Known Hibernacula,* PGC and DCNR will work to identify and gate Category 1 northern long-eared bat hibernacula over the permit term. Gated hibernacula will be closed to public use year-round. Ungated caves of unknown status will be closed to public visitation through signage during the following period:

- October 1 to April 30

Three designated recreation-use caves on State Forest lands (Barton, Lemon Hole, and Coon) are excluded from this measure. These caves are open seasonally (May 31 to October 1) for recreational use and gated the rest of the year. PGC and DCNR work closely with caving groups such as the Mid-Atlantic Karst Conservancy to maintain these caves for public use. The Conservancy follows all gear decontamination protocols and works annually to help PGC and DCNR monitor the caves. Maintaining public use of these caves during the summer months is important both to maintain goodwill with the caving community and to meet PGC and DCNR's legal mandates to promote recreational use of State Lands. In addition, cave use outside of winter months is not typically regulated by USFWS at other caves in the United States. To continue good stewardship of these caves, PGC and DCNR will offer an annual training to the Mid Atlantic Karst Conservancy on bat protection (CM-19 *Support Public Engagement*).

5.4.2 Timber Harvest

An important part of the conservation strategy includes measures to avoid and minimize the negative effects of timber harvest on individual Indiana bats and northern long-eared bats while maximizing the beneficial effects of these activities to bat habitat. The following measures describe how PGC, the Bureau of Forestry, and the Bureau of State Parks[4] will avoid and minimize effects on individual bats during timber harvests in each season. Timber harvest conservation measures are tied to areas where the covered bat species are most likely to be present during different times of year and are anticipated to shift on the landscape.

CM-4 Minimize Effects on Trees that Provide Summer Roosting Habitat

Rationale: During summer, Indiana bats and northern long-eared bats forage at night and spend their days resting in trees. In particular, female bats roost in maternity colonies where they raise their young. High temperatures inside bat roosts are associated with rapid growth of both fetal and juvenile bats; therefore, large tree snags with substantial solar exposure and loose bark provide important roosting habitat for both covered bats during the summer.

> **Applies to:**
>
> **Who**: PGC, Bureau of Forestry, Bureau of State Parks
> **When**: Year-round
> **Where**: Modeled summer habitat for Indiana bats; designated roosting activity areas for northern long-eared bats

While both species roost in trees during the summer, their habitat affinities and distributions in Pennsylvania require independent consideration. Indiana bats are relatively specialized, occupying a restricted range within the state. This species is associated with specific areas and climatic conditions making its location easier to model and predict. For this HCP, summer habitat for Indiana bats was modeled using MaxEnt and occurs in approximately 479,632 acres on State Lands. Unlike Indiana bats, northern long-eared bats are more generalized in distribution and habitat preference. Absent WNS, this species would be likely to occur on any forested parcel in Pennsylvania during the summer months. While MaxEnt models were generated for both species, the model for northern long-eared bats is too broad to identify areas of high conservation priority for the species and is thus not sufficiently protective. Rather, for the purposes of avoidance, minimization, and mitigation for northern long-eared bats, habitat protection is focused on known roost trees plus an 850-foot buffer around these trees. This approach builds on the northern long-eared bat 4(d) rule and allows for targeted conservation of the species, with an emphasis on protecting maternity colonies.

Indiana bat commitment: PGC and DCNR will include provisions in planning documents and timber sale contracts to retain trees with the greatest potential to be suitable roosts (Chapter 3, *Environmental Setting*, Table 3-5) in modeled summer habitat for Indiana bats. Shagbark hickory (*Carya ovata*) and shellbark hickory (*Carya lacinosa*) trees are of special value as potential roost trees for Indiana bats. The bark of these species loosens and begins to peel as the trees age, creating spaces under the loose bark for bats to roost. Trees that are more than 11 inches diameter at breast height (dbh) are most likely to have enough peeling bark to serve as suitable roost trees and are the most difficult to replace; therefore, these larger trees will be promoted across State Lands (Lacki et al. 2009).

[4] As noted in Chapter 2, *State Lands and Covered Activities,* State Parks' timber harvest program is restricted to occasional salvage sales and removal of hazards trees.

Prior to timber harvest, foresters trained as bat habitat identifiers (BHI) (CM-18 *Implement Staff Training Program*) will mark trees that will not be harvested (for example, by marking the tree above and below stump height with a certain color and pattern of paint). The following requirements will be implemented in modeled Indiana bat summer habitat.

- Maintain a minimum of nine trees per acre that, in keeping with USFWS guidelines (U.S. Fish and Wildlife Service 2005), meet the following criteria:
    - Six trees or snags per acre are 11 inches dbh or larger.
    - Three trees or snags per acre are 20 inches dbh or larger, if present (adapted from U.S. Fish and Wildlife Service undated).

Snags and trees with hollows will be targeted for preservation. The requirements to retain residual trees in summer habitat will not apply to those stands where aspen are being removed or regenerated, where plantations of trees (especially pines) are being converted to a more natural forest structure or in the cases where PGC or DCNR are creating forest openings specifically for wildlife habitat. The latter condition provides high-quality foraging habitat for Indiana bats. If there are not enough suitable trees to meet these guidelines, the correct number of near- suitable trees will be retained. In limited circumstances, tree removal of snags or other preferred trees is necessary for human safety.

In addition to the retention guidelines, the following restrictions apply to specific tree species in modeled Indiana bat summer habitat:

- No shag or shellbark hickory trees greater than 11 inches dbh will be harvested on State Lands.

These guidelines apply except in rare circumstances, whereby harvest of these trees will be reviewed by PGC or DCNR on a case-by-case basis after consultation and with approval of USFWS. Special circumstances include removal of hazard trees (e.g., trees damaged by storm or insect outbreak) or creation of firebreaks to control a wildfire.

Cutting younger shagbark and shellbark hickory trees (11 inches dbh or less) will be avoided because they have the potential to develop into suitable roost trees. PGC and DCNR will avoid cutting shagbark and shellbark hickory trees unless the density exceeds 16 trees per acre, or removal of targeted individuals is necessary to “release” other shag and shellbarks to grow to larger sizes (U.S. Fish and Wildlife Service undated). If the density of these trees exceeds this threshold, they may be harvested as long as the residual targets are met (nine potential roosts per acre with six of 11 inches diameter or greater and three of 20 inches or greater diameter).

Northern long-eared bat commitment: Northern long-eared bats make extensive use of interior, shaded trees that contain cavities, including all tree species with which Indiana bats are associated. Maternity colonies make use of a variety of tree size classes, but large trees (11 inches dbh or larger) are particularly important because they provide high-quality summer roosting habitat. Larger-diameter trees with the right characteristics provide opportunities for more bats to roost than do smaller-diameter trees with the same characteristics (Appendix B, *Species Accounts*).

As discussed, summer habitat for northern long-eared bats is focused on known roost trees. Up to 100 of these roosts will be treated as the centroid of a bat management area outlined by an 850-foot buffer. The goal is to protect not only the centroid roost but also most other roosts used by the colony (Figure 5-3).[5]

According to August 1, 2016 data from the Pennsylvania Natural Diversity Inventory database, there are 59 known roost trees on State Lands, with more likely to be discovered. All 59 of these known roost trees will be protected in roosting activity areas upon permit issuance.[6] Within these designated northern long-eared bat roosting activity areas, PGC and DCNR will avoid effects on bats, including maternity colonies as follows.

- Retain any trees documented as roosting activity areas by northern long-eared bats.
- Retain all live or dead trees of at least 3 inches dbh that have exfoliating bark, cracks, or crevices.
- Retain other trees surrounding known roost tree identified as potential roosts (e.g., trees with hollow cavities, snags) to maintain the microclimate.
- Where not a safety hazard, leave dead or dying trees standing.
- Retain shagbark and shellbark hickory as described for Indiana bats.
- Complete targeted management activities (potentially including harvests and prescribed fires) at times when northern long-eared bats are absent.

Additional roosting activity areas will be identified over time through existing surveys of modeled summer habitat (Section 5.8.2, *Effectiveness Monitoring*). As new roost trees for northern long-eared bats are discovered on or immediately adjacent to State Lands, PGC and DCNR will protect up to 100 roosting activity areas.

[5] Johnson et al. 2012 and Silvis et al. 2014 collected data on northern long-eared bat spatial distribution around roosts. Analyses of these data indicate that each colony has a centroid of activity (or primary roost) and that activity declines with increasing distance from this centroid. The pattern of decline for roosting activity indicates that 50 percent of the bat activity associated with a given roost tree occurs within 250 meters (approximately 820 feet) of the centroid (or primary roost). As 850 feet is a distance that PGC and DCNR foresters already use, this buffer was extended to 850 feet. This buffer is substantially greater than that proposed in the final 4(d) rule (81 *Federal Register* 1900, January 14, 2016), which prohibits incidental take inside the WNS zone if caused by tree removal that cuts or destroys a known occupied maternity roost tree or any other trees within a 150-foot radius of the maternity roost tree during the pup season (June 1 to July 31).

[6] Because some of these roost trees may occur within 850 feet of each other, several roost trees may occur within the same roosting activity area. Therefore, there may be fewer than 59 roosting activity areas designated and protected in the first year (but all known roost trees will be protected).

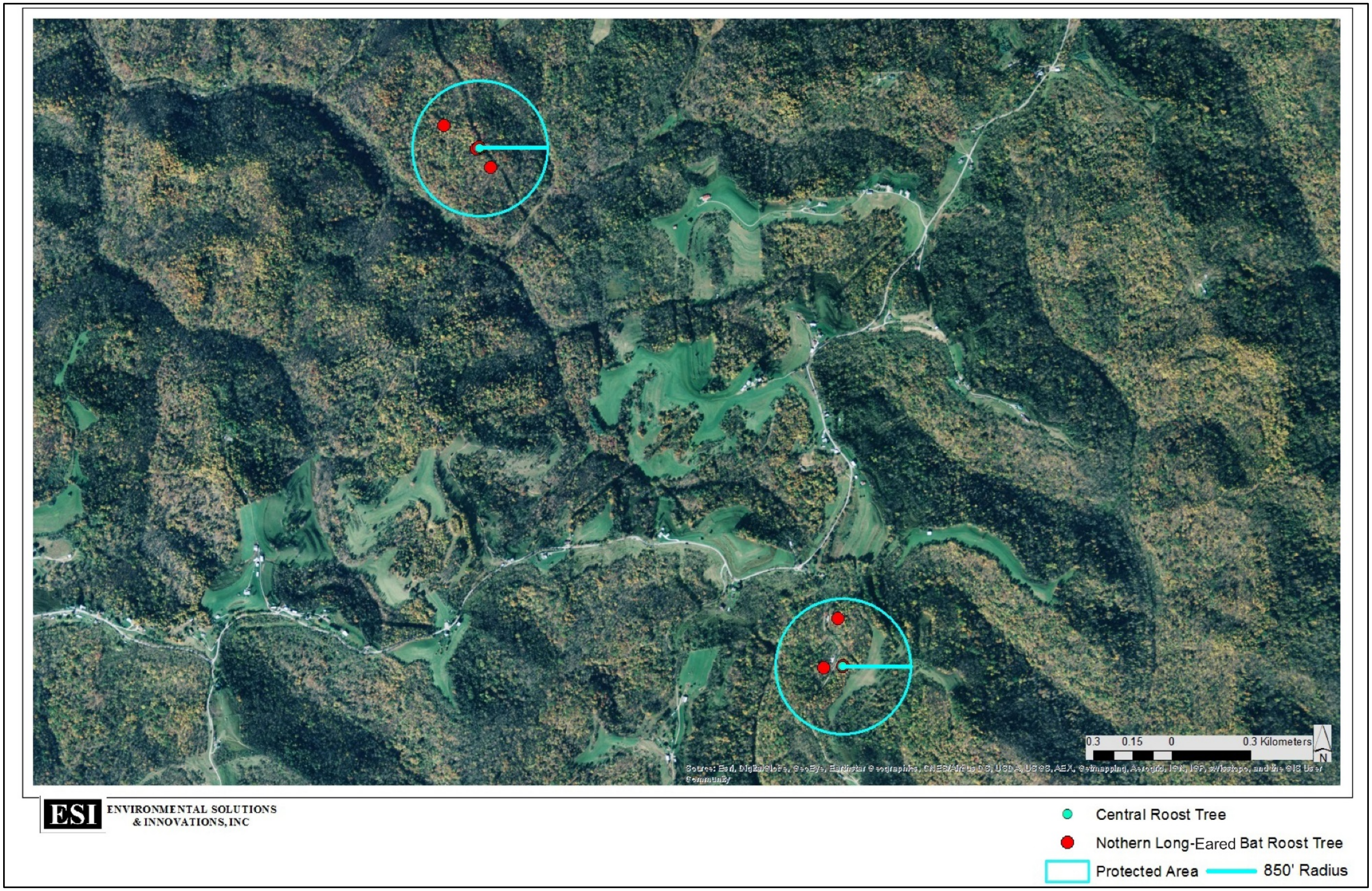


Figure 5-3. Example of Northern Long-Eared Bat Roosting Activity Areas

CM-5 Avoid Timber Harvest Effects on Non-Volant Pups in Maternity Colonies

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: June 1- July 31 for both species
Where: Modeled summer habitat for Indiana bats; designated roosting activity areas for northern long-eared bats

Rationale: Covered bats roost in trees with loose bark, hollows, cracks and crevices, and both species prefer larger trees and snags. Such trees are preserved on the landscape as part of CM-4 *Minimize Effects on Trees that Provide Summer Roosting Habitat* and CM-21 *Enhance Foraging and Roosting Habitat.* However, some harvest of potential roost trees will occur. To protect bats while pups are non-volant (unable to fly) and particularly vulnerable (June 1 to July 31), this measure will restrict harvest of potential roost trees to provide added protections for female bats and their pups.

Indiana bat commitment: Harvest of potential roost trees (snags, hollow trees, trees with cracks and crevices and trees with loose bark) in modeled summer habitat will be restricted during the pup season (June 1 to July 31). Salvage cut and hazard tree removals will be conducted before trees become suitable roosting sites because salvaging trees that are dead or dying from decline or disease will pose less of a threat to bats. These trees should be harvested while the bark is tight (because cavities or large branches with loose bark could serve as roost sites) or when bats are hibernating. Individual trees can be removed within 24 hours of a negative emergence count. Trees that have fallen to the ground may be salvaged regardless of bark condition.

Northern long-eared bat commitment: To reduce potential effects on roosting northern long-eared bat maternity colonies, timber harvest will be restricted within designated roosting activity areas during the pup season (June 1 to July 31). In addition, all known roost trees will be avoided during the pup season.

CM-6 Cease Harvest Activities when Bats Are Detected

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: All State Lands

Rationale: Although this HCP is designed to avoid affecting active roosts, there is still a potential for affecting unknown roosts. Research shows that mortality from forestry operations is low even when non-volant juveniles are present (Belwood 2002; U.S. Fish and Wildlife Service 2018). In addition, both covered species have been documented retrieving fallen pups from the ground (Burnett and Kunz 1982; Hoying and Kunz 1998; Belwood 2002; Krochmal and Sparks 2007). This conservation measure is intended to allow adults time to retrieve pups disturbed during forestry operations and to avoid repeatedly flushing the same group of bats.

Indiana bat commitment: Cease tree felling and tree removal activities if bats are observed within or fleeing from a felled tree, or if dead bat(s) are found. This applies to timber harvest, operations (fencing and firewood), roads, trails, and firebreaks, but excludes prescribed burns. The field supervisor for the activity will immediately contact the PGC senior biologist (or DCNR, if on their lands). PGC or DCNR staff will go to the site to collect and identify any carcasses, and to assess and evaluate the situation to determine if any additional measures need to be implemented.

Northern long-eared bat commitment: Same as for Indiana bats.

CM-7 Avoid Timber Harvest Effects on Winter Habitat

Rationale: Winter habitat is highly associated with known hibernacula, and hibernating bats are highly sensitive to disturbance.

Indiana bat commitment: Timber harvest and firewood collection will be restricted year-round in identified winter habitat for Indiana bats (i.e., all State Lands within a 0.25-mile buffer of known hibernacula; see Section 3.5.4.1, *Winter*). Only forestry actions identified by a QBS and taken for the express purpose of enhancing bat habitat will be permitted in this habitat (for example, harvest of 6-inch-dbh red maples to promote growth of the shagbark and shellbark hickories that are beneficial to Indiana bats). Such activities will be allowed in winter habitat if the following conditions are met:

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: Winter habitat for both species

- They are completed to improve bat habitat quality.
- They are completed under the direction of a certified QBS (implementation can be done by a certified BHI (CM-18 *Implement Staff Training Program*)).
- They are completed at a time of year that avoids and minimizes potential negative effects on bats.

When a storm or insect infestation has resulted in hazard trees that need to be removed for safety reasons, this removal will also be completed at the direction of a certified BHI.

Northern long-eared bat commitment: PGC and DCNR will identify and protect hibernacula for northern long-eared bats (CM-1 *Install Gates at Known Hibernacula*). Timber harvest and firewood collection will be restricted year-round within winter northern long-eared bat habitat (i.e., all State Lands within a 0.25-mile buffer of the existing Category 1 or Category 3 hibernacula; see Section 3.6.4.1, *Winter*). As with Indiana bats, only those forestry actions identified by a certified QBS and taken for the express purpose of enhancing or protecting bat habitat will be permitted in this habitat.

5.4.3 Firewood

Similar to timber harvest, the State Lands Forestry HCP includes measures to avoid and minimize the negative effects of firewood collection on Indiana bats and northern long-eared bats in summer and fall/spring habitat.

CM-8 Limit Firewood Collection Seasonally (Fall/Spring)

Rationale: Standing dead trees have the potential to provide high-value roost sites for both bat species. Bats can roost in the cavities and loose bark of dead trees, and standing dead trees are likely to have adequate solar exposure. However, the state's large firewood collection program[7] serves an important purpose to remove hazardous trees that tend to occur adjacent to roads. The program focuses on these hazardous trees because collectors must hand-carry firewood from the felling site. Collecting trees for firewood is limited to downed trees in State Parks, and PGC does not issue firewood collection permits for State Game Lands. However, collection of standing dead and marked live trees for firewood is permitted in State Forests. The Bureau of Forestry regulates firewood collection in State Forests through the issuance of permits. Permits are issued for each forest district and specify along which roads in the forest district permittees may collect firewood. To minimize the collection of standing dead trees for firewood in areas where bats have the potential to roost, the collection program can be focused further, while maintaining its purpose of removing hazardous standing dead trees.

Applies to:

Who: Bureau of Forestry
When: April 1 to May 14; September 1 to November 1
Where: Fall/spring habitat for Indiana bats

Indiana bat commitment: To prevent the harvesting of occupied roost trees for firewood in State Forests, the Bureau of Forestry will close all areas of fall/spring Indiana bat habitat to the collection of standing dead trees during the following periods:

- April 1 to May 14
- September 1 to November 1

Note that dead trees already on the ground may be collected for firewood during these periods.[8]

Northern long-eared bat commitment: Northern long-eared bats are more generalized in their roosting needs with a concomitantly larger portion of the state providing suitable habitat (Appendix B, *Species Accounts*). The typical roost tree for northern long-eared bats is smaller and more shaded, and is often a live tree with cavities (U.S. Fish and Wildlife Service 2018; Sasse and Pekins 1996; Foster and Kurta 1999; Carter and Feldhamer 2005; Stauffer 2016). Thus, northern long-eared bats are more likely to select roosts in live trees in the forest interior and less likely to select open roosts along a road than Indiana bats. Because of this lower likelihood of selecting a roost along a road, the much larger number of potential roosts (which serves to dilute risk), and a preference for trees that are not regularly removed by the firewood program, northern long-eared bats are at a lower risk of mortality from firewood collection. In addition, seasonal restriction of firewood harvest in their larger area of suitable habitat would result in a moratorium on firewood harvest in those districts where hibernacula are present. As such, this restriction does not apply to this species in areas of fall/spring northern long-eared bat habitat (beyond those lands already protected for Indiana bats[9] and the designated roosting activity areas described under CM-4 *Minimize Effects on Tress that Provide Summer Roosting*).

[7] The Bureau of Forestry sells more than 10,000 firewood collection permits annually; PGC does not have a firewood collection program or permit process.

[8] Downed trees are not expected to be used by bats and thus no take is anticipated from removal of these trees.

[9] Northern long-eared bats are found in all hibernacula containing Indiana bats. As a result, fall/spring habitat for northern long-eared bats overlaps at 7 of the potential 32 northern long-eared bat hibernacula.

CM-9 Limit Firewood Collection Seasonally (Summer)

Rationale: Same as for CM-8 *Limit Firewood Collection Seasonally (Fall/Spring).*

Indiana bat commitment: To limit the harvest of potential roost trees for firewood in State Forests, the Bureau of Forestry will close areas to the collection of standing dead trees in areas modeled as summer habitat for Indiana bats from May 15 to August 31.

> **Applies to:**
>
> **Who**: Bureau of Forestry
> **When**: May 15 to August 31
> **Where**: Modeled summer habitat for Indiana bats for Indiana bats

The Bureau of Forestry will identify closure areas using the Indiana bat habitat distribution model (Chapter 3, *Environmental Setting*). Roads or road segments that support 30 percent or more of their length in modeled Indiana bat summer habitat will be closed to the collection of standing dead trees from May 15 to August 31. The threshold of 30 percent was selected based on a GIS review of areas of suitable habitat in comparison with the existing road network. Using a cutoff of 30 percent allows all forest districts to maintain firewood harvest on at least one road during summer—an important consideration for those who rely on this wood as a source of fuel. The habitat suitability model is extremely conservative and recognizes areas with a 25 percent chance of occupancy as being suitable. Thus, road segments for which less than 30 percent is deemed suitable are likely to be areas right on the boundary between areas identified as suitable versus areas identified as unsuitable—meaning such roads are marginal habitat.

During this period when bats are most active in summer habitat (Appendix B, *Species Accounts*), the Bureau of Forestry will close all roads in forest districts where nearly every road has 30 percent or more of its length within summer habitat for Indiana bats. In addition, the Bureau of Forestry will close any area to standing dead tree collection if bats are observed in the area. In all areas, trees already on the ground may still be collected for firewood during this period.

Northern long-eared bat commitment: Northern long-eared bats are more generalized in their roosting needs with a concomitantly larger portion of the state providing suitable habitat (Appendix B, *Species Accounts*). The typical roost tree for northern long-eared bats is smaller and more shaded, and is often a live tree with cavities (U.S. Fish and Wildlife Service 2018; Sasse and Pekins 1996; Foster and Kurta 1999; Carter and Feldhamer 2005; Stauffer 2016). Thus, northern long-eared bats are more likely to select roosts in live trees in the forest interior and less likely than Indiana bats to select open roosts along a road. Because of this lower likelihood of selecting a roost along a road, the much larger number of potential roosts (which serves to dilute risk), a preference for trees that are not regularly removed by the firewood program, and the fact that northern long-eared bats have now become very rare; northern long-eared bats are at a lower risk of mortality from firewood collection. In addition, seasonal restriction of firewood harvest in their larger area of suitable habitat would result a summer moratorium on firewood harvest. As such, this restriction does not apply in areas of summer habitat for northern long-eared bats (beyond those lands already protected for Indiana bats, located within designated roosting activity areas described under CM-4 *Minimize Effects on Tress that Provide Summer Roosting* or associated with another known roost under CM-5 *Avoid Timber Harvest Effects on Non-Volant Pups in Maternity Colonies*).

5.4.4 Prescribed Fire

Prescribed fire is an important management tool for maintaining healthy forests to support Indiana bats and northern long-eared bats, as well as a wide variety of other wildlife (Ford et al. 2016; U.S. Fish and Wildlife Service 2013). Prescribed fire is often used to maintain existing open communities (e.g., grasslands) and these fires are not restricted in the State Lands Forestry HCP. In forested systems, prescribed fire is used to promote and manage fire-dependent habitat types, including oak-dominated forests. Prescribed fire can be used as a tool to benefit wildlife by manipulating plant community dynamics to favor the occurrence of desirable plant species. It is often used to initiate forest succession and foster a mosaic of plant communities that provide habitat for a variety of species ranging from the barrens buckmoth to ruffed grouse, Appalachian cottontail, and golden-winged warbler.

Site preparation burning prepares the seed bank for future oak seedling establishment. The goal is to reduce the amount of litter and any dense understory that would shade the oak. This type of burn, which is typically of low intensity, needs to be conducted in the late spring (April and May) to be successful. The Bureau of Forestry has attempted site preparation burning in October and November, but the success rate is very low (Barnes and Van Lear 1998; Brose and Van Lear 1998; Brose et al. 2008; Brose 2013).

Release burning frees the oak from competition by killing other less desirable woody species that provide fewer benefits to wildlife, such as birch, mountain laurel, and striped maple. These burns are conducted in the late spring and are of moderate to high intensity, with flame lengths greater than 2 feet. The late spring burns achieve the greatest results because the sap needs to be flowing to ensure maximum mortality of the undesirable thin-barked species in the understory layer. The window to achieve this burn is from bud swelling to full expansion of the canopy trees. Burns conducted at any other time of year do not achieve the desired timber harvest objectives.

Damage to residual trees (nontargeted trees and shrubs other than those mentioned previously) should be minimal during a prescribed fire. If the residual trees have heavy slash accumulation at the base, the slash is removed to protect the tree from fire. The prescribed fire targets the duff layer, seedlings, and smaller saplings. It does not target the larger trees in the stand.

As described in Section 5.2, *The Impact of the Taking*, prescribed fires can have short-term negative effects on bats roosting in stands at the time of the fire, but the habitat benefits can be dramatic and sustained. Preference for burned habitats during foraging (Lacki et al. 2009) and roosting (Ford et al. 2016; Boyles and Aubrey 2006) has been identified for both covered species at time scales ranging from within days of the fire to multiple years post-burn. Notably, potential roosts created by fires may remain on the landscape for years. The negative effects of prescribed fire on habitat are generally outweighed by the restoration and enhancement of habitat that is heavily used by both covered bat species—relatively open stands with many dead trees. Maintaining the use of prescribed fire as a management tool while implementing measures to reduce the potential negative effects of burns on individual bats is an important component of the conservation strategy. The following measures describe how PGC and DCNR will avoid and minimize effects on summer, fall/spring, and winter habitat.

CM-10 Restrict Prescribed Fire Seasonally (Winter)

Rationale: Prescribed fire can disturb, injure, or kill individual bats (especially juveniles) roosting in trees near hibernacula.

Indiana bat commitment: To avoid and minimize the effects of prescribed fire on Indiana bats, prescribed burns will be restricted year-round in forested Indiana bat winter habitat (all State Lands within a 0.25-mile buffer of known hibernacula; see Section 3.5.4.1, *Winter*) to prevent smoke from entering hibernacula.

Northern long-eared bat commitment: Prescribed fire will be restricted year-round in forested northern long-eared bat winter habitat (all State Lands within a 0.25-mile buffer of Category 1 or 3 hibernacula; see Section 3.6.4.1, *Winter*).

> **Applies to:**
>
> **Who**: PGC, Bureau of Forestry, Bureau of State Parks
> **When**: Year-round
> **Where**: Winter habitat for both species

CM-11 Restrict Prescribed Fire Seasonally (Summer)

Rationale: In forested areas, prescribed fire can disturb, injure, or kill individual bats. Take from fire comes from two main sources. Roost trees are often dead and therefore more susceptible to the destructive effects of fire. The removal of roost trees by the fire itself (Boyles and Aubrey 2006) or by felling roost trees during fire management activities could disturb, injure, or kill individual bats if the roosts are occupied. In addition, smoke and heat from prescribed fires can cause bats to flush from their roosts, exposing them to predation risk (Rydell and Speakman 1995; Sparks et al. 2000).

Summer fire restrictions ensure that juvenile bats are volant and that all bats in the vicinity are making minimal use of torpor, and therefore capable of changing roosts in response to prescribed fire activities (U.S. Fish and Wildlife Service 2007).

> **Applies to:**
>
> **Who**: PGC, Bureau of Forestry, Bureau of State Parks
> **When**: May 15 to August 15 for Indiana bats; June 1 to July 31 for northern long-eared bats
> **Where**: Summer habitat for Indiana bats; designated roosting activity areas for northern long-eared bats

Prescribed burns may be used in nonforested habitat (especially grasslands and oak-scrub systems) throughout the year. These habitats are primarily used for foraging, not roosting, and there is little potential for take.

Indiana bat commitment: Indiana bats are relatively concentrated on the landscape during the summer. To avoid and minimize the effects of prescribed fire on Indiana bats, prescribed burns will be restricted in forested Indiana bat summer habitat during the following period:

- May 15 to August 15

Northern long-eared bat commitment: Northern long-eared bats are widespread on the landscape during the summer. Further, much of this once-suitable habitat is likely no longer occupied due to declines associated with WNS (Butchkoski and Bearer 2016; U.S. Fish and Wildlife Service 2018). Additionally, curtailment of prescribed fire across a wide landscape would preclude the long-term habitat benefits of prescribed fire. As such, designated roosting activity areas will be protected from fire from June 1 to July 31.

CM-12 Manage Prescribed Burns to Minimize Effects on Bats

Rationale: Smoke from prescribed fires can negatively affect Indiana bats and northern long-eared bats if smoke enters roosts or hibernaculum; all bats in that roost or hibernaculum could be injured, killed, harmed, or harassed, although this occurrence has never been documented. This measure will minimize the risk that smoke from prescribed fires will lead to take of roosting bats or bats in hibernaculum.

This measure also recognizes that tree-roosting bats may be killed, harmed, or harassed by smoke or heat from fires (Lacki et al. 2009) and implements measures recommended by that paper to minimize effects.

Indiana bat commitment: The Pennsylvania Prescribed Fire Standards, outlined under the Prescribed Burn Practices Act, require a prescribed fire plan be approved by the agency administrator for all prescribed burns conducted in Pennsylvania. This document serves as a site-specific implementation document and contract between the appropriate agency administrator and the burn boss responsible for conducting the burn. Prior to approving a prescribed fire plan, the PGC and DCNR agency administrators will ensure that the burn adheres to the seasonal restriction windows previously identified (CM-10 *Restrict Prescribed Fire Seasonally (Winter)*, CM-11 *Restrict Prescribed Fire Seasonally (Summer)*). There may be situations in which a management activity requires burns to be conducted outside of these seasonal restriction windows (for example, management of some pest insect species may require burns at specific times of the year to be effective). In these situations, PGC or DCNR will seek to avoid effects on bats, roosts, or bat hibernacula and will secure written approval from USFWS for the burn prior to submission of the prescribed fire plan. Any additional take resulting from burns outside the seasonal restriction window will be subtracted from the take allotment provided in the permit.

As outlined in the prescribed fire standards, a smoke management plan is a required component of all prescribed fire plans. Under the prescribed fire standards, smoke management plans are required to list and describe any smoke-sensitive areas that could be affected by the burn (taking into account not only the day of the burn but also the following days) and to describe desirable smoke behavior and smoke management actions. In addition, PGC and DCNR will use the following fire management practices to minimize the effect of prescribed burns on bats.

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round

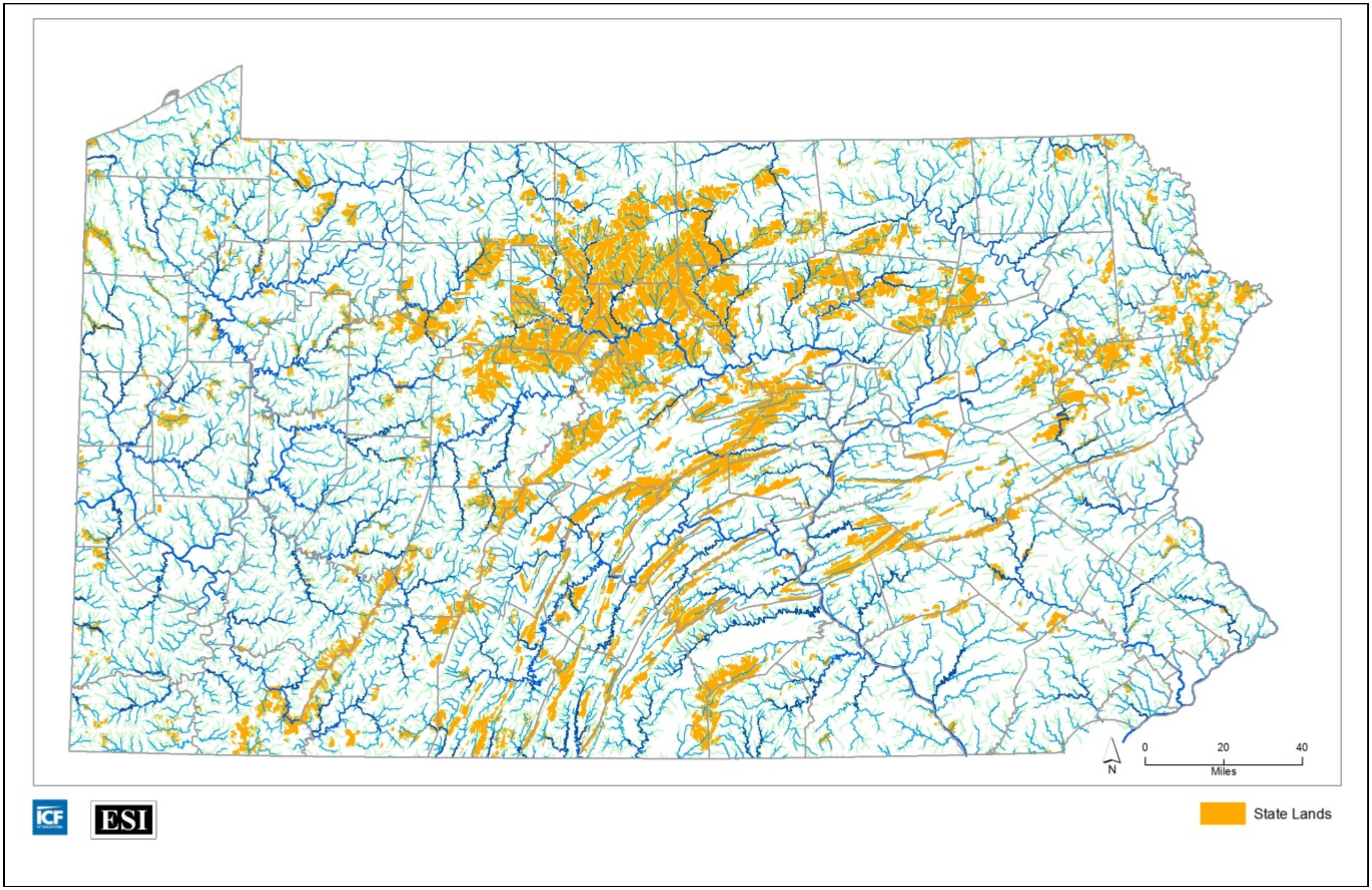
- Use ignition tactics that reduce fire intensity and flame length so that the critical plume temperature at which bats could be injured (140°F) does not reach roost height. Indiana bats typically roost under bark at approximately 30 feet in height. The height at which crown scorch will occur should be monitored because that is the height at which bats are at greater risk.
- Use ignition tactics that cue tree-roosting bats to arouse from torpor and flush. Good techniques proceed slowly at first so that the smoke travels over the burn unit before the main ignition begins.

- Burn in the appropriate season and weather. Smoke lift and heat are influenced by combinations of weather and season. Fire managers should take these factors into account when planning and implementing burns.
- Minimize the loss of potential roost trees to ensure there is an ample supply of roost snags and trees. Large snags and trees should be left on the landscape to provide alternative roosting habitat during prescribed burns.

Northern long-eared bat commitment: Same as for Indiana bats. Northern long-eared bats are more variable in their roosting ecology but also tend to roost in cavities, which may help buffer this species from heat and smoke.

5.4.5 Streams and Riparian Areas

Indiana bats and northern long-eared bats feed extensively on aquatic insects; stream and riparian areas often provide high-quality foraging grounds for the species (Sparks et al. 2004; Henderson and Broders 2008). Riparian areas close to the forest edge provide high-quality foraging habitat for bats, especially *Myotis* (Jachowski et al. 2014), and species such as northern long-eared bats and Indiana bats may be better able to exploit these areas as populations of other bats decline. Streams and riparian areas also create travel corridors between roosting areas and foraging sites. Measures to avoid and minimize effects on these habitats will protect the prey base and improve movement corridors for bats. Figure 5-4 depicts all perennial streams on State Lands identified as “blue-line” streams on U.S. Geological Survey 1:24k quadrangle topographic maps. The measures that follow describe how PGC and DCNR will avoid and minimize effects on streams and riparian areas in summer, fall/spring, and winter habitat.



Source: ESRI, Pennsylvania Department of Environmental Protection, and Pennsylvania Department of Transportation

Figure 5-4. Perennial Streams in Pennsylvania

CM-13 Restrict Vehicles and Equipment in Perennial Stream and Riparian Areas

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: All State Lands

Rationale: Roads and road use can generate pollution that enters the air or water and degrades habitat (ESI 2007). In addition, contaminants used in construction vehicles and equipment as well as soil erosion from construction activities can degrade waterways; both of these operations activities can affect the insect forage base for Indiana bat and northern long-eared bats.

Indiana bat commitment: PGC and DCNR will restrict vehicles or equipment used for construction and timber harvest activities near streams or wetlands in accordance with existing PGC and Bureau of Forestry Stream Buffer Guidelines (Appendix L, *Stream Buffer Guidelines*), which include the measures described in Table 5-6.

Table 5-6. Stream Buffer Guidelines

PGC Stream Buffer Guidelines[a]	Bureau of Forestry Stream Buffer Guidelines
Vegetation management in the inner section and the operation of motorized equipment outside of existing, stabilized roads that cross the inner section is not permitted. No new road or trail development should occur.	Earth disturbance activities near streams should be avoided whenever possible.
The elimination or minimization of existing roads, trails, or parking areas, and the responsible restoration of those areas are strongly encouraged within the inner section.	Administrative roads within a 0.25 mile of streams should be gated to prevent public access.
Entry by motorized equipment should be limited to machinery designed for operation on sensitive soils. Trail development should be avoided.	New public use roads should be kept at least 0.25 mile away from streams, unless topography or other physical features are an issue.
--	Parallel roads and trails should be located at least 200 feet plus 4 feet for every 1% of slope away from the stream bank.

[a] PGC and Bureau of Forestry Stream Buffer Guidelines specify different inner and outer buffers for different stream classifications. These inner and outer buffers are defined in detail in Appendix L, *Stream Buffer Guidelines*.

Northern long-eared bat commitment: Same as for Indiana bats.

CM-14 Retain Vegetation in Perennial Stream and Riparian Areas[10]

Rationale: Soil erosion in riparian areas can degrade the waterways important to the bat's insect prey base. Vegetation in riparian areas reduces and prevents the erosion of soil into waterways.

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: All State Lands

Indiana bat commitment: In accordance with PGC and DCNR's Stream Buffer Guidelines (Appendix L, *Stream Buffer Guidelines*), appropriate natural vegetation will be retained within 50 feet of perennial streams and around wetlands. Riparian corridors will be managed to perpetuate a diversity of native habitats, particularly forest types and age classes. Timber harvests should consider the prescribed treatments in adjacent stands and employ gradual or feathered transitional areas (i.e., vertical and horizontal stratification) from the outermost limit of an aquatic buffer to the inner zone. Harvest plans should maintain no-cut (inner zone) and cut (outer zone) buffers as described in the Bureau of Forestry's Silviculture Manual (Pennsylvania Department of Conservation and Natural Resources 2016). Reforestation should be considered on riparian lands lacking minimum forest cover. Rare exceptions to the full retention of vegetation within 50 feet of perennial streams and wetlands may be necessary to address situations such as vegetation removal for hazard reductions, emergency, or developed visitor use areas.

Northern long-eared bat commitment: Same as for Indiana bats.

CM-15 Implement Erosion and Sediment Control Plans

Rationale: Sedimentation in streams and riparian areas can degrade water quality and affect the bat's insect forage base.

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: All State Lands

Indiana bat commitment: PGC and DCNR will develop and implement erosion and sediment control plans for logging and other earth-disturbing activities, as needed. A sample erosion and sediment control plan is provided in Appendix F, *Erosion and Sediment Control Plan*.

Northern long-eared bat commitment: Same as for Indiana bats.

[10] This conservation measure only applies to perennial streams (and their associated riparian areas) identified as "blue-line" streams on U.S. Geological Survey 1:24k quadrangle topographic maps.

CM-16 Implement Spill Pollution Prevention Measures

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: All State Lands

Rationale: Spills, although infrequent and often related to accidents, can transfer contaminants directly from vehicles or cargo into the environment. By state law, all timber operators are required to report to the Department of Environmental Protection and the district forester any spill or leak that exceeds 5 gallons in size or a leak of any size into water. This conservation measure will ensure that this provision, as well as others, is included in all timber sale contracts.

Indiana bat commitment: To avoid and minimize the effect of spills and pollution on the insect prey base for Indiana bats, PGC and DCNR will continue to implement spill pollution prevention measures for operations activities and will include provisions in all timber sale agreements requiring the following actions of operators.

- Carry oil spill kits for hydraulic fluids, lubricating oils, fuels, and other environmentally hazardous fluids onsite when equipment is active.
    - Spill kits must include pads and containment socks that are rated to absorb at least 8 gallons of petroleum-based fluids and containers (or heavy-duty bags) capable of holding an equivalent amount of contaminated soil and other absorbents. A shovel must be available on site. Pads must be capable of absorbing fluids in water as well as on the ground. Any leaks or spills must be contained immediately.
    - Soil and absorbents must be properly disposed of through a landfill approved by the Department of Environmental Protection.
- Take any precautions, as directed by PGC foresters and DCNR district foresters, to prevent soil erosion, water pollution, and other conditions detrimental to the environment on State Lands.
- Correct environmental conditions immediately, to the satisfaction of the Department of Environmental Protection and PGC or DCNR, in the event of water pollution on State Lands resulting from timber harvest activities.
- Maintain equipment to minimize fluid leakage. Oil-soiled areas must be excavated and the soil properly disposed.
- Park equipment overnight more than 100 feet away from sinkholes, streams, intermittent streams with a defined bed and banks, and any other water body where fluids can leak into them.
- Drain oil from equipment into suitable containers and dispose of properly.
- Do not dispose of human waste, garbage, kitchen or laundry wash, manure, sawdust or other mill refuse, oil, or any other substance harmful or destructive to human, aquatic or fish life into any spring, stream, watercourse (including a mine or cave), dam, pond, or lake.

Northern long-eared bat commitment: Same as for Indiana bats.

5.4.6 Roads and Trails

Regular PGC and DCNR operations activities include the construction, maintenance, and use of roads for motorized travel and trails for nonmotorized travel. Because bats might use small roads and trails as travel corridors, this conservation program includes measures to avoid and minimize the effects of roads and trails on Indiana bats and northern long-eared bats. The following measures describe how PGC and DCNR will avoid and minimize effects on both species.

CM-17 Maintain Speed Limits on Forest Roads

Rationale: Relatively small, infrequently used roads such as skid trails and haul roads often serve as travel corridors for bats. Where bat travel corridors and roads intersect, there is a higher probability of collisions and bat fatalities (Russell et al. 2009; Bennett and Zurcher 2012). Research by Zurcher et al. (2010) on the influence of vehicular traffic on the behavior of commuting bats suggests that measures to minimize the presence and speed of vehicular traffic can reduce the risk of bat-vehicle collisions and fatalities. If bats respond to vehicles in a manner similar to birds (DeVault et al. 2015), then escape behavior is initiated based primarily on the distance to the perceived threat as opposed to the time available to escape. These authors found that brown-headed cowbirds (*Molothrus ater*) were typically able to avoid potential collisions at speeds of 37 to 75 miles per hour. The condition and design of unpaved forest roads often preclude driving faster than 25 miles per hour, which is lower than typical speeds of the Zurcher et al. (2010) study.

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: Summer habitat for both species

Indiana bat commitment: PGC and DCNR will maintain a 25 miles-per-hour speed limit at all times on all roads under their jurisdiction in summer habitat. Speed limits for unpaved roads are established in the Rules and Regulations for DCNR State Parks and State Forests under Title 17 of the Pennsylvania Code (Chapters 11.207 for State Parks and 21.21 for State Forests). Regulations concerning the speed limit on State Game Land roads are found in Title 58 of the Pennsylvania Code (Chapter 135.41). These sections prohibit operation of a vehicle at a speed in excess of the posted limit or, where no speed limit is posted, in excess of 25 miles per hour. When the speed limit is not posted on the road, all timber operators or contractors will be notified of the 25 miles-per-hour speed limit when they receive a copy of the applicable state rules and regulations as part of their operating contract.

Northern long-eared bat commitment: Same as for Indiana bats.

5.4.7 Outreach and Training

Outreach and education efforts can play an important role in identifying Indiana bats and northern long-eared bats and their habitat and in minimizing the spread of WNS. Because outreach and training efforts will not be confined to the existing range of known Indiana bat or northern long-eared bat habitat, the following conservation measures apply to all State Lands.

CM-18 Implement Staff Training Program

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: All State Lands

Rationale: PGC and DCNR staff members are crucial to the success of the conservation strategy for the State Lands Forestry HCP. Agency staff members are responsible for planning and implementing the covered activities outlined in the State Lands Forestry HCP and will similarly be responsible for implementing the conservation measures. Agency staff members can provide observations of bat sightings and behavior and can share their knowledge of bat conservation with private landowners, loggers, and members of the public.

This conservation effort will allow personnel to make educated decisions about forest management practices at a local scale. The ability to make such decisions is an important component of selecting appropriate trees to be left for bats (CM-4 *Minimize Effects on Trees that Provide Summer Roosting*) and deciding which areas should be closed to firewood harvest (CM-8 *Limit Firewood Collection Seasonally (Fall/Spring),* CM-9 *Restrict Prescribed Fire Seasonally (Winter)*).

Indiana bat commitment: To ensure that agency staff members have the knowledge to implement the State Lands Forestry HCP and to communicate important information about Indiana bat and northern long-eared bat conservation to the public, PGC and DCNR will develop or document existing training programs for agency staff within 6 months of permit issuance.

The content of the training programs will be approved by USFWS and will vary based on the role of the staff in HCP implementation. At a minimum, all training programs will cover bat natural history, important habitats for Indiana bats and northern long-eared bats, WNS, and the management implications of the State Lands Forestry HCP. Trainings will be held, at a minimum, annually in years 1 and 2, and then every 5 years starting in year 5. Trainings will be provided to new PGC and DCNR staff on an as-needed basis. Trainings will be provided to all agency staff responsible for making and implementing management decisions on State Lands.

PGC and DCNR staff with implementation responsibilities will be trained and certified as BHIs. To be designated as a BHI, individuals must be trained and possess the necessary experience to allow them to perform habitat evaluations and assessments for Indiana bats and northern long-eared bats. A BHI should be able to do the following activities.

- Identify hibernacula suitable for covered bats.
- Identify, mark, and distinguish potential roost trees for covered bat species.
- Provide a biologically justifiable assessment of habitat quality for covered bats.
- Identify, describe, and perform emergence counts of day roosts.
- Document study information (bats, net sets, portal entrances) with photography (Pennsylvania Game Commission 2013).

PGC and USFWS are also responsible for reviewing and approving the credentials of potential QBS and BHIs; if approved, they are added to USFWS' most current official QBS and BHI list. Agency staff and consultants trained as QBS and BHI are required to have training equivalent to or exceeding that of BHIs and therefore can assist with all implementation and monitoring efforts (Section 5.8, *Monitoring*) assigned to BHIs.

Northern long-eared bat commitment: Same as for Indiana bats.

CM-19 Support Public Engagement

Rationale: Educating members of the public, such as State Land users and visitors, private landowners, cavers, and loggers, about Indiana bats and northern long-eared bats can help to promote conservation efforts across the State. Informing the public about WNS can help to reduce the transmission of the disease to new hibernacula. In addition, education and outreach efforts can help loggers and private landowners implement practices on private lands that benefit Indiana bats and northern long-eared bats. Given that most suitable habitat and therefore most Indiana bats and northern long-eared bats reside wholly or partly on private lands, this conservation measure provides an important safety net for conservation efforts on State Lands.

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: All State Lands

Indiana bat commitment: to promote these conservation practices, the Bureau of State Parks will develop an outreach program for the public within 6 months of permit issuance. This program will provide instruction on the following capabilities.

- Recognize and protect Indiana bat and northern long-eared bat hibernacula on private lands.
- Identify and avoid effects on potential roost trees in areas where bats are known to occur.
- Provide high-quality summer habitat for Indiana bats and northern long-eared bats.

PGC and DCNR will offer this program to the public through at least four speaking engagements or outreach opportunities annually. For example, the Bureau of State Parks will exhibit and provide outreach materials at public events such as the Pennsylvania Farm Show in Harrisburg held each January. The Bureau of Forestry provides Sustainable Forestry Initiative training to loggers operating on State Forests and will update the bat module included in the training to reflect HCP commitments. In addition, PGC and DCNR will offer an annual training to the Mid Atlantic Karst Conservancy on bat protection in caves.

Northern long-eared bat commitment: Same as for Indiana bats.

5.5 Mitigation Measures

The primary goal of the covered activities is to manage a diversity of habitats and their associated species across the state lands. As such, this HCP differs from many others because the applicants' activities are not replacing areas of suitable habitat with an inhospitable landscape. Rather, the applicants seek to use timber harvest and prescribed fire as ecological disturbances that allow successional changes. Over time, these disturbances ameliorate as the stand recovers. Thus, while a clear-cut results in a dramatic change in vegetation at the time of harvest, the long-term result is the growth of a new forest. In addition to the avoidance and minimization-based conservation measures described in Section 5.4, *Avoidance and Minimization*, the conservation program includes the following proactive conservation measures that are intended to benefit Indiana bats and northern long-eared bats on State Lands. These conservation measures, which support Biological Goals 2 through 4, aim to ensure that manipulated stands always retain some value of bats and that, over time, habitat quality actually improves.

5.5.1 Forest Management

Indiana bats and northern long-eared bats spend much of the active part of the year roosting in trees and foraging in forested areas. Indiana bats are the more specialized of these species, but research has indicated that habitat suitable for Indiana bats is also suitable for northern long-eared bats (Pauli 2014; Pauli et al. 2015a; Pauli et al. 2015b). The following measures describe how PGC and DCNR will mitigate for take in modeled habitat for both species.

CM-20 Maintain a Forested Landscape in a Variety of Seral Stages

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: All State Lands

Rationale: Indiana bats and northern long-eared bats spend much of the active part of the year roosting in trees and foraging in forested areas. Bats are far-ranging species and have a suite of life-history requirements that are meaningful at the landscape level. Protecting and managing forests at this scale provides bats with a diversity of habitat types and large areas over which to migrate, forage, swarm, breed, and winter. Furthermore, a diversity of seral stages provides needed habitat for Indiana bats (Rommé et al. 1995) and habitat for northern long-eared bats is likely to decline without intervention (Silvis et al. 2012). Targeting, when feasible, modeled bat habitat for acquisition will also benefit the species by increasing the protected status of habitat within Pennsylvania forests. Once protected, these habitats must be managed in order to ensure their viability for the present and into the future. If a tree has little potential to be used as a roost until it is at least 30 years of age, then the timber-management activities undertaken as part of this HCP will ensure available roosts after the permit is completed, speed up the generation of those future roosts, and ensure the presence of high quality habitat for both species in the present.

Indiana bat commitment: Of the 4 million acres of land owned and managed by PGC and DCNR, at least 3.5 million acres of forest will be retained on the landscape to provide forested habitat for bats. While not all forest is modeled as habitat for bats, forests provide the fundamental environmental conditions necessary for covered bats. Large expanses of forest provide areas in which bats migrate, forage, and disperse. Currently unoccupied areas of forest provide areas of resilience to climate change, allowing bat populations to shift their distribution over time. This conservation measure commits PGC and DCNR to maintain at least 3.5 million acres as forest lands over the permit term, keeping this land out of the development stream and providing landscape-level benefits for covered bats.

Northern long-eared bat commitment: Same as for Indiana bats.

CM-21 Enhance Foraging and Roosting Habitat

Rationale: As large, older trees die and become snags, they provide a continuous supply of potential roost sites for bats. The management goal is to develop patchiness, vertical height diversity,

diversity of tree sizes, and an adequate number of hollow, dead, and dying trees in each management unit.

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Year-round
Where: All State Lands

In addition, by selectively removing tree species with limited potential to grow into high-value roost trees from the manipulated stand, foresters are able to "push" succession toward a mature forest community more suitable for Indiana bats and northern long-eared bats. Given the current dominance of red maples in the understory of much of Pennsylvania's forests, a lack of manipulation of existing stands will likely yield a near monoculture of red maples in the overstory within the next 30 years. While Indiana bats and northern long-eared bats are known to use red maples, the consensus among biologists familiar with the species is that red maples are not ideal roosts. Certainly, a monoculture of this species is not desirable.

Tree-retention guidelines for both bat species serve to increase stand diversity and thus are more broadly applicable then the specific retention guidelines for Indiana bats under CM-4 *Minimize Effects on Tress that Provide Summer Roosting Habitat*.

Indiana bat commitment: PGC and DCNR will increase the quality of existing habitat for Indiana bats across State Lands. Currently there are 479,632 acres of summer and 99,051 acres of fall/spring habitat for Indiana bats across State Lands. Prescribed fire and timber harvest will create or enhance existing summer habitat by 78% and fall/spring habitat by 74% over the permit term for Indiana bats. As detailed in Section 4.2.2.1, *Quantifying Effects on Habitat*, the location of covered activities will often overlap with areas manipulated in previous years.

Timber harvest and prescribed fire will be used to promote and maintain forest habitat in a variety of successional states. Forest management practices that perpetuate hardwoods and maintain or create a diversity of age and size classes will be incorporated. Mature and over-mature trees will be well represented within managed forested landscapes in each management unit (individual State Game Land, State Forest District, or State Park), as applicable and as described in PGC's Forestry Manual (Pennsylvania Game Commission undated) and Bureau of Forestry's Silviculture Manual (Pennsylvania Department of Conservation and Natural Resources 2016).[11]

Forest management will also encourage the development and retention of early- to mid-seral stages such as oak/pine, oak/hickory, and bottomlands dominated by cottonwood and other species that produce sloughing bark. Early-seral improvements reduce clutter, such as shrubs, saplings, and lower branches of canopy trees, in existing stands of young trees. Such activities also produce standing dead trees in areas with little to no roosting potential and simultaneously reduce competition and increase growth rates of surviving trees. State-owned nurseries, as available, will develop and maintain native stock of shagbark and shellbark hickories to sell to homeowners and for limited use in conservation plantings.

In addition, foresters will follow general tree retention guidelines outlined in PGC's Forestry Manual (Pennsylvania Game Commission undated) and Bureau of Forestry's Silviculture Manual (Pennsylvania Department of Conservation and Natural Resources 2016) during all timber harvest

[11] Some management units, particularly State Parks, are urban in nature or consist of grassland habitats. This management guideline is not applicable to these management units.

activities to promote species, genetic, and structural diversity within the forest. Specifically, PGC and DCNR will maintain at least 10 square feet per acre in overstory removals and clear-cuts with residuals and at least 20 square feet of basal area to the acre will be reserved in two-aged stands. Harvest openings with no retention will be limited to 10 acres. PGC and DCNR will retain dead snags on the landscape unless cutting is required for health (human or forest) or safety reasons, and will retain all snags and trees with cavities on sales adjacent to riparian areas. If snags are cut for safety reasons, they should be left on site and replaced through girdling—this is done to provide an economic incentive to forestry crews to save potential roosts when possible.

Unharvested tree stands ranging in size from 0.25 to 1 acre will be retained for every 10 acres of harvest. Layout of the retained stands will consider the features of each sale, including site conditions, topography, seasonal pools, seeps, streams, wetlands, potential roost trees, snags, and habitat connectivity. Retained stands should be identified at the shelterwood stage in two-entry regeneration treatment, or in the initial "thin from below" in the three-entry shelterwood systems.

Northern long-eared bat commitment: PGC and DCNR will increase the quality of existing habitat for northern long-eared bats across State Lands using the same practices described for Indiana bats. Currently there are 3,379,488 acres of summer and 665,179 acres of fall/spring habitat for northern long-eared bats across State Lands. Prescribed fire and timber management activities are expected to improve the quality of these existing habitats by 68 percent for summer habitat and by 73% for fall/spring habitat. As detailed in Section 4.2.2.1, *Quantifying Effects on Habitat*, the location of covered activities will often overlap with areas manipulated in previous years. Timber harvest and prescribed fire will remove clutter and create the type of small openings that provide highly suitable foraging habitat for northern long-eared bats (Pauli 2014; Pauli et al. 2015a; Pauli et al. 2015b). The large, live trees preferentially used by this species will be retained. Tree species that commonly form hollows and are frequently used as roosts by northern long-eared bats include live beech, hackberry, sassafras, and black locust. Any tree commonly used by Indiana bats can also be excavated by woodpeckers when all or part of the tree is dead and can form a suitable roost for northern long-eared bats.

5.5.2 Artificial Roosts

Bat boxes and other types of artificial roost structures can provide additional roosting habitat for Indiana bats and northern long-eared bats in summer habitat and, in certain cases, winter habitat. While the use of artificial habitat among Indiana bats is uncommon (U.S. Fish and Wildlife Service 2007), Indiana bats have been documented occupying artificial roosts in Pennsylvania (Butchkoski and Hassinger 2002; Pennsylvania Game Commission 2011) and elsewhere (e.g., Carter 2002; Ritzi et al. 2005; Salyers et al. 1996; Whitaker et al. 2006; Whitaker and Sparks 2008). Northern long-eared bats readily make use of artificial roosts, and some colonies in heavily disturbed areas have been documented making almost exclusive use of such structures (Sparks 2003; Whitaker et al. 2006). As a result, PGC and DCNR will mitigate for effects on Indiana bats and northern long-eared bats by creating artificial roost structures, such as bat boxes, in summer habitat for both species.

CM-22 Install Artificial Roost Structures

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Not applicable
Where: Summer habitat for both species

Rationale: The use of bat boxes in summer habitat is beneficial to bats (Salyers et al. 1996; Whitaker et al. 2011), especially when placed near known maternity roosts (Brittingham and Williams 2000; Ritzi et al. 2005). If habitat is lost or destroyed, bat boxes may provide a temporary roosting spot (Chambers et al. 2002) in familiar summer habitat until new roosting trees can be found. Bat boxes on lands owned by the Indianapolis International Airport have been shown to serve as potential overflow roosts when located adjacent to inhabited roost trees (Whitaker et al. 2006; Whitaker and Sparks 2008; Whitaker et al. 2011). At this study site, artificial roosts were used by a few to more than 100 Indiana bats per night for several nights on end. During the course of the study at the Indianapolis Airport, 418 traditional bat boxes were constructed; of these, six were ultimately inhabited by Indiana bat colonies as summer roosting habitat. At least five separate colonies of northern long-eared bats also used these artificial roosts. Some colonies occupied artificial roosts almost every day. Based on data from artificial roost usage at the Indianapolis airport (Whitaker et al. 2006), one bat box is expected to be occupied by Indiana bats and most to be occupied by northern long-eared bats over the permit term. The installation of artificial roosts in summer habitat will help offset effects on both covered species from timber harvest that occurs during the summer.

Indiana bat commitment: PGC and DCNR will install, maintain, and monitor seven artificial roost structures, such as bat boxes or artificial bark, every other year in Indiana bat summer habitat for the first 10 years of implementation (35 structures). Artificial roost structures will be placed in areas that are climatically suitable but lack larger-diameter dead trees, with the intention of creating roosting habitat. When possible, structures will be placed near known maternity roosts. To maximize the effectiveness of these structures as artificial roosts, structures will be constructed and installed following the guidelines in PGC's *Bat Box Plans* (Butchkoski 1998). Interpretive signs may be placed near the structures to inform visitors to State Lands of their importance to bats. Metal- or plastic-shelled bat boxes are preferred over wooden boxes because of their longer life spans. When possible, boxes will be placed in areas where roosts are otherwise limited such as in or adjacent to young timber. Existing artificial roost structures on State Lands will be included in HCP monitoring efforts.

Northern long-eared bat commitment: PGC and DCNR will install, maintain, and monitor seven artificial roost structures, such as bat boxes or artificial bark, every other year in modeled habitat that overlaps with Indiana bat summer habitat for the first 10 years of implementation (35 structures). Combined with Indiana bats, 70 structures will be made available for use by both species.

5.5.3 Hibernacula

Indiana bats and northern long-eared bats in Pennsylvania are not currently limited by summer habitat. The most significant conservation gains for both species can be achieved by protecting and managing caves and mines that are suitable as hibernacula. The following measures describe how PGC and DCNR will mitigate for effects on winter habitat for both species.

CM-23 Identify, Assess, Protect, and Enhance Potential Hibernacula

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Not applicable
Where: All State Lands

Rationale: Bats are sensitive to disturbance at hibernacula sites and Indiana bats have a narrow range of climatic and other variables that make hibernacula suitable. Identifying, protecting, and enhancing caves and mines for use as hibernacula will benefit bats.

Indiana bat commitment: In addition to the seven known and occupied hibernacula protected under CM-1 *Install Gates at Known Hibernacula,* PGC and DCNR will search for and protect at least 10 additional sites on State Lands suitable as hibernacula for both Indiana bats and northern long-eared bats over the permit term by identifying and protecting potential underground structures (e.g., mines, tunnels, bunkers, and abandoned large culverts). These suitable hibernacula sites may or may not be occupied by Indiana bats at the time they are protected. Ten sites were chosen as the maximum feasible number of potential hibernacula that could be found and protected on State Lands based on the density of known hibernacula, the proportion of unsurveyed mines and caves, and the expected physical conditions of those unsurveyed mines and caves on State Lands.[12]

These enhanced hibernacula will be subject to CM-1 *Install Gates at Known Hibernacula,* CM-2, *Remove Obstructions around Known Hibernacula*, and CM-3. *Close Hibernacula Seasonally to Public Visitors*, as described in each measure. Potential hibernacula include structures that have the correct microclimate for Indiana bats (Appendix B*, Species Accounts*) and/or show evidence of extensive use by bats of multiple species. For example, State Game Land 51 contains mines that could serve as hibernacula with appropriate airflow modifications.

As a new underground structure is identified, qualified PGC and DCNR personnel or QBS will survey the entrances at an appropriate time of year to determine if it is already being used by bats and assess its potential as an Indiana bat hibernaculum. Eighty-seven percent of bats in Pennsylvania hibernacula are found in mines (Butchkoski 2010); therefore, priority will be given to identifying abandoned coal mines that could be used as hibernacula. If the mine openings or other features do not pose a threat to human safety, bat-friendly gates will be constructed following *Agency Guide to Cave and Mine Gates* (American Cave Conservation Association et al. 2009) to protect the potential hibernacula.

PGC and DCNR have a partnership with the U.S. Department of the Interior, Bureau of Reclamation, Office of Surface Mining, and the Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation to identify and protect potential bat hibernacula (Butchkoski 2010). If potential hibernacula are located on state lands scheduled for mine reclamation, then reclamation activities will take place during the summer while bats are not in the hibernacula, in accordance with USFWS guidance (2018). This includes efforts that exceed the Office of Surface Mining requirements under the ESA. To date, this effort has protected multiple bat hibernacula and has modified one so that it is suitable for—and used—by Indiana bats. Under this conservation measure, this partnership will continue.

[12] For example, at least half of new mines and caves are eliminated as potential Indiana bat hibernacula because the mine or cave opening is unsuitable for bat access.

Because the Bureau of Abandoned Mine Reclamation will implement many reclamation efforts, PGC will provide expert assistance, as necessary, regarding structural modifications that may be made to enhance potential hibernacula through creation of more favorable microclimatic conditions.

Northern long-eared bat commitment: This conservation measure will identify and protect hibernacula for the benefit of both covered species.

CM-24 Provide Artificial Roosts for Infected Bats

Rationale: Bats have been known to use bat boxes near known hibernacula, especially during autumn and spring swarming. Infected bats often flee hibernacula prior to the typical end of hibernation. During the winter, these structures will warm on sunny days and can provide WNS-infected bats with a warm location outside the hibernaculum. Access to warmer roosting areas during periods of temporary arousal can reduce energy expenditures and promote survival (Boyles and Willis 2010).

Applies to:

Who: PGC, Bureau of Forestry, Bureau of State Parks
When: Not applicable
Where: Winter habitat

Indiana bat commitment: PGC and DCNR will install artificial roosts within 0.25 mile of the entrance to each Indiana bat hibernaculum with known or suspected WNS contamination to allow bats infected with WNS a place to roost once they emerge from hibernation. The number of roosts provided will be based on the occupancy of the hibernaculum, with one roost installed for each of the two covered species. This equates to seven roosts for Indiana bat and seven roosts for northern long-eared bat, noting that species are anticipated to share roost sites. Artificial roosts will be constructed and installed following current guidelines (e.g., PGC's *Bat Box Plans* [Butchkoski 1998]). Artificial roosts in winter habitat for Indiana bats will be installed within the first year of the permit term.

Northern long-eared bat commitment: northern long-eared bats readily make use of artificial roosts; therefore, it is likely that bat boxes installed for Indiana bats under this conservation measure will also be used by northern long-eared bats. In addition to the seven boxes installed for northern long-eared bats at shared hibernacula, PGC and DCNR will install one artificial roost near each of the 30 Category 1 hibernacula identified under CM-1 *Install Gates at Known Hibernacula* for 30 roosts over the permit term. This equates to 37 roosts targeted at northern long-eared bats and altogether 44 artificial roosts that may be used by northern long-eared bats (seven of which are targeted at Indiana bat). Artificial roosts will be constructed and installed following current guidelines (e.g., PGC's *Bat Box Plans* [Butchkoski 1998]). Artificial roosts within the winter habitat for northern long-eared bats will be installed by year ten of the permit.

5.6 Summary of Effects

This section summarizes how achievement of the goals and objectives of the conservation strategy offsets the take described in Chapter 4, *Potential Effects of Covered Activities*.

As noted, PGC and DCNR protect and sustainably manage approximately 3.5 million acres of forest. Management of working forests at the landscape level protects potential habitat for bats, keeps lands out of the development stream, prevents habitat fragmentation, and maintains foraging and roosting habitat in high quality over time (Objective 2.1). Covered activities are expected to affect up to 3 percent of suitable habitat annually on State Lands for both Indiana bats and northern long-eared bats. Over the 30-year permit term, the combined effect of prescribed fire and timber harvest (the primary drivers for this plan) are expected to create 1,069,322 acres of modeled Indiana bat habitat and 4,546,256 acres of modeled habitat for northern long-eared bats (Table 5-1). Overall, the positive, long-term effects of prescribed fires are expected to improve the quality of more acres of suitable habitat than the negative effects of timber harvest. As discussed in Chapter 4, these affected acres contain a low density of bats, and the risk of taking a bat from a given covered activity is expected to be minor because WNS has reduced the number of bats in residence.

The conservation strategy described in Sections 5.3, *Biological Goals and Objectives*; Section 5.4, *Avoidance and Minimization Measures*; and Section 5.5, *Mitigation Measures*, is aimed at avoiding, minimizing, and mitigating the effects of covered activities such that take is fully offset. Avoidance and minimization of effects on bats is achieved by leaving potential roost trees undisturbed (where feasible), protecting known roosts, avoiding wintering bats, and reducing effects from other covered activities (Objectives 1.2, 1.3, 3.1). Several objectives aim to enhance habitat for covered bats over time by creating favorable conditions for foraging and roosting (Objectives 1.3, 2.2, 2.3). The practice of forestry with residuals, along with prescribed fire, enhances habitat and has demonstrated benefits for covered bats (Guldin et al. 2007; Boyles and Aubrey 2006) (Table 5.1 and Objectives 1.2, 2.1). The conservation strategy also promotes outreach, training, and understanding of covered bats (Objectives 5.1, 5.2).

While the driver of the State Lands Forestry HCP is forestry, several hibernacula are located on State Lands. Actions to protect and enhance hibernacula include gating, removing obstructions around hibernacula entrances, closing hibernacula seasonally to public visitation, and avoiding effects from timber harvest and prescribed burning (Objective 1.1). PGC and DCNR also promote recovery from WNS through provisioning of artificial roosts for infected bats (Objective 4.1).

Collectively, these actions fully offset the take of bats associated with the covered activities.

5.7 Adaptive Management

Based on the HCP Handbook (U.S. Fish and Wildlife Service 2016), adaptive management is a tool to address uncertainty in the conservation of a covered species. Specifically, adaptive management is aimed at resolving significant data or information gaps. Uncertainty regarding the conservation of the covered bat species is driven almost entirely by WNS—how it will play out in the plan area, whether a cure will be discovered, and how resilient the species might be over time. This issue and associated responses (remedial measures) are described in Section 6.5.1.2, *White-Nose Syndrom*e.

Other significant data or information gaps relevant to managing the species on State Lands include the location of occupied hibernacula, the use of hibernacula, the location and use of maternity colonies, and the way habitat in the plan area may change over time, especially if some shifts are driven by changes in climate. Nevertheless, uncertainty regarding the effectiveness of conservation measures on the target species cannot be reliably tested in a population of bats that is rapidly declining because of issues outside PGC's and DCNR's control. Therefore, adaptive management in this HCP is focused on the following actions.

- Describe an overall approach of *learning by doing* that will inform monitoring and management.
- Outline a strategy for protecting additional hibernacula and removing restrictions on unoccupied hibernacula.
- Describe a method for adaptively protecting the 100 maternity colonies targeted for northern long-eared bats.
- Remap modeled habitat periodically to reflect new information and changing conditions.

5.7.1 General Procedures

The State Lands Forestry HCP adaptive management program incorporates the four elements USFWS recommends for adaptive management strategies in HCPs (65 *Federal Register* 35252).

- Identify uncertainties and the questions that need to be addressed to resolve the uncertainties.
- Develop alternative strategies. Evaluate pilot projects implementing alternative strategies on a small scale to determine which strategies to implement more broadly.
- Integrate a monitoring program to detect the necessary information for strategy evaluation.
- Incorporate feedback loops that link implementation and monitoring to a decision-making process.

Figure 5-5 illustrates how adaptive management will be used during HCP implementation.

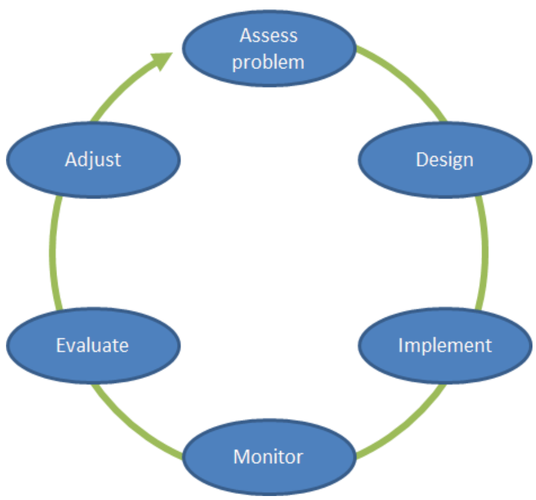


Figure 5-5. Adaptive Management Concept Model

PGC and DCNR will strive to work adaptively and to integrate new information, both gathered externally to the HCP process and through HCP implementation, to make the conservation program more effective. As stated in Section 5.8, *Monitoring*, a database will track monitoring results and any modifications to management practices or alternative strategies selected for implementation in response to monitoring results. Biologists from each agency will oversee the monitoring process; a GIS manager will oversee the database (Chapter 6, *Implementation and Assurances*).

5.7.2 Location and Use of Hibernacula

The locations and use of existing and future hibernacula on State Lands are uncertain. There are currently 20 known Indiana bat hibernacula in Pennsylvania, seven of which are on State Lands. As part of the conservation program, all seven are protected and managed for continued occupation by Indiana bats (CM-1 *Install Gates at Known Hibernacula,* CM-2 *Remove Obstructions around Known Hibernacula,* and CM-3 *Close Hibernacula Seasonally to Public Visitation*). Additional hibernacula may be identified opportunistically. If new, occupied Indiana bat hibernacula are found on State Lands, up to three will be gated and managed for the species. If these sites are identified, winter and fall/spring habitat will be designated and the associated restrictions will be followed (e.g., CM-7 *Avoid Timber Harvest Effects on Winter Habitat*). If more than three new hibernacula are identified, PGC and DCNR will reduce the amount of bat boxes in the plan area and reallocate resources to gate additional caves, with approval from USFWS. A hibernaculum is considered occupied if the species is found hibernating at the site or is captured at the entrance during swarming or staging.

For northern long-eared bats, 32 sites on State Lands have been identified as potential hibernacula. However, these have not been established as currently occupied. Identification of occupied hibernacula will be prioritized through the development of a survey plan in the first year of plan implementation, and all sites will be designated as Category 1, 2, or 3. Category 1 hibernacula will be gated as described in Section 5.4.1, *Caves and Mines.* Should additional new, occupied sites for northern long-eared bats be located, up to three of those will be gated during the permit term and additional fall/spring habitat designated. If more than three new hibernacula are identified, PGC/DCNR will reduce the amount of bat boxes established within the plan area and reallocate resources to gate additional caves, with approval from USFWS.

Conversely, if bat populations continue to decline, hibernacula and associated habitat may be vacated by the species. An Indiana bat or northern long-eared bat hibernaculum will be considered historical if it has been surveyed annually but no bats were observed for the past 10 years. In this case, associated winter and fall/spring habitat restrictions will be lifted (CM-1 *Install Gates at Known Hibernacula,* CM-2 *Remove Obstructions around Known Hibernacula,* CM-3 *Close Hibernacula Seasonally to Public Visitation,* CM-7 *Avoid Timber Harvest Effects on Winter Habitat*, CM-8 *Limit Firewood Collection Seasonally (Fall/Spring),* CM-11 *Restrict Prescribed Fire Seasonally (Summer)*). Subsequently, biannual winter surveys will reaffirm that the hibernaculum is not occupied by covered bats.

For both species, PGC and DCNR will determine how to document lack of occupancy through hibernacula surveys. PGC and DCNR may choose to assume a cave is occupied rather than document lack of occupancy. If hibernacula are classified as historical/unoccupied, HCP restrictions on covered activities in the associated winter and fall/spring habitat will be removed.

5.7.3 Prioritization of Roost Tree Protections

The location and use of northern long-eared bat roost trees are uncertainties under this HCP. Northern long-eared bat roosting activity areas will be limited to 100 (approximately 5,210 acres), and may shift because of the summer habitat surveys conducted as part of the monitoring program. CM-6, *Cease Harvest Activities when Bats Are Detected*, details how these areas will be identified for protection, including how they will be managed adaptively over time.

Protected roosting activity areas will be resurveyed periodically (each roost will be surveyed at least once every 5 years) to verify their continued use. If roosting activity areas are no longer in use, PGC, DCNR, and USFWS will jointly determine, based on field data, whether the protections for the roosting activity area can be relinquished.

If more than 100 roosting activity areas are identified on State Lands, PGC and DCNR will, in collaboration with USFWS, develop a prioritization system to identify which of the 100 roosting activity areas provide the best conservation value to the species. The following factors will be considered in the prioritization system.

- Prioritize roosts or colonies with large numbers of bats in order to protect the maximum number of individuals.
- Prioritize areas where bats have been known for many years in order to focus conservation efforts on those colonies that remain stable.
- Prioritize locations that are spread throughout State Lands to protect colonies under a diverse set of climatic conditions.

5.7.4 Shifts in Modeled Summer Habitat

Habitat may grow or shrink depending on climate change, associated shifts in the extent and location of vegetation, and new bat occurrence data, among other variables. It is uncertain how much and where modeled habitat for both bat species will be located throughout the permit term. This uncertainty will be addressed through adaptive management.

Three conservation measures are based on modeled summer habitat for Indiana bats (CM-4 *Minimize Effects on Trees that Provide Summer Roosting Habitat*, CM-5 *Avoid Timber Harvest Effects on Non-Volant Pups in Maternity Colonies,* and CM-9 *Limit Firewood Collection Seasonally(Summer)*), and permitted take levels are based on acres in the modeled habitat. As discussed in Chapter 3, *Environmental Setting*, the modeled habitat for Indiana bats is heavily influenced by climate. The results of this model support the hypothesis that much of Pennsylvania is currently too wet and cold to serve as viable Indiana bat habitat during summer. These results are consistent with multiple previous studies (Brack et al. 2002; Loeb and Winters 2013; Weber and Sparks 2013). Loeb and Winters (2013) used MaxEnt (v. 3.3.3e) to model current and future distributions of Indiana bat summer maternity colonies, using county-level maternity records and climate data for the eastern United States over a range of climate scenarios. Summer habitat selection was predicted to move northward or up in elevation in response to climate change for almost all scenarios and periods. Loeb and Winters (2013) also hypothesized that the topographic complexity of the Appalachian Mountains could provide more micro-refugia for Indiana bats. As predicted by Loeb and Winters (2013), it is likely that climate change will result in portions of the state that are currently too cold and wet to become suitable Indiana bat habitat. Recent data (Schimel et al. 2013) indicate that Pennsylvania (and the rest of the Northeast) is warming more rapidly than the current center of the species' summer range (the agricultural Midwest). These data indicate that a typical species range for Indiana bat could change by an average rate of 0.5 kilometer (approximately 547 yards) per year, with many species requiring 1 to 10 kilometers (approximately 1,094 yards to 6 miles) per year to maintain their current climatic conditions. By the end of the permit term, portions of the north-central area of the state could become climatically suitable for Indiana bats during summer. However, while it seems likely that more northern and high-altitude areas could become more suitable, allowing for a northern range expansion, it is less clear that there will be southern range contraction of suitable habitat, including in Pennsylvania.

At present, no studies have been completed that predict the response of northern long-eared bats to climatic changes. As with many species, some northward shift in the species' distribution will occur. Unlike for Indiana bats, the modeled summer habitat for northern long-eared bats (Table 3-14) was not highly dependent on climatic variables. This is not surprising given the species' wide geographic range. As such, it is anticipated that northern long-eared bats are less likely to experience shifts in habitat extent and distribution relative to Indiana bat.

In response to potential changes in bat habitat, modeling for both species will be adjusted every 5 years to incorporate new occurrence data, new vegetation data, new temperature information, and other model attributes as described in Chapter 3, *Environmental Setting,* and Appendix H, *Habitat Distribution Modeling Using MaxEnt*. HCP commitments that affect summer habitat will shift as summer habitat shifts. Because of the lag time between actual changes to climate and response in terms of temperature, vegetation, and occurrence data, it is not anticipated that climate change will significantly shift mapped habitat over the course of the permit term, although effects are predicted to be stronger toward the end of the permit term.

PGC and DCNR have limited resources and even the current seasonal restrictions in summer habitat create a challenge for implementing the broad-based management needed to protect all of the state's natural resources. In order to balance the potential increase in suitable habitat against the legal mandate to manage all natural resources for future generations, PGC and DCNR commit to extending the summer habitat conservation measures that could be affected by a change in modeled habitat of Indiana bats to no more than a 10 percent increase (approximately 533,000 acres). PGC and DCNR will consult with USFWS to determine which of those acres will be managed for covered species if summer habitat increases by more than 10 percent.

Conversely, PGC and DCNR are committed to extending the summer habitat conservation measures for Indiana bats across a landmass of at least 436,000 acres (90 percent of the current modeled summer habitat) throughout the permit term, even if modeled habitat decreases by more than 90 percent.

Should modeled summer habitat decrease or increase over the permit term by up to 10 percent, the commitments in CM-21 *Enhance Foraging and Roosting Habitat* and CM-22 *Install Artificial Roost Structures* would shift proportionately.

5.8 Monitoring

Monitoring the outcomes of avoidance, minimization, and mitigation is the foundation of an adaptive approach and can help advance scientific understanding and modify management actions iteratively. *Compliance monitoring* verifies that the permittees implement the terms of the State Lands Forestry HCP and its permit. *Effectiveness monitoring* evaluates the effects of the permitted actions and the achievement of the goals and objectives of the HCP. A standardized monitoring and reporting program ensures a consistent approach across covered lands. Because of the uncertain future of bats affected with WNS, most of the effectiveness monitoring efforts will focus on the goal of providing high-quality habitat should the species begin to recover.

5.8.1 Compliance Monitoring

Compliance monitoring tracks the implementation of the State Lands Forestry HCP and documents that requirements of the HCP are met. Specifically, it will verify that PGC and DCNR are implementing the terms of the State Lands Forestry HCP, the ITP, and the authorized level of incidental take. Management activities will be documented to demonstrate that the HCP and its required minimization, mitigation, and funding commitments are being properly implemented (e.g., acres of timber harvest, acres of prescribed fire, gates, or artificial hibernacula installed). Results of compliance monitoring will be included in an annual report submitted to USFWS

5.8.2 Effectiveness Monitoring

Effectiveness monitoring assesses the biological success of the State Lands Forestry HCP. Specifically, it will evaluate progress toward meeting the biological goals and objectives. It will assess whether the conservation program is effective at minimizing or mitigating effects and whether there is a need to adjust measures to improve the conservation strategy. Effectiveness monitoring is characterized as *effects monitoring* and *status and trends monitoring*, as described in the following subsections.

5.8.2.1 Effects Monitoring

Effects monitoring will ascertain the success of achieving desired outcomes, provide information and mechanisms for altering management, if necessary, and evaluate whether biological goals and objectives have been achieved.

5.8.2.2 Status and Trends

Existing baseline data for Indiana bats and northern long-eared bats on State Lands will be compiled within 8 months following permit issuance to document the status of both species and their habitats at the beginning of the permit term. This will provide a reference point for future status and trends monitoring.

PGC and DCNR will monitor the status and trends of the Indiana bat and northern long-eared bat population and bat habitat across State Lands. PGC will continue to support the USFWS statewide population estimates used to produce range-wide estimates. Surveys will include quantitative data on bat populations and habitat. Qualitative assessments of habitat quality will also be a component of status and trends monitoring.

Table 5-7 summarizes the monitoring actions, frequencies, and required documentation.

Table 5-7. Status and Trends Monitoring

ID No.	Monitoring Action	Frequency	Documentation in Annual Report to USFWS
Summer Habitat Surveys			
M-1	PGC and DCNR will continue mist-netting surveys (approximately 12 field days) in areas of greatest scientific value (e.g., in known populations of both Indiana and northern long-eared bats to understand WNS survivorship, calculate Indiana bat maternity colony success, understand fall migratory movements). Indiana and northern long-eared bats captured during these events will be radio-tracked in accordance with current USFWS and PGC protocols. PGC will continue to require mist netting and reporting from environmental contractors who must get a permit from PGC to handle bats in Pennsylvania. The results of both efforts will be compiled into the PGC bat net/trap database and provided to USFWS.	At least four sites annually during the approved summer survey period for Indiana and northern long-eared bats	Documentation of survey activities and findings in annual report, which will include appropriate data sheets as required by USFWS and PGC
M-2	PGC and DCNR will continue annual direct visual counts of the maternity colony at Canoe Creek State Park. Mist-netting of this colony will be conducted at least once every 3 years during the maternity season (Butchkoski 2003; Butchkoski and Mehring 2004; Butchkoski and Turner 2005, 2006, 2007, 2008; Butchkoski 2009, 2010). Indiana or northern long-eared bats captured during this effort will be tracked in accordance with current USFWS and PGC protocols.	Visual count annually; mist-netting at least once every 3 years	Documentation of activities and findings
M-3	PGC and DCNR will continue direct visual counts of maternity colonies and existing and new artificial roost sites, including those used by Indiana and northern long-eared bats, across the state as part of the Appalachian Bat Count.	Approximately 200 sites annually	Documentation of activities and findings
M-4	PGC and DCNR will continue to participate in the USGS NABat monitoring program by completing six transects in each of the six PGC regions throughout the state. Currently, this requires a minimum of 35 nights of monitoring which are completed by driving a designated route at 20 miles an hour, recording bat calls during the trip, and subsequently using approved software to analyze and identify calls. These routes provide an index of summer bat populations of all species and a means of locating unknown colonies of Indiana and northern long-eared bats.	Annually	Documentation of survey activities and findings

ID No.	Monitoring Action	Frequency	Documentation in Annual Report to USFWS
M-5	PGC will continue to request that telemetry of both covered bat species be conducted as a condition of PGC permit issuance to QBSs for handling of bats (PGC issued an average of 18 permits annually from 2010 to 2015). Telemetry will be conducted in accordance with the guidelines outlined in the *PA Game Commission Bat Surveyor Packet*, which is updated annually in coordination with USFWS. Because of both species' population decline in Pennsylvania, there may be years in which capture efforts fail to acquire one or both species.	As able	Documentation of activities and findings
Fall/Spring Habitat Surveys			
M-6	PGC will continue to perform sampling of bats "swarming" at cave or mine entrances using harp traps or mist nests during spring (April or May) or fall (August to November) to assess presence and population of covered bat species.	At least one trapping event at three to six different hibernacula annually	Documentation of survey activities and findings
Winter (Hibernacula) Surveys			
M-7	PGC will continue to perform visual inspection of caves and mines for hibernating bats from December through March to assess presence and population of covered bat species.	Annual surveys typically include at least one survey at each of 30 different hibernacula.	Documentation of survey activities and findings

PGC = Pennsylvania Game Commission; DCNR = Department of Conservation and Natural Resources; USFWS = U.S. Fish and Wildlife Service;; WNS = white-nose syndrome; USGS = U.S. Geological Survey; NABat = North American Bat (monitoring program); QBS = qualified bat surveyor

5.8.3 Monitoring Methods

Compliance and effectiveness monitoring will begin once the HCP is permitted. Monitoring the status and trends of Indiana bats and northern long-eared bats will build on existing baseline data assembled as part of HCP development (e.g., modeled habitat, bat populations, hibernacula counts, and location of maternity roosts). Where feasible, PGC and DCNR will draw from relevant and established monitoring protocols (USFWS and PGC survey protocols) and will adapt new protocols as more information becomes available and as guidelines change and progress. Sampling protocols will adjust the sensitivity of the data relative to the probability of detection, provide consistency over time such that annual information can be compared, and minimize potential transmission of WNS as part of any monitoring effort.

A schedule of PGC and DCNR monitoring actions (status and trends monitoring as well as conservation measure-specific monitoring) over the permit term is provided in Table 5-8. Table 5-8 also documents the effectiveness criteria for management actions (e.g., occupation of artificial roosts, successful gating of hibernacula, habitat variables achieved through active management such as timber harvest and fire).Table 5-9 shows the occurrence of conservation measures and monitoring actions over the 30-year permit term.

Table 5-8. Conservation Measure-Specific Monitoring

Conservation Measure	Monitoring Action (PGC and DCNR or designees)	Frequency	Documentation in Annual Report to USFWS
CM-1 Install Gates at Known Hibernacula	Compliance: Install gates and categorize hibernacula as described in Section 5.4.1, *Caves and Mines*. Check the location and condition of signs and gates to ensure that no vandalism has occurred and gates are structurally sound.	See hibernacula surveys in Table 5-7	• Photo documentation of the location and condition of signs at hibernacula entrances. • Photo documentation of the location and condition of hibernacula gates. • Documentation of northern long-eared bat hibernacula survey plan and findings.
	Effectiveness: In hibernacula that can be safely entered by agency staff, place cameras or speleologgers (light-sensitive event detectors) similar to those used in other states (Johnson et al. 2002) to ensure that gates and signage prevent human entry. Detectors placed in dark regions will record disturbance events in the hibernacula. Detectors will be serviced every other year as part of the hibernacula surveys in Table 5-7.	See hibernacula surveys in Table 5-7	• Documentation of maintenance of cameras and detectors. • Documentation of any recorded disturbance events. • Management recommendations to improve effectiveness.
CM-2 Remove Obstructions around Known Hibernacula	Compliance: Inspect the six Indiana bat hibernacula entrances annually in late summer or early fall to ensure that hibernacula have not become compromised by water, vegetation, or debris. Inspect Category 1 northern long-eared bat hibernacula at least every other year. Direct removal of problematic obstructions; however, removal activities can be conducted by BHIs at the direction of the QBS.	See hibernacula surveys in Table 5-7	• Documentation of QBS recommendations. • Documentation of obstruction removal, complete with photo documentation.
	Effectiveness: A QBS or bat identifier will conduct a survey of the status of each hibernaculum.	See hibernacula surveys in Table 5-7	• Documentation of QBS recommendations.
CM-3 Close Hibernacula Seasonally to Public Visitation	Compliance: Inspect signage and gates to close hibernacula on State Lands to visitation from September 15 to May 31.	See hibernacula surveys in Table 5-7	• Photo documentation of signage and other measures taken to prohibit human entry during this period.
	Effectiveness: Same as for CM-1.	See hibernacula surveys in Table 5-7	• Same as for CM-1.

Conservation Measure	Monitoring Action (PGC and DCNR or designees)	Frequency	Documentation in Annual Report to USFWS
CM-4 Minimize Effects on Trees that Provide Summer Roosting Habitat	Compliance: Avoid damaging or harvesting potential roost trees and identify northern long-eared bat roosting activity areas.	As needed	• Documentation of site visits with documentation and photos of potential roosts before and after harvest. • Documentation of identified northern long-eared bat roosting activity areas. • Documentation of any take of covered bats (regardless of season).
	Effectiveness: Monitor timber sale sites to ensure that the conditions of timber sale contracts are being met for completed sales. Ensure that best management practices are being implemented and that state guidelines for regeneration, snag retention, species retention, design, layout, road building, etc. are being followed. Ensure that the tree and snag retention guidelines are being met. Bureau of Forestry timber sales are also independently audited by the Forest Stewardship Council, which randomly audits four or five State Forest districts each year. The council will incorporate the timber harvest guidelines outlined in the HCP into their audit process. Bureau of Forestry will provide the results of all council audits to USFWS as part of the annual report (PGC and Bureau of Forestry).	Annually	• Documentation of site visits with documentation and photos of potential roosts before and after harvest. • Results of all Forest Stewardship Council audits conducted during the year.
CM-5 Avoid Timber Harvest Effects on Non-Volant Pups in Maternity Colonies	Same as for CM-4.	Annually	• Same as for CM-4.
CM-6 Cease Harvest Activities when Bats Are Detected	Same as for CM-4. In addition, perform a GIS review to ensure that no harvest is authorized in designated northern long-eared bat roosting activity areas during the pup season.	Annually	• Same as for CM-4. • Documentation of GIS review.
CM-7 Avoid Timber Harvest Effects on Winter Habitat	Compliance: Perform a GIS review to ensure that no harvests occurred in protected areas.	Annually	• Documentation of locations where timber harvest occurred throughout State Lands.
	Effectiveness: Not applicable—will be related to status and trend monitoring.	--	--

Conservation Measure	Monitoring Action (PGC and DCNR or designees)	Frequency	Documentation in Annual Report to USFWS
CM-8 Limit Firewood Collection Seasonally (Fall/Spring)	Compliance: Continue to monitor State Lands for illegal activity (which includes firewood collection where prohibited) and issue tickets for violations. Include a record of all citations issued for illegal firewood collection in closure areas in the annual report submitted to USFWS. Any take of Indiana bats or northern long-eared bats by woodcutters will be reported (PGC game wardens, wildlife conservation officers, DCNR rangers, and State Forest officers)	Annually	• Documentation of citations issued.
	Effectiveness: Visit closure areas during site reviews to ensure that roost areas are protected (Bureau of Forestry staff, BHIs).	Annually	• Report of any known take of Indiana bats or northern long-eared bats by woodcutters. • Management recommendations to improve effectiveness.
CM-9 Limit Firewood Collection Seasonally (Summer)	Compliance: Monitor as described for CM-8. Report any take of Indiana bats or northern long-eared bats by woodcutters.	Annually	• Documentation of citations issued.
	Effectiveness: Visit closure areas during site reviews to ensure that roost areas are protected. Evaluate the results of the habitat distribution model annually and update closure areas, as needed (Bureau of Forestry staff, BHIs).	Annually	• Report of any known take of Indiana bats or northern long-eared bats by woodcutters. • Management recommendations to improve effectiveness.
CM-10 Restrict Prescribed Fire Seasonally (Winter)	Compliance: Verify that all prescribed burns were conducted outside the restriction window unless preapproved by USFWS.	A minimum of once every 5 years	• Documentation and mapping of burns undertaken.
	Effectiveness: Not applicable—related to status and trend monitoring.	--	--
CM-11 Restrict Prescribed Fire Seasonally (Summer)	Compliance: Verify that all prescribed burns were conducted outside the restriction window, unless preapproved by USFWS.	A minimum of once every 5 years	• Documentation and mapping of burns undertaken.
	Effectiveness: Not applicable—related to status and trend monitoring.		

Conservation Measure	Monitoring Action (PGC and DCNR or designees)	Frequency	Documentation in Annual Report to USFWS
CM-12 Manage Prescribed Burns to Minimize Effects on Bats	Compliance: Verify that all prescribed burns were conducted outside the restriction window, unless preapproved by USFWS.	Annually	• Documentation and mapping of burns undertaken. • Smoke management plans prepared for each burn.
	Effectiveness: Perform a GIS review to determine if any prohibited areas were burned.	A minimum of once every 5 years	• Management recommendations to improve effectiveness.
CM-13 Restrict Vehicles and Equipment in Perennial Stream and Riparian Areas	Compliance: Monitor State Lands for illegal activity (which includes vehicle entry where prohibited) and issue tickets for violations. Provide a summary of all citations issued for illegal vehicle activity in the annual report submitted to USFWS (PGC game wardens, wildlife conservation officers, DCNR rangers, and State Forest officers).	Annually	• Documentation of enforcement activities. • Management recommendations to improve effectiveness.
	Effectiveness: Assess riparian areas for vehicle activity during regular monitoring of State Lands (PGC and Bureau of Forestry BHIs).		
CM-14 Retain Vegetation in Perennial Stream and Riparian Areas	Compliance: Monitor State Lands for illegal activity (which includes removing riparian vegetation where prohibited) and issue tickets for violations. Provide a summary of all citations issued for illegal vehicle activity in the annual report submitted to USFWS (PGC game wardens, wildlife conservation officers, DCNR rangers, and State Forest officers).	Annually	• Documentation of enforcement activities. • Management recommendations to improve effectiveness.
	Effectiveness: Assess riparian areas for vegetation removal during regular monitoring of State Lands (PGC and Bureau of Forestry BHIs).		
CM-15 Implement Erosion and Sediment Control Plans	Compliance: Annually review documentation to ensure that erosion and sediment control plans are developed for all logging and other earth-disturbing activities. During annual audits of timber sale sites, ensure that erosion and sediment control measures are being followed (PGC and Bureau of Forestry).	Annually	• Documentation of activities. • Management recommendations to improve effectiveness.
	Effectiveness: Not applicable.	--	--

Conservation Measure	Monitoring Action (PGC and DCNR or designees)	Frequency	Documentation in Annual Report to USFWS
CM-16 Implement Spill Pollution Prevention Measures	Compliance: Annually review documentation to ensure that spill pollution prevention measures are being implemented for appropriate agency activities. During annual audits of timber sale sites, ensure that steps are being taken to avoid point- and minimize nonpoint-source pollution in streams and other waterbodies.	Annually	• Documentation of plans. • Documentation of spills and the steps taken to address them. • Management recommendations to improve effectiveness.
	Effectiveness: Not applicable.	--	--
CM-17 Maintain Speed Limits on Forest Roads	Compliance: Monitor State Lands for illegal activity (which includes speed limit violations) and issue tickets for violations. Review road signage at least every 5 years to ensure that speed limit signs are in place and in good condition. Review records of speed limit citations on State Lands to determine if additional signage is needed (PGC game wardens, wildlife conservation officers, DCNR rangers, and State Forest officers).	Every 5 years	• Map or GIS layer showing the roads on State Lands where speed limits are restricted. • Documentation of activities.
	Effectiveness: Review the literature on bats and vehicle collisions and speed. If this review suggests that a different management approach would be useful, coordinate with USFWS.	A minimum of once every 5 years	• Documentation of any take of Indiana bats or northern long-eared bats. • Documentation of findings. • Management recommendations to improve effectiveness.
CM-18 Implement Staff Training Program	Compliance: Document training of land managers in overall ecology of covered bats and specialized habitat needs such as summer roosts, foraging areas, and identification of potential hibernacula for both species.	Annually	• Documentation of training events (to include date, location, and topics covered, number of attendees).
	Effectiveness: Not applicable.	--	--
CM-19 Support Public Engagement	Compliance: Document all outreach efforts (including date, location, and topics covered) on an annual basis.	Annually	• Documentation of outreach events (to include date, location, and topics covered, number of attendees).
	Effectiveness: Not applicable.	--	--

Conservation Measure	Monitoring Action (PGC and DCNR or designees)	Frequency	Documentation in Annual Report to USFWS
CM-20 Maintain a Forested Landscape in a Variety of Seral Stages	Compliance: Annually review timber sale records on State Lands to ensure that the amount of forest cover remains at or more than 3.5 million acres throughout the permit duration and that areas of modeled Indiana bat and northern long-eared bat habitat remain at or more than current levels (PGC and Bureau of Forestry).	Annually	• Documentation of acreage of forest cover across State Lands. • Documentation of acreage of summer, fall/spring, and winter habitat for covered bats across State Lands.
	Effectiveness: Perform a review of habitat cover and quality based on the most recent vegetative data maintained by the agencies.	Every 5 years	• Documentation of review and findings • Management recommendations to improve effectiveness.
CM-21 Enhance Foraging and Roosting Habitat	Compliance: Manage timber harvests and prescribed fire to ensure maintenance of summer habitat for covered bats. Review timber sale sites to ensure that retention guidelines are being followed as described under CM-4.	Annually	• Documentation of acreage of summer, habitat for covered bats across State Lands.
	Effectiveness: Review habitat cover and quality based on the most recent vegetative data maintained by the agencies.	Every 5 years	• Documentation of review and findings. • Management recommendations to improve effectiveness, as applicable.
CM-22 Install Artificial Roost Structures	Compliance: Record quantities, activities, and locations of structures installed or maintained.	As needed	• Documentation of location and status of artificial roosts.
	Effectiveness: Examine structures will be to determine bat use. If bats are present, count bat emergences. Mount a guano screen to the base to collect fecal pellets, which may be submitted for genetic analysis (Judy et al. 2010) (QBS or BHI).	Every 5 years	• Documentation of condition and use of artificial roosts. • Management recommendations to improve effectiveness.

Conservation Measure	Monitoring Action (PGC and DCNR or designees)	Frequency	Documentation in Annual Report to USFWS
CM-23 Identify, Assess, Protect, and Enhance Potential Hibernacula	Compliance: Document all efforts to survey State Lands for potential Indiana bat hibernacula. Identify and enhance at least five hibernacula in the first 15 years and the remaining five hibernacula in the remaining 15 years (if not sooner). Report annually on progress towards these benchmarks. Record the status of all identified potential hibernacula and any steps taken to enhance the quality of potential hibernacula for Indiana bats (through direct means, such as structural modifications, or indirectly through other management efforts).	Annually	• Documentation of steps leading to and locations of created hibernacula on State Lands.
	Effectiveness: Following gating and or modification, equip each site that is safe to enter with a speleologger to determine if the site provides suitable temperatures for Indiana bats.	Annually	• Documentation of survey data and findings. • Management recommendations to improve quality of hibernacula.
CM-24 Provide Artificial Roosts for Infected Bats	Compliance: Document or verify installation of artificial roosts near hibernacula so that WNS-infected bats can recover following emergence.	As needed	• Documentation of location and status of artificial roosts.
	Effectiveness: Monitor created roosts to determine use.	Annually	• Documentation of condition and use of artificial roosts.

PGC = Pennsylvania Game Commission; DCNR = Department of Conservation and Natural Resources; USFWS = U.S. Fish and Wildlife Service; QBS = qualified bat surveyor; BHI = bat habitat identifier; HCP = habitat conservation plan; GIS = geographic information system; WNS = white-nose syndrome

Table 5-9. Occurrence of Conservation Measures and Monitoring Actions over the Permit Term

Monitoring Action	Year																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Caves and Mines																														
Check hibernacula gates and signage, service speleologgers (CM-1, CM-3)																														
Check ungated hibernacula entrances for obstructions (CM-2)																														
Perform visual inspection for hibernating bats (CM-7)																														
Perform fall/spring sampling at cave entrances (CM-6)																														
Document all efforts to survey State Lands for potential hibernacula. (CM-23)																														
Timber Harvest																														
Regular inspection of timber sale sites (CM-5, CM-6)																														

Monitoring Action	Year																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
GIS review to ensure that no harvests occurred in protected areas (i.e., roosting activity areas) (CM-5, CM-7)																														
Mist-netting surveys in summer habitat (CM-1)																														
Mist-netting of Canoe Creek bat colony during maternity season (CM-2)[a]																														
Direct visual counts of Canoe Creek maternity colony (CM-1)																														
Direct visual counts of maternity colonies and artificial roost sites across the state (CM-3)																														
Bat acoustic transect surveys (CM-4)																														
Request telemetry as condition of permit issuance (CM-5)[b]																														

Monitoring Action	Year																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Firewood, Streams and Riparian Areas																														
Regularly monitor State Lands for illegal activity (CM-8, CM-9, CM-13, CM-14)																														
Assess riparian areas for vehicle activity and vegetation removal (CM-13, CM-14)																														
Review documentation to ensure that spill pollution prevention measures and erosion and sediment control plans are being developed and/or implemented (CM-15, CM-16)																														
Prescribed Fire																														
GIS review to ensure that no prescribed burns occurred in protected areas (CM-10, CM-11)																														
Roads and Trails																														
Review road signage and records of speed limit citations (CM-17)																														

Monitoring Action	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Review the literature on bats and vehicle collisions (CM-17)																														
Outreach and Training																														
Document training of PGC and DCNR staff (CM-18)																														
Document public outreach efforts (CM-19)																														
Forest Management																														
Review timber sale records on State Lands to ensure that the amount of forest cover remains at or more than 3.5 million acres (CM-20)																														
Review habitat cover and quality based on vegetative data (CM-20, 21)																														
Artificial Roosts																														
Survey artificial roost structures for bat use (CM-22, 24)[c]																														

[a] To occur at least once within the first 3 years of permit issuance and every 3 years thereafter.
[b] Telemetry will be requested as often as able, but is dependent on number of applications for PGC permits to conduct bat summer mist netting surveys each year (see CM-5).
[c] To occur at least once within the first 5 years of permit issuance and every 5 years thereafter.

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Chapter 6
Implementation and Assurances

6.1 Overview

Under the ESA, HCP implementation begins when the Section 10(a)(1)(B) ITP is issued. Primary responsibility for HCP implementation rests with PGC and DCNR.

This chapter describes the implementation framework of the State Lands Forestry HCP, including institutional arrangements, organizational structure, approval processes, the agencies' roles and responsibilities, and those of the agencies' permittees, lessees and contractors, and other stakeholders.

6.2 Implementation Structure

This section describes the organizational structure to implement the State Lands Forestry HCP. PGC and DCNR are applying as co-permittees for an ITP and will be jointly liable for its compliance and implementation. PGC and DCNR will jointly administer the State Lands Forestry HCP and share the responsibility for executing the requirements of this HCP.

PGC will be the main point of contact on behalf of both permittees. PGC will assign an employee to serve as the HCP administrator who will be responsible for managing and coordinating the work of staff and consultants responsible for implementing the conservation program (to include monitoring, reporting, and adaptive management). PGC and DCNR will each provide a GIS technician to track implementation of covered activities and conservation measures to demonstrate compliance with the State Lands Forestry HCP and permit terms and conditions. Senior biologists and foresters from each agency will also be responsible for implementation of the conservation program. The Bureau of State Parks will take the lead for public outreach, while the Bureau of Forestry and PGC will co-lead implementation of conservation measures related to timber harvest and prescribed fire.

The implementation structure in PGC and DCNR will consist of the following organizations:

- **Implementation Board.** Comprising key decision-makers from each agency (e.g., Executive Director of PGC, the Director of State Parks, the State Forester), this board will meet annually to be briefed on the progress of the State Lands Forestry HCP and to provide final input on outstanding HCP questions.
- **Steering Committee.** Comprising key foresters and biologists in charge of implementing avoidance and minimization measures, mitigation, and monitoring associated with the State Lands Forestry HCP, the composition of the committee will be based on the Steering Committee assembled during HCP development (Section 1.4.1, *Steering Committee*). This committee will meet quarterly for the first 5 years of HCP implementation. Meeting frequency may be reduced as necessary after the first 5 years but meetings will continue at least once a year throughout the permit term.

- **Implementing Team.** Comprising representatives from PGC (the State Lands Forestry HCP administrator), the Bureau of Forestry, and the Bureau of State Parks, the Implementing Team will meet monthly to coordinate day-to-day tasks associated with HCP implementation.

6.2.1 Implementation of Conservation Program

As noted in Chapter 1, *Introduction,* all activities covered under the State Lands Forestry HCP are ongoing activities conducted in accordance with PGC and DCNR's legal mandates and missions to conduct sustainable forest management. Current restrictions on these activities are communicated within both PGC and DCNR through agency-wide memos, internal guidance, and updates to the management plans for each management unit (i.e., State Game Land, State Forest, or State Park). These same tools will be revised to reflect HCP commitments. Due to the administrative burden needed to update the full suite of procedural documents across all State Lands, PGC and DCNR will update these documents iteratively. However, to ensure that HCP commitments are fully communicated to staff by Day 1 of the permit term, each agency (PGC and DCNR) will distribute a memo detailing HCP commitments upon permit issuance. The memo will be distributed to all agency staff, volunteers, or consultants certified as qualified bat surveyors (QBS) or bat habitat identifiers (BHI), PGC foresters, DCNR district foresters, PGC game wardens, wildlife conservation officers, DCNR rangers, State Forest officers, State Park managers, and any other staff with the authority to implement covered activities on State Lands. The memo will outline all changes to agency practice that result from implementation of the HCP, all new conservation measures that must be implemented, how these activities must be tracked and reported, and which staff are responsible for implementing and tracking HCP metrics. It will also provide staff with the contact information of the HCP Implementing Team for any questions related to HCP implementation.

This memo will be re-distributed every 6 months until the full suite of procedural documents has been updated. In addition, staff will be briefed on HCP commitments during management staff meetings until all documents have been updated. Because the activities proposed for coverage under the State Lands Forestry HCP are ongoing and because PGC and DCNR will continue to implement these activities in accordance with the USFWS Forest Management Guidelines until permit issuance (which include more restrictive provisions than those included in the State Lands Forestry HCP), no additional take would result from a delay in transmittal of HCP requirements.

In addition to the memo and meeting updates, the following procedural documents will be created or revised by PGC and DCNR staff to incorporate HCP commitments:

- Standard operating procedures for HCP implementation and reporting will be drafted and provided to staff within 6 months of permit issuance. The procedures will include, but will not be limited to:
  - A list of PGC and DCNR contacts on the Implementting Team, and how members of this team will be replaced, as necessary;
  - A description of those formally responsibilty for implementing those conservation measures that are not currently ongoing (e.g., CM-22 *Install Artificial Roost Strutures*)
  - A description of agency procedures for annual reporting, training, and fiscal tracking.
- PGC's agency guidelines on forestry and the DCNR forestry silviculture manual (Pennsylvania Department of Conservation and Natural Resources 2012) will be updated to incorporate HCP commitments within 6 months of permit issuance. As these documents prescribe how PGC and

DCNR foresters set up timber sale agreements, this will ensure that all new timber sales will incorporate relevant HCP commitments.

- As described in Section 2.2, *State Lands*, PGC and DCNR have plans that address management needs for each management unit. As part of HCP implementation, each of these plans will be revised to reflect HCP commitments, as applicable, during the next plan revision. The following plans will be updated:
  - Each State Game Land unit has a comprehensive management plan that addresses wildlife habitat management in the unit for each game and nongame species, including state and federally listed species. Comprehensive management plans are designed to last for 15 years and are updated every 5 years.
  - State Forest management is guided by the *2016 State Forest Resource Management Plan* (Commonwealth of Pennsylvania 2016), which establishes the broad goals for State Forest land management and is updated approximately every 5 years.
  - Individual plans for each State Forest District identify specific management goals and needs. These plans will be updated approximately every 5 years.
  - Each State Park has park and resource management plans. The park and resource management plans describes management activities and prescriptions relevant to the park, including habitat management for sensitive species. These plans are updated regularly and as needed, depending on new management techniques or prescriptions.
  - Existing prescribed burn plans will be updated within 90 days of permit issuance and all new burn plans will incorporate the relevant HCP commitments.
  - Bat monitoring data forms and databases will be updated prior to the first bat monitoring season to ensure that all the necessary information is being collected. If the ITP is issued less than 30 days prior to a bat monitoring season or in the middle of a bat monitoring season, the data forms and databases will be updated prior to the start of the following monitoring season.
  - Relevant fiscal tracking mechanisms will be updated as necessary within 90 days of permit issuance.

6.2.1 Distribution of Take

PGC and DCNR are applying for a joint permit from USFWS. Under the terms of this permit, the take limits represent a total cap for take across all three entities. As described in Section 4.3.4.3, *Five-Year Rolling Take Limits*, take limits are expressed as a 5-year rolling average to allow flexibility in covered activity amounts among agencies. As a result, if one entity exceeds their projected take allowance in a given year, one of the entities may be required to limit their take in that year or subsequent years so that the overall take limit is not exceeded. PGC and DCNR will meet annually before the end of the first fiscal quarter to discuss the take allowance included in the previous year's annual report and will identify covered activities that put co-permittees on a trajectory to exceed take within the 5-year period being evaluated. The agencies will then determine how future activities will be curtailed to maintain collective take below the 5-year rolling take limit.

6.2.2 HCP Controversies

PGC, DCNR, and USFWS (collectively, the *parties*) will strive at all times to work together in good faith to reach mutual agreement, as appropriate, on relevant implementation tasks, such as adaptive management, monitoring, and conservation actions. However, disputes concerning the implementation of the HCP may arise from time to time. The parties agree to work together in good faith to resolve such disputes, using the following process.

- **Step 1.** The party (PGC, DCNR or USFWS) wishing to institute dispute resolution will notify the other parties in writing of the dispute, identify the nature of the objection, and identify all grounds upon which the objection is based. The objecting party will also propose a solution or remedy to address the objection. The parties receiving the notice of dispute will respond in writing to the notice within 30 days or at such time as may be mutually agreed upon in writing by all parties. In doing so, the responding party will either propose a remedy to resolve the objection or, alternatively, explain why the objection is unfounded. Any party may seek clarification of any information provided related to the dispute. The objecting party will use its best efforts to provide any information then available that may be responsive within 10 days of receipt of such a request for clarification. If the response to an objection resolves the issue to the satisfaction of all parties, then the objecting party will so notify all parties in writing, and the agreed-upon remedy will be implemented by the responsible party.
- **Step 2.** If the response to an objection does not resolve the issue to the satisfaction of all parties, then the objecting party will notify all parties in writing, describing the reasons why the response does not resolve the objection and request a meeting of all parties. The notice will invite representatives from all parties to the meeting. All parties will meet within 30 days of the notice provided pursuant to Step 1 to resolve the dispute. The parties may, in writing, mutually agree to a different time for meeting. If the issue is resolved at this meeting, the resolution will be committed to writing and provided to all parties.
- **Step 3.** If the parties are unable to resolve a dispute through Steps 1 and 2, then an objecting party may elevate the dispute to a meeting of the chief executives of all parties. For purposes of this provision, *chief executive* will mean the Executive Director of PGC, the Director of State Parks, the State Forester, and the Assistant Regional Director of Ecological Services, Northeast Region, USFWS. Each party will be represented in person by its chief executive at the meeting, and the meeting will occur within 45 days of the notice of an objecting party following completion of Step 2.
- **Step 4.** At any time, any party may request mediation through the Commonwealth Office of General Counsel Dispute Resolution Program or where the USFWS is involved in the controversy, also the Department of the Interior's Office of Collaborative Action and Dispute Resolution.
- **Step 5.** The parties reserve their right, at any time without completing informal dispute resolution, to use whatever enforcement powers and remedies are available by law.

6.3 Implementation Responsibilities

6.3.1 PGC and DCNR

PGC and DCNR will oversee HCP implementation and will retain all program records. PGC and DCNR staff includes biologists, foresters, administrators, and other natural resource specialists who carry out planning and design, monitoring, adaptive management programs, and periodic coordination with and reporting to USFWS. To form a functional unit for carrying out this program, PGC and DCNR will assign HCP implementation responsibilities to specific individuals, including an HCP administrator, GIS technicians, biologists, foresters, and field crews. Sections 6.3.1.1 through 6.3.1.6 briefly describe the roles of these individuals. PGC and DCNR will provide USFWS with the names and titles of all agency staff fulfilling these key oversight roles within 30 days of permit issuance, and update that list through its annual reports, or more frequently, as warranted. Day-to-day implementation of the State Lands Forestry HCP will be managed collectively by staff of PGC and DCNR; however, PGC and DCNR will also coordinate with science advisors, outside consultants, and other land management agencies to ensure adequate and systematic implementation.

6.3.1.1 HCP Administrator and Implementing Team

PGC, the Bureau of Forestry, and the Bureau of State Parks will assign HCP implementation responsibilities to a specific individual who will serve as a member of the Implementing Team. As lead agency, PGC's representative will also serve as the HCP administrator. The HCP administrator will serve as a point of contact for HCP-related issues for PGC, DCNR, other state agencies, and USFWS. Each member of the team will provide support for and oversee the following tasks within their agency:

- Answer internal HCP-related questions.
- Coordinate bat surveys with supervising biologists.
- Coordinate audit activities for compliance with the HCP.
- Evaluate the effectiveness of the HCP.
- Develop and maintain annual budgets and work plans.
- Coordinate with GIS staff to perform periodic mapping of State Lands to update the modeled habitat (every 5 years).
- Maintain monitoring and survey data reports and archives, including monitoring results, and produce an annual report.
- Coordinate related training program(s) for PGC and DCNR staff.

HCP Administrator responsibilities are estimated to require 20 percent of one full-time employee's time annually. HCP Implementing Team responsibilities are estimated to require 15 percent of one full-time employee's time annually for the Bureau of Forestry and 10 percent of one full-time employee's time annually for the Bureau of State Parks (less time is allocated for the Bureau of State Parks because forestry activities and prescribed fire are limited on State Parks. When conducted, these activities are completed by Bureau of Forestry staff).

6.3.1.2 GIS Technician

PGC and DCNR will each provide one GIS technician who will develop GIS and other database systems to collect, store, and use spatial data necessary for HCP implementation. The PGC GIS technician will be responsible for State Game Lands; the DCNR GIS technician will be responsible for both State Forests and State Parks. Compliance monitoring will be addressed in part through the GIS database system. In addition, the status and trends of covered bats and their habitat across State Lands will be tracked through this system. PGC and DCNR will maintain the following baseline data:

- The location, extent, and timing of impacts on modeled habitat.
- The location, extent, and timing of implementation of all other conservation measures (e.g., protecting hibernacula, gating cave entrances, creating potential hibernacula, monitoring existing hibernacula, placing and maintaining artificial roosts in both summer and winter habitats)
- The results of all status and trends monitoring described in Section 5.8.2.2, *Status and Trends*.

The comprehensive data repository for compliance tracking will be operational within 8 months of HCP permit issuance. These reports and other data will be stored and archived electronically whenever possible. When electronic archiving is not available or feasible, PGC and DCNR will retain hard copy records, which, along with electronic records, will be available for inspection by USFWS.

Tracking and database updates related to program administration will require approximately 15 percent of a full-time employee's time annually between PGC and DCNR. Additional time will be required for implementation of specific conservation measures, monitoring actions, adaptive management, and changed circumstances (Chapter 7, *Cost and Funding*).

6.3.1.3 Community Outreach

As described in Section 5.4.7, *Outreach and Training*, PGC and DCNR staff will conduct outreach to State Land users and visitors, private landowners, cavers, and loggers about Indiana bats and northern long-eared bats to promote conservation efforts across the state. In addition, education and outreach efforts can help loggers and private landowners implement practices on private lands that benefit these species. To that end, the Bureau of State Parks will develop a public outreach program that will be delivered through at least four speaking engagements or outreach opportunities annually. For example, the Bureau of State Parks will exhibit and provide outreach materials at public events such as the Pennsylvania Farm Show in Harrisburg held each January. The Bureau of Forestry provides Sustainable Forestry Initiative training to loggers operating on State Forests and will update the bat module included in the training to reflect HCP commitments. In addition, PGC and DCNR will offer an annual training to the Mid Atlantic Karst Conservancy on bat protection in caves. These public outreach efforts will require approximately 1 percent of a full-time employee's time annually.

6.3.1.4 Senior Biologist

PGC and DCNR will each provide a senior biologist to oversee research and monitoring activities for that agency. The senior biologist duties include overseeing biological and technical staff performing fieldwork, providing logistical support, and ensuring that all research and monitoring work helps fulfill the biological goals and objectives of the State Lands Forestry HCP. PGC and DCNR biologists currently coordinate regularly as part of day-to-day operations and will continue to do so during the permit term to ensure consistency in implementation. Additional duties needed to oversee implementation of the conservation program will require approximately 50 percent of a full-time PGC senior biologist's time annually and 34 percent of a full-time DCNR senior biologist's time annually (the DCNR biologist will oversee projects on both State Forests and State Parks). More time is allocated to the PGC senior biologist, as this individual is likely to lead oversight of most implementation activities, with support from the DCNR senior biologist for specific projects on DCNR lands.

6.3.1.5 Biologist

PGC and DCNR will each provide a biologist to implement Indiana bat and northern long-eared bat surveys and conservation measures. The biologists will work on the ground to ensure compliance with state and federal regulations; establish monitoring and reference sites; keep detailed and accurate field and analytical records; and use an information management system to track, control, and report as necessary to achieve the goals and objectives of the conservation program. These duties will require approximately 20 percent of a full-time biologist's time annually for each agency. The DCNR biologist will complete HCP duties for both State Forests and State Parks.

6.3.1.6 Forestry Staff

PGC and the Bureau of Forestry will provide forestry staff to assist with planning and implementation of habitat enhancement and provide analysis of forest management efforts, including timber harvest and prescribed fire. These duties will require approximately 7 percent of a full-time Forest Assistant Manager's time for PGC and 8 percent of a full-time Forest Assistant Manager's time for the Bureau of Forestry.

6.3.1.7 Law Enforcement

Game wardens and DCNR rangers enforce the law on State Game Lands and DCNR lands respectively. These entities ensure that regulations related to illegal tree cutting and firewood removal, vehicle restrictions in stream areas, speed limits, and other activities are followed. These activities will continue under the State Lands Forestry HCP; therefore, no additional FTE time is needed.

6.3.1.8 Field Supervisor and Crews

PGC and DCNR operations and maintenance field supervisors will ensure that operations and maintenance field crews are trained in implementing the terms of the State Lands Forestry HCP. Supervisors will be responsible for requesting surveys, if needed and ensuring compliance during activities. Field crews will implement the State Lands Forestry HCP by attending environmental training and adhering to the avoidance and minimization measures specified for each job. These duties will require approximately 14 percent of a full-time employee's time annually.

6.3.1.9 Consultants and Contractors

PGC and DCNR periodically retain consultants and contractors to meet any technical or scientific needs that cannot be effectively or efficiently addressed by in-house staff. For example, outside qualified bat surveyors may be engaged for survey work if PGC and DCNR qualified bat surveyors are not available. The agencies will provide USFWS an updated list of all contractors as part of its annual report.

Additionally, some covered activities (e.g., timber harvest, firewood collection) are implemented by third-party contractors and/or permittees. As described in Chapter 2, *State Lands and Covered Activities,* PGC and DCNR bid timber sales out to third-party contractors. Through the timber sale process (Appendix N, *Timber Sale Process on Pennsylvania State Lands*) PGC and DCNR develop detailed instructions describing the trees to be cut and the trees to be retained during a sale; these instructions will incorporate all HCP commitments. The third-party contractor then cuts in accordance with these provisions and is subject to strict enforcement by PGC and DCNR if they fail to do so. Similarly, firewood collection in State Forests is subject to permit by DCNR. DCNR foresters will use the terms of the HCP to determine when and where firewood collection is permitted. Permittees will then collect firewood consistent with the terms of their permit (see example permit in Appendix O, *Firewood Program*).

6.3.2 USFWS

USFWS is the regulatory agency that issues and enforces the federal ITP. The successful execution of the conservation program by the state agencies—including monitoring, reporting, and adaptive management actions that are part of the State Lands Forestry HCP—may at times require USFWS review and approval. PGC and DCNR will coordinate with USFWS quarterly (through either the HCP administrator or the Implementing Team) and provide USFWS with annual reports concerning HCP implementation (Section 6.4, *Administration*).

Steering Committee meetings and annual implementation reports will keep USFWS apprised of progress toward conservation goals and objectives, funding, monitoring, adaptive management, and other relevant topics. The meetings will serve as a means for the agencies to alert USFWS to key conservation actions, such as land purchases, adaptive management, and monitoring prior to finalization. The meetings will also serve as a forum to troubleshoot potential issues before they affect permit compliance. USFWS will participate in these meetings in a technical capacity and will not have voting rights. USFWS participation in these meetings will not be construed as its endorsement of any resulting decision the Steering Committee recommends. In that regard, USFWS will maintain its regulatory and enforcement independence and reserve its rights to make its own decisions when called upon for approval, or when considering its enforcement options.

6.3.3 Scientific Review

The function of scientific review is to provide technical advice and to help assemble the best available scientific data on conservation actions, monitoring, and adaptive management. Scientists with expertise in conservation biology, management of local natural communities, and the ecology of the Indiana bat and northern long-eared bat will provide input, as appropriate, to PGC and DCNR. While no formal scientific review committee will be established, PGC and DCNR will consult outside scientists on an *ad hoc* basis as issues arise related to species ecology, habitat management, and monitoring. These reviewers could include the Pennsylvania Biological Survey's Mammal Technical Committee with which PGC has an existing relationship. This relationship is established through a Memorandum of Understanding between PGC and the Pennsylvania Biological Survey stating that the PGC recognizes the Pennsylvania Biological Survey and its pertinent technical committees as scientific advisors to the administrative and scientific staff of PGC.

6.3.4 Public Input

Public input is an important part of HCP implementation and can help PGC and DCNR generate continued support for the State Lands Forestry HCP throughout the process. PGC and DCNR will use a website[1] to provide key program information and reports. The website will also provide contact information to the public, which can be used to provide input and ask questions about the HCP. All reports associated with the State Lands Forestry HCP will be made available annually to the public through the HCP website, except reports documenting surveys on private lands being considered for acquisition but not owned by PGC or DCNR and location data for threatened and endangered species.

6.4 Administration

6.4.1 Data Tracking

Proper data management, analysis, and reporting are critical to tracking the monitoring and adaptive management program. Data on monitoring methods, results, and analysis must be managed, stored, and made available to staff, decision-makers, scientific advisors, USFWS, and others, as appropriate. A database and clear reporting procedures are also required for permit compliance. The database will be used to track HCP compliance and effectiveness, which includes the following elements.

- Progress toward achieving the biological goals and objectives by implementation of conservation actions (including avoidance, minimization, and mitigation).
- Implementation of covered activities, including location and extent of each activity (i.e., take allocated for that activity).
- Results of all monitoring activities described under Section 5.8, *Monitoring*.
- Changes to the boundaries of State Lands resulting from land transfers or acquisitions.
- Implementation of the changed circumstances and the monitoring and adaptive management program.
- Changes in modeled habitat for Indiana bats and northern long-eared bats.

6.4.2 Reporting

PGC and DCNR will prepare and submit a combined annual report for the duration of the permit term, detailing, among other things, compliance, effects, conservation actions, management actions, habitat restoration and creation actions, and monitoring results. The annual reports will summarize the previous state fiscal year's implementation activities (July 1 to June 30) and be provided to USFWS by January 15 following the reporting fiscal year. Annual reports will require synthesis of data and reporting on important trends. A due date of January 15 will allow time for the data from the previous fiscal year to be assembled, analyzed, and presented in a clear and concise format. In

[1] Website will be available when permit is issued.

addition to submitting to USFWS, annual reports will be made available to the public and posted to the HCP website.

The annual report will meet the following goals:

- Provide the information and data necessary for PGC and DCNR to demonstrate to USFWS and the public that the State Lands Forestry HCP is being implemented properly.
- Disclose any problems with HCP implementation and the corrective measures planned or implemented to address the problems.
- Identify amendments to the HCP or permit components required or requested of USFWS to increase the success of conservation measures, respond to changed circumstances, or address feedback loops through adaptive management.

The annual report will provide the following content, at a minimum:

- A copy of the memo communicating HCP requirements distributed to staff during year 1 of the permit term, as well as evidence of its distribution at permit issuance, and every 6 months until all PGC and DCNR procedural documents have been updated.
- Description of all covered activities implemented during the reporting period as well as cumulative total (i.e., from the start of the permit term).
    - Timber harvest—Total acreage of timber harvest conducted, including the location (i.e., game land unit, state forest, state park), the type of harvest, and the acreage of harvest in modeled seasonal habitat for covered bats.
    - Prescribed fire (burning and firebreaks)—Acres of prescribed fire, including the location (i.e., game land unit, state forest, state park), and the acreage of burning in modeled seasonal habitat for covered bats.
    - Fencing—Amount of new fence installed on State Lands, including the location (i.e., game land unit, state forest, state park), quantity of fencing (miles) and acreage of affected land in modeled seasonal habitat for covered bats.
    - Firewood collection—Amount of firewood collection on State Lands. This will include the number of firewood collection permits issued, a map of the road lengths designated for firewood collection, and the acreage of these areas in modeled seasonal habitat for covered bats.
    - Roads and trails constructed—Amount of new roads and trails constructed on State Lands, including the location (i.e., game land unit, state forest, state park), quantity of road or trail (miles) and the quantity of road or trail maintained.
- Calculation of the acreage of take for each type of modeled habitat (e.g., summer habitat for northern long-eared bats, fall/spring habitat for Indiana bats) using the covered activity data described previously, to demonstrate compliance with the authorized level of take on the ITP. If the implementation of covered activities resulted in the exceedance of take authorization (e.g., if timber harvest levels exceed authorized take levels in a given year), the report will include a detailed description of the circumstances leading to the exceedance and the steps to be taken to remedy such exceedance (for example, by reducing harvest levels in subsequent years so that the 5-year rolling average remains within the take levels authorized under the ITP).

- Documentation of applicable conservation measures, such as an updated, categorized list of northern-long eared bat hibernacula (CM-1 *Install Gates at Known Hibernacula*), an updated list of northern-long eared bat roosting activity areas (CM-4 *Minimize Effects on Trees that Provide Summer Roosting Habitat*), and artificial roosts installed under CM-22 *Install Artificial Roost Structures*, and CM-24 *Provide Artificial Roosts for Infected Bats*.
- Documentation of the annual and cumulative amount of killed, injured, harassed, or harmed Indiana and northern long-eared bats identified through implementation of covered activities.
- Documentation of all PGC and DCNR directives, guidance, or management plans used to establish HCP requirements (e.g., all comprehensive management plans on State Game Land units containing modeled bat habitat, the DCNR Forestry Manual [Pennsylvania Department of Conservation and Natural Resources 2012]), indicating the date each was last updated and when it is due for revision.
- Documentation of actual HCP costs over the reporting year.
- Description of any change in budget needs for the next reporting year (i.e., to account for inflation, changes to personnel, salaries), as well as evidence that the adjusted amount of needed funds have both been requested and secured for the upcoming year.
- Description of any changes in HCP implementation resulting from the adaptive management process during the reporting period, as applicable. This description will include the information that triggered the change, the rationale for the planned responses, and the results of any applicable monitoring actions.
- Summary of surveys conducted through the monitoring program for the reporting period, including description of surveys conducted, protocols used, survey results, and discussion of each survey identifying any issues, limitations, and implications of survey results.
- Recommendations for changes to the monitoring and research program based on interpretation of monitoring results and research findings, if applicable.
- Identification of any shortfalls and whether the methods need to be improved or quantities increased for habitat restoration and creation methods (i.e., installation of artificial roosts, modifications to hibernacula).
- Documentation of development of the staff training program, as well as a record of all trainings provided to PGC and DCNR staff, and the materials used in such trainings.
- Description of any HCP-directed studies undertaken during the reporting period, study results, and a description of integration with monitoring, assessment, and compliance and effectiveness elements.
- Summary of climatic conditions in the plan area, including average high and low monthly temperatures and average monthly precipitation over the reporting period.
- Assessment of the annual and cumulative impact of WNS on covered species in the plan area (Section 6.5.1.2, *White-Nose Syndrome*). This will include copies of reports or publications about WNS and covered bats released over the reporting year and the total number of hibernacula surveyed (including both known and potential habitat for covered species).

- Documentation of any changed and unforeseen circumstances that were triggered during the year, if applicable. If any were triggered, the report will also include any responses implemented, and resulting monitoring, to changed circumstances in prior years.
- A summary of any administrative changes, minor amendments, or major amendments proposed or approved during the reporting year (Section 6.5.2, *Modifications to the HCP or Permit*).

6.5 Assurances Requested

This section discusses the assurances requested by PGC and DCNR that will accompany the Section 10(a)(1)(B) ITP permit issued by USFWS. These assurances involve receiving coverage under the "No Surprises Regulation" and defining changed and unforeseen circumstances (Section 6.5.1, *Changed and Unforeseen Circumstances*) based on a common understanding of the commitments made in the State Lands Forestry HCP.

The federal No Surprises Regulation was established by the Secretary of the Interior on March 25, 1998, and is codified at 50 CFR § 17.22(b)(5) (endangered species) and § 17.32(b)(5) (threatened species). It provides assurances to Section 10 permit holders that no additional money, commitments, or restrictions of land or water will be required should unforeseen circumstances requiring additional mitigation arise once the permit is in place. The No Surprises Regulation states that if PGC and DCNR are properly implementing an HCP that has been approved by USFWS, no additional commitment of resources, beyond those already specified in the HCP, will be required.

As stated at 50 CFR § 17.22(b)(5):

(5) Assurances provided to permittee in case of changed or unforeseen circumstances. The assurances in this paragraph (b)(5) apply only to incidental take permits issued in accordance with paragraph (b)(2) of this section where the conservation plan is being properly implemented, and apply only with respect to species adequately covered by the conservation plan. These assurances cannot be provided to Federal agencies. This rule does not apply to incidental take permits issued prior to March 25, 1998. The assurances provided in incidental take permits issued prior to March 25, 1998 remain in effect, and those permits will not be revised as a result of this rulemaking.

(i) ***Changed circumstances provided for in the plan.*** If additional conservation and mitigation measures are deemed necessary to respond to changed circumstances and were provided for in the plan's operating conservation program, the permittee will implement the measures specified in the plan.

(ii) ***Changed circumstances not provided for in the plan.*** If additional conservation and mitigation measures are deemed necessary to respond to changed circumstances and such measures were not provided for in the plan's operating conservation program, the Director will not require any conservation and mitigation measures in addition to those provided for in the plan without the consent of the permittee, provided the plan is being properly implemented.

(iii) ***Unforeseen circumstances.***

(A) In negotiating unforeseen circumstances, the Director will not require the commitment of additional land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources beyond the level otherwise agreed upon for the species covered by the conservation plan without the consent of the permittee.

(B) If additional conservation and mitigation measures are deemed necessary to respond to unforeseen circumstances, the Director may require additional measures of the permittee where the conservation plan is being properly implemented, but only if such measures are limited to modifications within conserved habitat areas, if any, or to the conservation plan's operating conservation program for the affected species, and maintain the original terms of the conservation plan to the maximum extent possible. Additional conservation and mitigation measures will not involve the commitment of additional land, water or financial compensation or additional restrictions on the use of land, water, or other natural resources otherwise available for development or use under the original terms of the conservation plan without the consent of the permittee.

(C) The Director will have the burden of demonstrating that unforeseen circumstances exist, using the best scientific and commercial data available. These findings must be clearly documented and based upon reliable technical information regarding the status and habitat requirements of the affected species. The Director will consider, but not be limited to, the following factors:

(1) Size of the current range of the affected species;

(2) Percentage of range adversely affected by the conservation plan;

(3) Percentage of range conserved by the conservation plan;

(4) Ecological significance of that portion of the range affected by the conservation plan;

(5) Level of knowledge about the affected species and the degree of specificity of the species' conservation program under the conservation plan; and

(6) Whether failure to adopt additional conservation measures would appreciably reduce the likelihood of survival and recovery of the affected species in the wild.

Changed circumstances that could arise in the plan area are described in Section 6.5.1, *Changed and Unforeseen Circumstances*. If PGC or DCNR becomes aware of a changed circumstance on State Lands, the HCP administrator will notify USFWS via email and written letter within 72 hours (three business days) of a changed circumstance being triggered. The HCP administrator will remain in contact with USFWS following this notification to determine whether additional minimization or conservation measures are necessary consistent with the contingencies identified in Section 6.5.1.

6.5.1 Changed and Unforeseen Circumstances

Under Section 10 of the ESA, an HCP is required to identify anticipated and possible changed circumstances that could arise during its implementation. Identifying strategies and protocols for addressing such anticipated changes allows for appropriate program adjustments. PGC and DCNR will maintain sufficient financial reserves to fund all contingency actions throughout the permit term.

6.5.1.1 New Species Listings

Over the course of the permit term (30 years), USFWS could list species that are not covered under the State Lands Forestry HCP as threatened or endangered under the ESA. USFWS will notify PGC and DCNR when a noncovered species associated with habitat on State Lands has been proposed for listing, becomes a candidate for listing, or is emergency-listed (new noncovered species).

Trigger

This changed circumstance will be triggered when PGC and DCNR receive notification from the USFWS that a noncovered species associated with habitat on State Lands has been proposed for listing, becomes a candidate for listing, or is emergency-listed (new noncovered species).

Response

Following such notification, PGC and DCNR will take the following measures.

1. **Determine the potential for PGC and DCNR effects on newly listed species.** Within 1 month of such notification, PGC and DCNR will evaluate and determine (by following the Pennsylvania Natural Diversity Inventory environmental review procedures) the potential extent of the new species on State Lands and the necessary coordination with USFWS.
2. **Coordinate with USFWS and implement USFWS-provided avoidance measures.** If PGC and DCNR determine that the new species may be present on State Lands, they will initiate coordination with USFWS as soon as this determination is made. In coordination with USFWS, the potential effects of covered activities on the new noncovered species will be evaluated, including an assessment of the presence of suitable habitat on State Lands. If PGC, DCNR, and USFWS determine that the new species occurs or could occur on State Lands, PGC and DCNR will identify and implement any necessary measures provided by USFWS to avoid the take of the new noncovered species.
3. **Apply for permit amendment or alternative take coverage**. If PGC and DCNR proceed with activities that will cause take of the new listed noncovered species, they can begin the process to amend the State Lands Forestry HCP permit to include these species, or they could apply for a new and separate permit.

   The agencies will implement the interim take avoidance guidelines for the species until the permit amendment is finalized, or an alternate permit is issued to ensure compliance with the ESA. Permit amendments to include additional covered species require amendment to the HCP and the permit, and would require USFWS to re-initiate Section 7 consultation and conduct supplemental NEPA work.

6.5.1.2 White-Nose Syndrome

WNS is a disease affecting hibernating bats. It appears as a white fungus on the muzzle and other body parts of hibernating bats. USFWS estimates that more than 5.5 million bats have been killed since February 2006, when dead and dying bats were first observed in a cave in New York State. Since then, WNS has spread from New York west to Texas, south to Mississippi, and north to Canada, with an isolated detection in Washington State. In reality, bats in all states east of the High Plains likely are infected; infected bats have also recently been documented as far west as Washington

State (U.S. Fish and Wildlife Service 2016a). In some hibernacula, 90 to 100 percent of bats have died (U.S. Fish and Wildlife Service 2016b).

In Pennsylvania, the first bat mortalities related to WNS were reported in 2009 (Pennsylvania Game Commission 2010). Since then, the presence of WNS has been confirmed in 27 counties and is suspected in an additional six counties (Pennsylvania Game Commission 2016). Prior to the arrival of WNS in Pennsylvania, USFWS estimated that approximately 1,000 Indiana bats hibernated in the state; however, the arrival of WNS has led to a rapid decline. The 2013 Indiana bat population count was 120 bats, but the 2015 population estimate was only 24.

Indiana bats have the potential to become extinct in Pennsylvania in as few as 5 years (based on a 90 percent mortality rate during each 2-year reporting cycle). Further, a highly social species such as Indiana bats may suffer from an Allee affect, which means that small populations are incapable of recovering because of behaviors that rely on social interactions. Range-wide efforts to model a potential recovery by U.S. Geological Survey scientists (Thogmartin et al. 2013) had to assume that Indiana bats would eventually (5 years after infection) obtain immunity and resume population growth at a level similar to that seen prior to the arrival of WNS. It is expected that recovery of Indiana bats in Pennsylvania can only occur with a recovery in adjacent states.

Observations of regularly monitored northern long-eared bat hibernacula in the northeast showed declines of 98 percent in the 5 years following the arrival of WNS (Turner et al. 2011). Similarly, Francl et al. (2012a) documented a 77 percent decline in summer capture rates of northern long-eared bats in West Virginia and adjacent areas of Pennsylvania in the 2 years following the arrival of WNS. Reynolds et al. (2016) documented a 95 percent decline in summer capture rates in western Virginia following the arrival of WNS. Data from cave surveys conducted across multiple states (New York, Pennsylvania, West Virginia, and Tennessee) between 1999 and 2011 indicate that population declines averaged 31 percent among all four states and are attributable to WNS and other factors (Ingersoll et al. 2013). As stated in the 12-month finding on the petition to list the northern long-eared bat as an endangered species, “no other threat is as severe and immediate to the northern long-eared bat’s persistence as the disease, white-nose syndrome” (78 *Federal Register* 61046–61080).

Northern long-eared bats may persist longer due to their larger and more widespread populations; however, they also have the potential to become extinct in Pennsylvania by year 10 of the permit term. This species is much less restrictive in terms of hibernacula selection and may more readily make use of newly accessible habitats such as rocky outcrops. Thus, northern long-eared bats may have some resiliency and ability to relocate to sites that have not been infected with WNS.

For both species, scattered individuals may survive long after other individuals have died. Even in the presence of survivors, WNS changes the timing of reproductive events, and wing damage may limit the ability of bats to migrate long distances (Sparks et al. 2011; Francl et al. 2012a, 2012b), which could prevent bats that winter in West Virginia from reaching their summer grounds in Pennsylvania. Appendix B*, Species Accounts*, provides further details on the effects of WNS on Indiana bats, northern long-eared bats, and bat populations.

Through its monitoring program, PGC will track the status and trends of Indiana bat and northern long-eared bat populations on State Lands, including known incidences of the disease. Because PGC and DCNR are currently implementing all available measures to address the spread of WNS, there are no known additional measures to be taken if the disease should continue to spread. However, as members of the National WNS Working Group, both PGC and DCNR will stay abreast of current developments in this field and will take the following measures.

Trigger 1. Contraction of Covered Bat Populations to a Limited Number of Sites

The State Lands Forestry HCP's protections are based on the assumption that surviving bats are spread widely across the landscape. However, a predictable result of continued population declines due to WNS is a concentration of bats within a very small number of hibernacula during winter with a concomitant abandonment of other hibernacula and their associated fall/spring habitat. Further, both covered species are highly social and derive many benefits from communal living. Therefore, it is also foreseeable that the summer ranges may collapse into areas near the last few occupied hibernacula.

This changed circumstance will be triggered when PGC and DCNR determine that populations have collapsed such that:

- Indiana bat populations are only present in 2 hibernacula on State Lands; or
- Northern long-eared bats are only present in 5 hibernacula on State Lands; or
- Northern long-eared bats are only present in 10 known roosting activity areas on State Lands.

Response 1

If one of the changed circumstances is triggered, PGC and DCNR will abandon the use of seasonal avoidance around hibernacula where survey data (internal surveys and/or entrance trappings) indicate the absence of covered species for a period of 5 years. PGC and DCNR will then extend winter habitat for both bat species to a 5 mile buffer around all remaining hibernacula and a 1.5 mile buffer around known northern long-eared bat roosting activity areas. All HCP restrictions that apply to winter habitat and roosting activity areas will be applied within these new buffers, as well as any additional avoidance measures provided by the USFWS.

Trigger 2. Bat Populations Show Signs of Recovery from WNS

While not presently occuring, both covered species could begin to adapt to WNS, resulting in an increase in populations of both species over the permit term. This changed circumstance will be triggered when the results of survey data show that a hibernaculum has a population of more than 100 covered bats (of either or both species) and thus shows signs of recovery from WNS.

Response

If this changed circumstance is triggered, PGC and DCNR will notify USFWS via email and written letter within 72 hours (three business days) of the changed circumstance being triggered. In coordination with USFWS, PGC and DCNR will increase the number of artificial roost structures within winter habitat (within a 0.25-mile radius of that hibernaculum) to aid in the recovery of individual bats. Inclusion of artificial roosts near hibernacula may provide an opportunity for sick bats to restart their immune systems and survive the fungus (Boyles and Willis 2010). In addition, CM-24 *Provide Artificial Roosts for Infected Bats* will be modified such that at least two roosts will be installed at each of the 30 Category 1 northern long-eared bat hibernacula and at least four roosts (one for each species) at the seven hibernacula on State Lands containing both covered bats. The agencies commit to fully funding this contingency, including the maintenance or replacement of the any additional boxes over the permit term.

Trigger 3. Measures to treat WNS are Proven Effective.

Currently, few measures are known to reduce the effects of WNS on bats. New research suggests that naturally occurring antifungal bacteria may prove to be an important tool in controlling and preventing the spread of WNS. Researchers have identified multiple strains of bacteria with the potential to slow the spread of *Pseudogymnoascus destructans*, the fungus that causes WNS, and are working to culture these bacteria in the lab in the hope that these bacteria can ultimately be deployed into hibernacula (Hoyt et al. 2015; Cheng et al. 2016). Additional research is ongoing to ensure that deployment would not disturb hibernating bats or disrupt the natural microbial communities of hibernacula. Research also suggests that the differential susceptibility of *P. destructans* to ultraviolet light may be exploited for treatment of bats with WNS (Palmer et al. 2018).

This changed circumstance will be triggered if measures, such as the deployment of antifungal bacteria or UV light, are proven effective for treatment of bats with WNS.

Response

If this changed circumstance is triggered, PGC and DCNR will coordinate with USFWS to determine whether and to what extent these measures should be incorporated into the State Lands Forestry HCP. Implementation of such measures is subject to the approval of USFWS. Because no discrete contingency has yet to be identified, the addition of new WNS-related conservation measures into the HCP, or discontinuance of those that prove to be ineffective, will follow the HCP or permit amendment process described in Section 6.5.2, *Modifications to the HCP or Permit.* PGC and DCNR will update their cost estimates and funding assurances to include WNS treatments at the time it seeks an amendment.

6.5.1.3 Wildfire

In the centuries before settlement by European Americans, parts of the eastern deciduous forest had understory and stand-replacing fire regimes. Absent human intervention, lightning-caused wildfires burned in the mixed hardwood forests of the Appalachian uplands and the Mississippi Valley; however, because precipitation was plentiful in most years, these wildfires usually burned only small areas. Pennsylvania habitats associated with regular fires are the serpentine barrens in Chester County and the pine and scrub oak barrens of northeastern Pennsylvania and the Poconos. Pines and hardwood species with vigorous sprouting ability, especially oaks, tend to dominate after fire. Increased prominence of oaks is one of the most common results of disturbance in this kind of forest. Shade-intolerant species, including tuliptree and sweetgum, regenerate well on burned land. Many herbaceous species invade burned areas aggressively. Continued absence of fire allows eastern deciduous forests to be dominated by red maple, eastern hemlock, and American beech.

The Bureau of Forestry is responsible for protecting Pennsylvania's 17 million acres of public and private wildlands from damage by wildfire. The greatest danger of wildfires in Pennsylvania is during the spring months of March, April, and May, and the autumn months of October and November. In Pennsylvania, lightning-caused fires are relatively rare. Ninety-eight percent of wildfires in the state are caused by people (Pennsylvania Department of Conservation and Natural Resources 2014).

Certain conditions are necessary for a wildfire to occur. First, there must be a fuel source, such as grasslands or fields. Second, dry conditions, including the fuel source, are needed. Third, an ignition source—some way for the fire to start—is required. The first two factors occur most frequently in

Pennsylvania during the spring and autumn. As the spring sun climbs higher in the sky, days become longer and warmer. The trees are bare during this time, allowing the sunlight to reach the forest floor, warming the ground, and drying last fall's leaves. A dry fuel source, coupled with the fact that the winds in spring are often very strong and dry, leads to potentially high-risk conditions for wildfire.

Table 6-1 provides a history of wildfires on State Lands in Pennsylvania from 2002 to the present. Over this period, there were 913 wildfires in Pennsylvania, burning 17,624 acres. Fires ranged from an annual low of 20 acres burned in 2011 to an annual high of 4,936 acres in 2008. On average, wildfires burned 1,175 acres per year.

Table 6-1. Wildfire History on State Lands in Pennsylvania (2002 to 2016)

	State Forests		State Parks		State Game Lands		TOTAL	
Year	# Wildfires	Acres Burned	# Wildfires	Acres Burned	# Wildfires	Acres Burned	# Wildfires	Acres Burned
2002	44	449	4	1	32	383	80	834
2003	20	45	2	5	18	173	40	223
2004	15	39	7	5	1	0	23	44
2005	60	425	6	2	24	404	90	830
2006	58	3474	3	2	29	681	90	4,157
2007	46	204	9	22	14	88	69	314
2008	20	4393	7	29	24	515	51	4,936
2009	36	294	6	21	19	135	61	450
2010	47	385	18	66	16	796	81	1,247
2011	14	19	3	0	7	1	24	20
2012	35	256	4	742	25	108	64	1,106
2013	28	607	3	3	14	69	45	678
2014	20	46	2	1	19	1034	41	1,081
2015	41	281	6	4	18	229	65	514
2016	50	665	16	222	23	303	89	1,190
Total	534	11,582	96	1,125	283	4919	913	17,624

Source: Pennsylvania Department of Conservation and Natural Resources 2017

Trigger

Based on the historic fire regime and potential changes in frequency and extent of wildfires due to climate change (Section 6.5.1.4, *Climate Change*), up to 5,000 acres of forest have the potential to be altered annually through wildfire on State Lands over the permit term.

As a result, this changed circumstance will be triggered when wildfires in excess of this amount or size (5,000 acres) occur on State Lands. Wildfires in excess of 10,000 acres are considered unforeseen for the purposes of the State Lands Forestry HCP.

Response

Wildfire can negatively affect the Indiana bat and northern long-eared bat through smoke exposure. Wildfires can affect roosting habitat by reducing roost availability or by creating unsuitable conditions at existing roost trees. Alternatively, wildfire can provide additional roosting resources for bats and disturb a forest stand in a way similar to flooded forests, where snag abundance increases several-fold over preexisting conditions (Johnson et al. 2010). Despite the potential for natural wildfire to increase snag abundance in hardwood forests, few studies have investigated effects of wildfire on bat roosting habitat, particularly that of the endangered Indiana bat (Johnson et al. 2010).

In response to anticipated levels of wildfire on State Lands, PGC and DCNR will conduct a post-fire analysis on any fire of more than 5,000 acres (but less than 10,000 acres) occurring in summer, fall/spring, or winter habitat. The post-fire analysis will include assessing the potential cause of the fire and acres burned, as well as assessing forest areas to determine the extent to which the affected forest has retained suitable features such as snags, tree species, artificial roosts, and canopy, including any signs of bat death or carcasses found. If this analysis indicates a degradation in habitat quality (e.g., known roost trees or artificial roosts have been destroyed, site is close to a known hibernaculum), PGC and DCNR will develop a site-specific plan outlining assessment, monitoring and rehabilitation needs, which will include any measures necessary for bat habitat. PGC and DCNR will review plan specifications with USFWS within 90 days if bat habitat was degraded by the fire.

In general, wildfires are anticipated to have long-term beneficial effects on habitat for Indiana bats and northern long-eared bats. The fire(s), rehabilitation actions, and results of monitoring will be included in the annual report.

6.5.1.4 Climate Change

Climate change refers to the observed increase in mean global temperature due to an increase in greenhouse gas emissions, primarily carbon dioxide, because of human industrialization (Intergovernmental Panel on Climate Change 2007). Climate change is predicted to result in secondary global effects, such as sea-level rise and changing weather patterns. In the northeastern United States, climate assessments generally forecast heat waves, flooding, and more extreme precipitation events (U.S. Global Change Research Program 2013).

In Pennsylvania, the primary climate effects are predicted to be warmer temperatures during summer, with more extreme heat events, drier weather, and increased drought; and wetter winters, with more intense winter storms (Pennsylvania Department of Environmental Protection 2011). In particular, the mountainous regions of Pennsylvania are expected to experience more intense precipitation events, which will lead to greater flood risk in the drainage basins between the mountains (U.S. Global Change Research Program 2013).

Changes in climate could affect Indiana bats and northern long-eared bats and their habitat during the permit term. Relevant climate change impacts could include increases in the severity and frequency of flood events, droughts, wildfire, and the spread of invasive species, as well as general changes in precipitation and temperature throughout the species' range.

Flood events that result in water entering occupied bat roosts or hibernacula could result in the direct mortality of Indiana bats and northern long-eared bats. Even if these structures are uninhabited at the time of the flood, floodwaters can modify roost structures and hibernacula so that they are no longer habitable for bats the following season. In addition, flooding debris (especially sediment) can change airflow regimes in caves and mines, potentially rendering them unsuitable as hibernacula.

Severe droughts, particularly when coupled with unusually cold or hot temperatures, could have direct effects on bat reproductive success because water needs increase during pregnancy and lactation. In addition, insect population decline during drought can result in decreased annual survival for bats (Loeb et al. 2013). Potential effects of climate change could be compounded by mismatched timing of life cycles in food chains (e.g., changes in insect availability in relation to peak energy demands of bats) (U.S. Fish and Wildlife Service 2009) which could result in a change in timing of bat emergence, swarming, or breeding. Increases in the severity and frequency of droughts can also result in an increase in wildfires. As noted in Section 6.5.1.3, *Wildfire*, uncontrolled wildfires can destroy roosting habitat and result in bat mortality if individuals are subjected to significant smoke exposure.

The increased stress on Pennsylvania's ecosystems through increases in temperature, drought, and storm events could result in the spread of invasive species throughout the state. Thorny invasive species such as multiflora rose (*Rosa multiflora*) can obscure hibernacula entrances and cause excessive clutter near openings. In addition, fast-growing invasive species such as kudzu (*Pueraria montana* var. *lobata*) can kill trees in Indiana bat and northern long-eared bat habitat by girdling woody stems and trunks and uprooting trees through the force of their weight (Pennsylvania Department of Conservation and Natural Resources undated). Invasive species can also outcompete natural vegetation in riparian areas, altering the quality of riparian habitat and affecting the bat's insect prey base.

Changes in temperature and precipitation could also lead to shifts in the range and distribution of both bat species. Temperate-zone bats may be more sensitive than many other groups of mammals to these effects because their reproductive cycles, hibernation, and migration patterns are closely linked to temperature.

Summer maternity habitat for Indiana bats is currently centralized in the midwestern United States. However, recent research suggests that, as temperatures and precipitation patterns change, the suitable area for summer maternity colonies will shift to the northeastern United States and Appalachian Mountains (Loeb et al. 2013). This predicted range shift could mean that Indiana bat habitat in Pennsylvania will increase and be important for the species' recovery in the future.

The effects of climate change on northern long-eared bats are unclear. Predictions suggest a northward expansion of the species in pursuit of optimal hibernacula. Shifts in prey distribution and availability may also lead to mismatches with the timing of bat emergence resulting in food shortages in the spring or fall.

Suitable hibernacula distribution is also likely to shift under climate change scenarios (Humphries et al. 2002). Research on the physiologically similar little brown bat (*Myotis lucifugus*) has shown that the bioenergetic needs of bats for hibernation result in a relatively narrow combination of hibernaculum temperatures and winter season lengths that allow for successful hibernation (Humphries et al. 2002). Because this suitable range of environmental conditions is expected to shift under many climate change scenarios, Humphries et al. (2002) predict a pronounced northward range expansion of hibernating bats within the next 80 years. Because Indiana bats tend to be more selective in choosing hibernacula than little brown bats, this trend would likely be even more pronounced for Indiana bats (provided the larger hibernacula they prefer are available in these habitats). Similarly, northern long-eared bats are also likely to experience a shift into colder climates.

Some degree of climate change is a near certainty in the plan area and addressing climate change as part of the conservation program up front is more efficacious than addressing it post-hoc as a changed circumstance (Bernazzani et al. 2012). Therefore, measures to address climate change will be implemented through the adaptive management program (Section 5.7.4, *Shifts in Modeled Summer Habitat*). The actions that will be undertaken by the adaptive management program are summarized as follows.

- **Revise species habitat models.** If climate change affects the midwestern and northeastern United States as projected, the presence and distribution of known occurrences and preferred vegetation of Indiana bats and northern long-eared bats will shift. As described in Section 5.7.4, PGC and DCNR will revise species habitat models every 5 years to ensure that climate-related changes are incorporated into management efforts.
- **Revise seasonal restrictions.** If climate changes affects covered bats such that there are changes in the seasonality of their life cycles (i.e., there is a change in the dates in which they occupy winter, fall/spring, and summer habitat), PGC and DCNR will adjust the seasonal restrictions in the HCP to reflect the times of year when bats are occupying seasonal habitat.
- **Modify or enhance monitoring.** If vegetation shifts are documented through the mapping process described in Section 5.7.4 and linked to increases or decreases in the population status of covered bat species, the monitoring program will adapt to tracking new population levels. Also, climate change-related threats (e.g., increased disease and spread of nonnative species) will be monitored to ensure that new threats are being tracked.

6.5.1.5 Forest Insects and Disease

Invasive forest insects and disease are serious threats and can have devastating impacts on the long-term health and sustainability of forest ecosystems. As trees age or are stressed by external factors, they become less able to fight off insects and disease-causing pathogens, eventually succumbing to insect infestations and diseases that help finish off the declining tree. The following external factors can stress trees:

- Drought
- Excessive moisture
- Pollution
- Abnormal temperatures
- Wind damage

In a healthy forest, stressed trees are ultimately replaced by younger, healthier trees growing in the understory (the lower vegetation layer that includes young trees, shrubs, and other plants) through natural regeneration. Native insects and diseases (bark borer beetles, bark beetles, Armillaria root rot) contribute to the death of old and stressed trees, leading the way for this natural regeneration cycle. Nonnative insects and pathogens can dramatically alter this cycle; however, because native trees have less ability to fight off these invaders and succumb even when young and healthy. In Pennsylvania, the following forest insects and diseases are most prevalent:

- Emerald ash borer
- Gypsy moth
- Hemlock woolly adelgid
- Beech bark disease
- Oak wilt

Oaks continue to be at risk from gypsy moth defoliation and oak wilt disease, while beech bark disease continues to expand and threaten beech populations. Threats to oaks and beech are especially important because they are the largest remaining sources of hard mast[2] for wildlife after the demise of the American chestnut. Additionally, hemlock woolly adelgid, introduced into Pennsylvania in 1967, continues to spread westward and is affecting the eastern hemlock, Pennsylvania's state tree. Similarly, the emerald ash borer was detected in Pennsylvania in 2007, and is now found in most of Pennsylvania, causing widespread ash mortality.

DCNR has a variety of active surveys and projects to monitor and manage forest insects and diseases statewide. Each year, the DCNR conducts an aerial survey program to detect and map the following conditions:

- Tree dieback
- Mortality
- Defoliation
- Foliage discoloration

Ground surveys confirm the suspected insect or disease for each mapped area and the information is used to take the following actions

- Determine the extent of damage for insects and diseases of concern
- Anticipate future outbreaks
- Make management recommendations

Damage resulting from forest pests and disease from 2008 to 2017 is presented in Table 6-2.

Table 6-2. Forest Pests and Disease Damage—Statewide

Damage Agent	Year		Damage Acres
Abiotic damage	2014		62
		Total	*62*
Anthracnose	2011		7,505
	2012		17,458
	2014		3,103
	2015		1,822

[2] *Hard mast* refers to the production of hard-shelled seeds, such as acorns and hickory nuts, that form an important food source for forest wildlife.

Damage Agent	Year		Damage Acres
	2016		3,021
	2017		256
		Total	*33,165*
Beaver	2009		38
	2010		306
	2011		7
		Total	*351*
Beech bark disease complex	2012		1,766
	2014		14
	2015		1,792
	2017		7,188
		Total	*10,760*
Beech scale	2010		55
		Total	*55*
Chemicals	2010		57
		Total	*57*
Cherry scallop shell moth	2008		1,878
	2014		302
	2015		56,993
	2016		56,221
	2017		29,902
		Total	*145,296*
Conifer decline	2015		2,529
		Total	2,529
Cynipid wasp	2009		1548
	2011		21,166
		Total	*22,714*
Decline	2015		33
		Total	*33*
Diplodia	2012		172
		Total	*172*
Drought	2011		145
	2012		124
	2013		13,450
		Total	*13,719*
Eastern tent caterpillar	2009		252
	2010		294
		Total	*546*
Elongate hemlock scale	2010		210
	2014		1,280
		Total	*1,490*

Damage Agent	Year		Damage Acres
Emerald ash borer	2015		2,026
	2016		169
	2017		11,502
		Total	*13,697*
Fall cankerworm	2008		8,822
	2009		5,507
	2010		6,307
	2014		115,102
	2015		83,282
	2016		2,886
		Total	*221,906*
Fire damages	2011		70
	2012		428
	2017		48
		Total	*546*
Forest tent caterpillar	2008		80,950
	2009		371,815
	2010		482,501
	2011		25,510
	2012		9,705
	2013		4,933
		Total	*975,414*
Frost	2009		15,785
	2010		35,423
	2012		6,974
	2013		278,586
	2015		3,452
		Total	*340,220*
Gypsy moth	2008		948,706
	2009		348,096
	2010		30,737
	2011		10,333
	2012		1,131
	2013		149,010
	2014		213,953
	2015		546,961
	2016		90,916
	2017		63,068
		Total	*2,402,911*
Hail	2017		3,085
		Total	*3,085*

Damage Agent	Year		Damage Acres
Hemlock woolly adelgid	2008		9,512
	2009		257
	2010		2,714
	2011		830
	2012		2,057
	2013		1,761
	2014		283
	2015		584
	2016		277
	2017		659
		Total	*18,934*
Herbicides	2017		108
		Total	*108*
Jumping oak gall wasp	2015		29
		Total	*29*
Locust leafminer	2011		66
	2015		306
	2016		18
	2017		83
		Total	*473*
Maple decline (complexes)	2014		2,312
	2015		11,078
		Total	*13,390*
Multiple agents	2017		12
		Total	*12*
Norway spruce cytospora	2017		8
		Total	*8*
Oak & maple decline	2017		5,345
		Total	*5,345*
Oak decline (complexes)	2009		171
	2014		6,283
	2015		8,526
	2016		1,520
		Total	*16,500*
Oak leafminer	2010		15
		Total	*15*
Oak leafroller	2014		6,388
	2015		92,121
		Total	*98,509*
Oak wilt	2016		5
	2017		44
		Total	*49*

Damage Agent	**Year**		**Damage Acres**
Periodical cicada	2008		848
	2013		15,328
	2016		407
		Total	*16,583*
Pine needlecast	2016		7,117
		Total	*7,117*
Rhizosphaera needle cast	2014		3,871
	2015		241
		Total	*4,112*
Southern pine beetle	2017		227
	Total		*227*
Tornado damage	2017		32
		Total	*32*
Unknown	2009		2,251
	2010		1,049
	2011		3,220
	2012		1,277
	2013		13,388
	2014		255
	2015		48
	2016		27
	2017		4,578
		Total	*26,093*
Wind	2010		38
	2011		2,293
	2012		164
	2013		25
		Total	*2,520*
Yellow poplar weevil	2015		3,014
	2016		598
		Total	*3,612*
Grand Total			**4,402,396**

Trigger

This changed circumstance will be triggered when:

- A pathogen or insect is discovered with the potential to cause significant forest damage that was previously unknown to occur in Pennsylvania.
- A forest insect or pathogen causes forest defoliation, dieback, or mortality of more than 20,000 acres statewide or areas seeing significant local effects in 1 year.

Response

If this changed circumstance is triggered, the PGC and DCNR will develop a management plan outlining the best method of measuring, monitoring, and eradicating or controlling the outbreak. Reducing or minimizing the spread of forest insects and/or disease will be addressed adaptively as part of the conservation strategy. The following responsive actions address outbreaks:

- Determine the best method for measuring and tracking extent within 3 months of detection.
- Prepare a damage-assessment report within 6 months of detection. Recommend and take actions to address the threat within 6 months of detection.
- Modify the location or extent of timber harvest or prescribed fire activities to ensure that high-quality bat habitat is maintained across the plan area and that the HCP's take limit is not exceeded.

6.5.1.6 Take Projections Exceed Five-Year Rolling Average

As described in Section 6.2.1, *Implementation of Conservation Program,* PGC and DCNR are applying for a joint permit from USFWS that will describe the permit's take limitas a total cap for take across all three entities expressed as a 5-year rolling average.

The purpose of the 5-year rolling average is to allow flexibility if one entity exceeds their projected allowance in a given year (e.g., more timber harvest is needed on Bureau of Forestry Lands to address and outbreak of disease). The three entities can then work together to adjust harvest and burn projections to ensure that the overall take under the permit does not exceed the 5-year rolling limit.

Trigger

This changed circumstance will be triggered if conditions on State Lands change (e.g., as a result of more frequent disease outbreak due to climate change) such that the allocation of take among PGC and DCNR is different than projected to the degree in which it changes the impact of the taking analyzed in this HCP.

Response

If this changed circumstance is triggered, PGC and DCNR will notify USFWS via email and written letter within 72 hours (three business days) of identification that the changed circumstance has been triggered. In coordination with USFWS, PGC and DCNR will determine whether a modification to the HCP or permit will be required to address this changed circumstance.

6.5.2 Modifications to the HCP or Permit

The State Lands Forestry HCP or associated ITP may be modified in accordance with the ESA, the USFWS implementing regulations and policy, and this chapter. HCP and permit modifications are not anticipated on a regular basis; however, modifications to the HCP or ITP may be requested by either PGC and DCNR or USFWS. USFWS also may amend the ITP at any time for just cause, and upon a written finding of necessity, during the permit term in accordance with 50 CFR § 13.23(b). The categories of modifications for the HCP and/or permit are administrative changes and amendments.

Any administrative changes arising during a reporting year will be submitted to USFWS as addendums to the next annual report. Changes will be documented by providing USFWS with a redline version of the HCP containing the relevant text change(s). Upon request from USFWS, PGC and DCNR will provide a complete revised version of the HCP, including the revisions resulting from all administrative changes to date.

6.5.2.1 Administrative Changes

Administrative changes are internal changes or corrections to the HCP that may be made by PGC and DCNR, at their own initiative, or approved by PGC and DCNR in response to a written request submitted by USFWS. Requests from USFWS will include an explanation of the reason for the change as well as any supporting documentation.

Each revision of the HCP will not necessarily result in amending the ITP. The need to amend the permit will depend on the nature of the HCP changes, their inclusion in the permit, and their potential to trigger additional Section 7 or NEPA review. Administrative changes to the HCP will typically need to fit within the scope of the existing HCP analysis and presented to the public as part of the NEPA process. Administrative changes will also cover the need for clarification to address small errors, omissions, or language that may be too general or too specific for practical application.

Administrative changes in the HCP include the following examples.

- Corrections of typographical, grammatical, and similar editing errors that do not change the intended meaning or obligations.
- Corrections of any maps or exhibits to correct minor errors.
- Corrections of any maps, tables, or appendices to reflect approved amendments to the HCP or ITP.
- Changes to PGC and DCNR staff or changes to membership of the HCP stakeholder group without changing the representation of the PGC and DCNR.

6.5.2.2 Amendments

HCP and ITP amendments are not anticipated on a regular basis; however, these modifications may be requested by either PGC and DCNR or USFWS. Once an amendment is requested, USFWS will decide which documents must change, and the associated level of review needed to satisfy ESA and regulatory requirements, if any.

Amendments to the HCP can be approved through an exchange of formal correspondence, addenda to the HCP, revisions to the HCP, or permit amendments. Amendments that modify the projects and activities described in the HCP such that they may affect the effects analysis or conservation program of the HCP or affect other environmental resources or other aspects of the human environment in a manner not already analyzed, must comply with applicable permitting requirements, including the need to comply with NEPA, the National Historic Preservation Act, and Section 7 of the ESA.

The specific document requirements for the application may vary, based on the substance of the amendment. For example, minor changes to the HCP conservation strategy, or changes to the funding structure that does not affect the ability of PGC and DCNR to implement the HCP, would require an amendment to the text of the HCP; however, it would not require an amendment to the ITP. An HCP amendment may not require the need to reprint the entire affected HCP document. Typically, the USFWS would not need to advertise an amended HCP when it does not result in increased levels of incidental take and the activities do not expand in ways not analyzed in the original NEPA or Section 7 documents.

An ITP amendment would be required if the amendment involves an action that was not addressed in the original HCP or NEPA analysis. Under this example, the documents may need revision or new versions may need to be prepared to address the proposed ITP amendment. Upon submission of complete amendment documentation, USFWS will publish a notice of the receipt of the application in the *Federal Register*, initiating the NEPA and HCP public comment process. After the close of the public comment period, USFWS may approve or deny the proposed ITP amendment application. PGC and DCNR may, at their sole discretion, reject any ITP amendment proposed by USFWS. The following examples of changes would require an ITP amendment.

- Addition of covered species to the HCP.
- Increase in the allowable take limit of existing covered activities or addition of new covered activities to the HCP.
- Modifications of any important action or component of the conservation strategy under the HCP, including funding, that may substantially affect levels of authorized take, effects of the covered activities, or the nature or scope of the conservation strategy.
- A major change in the biological goals and objectives or conservation actions if monitoring or research indicate that they are not attainable because technologies to attain them are either unavailable or infeasible.

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Chapter 7
Cost and Funding

7.1 Introduction

The ESA requires that HCPs specify, "the funding that will be available to implement" conservation actions that minimize and mitigate impacts on covered species (16 U.S.C. § 1539(a)(2)(A)). The act also requires USFWS to find that the applicant will ensure that adequate funding is available to implement the HCP.[1] This chapter outlines the estimated costs to implement the State Lands Forestry HCP over the proposed 30-year permit term and provides assurances that PGC and DCNR will pay for those costs.

The costs outlined in this chapter reflect the estimated costs to implement the plan during year 1 of the permit term based on 2016 dollars. These values are not adjusted for inflation because plan costs are expected to increase at the same rate as plan funding sources. For example, any revenue sources that fund agency operations in part (e.g., sale of hunting and fur-taker licenses) are reevaluated each year and adjusted for inflation, as necessary. The state's annual budget process will adjust budget requests for inflation at the same rate that plan costs will increase due to inflation.

7.2 Implementation Cost

As described in Chapter 6, *Implementation and Assurances*, PGC and DCNR staff will oversee implementation of the State Lands Forestry HCP. Staff includes administrators, GIS and database managers, biologists, foresters, park managers, and other natural resource specialists who will carry out planning and design, monitoring, adaptive management, and periodic coordination with USFWS. The cost to implement the State Lands Forestry HCP is divided into four categories, summarized in the following subsections. All estimated costs are expressed in 2016 dollars.

7.2.1 Program Administration

Program administration involves ongoing or yearly costs associated with staff time for coordination, agency meetings, database tracking, and reporting. The HCP administrator, staffed by PGC, will be responsible for overarching administration needs such as contract management and leading coordination efforts with USFWS. The HCP administrator will also serve on the Implementing Team on behalf of PGC. GIS staff will maintain and update a database(s) that house spatial data necessary for tracking the State Lands Forestry HCP. Program administration costs are estimated to be $103,997 per year over the life of the permit (Table 7-1).

[1] Id at 1539(a)(2)(B)(iii).

Table 7-1. Program Administration Costs

	PGC	BoF	BSP	Years		Annual Cost in Year 1[b]		Cost Over 30-Year Permit Term	
	FTEs	FTEs	FTEs	Needed	Rate[a]	PGC	DCNR	PGC	DCNR
HCP Staff[c]									
HCP Administrator	0.20	0.00	0.00	30	$117,401	$23,480	$0	$704,406	$0
HCP Implementing Team[d]	0.00	0.15	0.00	30	$129,666	$0	$19,450	$0	$583,497
	0.00	0.00	0.10	30	$117,401	$0	$11,740	$0	$352,203
GIS Technician	0.07	0.07	0.00	30	$90,142	$6,310	$6,310	$189,298	$189,298
Total Cost Per Agency						**$29,790**	**$37,500**	**$893,704**	**$1,124,998**
TOTAL COST OF HCP						**$67,290**		**$2,018,702**	

[a] Rate for staff time includes staff base salary plus an overhead cost equal to 90% of the base salary.

[b] Equal to the annual cost to the HCP times the proportion of the full-time employee's time.

[c] See Section 6.3, *Implementation Responsibilities*, for a description of the roles of HCP staff.

[d] PGC HCP implementation team time is included in the estimate for the HCP administrator.

PGC = Pennsylvania Game Commission; BoF = Bureau of Forestry; BSP = Bureau of State Parks; FTE = full-time employee; DCNR = Department of Conservation and Natural Resources (includes BoF and BSP); HCP = habitat conservation plan; GIS = geographic information system

7.2.2 Conservation Program

As stated in Chapter 5, *Conservation Program*, the conservation program implements the biological goals and objectives and fulfills the HCP requirement to avoid, minimize, and mitigate impacts of the taking to the maximum extent practicable. Costs associated with the conservation program include implementation of avoidance and minimization measures and mitigation actions, as well as the staff time associated with tracking these elements. The cost associated with each of these program elements is described in each subsection.

7.2.2.1 Staff Costs

HCP staff will implement the conservation program by overseeing avoidance and minimization measures as well as designing and implementing mitigation actions.

Existing positions in PGC and DCNR, such as biologists, foresters, park managers, and planners will oversee and assist with implementation of the conservation program, so a portion of a full-time salary was allocated across the agencies to account for these costs.

7.2.2.2 Avoidance and Minimization Measures

PGC and DCNR already practice many of the avoidance and minimization measures included in the State Lands Forestry HCP or will otherwise incorporate such measures into currently established programs and practices. For example, the new tree-retention guidelines outlined in Chapter 5, *Conservation Program*, will need to be communicated to PGC and DCNR foresters through HCP staff training but then can be implemented in the same manner as existing retention guidelines. As implementation of these measures will not require any additional staff time or materials, there are no HCP costs associated with implementation (Table 7-2). In addition, the Bureau of Forestry will be responsible for overseeing most timber harvest and prescribed fire on State Parks; therefore, no additional Bureau of State Parks staff time will be needed to complete these activities.

Implementation of the State Lands Forestry HCP will require the communication of new and different measures as well as some new activities (e.g., the addition of gates associated with CM-1). The additional costs of implementing these measures are outlined in Table 7-2.

7.2.2.3 Mitigation Actions

The mitigation actions include a variety of activities intended to enhance habitat value for Indiana bats and northern long-eared bats and to increase the number of Indiana bat and northern long-eared bat individuals in the state. As with the avoidance and minimization measures, many mitigation actions will be implemented using existing practices. Those that will result in additional costs include creation of hibernacula and installation of artificial roosts in bat habitat.

Direct costs associated with implementation of mitigation actions include photocopies, handouts and other materials for trainings and public outreach.

Table 7-2. Costs of Implementing Conservation Measures

	Additional Staff Time for Implementation															Direct Costs				Total Annual Costs		Total Over Permit Term		
	PGC FTEs					BOF FTEs					BSP FTEs													
Conservation Measure	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Park Manager	Community Liaison	Field Crew	Annual Cost in Year 1	Over Permit Term	Cost per Event	# of actions	Annual Cost in Year 1	Over Permit Term	PGC	DCNR	PGC	DCNR	Notes
CM-1 Install Gates at Known Hibernacula[a]	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	$9,392	$281,762	$0	0	$32,667	$980,000	$4,696	$4,696	$140,881	$140,881	FTE estimates assume that PGC lead bat biologist will oversee all gating and survey efforts, with support from DCNR biologist for hibernacula on State Forests or State Parks.
Gating[b]	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*$0*	*$0*	*$25,000*	*32*	*$26,667*	*$800,000*	*$13,333*	*$13,333*	*$400,000*	*$400,000*	Cost estimate includes both materials and contractor labor and assumes that contractors will be hired to complete this work. Actual costs may be less if completed by PGC or DCNR staff. Cost includes gating of two Indiana bat hibernacula and 30 northern long-eared bat hibernacula over the permit term, plus installation of no trespassing signs at each hibernaculum. Costs associated with regular inspection or repair of existing gates are included as monitoring costs (Table 7-3). Costs associated with gating new hibernacula are included as adaptive management costs (Table 7-4).
Surveys[c]	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*$0*	*$0*	*$30,000*	*6*	*$6,000*	*$180,000*	*$3,000*	*$3,000*	*$90,000*	*$90,000*	Cost includes desktop review prior to on-the-ground survey work and assumes that contractors will be hired to complete this work. Actual costs may be less if completed by PGC or DCNR staff. Reflects survey work conducted every 5 years throughout the permit term for a total of six surveys.
CM-2 Remove Obstructions around Known Hibernacula.[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Cost reflects same process and staff as pre-HCP day-to-day operations; no additional FTE costs or materials are needed. FTE costs associated with communicating this requirement to PGC and DCNR are addressed in CM-18.
CM-3 Close Hibernacula Seasonally to Public Visitation[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Cost reflects the same process and staff as pre-HCP day-to-day operations; no additional FTE costs or materials are needed. FTE costs associated with communicating this requirement to PGC and DCNR are addressed in CM-18.

	Additional Staff Time for Implementation															Direct Costs				Total Annual Costs		Total Over Permit Term		
	PGC FTEs					BOF FTEs					BSP FTEs													
Conservation Measure	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Park Manager	Community Liaison	Field Crew	Annual Cost in Year 1	Over Permit Term	Cost per Event	# of actions	Annual Cost in Year 1	Over Permit Term	PGC	DCNR	PGC	DCNR	Notes
CM-4 Minimize Effects on Trees that Provide Summer Roosting Habitat[a]	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	$6,499	$194,966	$0	$0	$0	$0	$4,151	$2,348	$124,526	$70,441	Assumes each GIS staff member will take approximately 0.5 week to update databases to reflect northern long-eared bat roosting activity areas; PGC lead bat biologist will take 1 week to coordinate with USFWS to prioritize roosting activity areas.
CM-5 Avoid Timber Harvest Impacts on Non-Volant Pups in Maternity Colonies[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed in CM-18.
CM-6 Cease Harvest Activities when Bats Are Detected[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Implementation of this measure will utilize the same process and staff as pre-HCP day-to-day operations; therefore, no additional FTE costs or materials are needed to implement this measure. FTE costs associated with communicating this requirement to PGC and DCNR staff are addressed in CM-18.
CM-7 Avoid Timber Harvest Effects on Winter Habitat[d]	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	$4,151	$124,526	$0	$0	$0	$0	$1,803	$2,348	$54,085	$70,441	Assumes each GIS staff member will take approximately 1 week to update databases to reflect winter habitat. FTE costs associated with communicating this requirement to PGC and DCNR staff are addressed under CM-18.
CM-8 Limit Firewood Collection Seasonally (Fall/Spring)[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	$2,348	$70,441	$0	$0	$0	$0	$0	$2,348	$0	$70,441	Assumes each BoF GIS staff member will take approximately 1 week to update database to reflect firewood closure areas. No FTE time for PGC or BSP as they do not issue permits for collecting standing dead trees.
CM-9 Limit Firewood Collection Seasonally (Summer)[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	$2,348	$70,441	$0	$0	$0	$0	$0	$2,348	$0	$70,441	See notes for CM-8.
CM-10 Restrict Prescribed Fire Seasonally (Winter) [d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed in CM-18.
CM-11 Restrict Prescribed Fire Seasonally (Summer)[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed in CM-18.

	Additional Staff Time for Implementation															Direct Costs				Total Annual Costs		Total Over Permit Term		
	PGC FTEs					BOF FTEs					BSP FTEs													
Conservation Measure	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Park Manager	Community Liaison	Field Crew	Annual Cost in Year 1	Over Permit Term	Cost per Event	# of actions	Annual Cost in Year 1	Over Permit Term	PGC	DCNR	PGC	DCNR	Notes
CM-12 Manage Prescribed Burns to Minimize Effects on Bats [d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed in CM-18.
CM-13 Restrict Vehicles and Equipment in Perennial Stream and Riparian Areas [d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed in CM-18.
CM-14 Retain Vegetation in Perennial Stream and Riparian Areas [d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed in CM-18.
CM-15 Implement Erosion and Sediment Control Plans [d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed in CM-18.
CM-16 Implement Spill Pollution Prevention Measures [d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed in CM-18.
CM-17 Maintain Speed Limits on Forest Roads [d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed in CM-18.
CM-18 Implement Staff Training Program [h]	0.04	0.04	0.04	0.04	0.02	0.04	0.04	0.04	0.04	0.02	0.04	0.00	0.00	$43,532	$1,305,970	$0	$0	$0	$0	$18,636	$24,896	$559,084	$746,885	Assumes BSP will take the lead in preparing materials, but staff from each entity will deliver and participate in trainings.
CM-19 Support Public Engagement [i]	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	$3,399	$101,971	$200	30	$200	$6,000	$1,280	$2,319	$38,399	$69,572	Assumes both agencies will develop outreach information.
CM-20 Maintain a Forested Landscape in a Variety of Seral Stages [d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed in CM-18.
CM-21 Enhance Foraging and Roosting Habitat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed in CM-18.

	Additional Staff Time for Implementation															Direct Costs				Total Annual Costs		Total Over Permit Term		
	PGC FTEs					BOF FTEs					BSP FTEs													
Conservation Measure	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Park Manager	Community Liaison	Field Crew	Annual Cost in Year 1	Over Permit Term	Cost per Event	# of actions	Annual Cost in Year 1	Over Permit Term	PGC	DCNR	PGC	DCNR	Notes
CM-22 Install Artificial Roost Structures[e]	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$4,696	$140,881	$1,800	70	$4,200	$126,000	$4,448	$4,448	$133,441	$133,441	Assumes seven artificial roost structures are installed annually for the first 10 years; 70 structures over the 30- year permit term.
CM-23 Identify, Assess, Protect, and Enhance Potential Hibernacula[f]	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$4,696	$140,881	$55,000	10	$18,333.33	$550,000	$11,515	$11,515	$345,441	$345,441	Assumes 10 new sites are identified, gated, and surveyed over the permit term.
CM-24 Provide Artificial Roosts for Infected Bats[g]	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$2,348	$70,441	$1,800	44	$2,640	$79,200	$2,494	$2,494	$74,820	$74,820	Includes installation of two artificial roosts (one for each species) at the seven hibernacula on State Lands containing both covered bats and installation of one artificial roost at each of the 30 Category 1 northern long-eared bat hibernacula gated in CM-1.
Total Cost Per Agency																				**$65,356**	**$76,093**	**$1,960,677**	**$2,282,804**	
Total Cost of HCP																				**$141,449**		**$4,243,481**		

[a] FTE estimate based on personal communication with QBS consultant based on recent project experience.
[b] Gating costs based on personal communication with Cal Butchkoski, retired lead bat biologist for PGC.
[c] Survey costs based on personal communication with QBS consultant based on recent project experience.
[d] Not applicable
[e] FTE estimate and cost of installing artificial roosts based on personal communication with QBS consultant based on recent project experience.
[f] FTE estimate and cost of hibernaculum modifications based on personal communication with QBS consultant based on recent project experience.
[g] Materials cost by BSP based on past training efforts.
[h] Materials cost by BSP based on past training efforts. FTE estimate based on personal communication with QBS consultant based on recent project experience.
[i] FTE estimate by BSP based on past public outreach efforts.
PGC = Pennsylvania Game Commission; BoF = Bureau of Forestry; BSP = Bureau of State Parks; DCNR = Department of Conservation and Natural Resources; FTE = full-time employee; GIS = geographic information system; QBS = qualified bat surveyor

7.2.3 Monitoring

The costs of implementing monitoring actions are summarized in Table 7-3.

Table 7-3. Costs of Implementing Monitoring Actions

	Additional Staff Time Needed to Monitor HCP Implementation													Direct Costs						Total Annual Costs		Total Over Permit Term		
	PGC FTEs					BoF FTEs					BSP FTEs													
Monitoring Action	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Biologist	Community Liaison	Field Crew	Annual Cost in Year 1	Over Permit Term	Cost per Event[a]	# of actions	Annual Cost in Yr 1	Over Permit Term	PGC	DCNR	PGC	DCNR	Notes
Hibernacula surveys (Table 5-8)[a]	0.08	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$15,262.13	$457,864	$0	$0	$2,660	$79,800	$10,722	$7,200	$321,662	$216,002	Assumes that FTE time covers the three monitoring actions below.
Speleologger installation[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$300	36	$360	$10,800	$360	$0	$10,800	$0	
Speleologger or camera maintenance[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$300	30	$300	$9,000	$150	$150	$4,500	$4,500	
Gate repair and maintenance[c]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0.00	$2,000	30	$2,000	$60,000	$1,000	$1,000	$30,000	$30,000	Assumes one gate needs major repair every year.
Hibernacula surveys (Table 5-8)[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Timber sale site monitoring (Table 5-8)[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	PGC and DCNR already perform this monitoring action as part of their standard operating procedures; no additional costs.
Timber sale site monitoring (Table 5-8). GIS review to ensure no harvest in protected areas[a]	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	$2,075	$62,263	$0	$0	$0	$0	$901	$1,174	$27,043	$35,220	See note above. Assumes 1 week of FTE time for GIS staff.
GIS review to ensure no harvest in protected areas[a]	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	$2,075	$62,263	$0	$0	$0	$0	$901	$1,174	$27,043	$35,220	Assumes 0.5 week of FTE time for GIS staff.
Visit closure areas[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	DCNR already performs monitoring of closure areas as part of their standard operating procedures; no additional costs.
Status and trends monitoring (Table 5-8)[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	PGC and DCNR already perform this monitoring as part of their standard operating procedures; no additional costs.

	Additional Staff Time Needed to Monitor HCP Implementation													Direct Costs						Total Annual Costs		Total Over Permit Term		
	PGC FTEs					BoF FTEs					BSP FTEs													
Monitoring Action	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Biologist	Community Liaison	Field Crew	Annual Cost in Year 1	Over Permit Term	Cost per Event[a]	# of actions	Annual Cost in Yr 1	Over Permit Term	PGC	DCNR	PGC	DCNR	Notes
Regular monitoring for illegal activity[d]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	See note above.
Document review, monitoring of timber sale sites[d]	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$4,696	$140,881	$0	$0	$0	$0	$2,348	$2,348	$70,441	$70,441	See note above. For document review, assumes 1 week of FTE time by a member of the HCP Implementing Team.
GIS review of habitat cover and quality[a]	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	$4,151	$124,526	$0	$0	$0	$0	$1,803	$2,348	$54,085	$70,441	Assumes 1 week of FTE time for GIS staff.
Monitor artificial roosts for bat use[a]	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$9,392	$281,762	$0	$0	$0	$0	$4,696	$4,696	$140,881	$140,881	Assumes 2 weeks annually of FTE time for Senior Biologist.
Presence/absence monitoring[e]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$300	672	$6,720	$201,600	$6,720	$0	$201,600	$0	Assumes 112 roosts are visited every 5 years during the permit term (six visits). Cost includes both materials and labor, assuming that PGC or DCNR hires a contractor. Actual costs may be less if completed by PGC or DCNR staff. A QBS will visit roost sites on a rolling basis so each roost site is surveyed at least once every 5 years.
Species identification[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$20,120	6	$4,024	$120,720	$4,024	$0	$120,720	$0	Cost includes installation of guano screen to base of artificial roost to collect fecal pellets and genetic analysis of two fecal samples per roost to identify bat species.
Hibernacula surveys (Table 5-8)[d]	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$2,348.02	$70,441	$0	$0	$0	$0	$2,348	$0	$70,441	$0	PGC and DCNR already perform this monitoring action as part of their standard operating procedures; no additional costs.
Monitor artificial roosts for bat use[d]	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$1,174.01	$35,220	$0	$0	$0	$0	$1,174	$0	$35,220	$0	Cost of monitoring artificial roosts included in the costs of monitoring artificial roosts (CM-20).
Document trainings[a]	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	$14,579	$437,362	$0	$0	$0	$0	$4,696	$9,392	$140,881	$281,762	Assumes 2 weeks of FTE time per agency to document trainings.

	Additional Staff Time Needed to Monitor HCP Implementation													Direct Costs						Total Annual Costs		Total Over Permit Term		
	PGC FTEs					BoF FTEs					BSP FTEs													
Monitoring Action	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Biologist	Community Liaison	Field Crew	Annual Cost in Year 1	Over Permit Term	Cost per Event[a]	# of actions	Annual Cost in Yr 1	Over Permit Term	PGC	DCNR	PGC	DCNR	Notes
Document public outreach efforts[g]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	$2,078	$62,347	$0	$0	$0	$0	$0	$2,078	$0	$62,347	Assumes 1 week of FTE document to document public outreach efforts
	0.13	0.00	0.00	0.00	0.04	0.15	0.00	0.00	0.00	0.04	0.04	0.02	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Total Cost Per Agency																				**$41,843**	**$31,560**	**$1,255,317**	**$946,814**	
Total Cost of HCP																				**$73,404**		**$2,202,131**		

[a] FTE estimate based on personal communication with QBS consultant based on recent project experience.
[b] Speleologger costs based on personal communication with QBS consultant based on recent project experience.
[c] Repair costs based on personal communication with QBS consultant based on recent project experience.
[d] Not applicable
[e] FTE estimate and cost of installing artificial roosts based on personal communication with QBS consultant based on recent project experience.
[f] FTE estimate by PGC, BOF, and BSP based on past efforts.
[g] FTE estimate by BSP based on past public outreach efforts.
PGC = Pennsylvania Game Commission; BoF = Bureau of Forestry; BSP = Bureau of State Parks; DCNR = Department of Conservation and Natural Resources; FTE = full-time employee; GIS = geographic information system; QBS = qualified bat surveyor

7.2.4 Adaptive Management and Changed Circumstances

Chapter 5, *Conservation Program*, describes costs associated with the monitoring, adaptive management program, and changed circumstances.

PGC and DCNR employees conducting monitoring and adaptive management will plan, coordinate, and report on HCP monitoring. As with many elements of the conservation program, monitoring actions will be incorporated into existing practices. For example, foresters already conduct monitoring to make sure that firewood collection is in line with permit guidelines; these monitoring actions would continue under the State Lands Forestry HCP (even though closure areas would change because of HCP implementation). Monitoring actions that will result in additional costs due to HCP implementation include monitoring of gated hibernacula and artificial roost sites.

The adaptive management program outlined in Chapter 5 describes actions that PGC and DCNR will take to respond to uncertainties related to the spread of WNS, other changes to bat populations or habitat, and climate change.

7.2.4.1 Contingency Measures

The costs of contingency measures are included in this section because contingency measures are implemented as part of the adaptive management program and changed circumstances. Contingency measures may also be necessary if foreseeable changes occur that may alter the assumptions or information upon which the HCP is based (see Chapter 6, *Implementation and Assurances*, for a description of changed circumstances). Contingency measures are calculated as 5 percent of the cost of conservation program implementation, which equates to the sum of the costs to implement avoidance and minimization measures and mitigation actions. Five percent is consistent with the contingency amount allocated in other plans and has been demonstrated to be adequate for plans in implementation (Santa Clara Valley Habitat Agency 2018; East Contra Costa County Habitat Conservancy 2018).

Table 7-4. Costs of Implementing Adaptive Management Actions and Changed Circumstances

		Additional Staff Time Needed to Implement Adaptive Management Actions and Change Circumstances															Direct Costs				Total Annual Costs		Total Over Permit Term		
		PGC FTEs					BOF FTEs					BSP FTEs													
		Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Park Manager	Community Liaison	Field Crew	Annual Cost in Year 1	Over Permit Term	Cost per Event[a]	# of actions	Annual Cost in Yr 1	Over Permit Term	PGC	DCNR	PGC	DCNR	Notes
Adaptive Management																									
White-Nose Syndrome	Monitor WNS effects and update the habitat distribution model as necessary[a]	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	$4,151	$124,526	$0	$0	$0	$0	$1,803	$2,348	$54,085	$70,441	Assumes 1 week of FTE time annually per agency to update the model in response to new data on WNS.
	Remain abreast of current research and coordinate with USFWS regarding the testing and/or use of treatment methods	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Covered by current senior biologist duties.
	Evaluate existing habitat on State Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Costs reflected in Table 7-3.
	Coordinate with USFWS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Costs reflected in Table 7-1.
Changes to Bat Populations or Habitat	Gate additional hibernacula[a]	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	$2,348	$70,441	$25,000	3	$2,500	$75,000	$2,424	$2,424	$72,720	$72,720	Assumes three additional hibernacula are gated and biologist from both agencies assist.
	Shift habitat[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	5-year updates to the habitat distribution model will be performed as part of plan implementation; no additional costs.
Climate Change Adaptation	Conduct surveys[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Costs reflected in Table 7-3.
	Update habitat distribution model every 5 years[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	5-year updates to the habitat distribution model will be performed as part of plan implementation; no additional costs.

		Additional Staff Time Needed to Implement Adaptive Management Actions and Change Circumstances															Direct Costs				Total Annual Costs		Total Over Permit Term		
		PGC FTEs					BOF FTEs					BSP FTEs													
		Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Park Manager	Community Liaison	Field Crew	Annual Cost in Year 1	Over Permit Term	Cost per Event[a]	# of actions	Annual Cost in Yr 1	Over Permit Term	PGC	DCNR	PGC	DCNR	Notes
Changed Circumstances																									
Additional Species Listed	Conduct an impact assessment and implement avoidance measures[a]	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$4,696	$140,881	$0	$0	$0	$0	$2,348	$2,348	$70,441	$70,441	
	Apply for permit amendment or alternative take coverage[a]	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	$139,058	$4,171,742.40	$0	$0	$0	$0	$4,696	$9,883	$140,881	$296,480	Assumes up to 2 weeks of HCP Implementing Team time to coordinate with USFWS on avoidance and next steps.
White-Nose Syndrome	Increase the number of artificial roosts near hibernacula[a]	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$2,348	$70,441	$1,800	44	$2,640	$79,200	$2,494	$2,494	$74,820	$74,820	Includes installation of artificial roosts (two for each species) at the seven hibernacula on State Lands containing both covered bats, and installation of two artificial roosts at each of the Category 1 northern long-eared bat hibernacula gated in CM-1.
White-Nose Syndrome, continued	Adopt new measures to benefit Indiana bats and northern long-eared bats[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	As no such measures currently exist, PGC and DCNR do not have a means of estimating this cost. If such measures prove effective at treating WNS, HCP funds will be diverted from other parts of the plan (e.g., installation of artificial roosts).
Wildfire	Conduct post-fire analysis and implement remedial actions[a]	0.02	0.00	0.00	0.02		0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	$8,629.99	$258,900	$0	$0	$0	$0	$3,922	$4,708	$117,662	$141,238	Assumes 2 weeks of FTE time to complete the post-fire analysis and 2 weeks for a field crew to implement remedial actions.
Climate Change	Revise species habitat models[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	Addressed under WNS adaptive management measure.
	Modify or enhance monitoring[a]	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	$4,696	$140,881	$0	$0	$0	$0	$4,696	$0	$140,881	$0	Assumes up to 2 weeks of FTE time by PGC senior bat biologist to conduct additional monitoring.

		Additional Staff Time Needed to Implement Adaptive Management Actions and Change Circumstances															Direct Costs				Total Annual Costs		Total Over Permit Term		
		PGC FTEs					BOF FTEs					BSP FTEs													
		Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Senior Biologist	Biologist	Forest Assistant Manager	Field Crew	GIS	Park Manager	Community Liaison	Field Crew	Annual Cost in Year 1	Over Permit Term	Cost per Event[a]	# of actions	Annual Cost in Yr 1	Over Permit Term	PGC	DCNR	PGC	DCNR	Notes
Forest Insects and Disease	Prepare damage-assessment report[a]	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	$4,429	$132,882	$0	$0	$0	$0	$2,081	$2,348	$62,441	$70,441	Assumes 0.5 week of FTE time by forester to assess effects on bats; 0.5 week of assistance from GIS staff.
	Modifying the location or extent of timber harvest or prescribed fire activities[a]	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	$2,360	$70,798	$0	$0	$0	$0	$1,180	$1,180	$35,399	$35,399	Assumes 0.5 week of forestry FTE time to adjust location of harvest or fire activities.
Sum of Adaptive Management and Changed Circumstances Costs																					**$25,644**	**$27,733**	**$769,331**	**$831,980**	
Contingency																					**$1,282**	**$1,387**	**$38,467**	**$41,599**	
Total Cost Per Agency																					**$26,927**	**$29,119**	**$807,797**	**$873,579**	
Total Cost of HCP																					**$56,046**		**$1,681,376**		

[a] FTE estimate based on personal communication with QBS consultant based on recent project experience.

[b] Not applicable

PGC = Pennsylvania Game Commission; BoF = Bureau of Forestry; BSP = Bureau of State Parks; DCNR = Department of Conservation and Natural Resources; FTE = full-time employee; GIS = geographic information system; QBS = qualified bat surveyor; USFWS = U.S. Fish and Wildlife Service

7.2.5 Summary of Implementation Costs

Table 7-5 summarizes the different cost elements and presents the total costs of HCP implementation. Note that all implementation costs were annualized over the permit term; however, not all implementation activities will occur on an annual basis and therefore not all costs will occur on an annual basis. In addition to the costs outlined previously, winter habitat for covered bats will be set aside and primarily managed for bat habitat. While not represented quantitatively in this chapter, these lands are associated with some loss of annual revenue due to the timber harvest restrictions outlined in the State Lands Forestry HCP.

Table 7-5. Summary of Implementation Costs

	Annual Cost in Year 1[a]		Over Permit Term	
Cost	**PGC**	**DCNR**	**PGC**	**DCNR**
Program administration costs	$29,790	$37,500	$893,704	$1,124,998
Conservation program	$65,356	$76,093	$1,960,677	$2,282,803
Monitoring actions	$41,844	$31,560	$1,255,317	$946,814
Adaptive management and changed circumstances	$26,927	$29,119	$807,797	$873,579
Total Cost Per Agency	**$163,916**	**$174,273**	**$4,917,495**	**$5,228,193**
Total Cost of HCP (PGC + DCNR)	**$338,190**		**$10,145,688**	

[a] All implementation costs were annualized over the permit term; however, not all implementation activities will occur on an annual basis, therefore not all costs will occur on an annual basis.

PGC = Pennsylvania Game Commission; DCNR = Department of Conservation and Natural Resources

7.3 Funding Assurances

PGC is funded primarily through the sale of hunting and fur-taker licenses, federal Pittman-Robertson funds collected from an excise tax on sporting arms and ammunition, and revenue derived from the sale of natural resources such as timber, oil, and gas on lands owned by PGC. DCNR is funded through the state general fund, state special revenues, and federal funds for certain programs. [2]

PGC and DCNR spending authority is granted through an annual legislative process, with fiscal years beginning on July 1. At the beginning of each budgeting cycle, PGC and DCNR submit their proposed budgets and spending requests for the upcoming integration into the Governor's annual budget. The Executive Budget is then reviewed by the joint subcommittees and then the House Appropriations Committee and Senate Finance and Claims Committees for possible revision and eventual passage by both the Pennsylvania House and the Senate. Part of the Legislature's budgeting responsibilities

[2] With respect to the use of federal funds, PGC and DCNR's use of these funds is not unfettered or unlimited. For example, grants and license revenues under the Pittman-Robertson Wildlife Restoration Act are strictly regulated. Both the Act and the Service's regulations implementing it stipulate the purposes for which funds and license revenues can be used, and by which state entities (see 16 U.S.C. §§ 777-777n, except § 777e-1 and g-1; and 50 CFR Part 80. Given that misuse of these funds and diversion of license revenue affect the PGC and DCNR's eligibility for participation in the Wildlife Restoration program, the PGC and DCNR will closely coordinate with USFWS prior to expending funds on permit implementation.

is authorizing the expenditure of federal funds, including grants and appropriations. When the Legislature is not in session, the Office of the Budget reviews and approves spending authority for any new federal funds.

Because PGC's and DCNR's funding is not set by state law, and the state constitution mandates a balanced budget, a portion of funding depends on sufficient General Fund revenues. Budget deficits, either due to lower-than-expected revenues or unforeseen increased expenditures in other programs, may require state agencies, including PGC and DCNR, to reduce spending to less than what was originally appropriated, thereby maintaining a balanced budget statewide. Conversely, for years in which revenues exceed budget needs, PGC and DCNR may request and receive additional funds appropriated from the resulting available discretionary funds.

As a result of this budget process, PGC and DCNR cannot guarantee state funds, which are not yet appropriated by the Legislature, for the requirements set forth in the HCP over its permit term. However, as a commitment of this State Lands Forestry HCP, PGC and DCNR will each incorporate in its annual budget request to the Legislature a budget that will be adequate to fulfill its obligations under the State Lands Forestry HCP, including all costs associated with the administration of the HCP, implementation of the conservation program, monitoring, reporting, adaptive management, changed circumstances, and all contingency costs (i.e., the costs identified in Section 7.2, *Implementation Cost*). Each year's requests will be adjusted for inflation of hard and softs costs, including salaries and benefits. PGC and DCNR will provide evidence of both: 1) their annual budget requests to the Legislature; and, 2) that the Legislature has appropriated sufficient funding to implement this HCP by July 15th each year. In addition, HCP commitments will be reflected in the dedication of staff resources through PGC's and DCNR's annual budgets, adjusted for inflation, and documented in the HCP Annual Report, which will continue for the duration of the permit. PGC and DCNR recognize that failure to annually ensure adequate funding to implement the State Lands Forestry HCP means that permit coverage will not be extended for the upcoming year, and may be grounds for suspension or partial suspension of the ITP. Incidental take authorization under the permit is contingent on demonstrating adequate annual funding for plan implementation.

Chapter 8
Alternatives to Take

8.1 Alternatives to Take

The ESA requires that applicants for an ITP specify what alternative actions to the take of federally listed species were considered and why those alternatives were not selected. The *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration Fisheries 2016) identifies two alternatives commonly used in HCPs.

- Any specific alternative that would reduce take below levels anticipated for the proposed project.
- An alternative that would avoid take and, therefore, not require a permit from USFWS.

The choice of a preferred alternative represents the best attempt to reduce significant impacts on the Indiana bat and northern long-eared bat, while allowing PGC and DCNR to conduct forest management activities.

In accordance with the ESA, this chapter discusses alternatives that were considered but not selected and the reasons those alternatives were not selected for analysis.

8.2 Description of Alternatives

The following three alternatives were considered but not selected for analysis in the State Lands Forestry HCP: no take, reduced covered activities, and activity-by-activity permitting. These alternatives and the rationales for their elimination are discussed in the following sections. A comprehensive discussion and evaluation of these, as well as other potential alternatives considered, will also be provided in the NEPA analysis for the State Lands Forestry HCP, which accompanies this document and which will be publicly available with release of the public draft State Lands Forestry HCP.

8.2.1 No Take Alternative

The State Lands Forestry HCP is unique because it was prepared to obtain incidental take authorization for covered activities that are currently ongoing. As a result, to achieve a “no take” alternative, PGC and DCNR would have to take one of two possible approaches:

1. **Cease covered activities on bat habitat in State Lands.** Under this approach, PGC and DCNR would cease all current and future planned covered activities (e.g., timber harvest, prescribed fire, firewood collection, fencing, road construction and maintenance) across State Lands.

   This approach would be unviable for PGC and DCNR because they conduct forest management activities to meet their legal mandates and mission statements (Chapter 1, Section 1.1.1, *Background*). PGC and DCNR meet these legal requirements through forest management activities, especially timber harvest, that benefit a variety of organisms, maintain ecological services, and provide recreational opportunities for Pennsylvanians and other visitors. PGC and DCNR would be unable to meet these legal mandates or fulfill their mission statements if this approach were to be implemented.

- **PGC mission.** The mission of PGC is to manage Pennsylvania's wild birds and mammals and their habitats for current and future generations. PGC fulfills this mandate through its many duties, which are outlined in the Pennsylvania Game and Wildlife Code (34 Pa.C.S. §§ 2101, 2167, 2924, 925). PGC legal responsibilities include the conservation, protection, and restoration of wildlife populations for their many public values, to improve the public's appreciation of wildlife and their awareness and understanding of wildlife resource management, and to manage and protect a network of public and private lands and waters to provide habitat for wildlife (Pennsylvania Game Commission 2015).
- **DCNR mission.** The DCNR mission is to serve as Pennsylvania's leader in conservation and outdoor recreation and to inspire Pennsylvanians to value their natural resources, engage in conservation practices, and experience the outdoors. DCNR responsibilities include maintaining, improving, and preserving State Parks; managing State Forests to ensure their long-term health, sustainability, and economic use; and administering programs that will benefit river conservation, trails and greenways, local recreation, regional heritage conservation, and environmental education programs across Pennsylvania (Pennsylvania Department of Conservation and Natural Resources 2013).

In addition, complete cessation of covered activities in bat habitat would ultimately be disadvantageous for covered bats in the long term. Timber harvest and prescribed fire, when managed correctly, result in mixed-age forest stands with increased structural and species diversity, as well as increased forest health and resilience. These forest conditions provide habitat for covered bats as well as other wildlife species.

2. **Implement avoidance and minimization measures to achieve "no take."** This approach would entail implementing avoidance and minimization measures that eliminate all potential negative effects of covered activities. In order to achieve this while continuing to conduct forest management activities, PGC and DCNR would need to limit all tree-cutting activities to those months when bats are not likely to be present (i.e., the winter months when they are hibernating). PGC and DCNR would also need to conduct extensive surveys to ensure that every tree removed, or area designated for forest management, did not contain any winter roosts to eliminate the potential for any impacts.

   This approach is not feasible for PGC and DCNR because many areas of State Lands are not accessible for harvest during the winter months because of hazardous weather conditions. Restricting harvest to the winter months is not only impracticable on such sites—it is impossible. Further, these areas are highly suitable habitat for covered bat species precisely because they have been managed as a diverse and functioning forest by PGC and DCNR through forest management. Thus, while these restrictions could help avoid take from forest management activities, they would ultimately result in poorer habitat conditions for covered species by limiting the beneficial effects of more comprehensive forest management.

Chapter 2, *State Lands and Covered Activities*, identifies forest management activities that are necessary for PGC and DCNR to meet their required mandates. Take of Indiana bats and northern long-eared bats can be minimized but not entirely avoided because as described above, covered activities are implemented to protect and improve habitat for Indiana bats and northern long-eared bats, and covered activities are necessary for PGC and DCNR to fulfill their legal obligations. As a result, the no take alternative was rejected.

8.2.2 Reduced Covered Activities Alternative

The State Lands Forestry HCP covers timber harvest, prescribed fire, firewood collection, fencing, and road construction and maintenance. Under the reduced covered activities alternative, firewood collection (one of the covered activities with the highest risk of take) would not be covered under the State Lands Forestry HCP, thereby reducing the overall level of take covered under the plan. Firewood collection has a high risk of take because it can involve tree cutting and/or removal of dead trees and snags, habitat features preferred by covered bats for roosting. Thus, firewood collection has the potential to result in the take of bats occupying an existing roost or removal of a future potential roost. Under this alternative, all other elements of the plan would be as described throughout the rest of this HCP.

Firewood collection is managed by DCNR's Bureau of Forestry as part of a suite of forest management techniques. For example, when DCNR staff identify the need to reduce or eliminate hazard trees, conduct post-storm cleanup, timber-stand improvement, habitat improvement, or sanitation (i.e., removal of trees infested with a disease or insect), they can either designate forest areas for timber harvest as a means of reducing the needed trees, or they can designate these areas for firewood collection. They make the assessment of which technique is best for a given stand based on the extent of removal needed, the type of treatment necessary, and the accessibility of the stand.

Removing firewood collection from coverage under the HCP would mean that DCNR would be required to continue to follow the USFWS Forest Management Guidelines to avoid take of covered bats from this activity. This would require DCNR to limit firewood collection to snags that pose a serious human safety hazard, as well as to limit any cutting for firewood until bats are hibernating or concentrated near their hibernacula (between October 1 and March 31). Not only would this eliminate needed revenue that DCNR collects from firewood permits, but this would also eliminate firewood collection as a potential forest management technique in those areas of the state that are inaccessible during the winter months. For those stands where other means of timber harvest are impossible or impractical, this could result in a lack of management of these forest stands, resulting in habitat that has less value for covered bats.

Because these activities are connected to other forest management practices covered under the State Lands Forestry HCP, it would not be beneficial to consider them separately from the full complement of forest management practices. Covering all of these activities under this HCP will lead to a more comprehensive, large-scale planning conservation strategy that will provide greater conservation benefit to Indiana bats and northern long-eared bats. As a result, the reduced covered activities alternative was rejected.

8.2.3 Activity-by-Activity Permitting Alternative

Under the activity-by-activity alternative, PGC and DCNR would apply for individual take permits, as needed, to carry out forest management activities that are likely to result in take of Indiana bats and northern long-eared bats. PGC and DCNR evaluated the possibility of obtaining incidental take authorization for individual forest management operation and maintenance activities through

Section 7 of the ESA (if a federal nexus exists) or Section 10 of the ESA (where no federal nexus exists).

PGC and DCNR determined that the activity-by-activity alternative would not accommodate the proactive, systematic mitigation included in this State Lands Forestry HCP. The conservation strategy in this HCP requires a specified amount of habitat restoration and enhancement regardless of whether permitted activities are performed. This approach ensures that mitigation preempts—and likely overcompensates for—projected impacts.

The conservation strategy in the State Lands Forestry HCP includes comprehensive, landscape-level planning, with the goal of managing contiguous, improved lands into functioning habitat for Indiana bats and northern long-eared bats. By comparison, the activity-by-activity permitting alternative would produce piecemeal mitigation lacking the advantage of comprehensive, large-scale planning and up-front mitigation. Comprehensive land management would contribute to the preservation and enhancement of functioning habitat blocks and linkages and would protect a broader array of species than would activity-by-activity permitting. As a result, this alternative would likely result in a biologically inferior program.

The State Lands Forestry HCP also addresses changed circumstances and other emergencies (Chapter 6, *Implementation and Assurances*) not covered proactively in an activity-by-activity approach. Therefore, the proposed conservation strategy offers greater operational flexibility and integrates better planning and budgeting to address more effectively rare but foreseen events on State Lands.

Because the conservation strategy in the State Lands Forestry HCP provides a biologically superior mitigation approach, increases administrative efficiency for PGC and DCNR, and provides operational streamlining for changed circumstances, the activity-by-activity permitting alternative was rejected.

Chapter 9
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Chapter 10
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