March 20, 2004

Mr. Robert T. Jacobs
Regional Forester
U.S. Forest Service, Southern Region
1720 Peachtree Road, NW.
Atlanta, Georgia 30367-9102

Dear Mr. Jacobs:

Subject: FWS #04-0227; Final Biological Opinion on implementation of the revised Land and Resource Management Plan and it effects on the Indiana bat, Daniel Boone National Forest, Kentucky

This document sends the U.S. Fish and Wildlife Service's (Service) informal consultation, conference opinion, and biological opinion based on our review of the U.S. Forest Service (USFS) Daniel Boone National Forest's (DBNF) proposed implementation of a revised Land and Resource Management Plan (LRMP), and its effects on the Indiana bat (*Myotis sodalis*) under section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.). Your November 13, 2003 request for formal consultation was received on November 19, 2003.

This informal consultation, conference opinion (relating to impacts to proposed critical habitat), and biological opinion is based on information provided in the November 13, 2003, BA, the supplemental information to the BA that the Service requested on December11, 2003, and was received on February 4, 2004, the April 2003 Draft Environmental Impact Statement for the LRMP, other available literature, personal communications with experts on federally listed species that occur on the DBNF, and other sources of information. A complete administrative record of this consultation is on file at this office.

INTRODUCTION

The Service has reviewed the BA for implementation of the revised LRMP and all of the above-referenced supporting and supplemental information. The BA evaluates the potential and actual effects of implementation of the LRMP on 32 federally listed species and proposed critical habitat for the Cumberlandian combshell (*Epioblasma brevidens*), oyster mussel (*Epioblasma capsaeformis*), and Cumberland elktoe (*Alasmidonta atropurpurea*). This document represents our (A) concurrence with the effects determinations stated in the BA on the additional 31 federally listed species that could occur on the DBNF; (B) concurrence with the effects determination stated in the BA relating to adverse modification of proposed critical habitat units for federally listed freshwater mussels; and (C) biological opinion on the effects of that action on

the endangered Indiana bat in accordance with Section 7 of the Act. The Indiana bat was the only species the DBNF made a "may affect" determination on relative to LRMP implementation.

The DBNF considered potential effects to 31 additional listed species that are currently known to occur on the DBNF or historically occurred there. Assessment of effects to those species resulted in "no effect" determinations for the following nine species, because these species have been extirpated from the DBNF and its vicinity (Table 1):

Table 1. Species that were evaluated where a "no effect" determination was made for the proposed action.

Scientific Name	Common Name	Listing Status	In Action Area	Not in Action Area
Dromus dromas	dromedary pearly mussel	endangered		+
Epioblasma florentina florentina	yellow-blossom pearly mussel	endangered		+
Epioblasma sulcata sulcata	purple catspaw pearly mussel	endangered		+
Epioblasma torulosa torulosa	tuberculed-blossom pearly mussel	endangered		+
Hemistena lata	cracking pearly mussel	endangered		+
Obovaria retusa	ring pink	endangered		+
Picoides borealis	red-cockaded woodpecker	endangered		+
Pleurobema clava	clubshell	endangered		+
Pleurobema plenum	rough pigtoe	endangered		+

Based on the apparent extirpation of these species within the DBNF, the Service concurs that implementation of the LRMP will have no effect on these nine species and that additional section 7 consultation will not be necessary for these species. However, the DBNF's obligations under section 7 must be reconsidered relative to these nine species if any of these species are identified within the DBNF or in the vicinity of the DBNF.

In addition, the BA made "not likely to adversely affect" determinations for the following species (Table 2):

Table 2. Species that were evaluated where a "not likely to adversely affect" determination was made for the proposed action.

Scientific Name	Common Name	Listing Status	In Action Area	Not in Action Area
Alasmidonta atropurpurea	Cumberland elktoe	endangered	+	
Arenaria cumberlandensis	Cumberland sandwort	endangered	+	
Conradina verticillata	Cumberland rosemary	threatened	+	
Corynorhinus townsendii virginianus	Virginia big-eared bat	endangered	+	
Cyprogenia stegaria	Fanshell	endangered	+	
Epioblasma brevidens	Cumberlandian combshell	endangered	+	

2

Epioblasma capsaeformis	oyster mussel	endangered	+	
Epioblasma torulosa rangiana	northern riffleshell	endangered	+	
Epioblasma walkeri	tan riffleshell	endangered	+	
Etheostoma percnurum	duskytail darter	endangered	+	
Haliaeetus leucocephalus	bald eagle	threatened	+	
Helianthus eggertii	Eggert's sunflower	threatened	+	
Lampsilis abrupta	pink mucket pearly mussel	endangered	+	
Myotis grisescens	gray bat	endangered	+	
Notropis albizonatus	palezone shiner	endangered	+	
Pegias fabula	little-wing pearly mussel	endangered	+	
Phoxinus cumberlandensis	blackside dace	threatened	+	
Schwalbea americana	American chaffseed	endangered	+	
Solidago albopilosa	white-haired goldenrod	threatened	+	
Spiraea virginiana	Virginia spiraea	threatened	+	
Trifolium stoloniferum	running buffalo clover	endangered	+	
Villosa trabalis	Cumberland bean pearly mussel	endangered	+	

These "not likely to adversely affect" determinations were based on the DBNF's commitment to continue project-specific section 7 consultations on each of these species for the duration of the LRMP. Based on the DBNF's intention to conduct project-specific analysis and initiate section 7 consultation, formal or informal when appropriate, on these 22 species, the Service concurs that implementation of the LRMP will not likely adversely affect these 22 species.

The BA also considered potential effects to four stream segments (Buck Creek, Marsh Creek, Rock Creek, and Sinking Creek) occurring on or adjacent to the DBNF that have been proposed for designation as critical habitat for the Cumberlandian combshell, oyster mussel, and/or Cumberland elktoe (Table 3).

Table 3. Proposed critical habitat areas where a "not likely to adversely modify" determination was made for the proposed action.

Proposed Critical Habitat Area	Species Associated With Critical Habitat Area	Critical Habitat Area Present In Action Area
Buck Creek	Cumberlandian combshell, oyster mussel	No*
Marsh Creek	Cumberland elktoe	Yes
Rock Creek	Cumberland elktoe	Yes
Sinking Creek	Cumberland elktoe	Yes

* The DBNF proclamation boundary includes one side of Buck Creek, but the current ownership boundary does not include this property.

The Service announced a proposed rule to designate critical habitat for these species in a June 3, 2003, Federal Register notice. The DBNF determined that the potential effects of the revised LRMP would not likely result in the adverse modification of the proposed critical habitat in those four stream segments because: (A) all five primary constituent elements identified by us in the Federal Register notice are addressed and built in to the Specific Goals of the Riparian Corridor prescription Area of the revised Forest Plan; (B) many revised Forest Plan Standards

apply to the Riparian Corridor Prescription Area and relate to protection and/or conservation of the primary constituent elements identified in the proposed rule; and (C) the DBNF will continue to consult on a project-specific basis to determine if adverse modification of these proposed critical habitat areas is likely to occur. Based on these three factors, the Service concurs that implementation of the LRMP will not result in the adverse modification of proposed critical habitat for these three listed mussel species.

Further, the Service believes that the DBNF has fulfilled its section 7 consultation requirements relating to the LRMP for these 31 species and the proposed critical habitat for the Cumberlandian combshell, oyster mussel, and/or Cumberland elktoe. Therefore, this biological opinion will not address those species or critical habitat areas.

Consultation History

On May 5, 2003, the DBNF hosted a meeting with our office where a summary presentation on and an advanced copy of the draft Environmental Impact Statement (DEIS) and draft revised LRMP were provided. The DBNF indicated at the time that the Section 7 consultation would likely be handled informally for the revised LRMP since a site specific BA would be completed for all proposed projects prior to implementation. The Service suggested that informal consultation may be adequate for compliance with section 7 on certain parts of LRMP implementation, but formal consultation may be necessary for the Indiana bat.

On August 13, 2003, the Service provided written comments to the DBNF on the DEIS and LRMP. Our comments supported the approach the DBNF had taken to managing the more than 700,000 acres of federally owned lands and the preliminary selection of Alternative C1 as the preferred alternative for revising the 1985 forest plan. The Service also notified the DBNF that informal section 7 consultation would likely be necessary and that consultation should begin immediately or at the point the DBNF decided on the preferred alternative for the LRMP.

In August 25, 2003, the DBNF hosted a meeting to discuss the Service's written comments on the DEIS and LRMP. After some discussion of the comments, the dialogue quickly moved to what section 7 consultation approach would best serve the DBNF to address potential effects on federally listed species. Upon reviewing the draft EIS and LRMP, the Service suggested the DBNF consider entering formal consultation with all or a portion of the 32 federally listed species known to occur within or adjacent to the forest so that the DBNF would have flexibility to manage the forest according to the revised forest plan in order to maintain and restore ecological processes and functions while providing for multiple public benefits.

On September 12, 2003, the DBNF held an internal meeting to discuss their consultation strategy for the LRMP. As a result of this meeting, the DBNF decided and then notified us that formal consultation on the revised plan would be needed due to a "likely to adversely affect" determination for the Indiana bat. At the time, the rationale for the determination of effect was based on the potential tree cutting activities that would be conducted from May 1 thru July 15, or the time period during which young Indiana bats are non-volant (i.e., unable to fly).
On October 7, 2003, the Service hosted a meeting in which the DBNF presented their proposed consultation strategy, the objectives of this strategy, and a detailed discussion of the management

4

activities for which the DBNF was requesting formal consultation. Specifically the types of management activities included: green tree harvests, salvage harvests from stochastic events, and prescribed burning. The DBNF had estimated the total annual acreage of each of these activities that would likely occur during the May 1 thru September 15, or the time period during which Indiana bats are most likely to be roosting in the DBNF each year. The meeting also included a discussion of how the standards of the revised LRMP might be modified given the increased flexibility provided the DBNF through the formal consultation.

On November 13, 2003, the DBNF hosted a meeting with us to present a draft final copy of the BA and revised LRMP and to offer any assistance necessary toward the completion of the biological opinion. The DBNF explained that the U.S. Forest Service's Southern Regional Office would provide us with the final BA as soon as all signatures were obtained. To that end, the Service received the final BA for the revised LRMP that requested initiation of formal consultation on November 19, 2003.

On December 1, 2003, the DBNF provided, through e-mail, a document containing changes to the revised forest plan made since the receipt of the copy on November 13, 2003.

On December 11, 2003, the Service provided the DBNF with a letter explaining that additional information on the types of activities that were associated with green tree harvests, salvage harvests from stochastic events, and prescribed burning and the likely effects of those activities on the Indiana bat was needed.

From December 11, 2004, to February 3, 2004, the Service worked with the DBNF on information relating to the effects of the proposed action and the types of activities that would be undertaken by the DBNF in association with green tree harvests, salvage/sanitation harvests, and prescribed burns. This information would be provided in supplements to the November 19, 2004, BA.

On February 4, 2004, the DBNF provided supplemental information relating to the activities associated with green tree harvests, salvage harvests from stochastic events, and prescribed burning and the likely effects of those activities on the Indiana bat.

On February 5, 2004, the Service notified the DBNF that sufficient information to initiate formal consultation had been received, and formal consultation was initiated on that date.

This biological opinion is based on information provided in the November 13, 2003, biological assessment; the February 4, 2004, supplemental information documents; meetings with Ben Worthington, DBNF Forest Supervisor; George Bain, DBNF Deputy Forest Supervisor; Jim Bennett, DBNF Endangered Species Biologist; Richard Braun, DBNF Wildlife Program Manager; Rex Mann, DBNF Timber, Fire, and Wildlife Staff Officer; Kevin Lawrence, DBNF Planning Staff Officer; Vicki Bishop, DBNF Fishery Biologist; and David Taylor, DBNF Botanist; and other sources of information. A complete administrative record of this consultation is on file at the Service's Kentucky Field Office, 3761 Georgetown Road, Frankfort, Kentucky 40601; telephone 502/695-0468; fax 502/695-1024.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

As defined in the Service's section 7 regulations (50 CFR 402.02), "action" means "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas." The "action area" is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The direct and indirect effects of the actions and activities must be considered in conjunction with the effects of other past and present Federal, State, or private activities, as well as the cumulative effects of reasonably certain future State or private activities within the action area. This biological opinion addresses only those actions for which the Service believes adverse effects may occur. In their BA, the DBNF outlined those activities in the proposed LRMP (and projects predicated upon it) that would affect the Indiana bat. This biological opinion addresses whether implementation of the LRMP is likely to jeopardize the continued existence of the Indiana bat.

Action Area

The action area for this biological opinion is the DBNF in Kentucky (see map in Appendix A). The DBNF is distributed across 21 counties in eastern Kentucky. The proclamation boundaries encompass two separate areas. The larger area is a relatively narrow strip running 140 miles along the western edge of the Cumberland Plateau from the Tennessee border to within 20 miles of the Ohio border. This area was proclaimed in 1937 as the Cumberland National Forest, which included all or part of Lewis, Fleming, Rowan, Bath, Menifee, Morgan, Powell, Wolfe, Estill, Lee, Jackson, Owsley, Rockcastle, Laurel, Pulaski, Wayne, McCreary, and Whitley counties. A second area, located to the east and separate from the original proclamation area and known as the Redbird Purchase Unit, was added in 1964, which includes all or part of Owsley, Breathitt, Clay, Laurel, Knox, Bell, Leslie, Perry, and Harlan counties. In 1966, the Cumberland National Forest was renamed the Daniel Boone National Forest.

Today, about one-third of the proclamation area's over two million acres -- nearly 700,000 acres -- is federally owned and managed by the U.S. Forest Service. The federally-owned tracts are discontinuous and scattered within the proclamation boundary. Individual private landowners hold most of the privately-owned land in tracts averaging from 100 to 300 acres.

The DBNF lies mostly within the Northern Cumberland Plateau Section of the Eastern Broadleaf Forest (Oceanic) Province. The Northern Cumberland Plateau, an uplifted plateau, has been moderately dissected by stream action. Steep-sided, winding valleys and ridges mark the DBNF's hilly to mountainous terrain. Clifflines, caves, and geologic arches are prominent features. Local relief varies from about 400 feet in the north to about 2,000 feet in the south. Thousands of miles of small streams dissect this area of flat-topped ridges and rolling hills.

6

More than 80 soil types are mapped on the DBNF. Acid sandstone, shale, and some siltstone and limestone underlie the area in alternating layers. Soils formed from these various materials are mostly of mixed mineralogy, generally acidic, and possess low to moderate fertility.

Soil erosion losses range from an average low of about 0.1 ton per acre per year on undisturbed forested land; 10 tons per acre on cropland being cultivated under special-use authorization; to as much as 50 to 100 tons or more per acre at surface-mining sites, development sites, and road construction sites.

Three rivers, the Licking, Kentucky, and Cumberland, drain portions of the DBNF. Water quality is generally good to excellent, except in some smaller streams that are impacted by activities on private lands such as brine disposal from oil and gas drilling and acid discharges from abandoned surface and deep coal mines. However, streams with substandard water quality account for only three percent of the water flow.

Forested lands of the DBNF are generally classified as mixed mesophytic forest and Appalachian oak forest. An extremely wide variety of species thrive in both the under- and over-stories, including more than 40 commercially valuable tree species. The DBNF is a mosaic of various developmental stages of ecological succession with mostly upland hardwood types. Oak-hickory is the most common forest type. Shortleaf pine-oak forest type was well represented on the southern end of the DBNF until a major outbreak of the southern pine beetle, which began in late 1999, destroyed or damaged a majority of the shortleaf pines within the DBNF.

The DBNF provides habitat for a wide variety of terrestrial and aquatic fauna. Some of these species are relatively rare, including a number that are federally listed as threatened or endangered. Most species are relatively abundant, including huntable populations of white-tailed deer, wild turkey, gray squirrel, and ruffed grouse. Recent efforts by the Kentucky Department of Fish and Wildlife Resources and other partners have resulted in the establishment in and near the DBNF of the largest elk herd in the eastern United States. Game fish are plentiful in the large lakes and a number of streams are stocked annually with trout.

Five million annual visitors make recreation one of the DBNF's largest uses. There are also 18,000 acres of designated Wilderness and 19 miles of Wild and Scenic Rivers. The proclamation area is also home to three state parks and four Corps of Engineer-managed lakes. The Big South Fork National River and Recreation Area abuts the DBNF's southern boundary.

About 75 percent of subsurface mineral rights on the DBNF are either outstanding to third parties or reserved by the previous surface owners. Minerals currently being extracted include coal, petroleum, natural gas, and limestone.

Proposed Action

The proposed action is the implementation of the proposed 2004 Land and Resource Management Plan (LRMP) (FEIS Alternative C-1) which would take the place of the DBNF's 1985 Forest Plan. Implementation of the revised LRMP will provide programmatic management direction and guidance to all natural resource management activities on the DBNF in order to meet the objectives of federal law, regulations, and policy. The National Forest Management

Act of 1976 (NFMA) requires that each national forest develop a Land and Resource Management Plan that is revised every 10 to 15 years, or when conditions change significantly.

The LRMP does not contain a commitment to select any specific project. Instead, the LRMP would set up a framework of Desired Future Conditions with Goals, Objectives, and Standards to guide project proposals. Projects are proposed to solve resource management problems, move the DBNF's environments toward the Desired Future Conditions, and supply goods and services to the public. Further, these Goals, Objectives, and Standards dictate the conditions under which project-level activities (e.g., timber sales, wildlife habitat management, road construction, special uses, etc.) may be planned and implemented to meet the management direction of the DBNF. Future habitat conditions will depend on far-sighted management decisions as they are directed toward the attainment of the desired future conditions identified in the LRMP. Revision of the LRMP is needed by the DBNF to satisfy legal requirements and address new information about the forest and its uses.

The LRMP is a programmatic document and, as such, does not identify specific projects or actions that the DBNF will undertake. Similarly, the Service's review of the LRMP and its associated BA is programmatic in nature. Although there are a variety of project-specific activities that occur or will occur on the DBNF that potentially could result in adverse effects to Indiana bats and/or their habitat, the DBNF typically places limitations on those activities in order to protect the species, enhance and conserve its habitat, and avoid adverse effects. These limitations involve the implementation of the Standards contained in the LRMP and the requirements of project-specific section 7 consultations. Based on the DBNF's commitment to place LRMP Standard-based limitations on future projects and to conduct project-specific reviews for projects, the Service has concurred (see Introduction above) that the programmatic effects of LRMP implementation will have "no effect" or "are not likely to adversely affect" on 31 listed species shown in Table 1 and Table 2 above.

Nevertheless, in a subset of the DBNF's activities and/or projects, it is possible that incidental take and adverse effects to Indiana bats could occur, including activities associated with green tree harvests, salvage/sanitation harvests, and/or prescribed burning activities. Although the effects of these three activities are addressed in this biological opinion, the DBNF will continue to require compliance with the consultation provisions of section 7 of the Act by requiring a separate, project-specific analysis of each green tree harvest, salvage/sanitation harvest, or prescribed burning project for listed species that occur on the DBNF. This will allow the Service another opportunity to review the potential effects of those activities on listed species.

The BA and its supplements provide a description and analysis of green tree harvests, salvage/sanitation harvests, and prescribed burning, including the expected management actions, the anticipated levels of activity, and the likely effects of those actions on Indiana bats. Therefore, this biological opinion also addresses the specific direct, indirect, and cumulative effects of these three types of management activities. The DBNF has determined that these activities may result in adverse effects on the Indiana bat if the activities are implemented during the Indiana bat's summer roosting period (April 1 to September 15). Therefore, this biological opinion focuses on those activities and their effects, as described below.

8

Description of Green Tree Harvests - Cutting green (i.e., live) trees is a tool that will be utilized to attain some of the desired future conditions on the DBNF. Some of the green trees that will be harvested will have desirable physical characteristics that make them suitable for roosting Indiana bats during the non-hibernation period. Green tree cutting will occur across the forest (ref: appendix H, Revised Forest Plan) on up to 4,500 acres per year. Because of other programmatic limitations (such as seasonal equipment use restrictions), up to 4,000 acres of green tree harvest is anticipated to occur during the time of year that Indiana bats are utilizing trees as roosts (April 1 to September 15). However, this harvest level may not occur every year.

A green tree harvest is initiated by a management decision to implement a silvicultural prescription for a timber harvest. Detailed discussion of the silvicultural prescriptions and under what conditions they will be applied is provided in the BA, but approximately 90 percent of the proposed green tree harvests will utilize a two-aged silvicultural system (i.e., shelterwood with reserves and seed tree with reserves). The remaining 10 percent of the harvests will utilize either the even-aged or uneven-aged silvicultural system. Regardless of system used, all green tree harvests will include the Standards in the LRMP to avoid and minimize impacts to Indiana bats as described in the BA and analyzed in this biological opinion.

Green tree timber harvests on the DBNF typically include the following actions which make up a harvest operation: administration, felling, skidding, decking, loading, and hauling of timber products from the sale area. A detailed description of these actions is provided in the BA.

Description of Salvage/Sanitation Harvests - Stochastic events can bring about unplanned alterations of the forest overstory. In the past, these events on the DBNF have usually been related to wind and/or ice/snow storms, insect and disease outbreaks, and wild fire. While the nature and occurrence of a stochastic event is unplanned, management actions can occur in response to the changes in forest conditions brought about by these events.

Based on 10 years of occurrence data, the DBNF has estimated that an average of 700 acres are annually impacted by stochastic events. This estimate does not include, nor is it intended to include, large-scale events such as the southern pine beetle epidemic that recently killed most pine trees on the DBNF. Large-scale events will be analyzed separately, are not part of the BA's analysis, and are not considered in this biological opinion. In response to the tree damage brought about by these random stochastic events and based on the likelihood that stochastic events will continue, DBNF resource managers have proposed salvage or sanitation harvests on roughly half of the 700 acres that is estimated to occur each year. This level of harvest may not occur every year, but, because of other programmatic limitations, the 350 acres of harvest may occur during the time of year that Indiana bats are utilizing trees as roosts. However, all LRMP Standards associated with the Indiana bat, unless specifically exempted in the Standard itself, will apply to harvest actions associated with these projects. These exempted standards are DB-WLD-1 and DB-WLD-7 as defined in the BA.

Salvage/sanitation harvests typically include the same type of activities described for green tree timber sale actions, including the administration, felling, skidding, decking, loading, and hauling of timber products from the sale area. While the activities associated with salvage/sanitation harvests are similar to green tree harvests, there is one fundamental difference between the green

tree harvests and salvage/sanitation harvests. In salvage/sanitation harvests, it is typically the dead trees (i.e., snags) or damaged trees (i.e., immediate roost trees) that are the focus of the harvest. Therefore, it is more likely that Indiana bats may be adversely affected.

Description of Prescribed Burning - The use of prescribed fire is a management tool that will be utilized to attain and maintain some of the Desired Future Conditions across the DBNF and may occur, depending on location and site-specific conditions, on a year-round basis. From a programmatic standpoint, the LRMP anticipates that between 15,000 and 50,000 acres will be burned using prescribed fire on an annual basis. However, this level of prescribed burning may not occur every year due to weather conditions and a variety of other factors. Further, the DBNF estimates that it will take nearly a decade for the upper goal of 50,000 acres burned annually to be achieved. Most of the prescribed burning that will occur on the DBNF will be for fuel reduction, but other purposes for prescribed burning include habitat improvement and site preparation. The DBNF believes that most of the burning in potential roosting habitat will take place during the winter-spring period with some occurring during the late summer and early fall, which is during the period Indiana bats roost in trees (1 April thru 15 September).

Prescribed burning projects on the DBNF typically include the following activities: burn plan preparation/layout, line construction, ignition, and mop-up. A detailed discussion of these activities is provided in the BA.

STATUS OF THE SPECIES/CRITICAL HABITAT

The Indiana bat was listed as an endangered species on March 11, 1967 (32 FR 4001), under the Endangered Species Preservation Act of October 15, 1966 (80 Stat. 926; 16 U.S.C. 668aa(c)). It is currently included as an endangered species under the Endangered Species Act of 1973, as amended. Critical habitat was designated on September 24, 1976 (41 FR 41914), and included caves in Kentucky, Tennessee, Illinois, Indiana, Missouri, and West Virginia. At the time of critical habitat designation, the Service estimated that approximately 75 percent of the known population of Indiana bats hibernated at the 13 sites that were designated as critical habitat. Since routine surveys began in 1980, populations of Indiana bats at hibernacula, including many of the previously designated critical habitat caves, have witnessed significant decreases in numbers. No summer roosting habitat has been designated as critical habitat for the Indiana bat.

Based on censuses taken at hibernacula between 1995 and 1997, the known Indiana bat population was estimated at approximately 353,000 bats; this represents a decline of about 60% since surveys began in the 1960s. Although the 1997 data were incomplete, the trend continues downward. The most severe declines were in Kentucky and Missouri, where 180,000 and 250,000 bats were lost, respectively, between 1960 and 1997. In Indiana, however, populations dropped by 50,000 between the earliest censuses and 1980 but have rebounded to former levels in recent years. Currently, half the known Indiana bats winter in Indiana.

The primary objective of the Indiana Bat Recovery Plan is to remove the Indiana bat from endangered status. The important features of the recovery plan are: (A) to determine the cause(s) of observed declines during both non-hibernation and hibernation seasons, and (B) to control

10

access to important Indiana bat hibernacula, thus protecting the bats from human disturbance. In addition, summer foraging habitat must be maintained, protected, and restored. Lastly, in order to evaluate the success of protection efforts, a monitoring program is needed to document changes in Indiana bat populations.

Criteria for reclassification from endangered to threatened status will be based upon the status of the Indiana bat throughout its range, as determined through a 12 year, two-stage process. The species will be evaluated for reclassification following documentation of stable or increasing populations for three consecutive census periods (six years) and permanent protection [i.e., public ownership or long- term easement/lease, and gate/fence (where necessary and feasible)] at all Priority One hibernacula. To delist, the above criteria must be met, in addition to protection and documentation of stable or increasing populations for three consecutive census periods at 50% of the Priority Two hibernacula in each state, and the overall population level must be restored to that of 1980. This level is believed to be sufficient to maintain enough genetic diversity to enable the species to persist over a large geographic area and avoid extinction.

The Service (USFWS 1999) completed an agency draft of a revised recovery plan for the Indiana bat. The recovery plan is being revised to: (A) update information on the life history and ecology of the Indiana bat, especially information on summer ecology gathered since 1983; (B) highlight the continued and accelerated decline of the species; (C) continue site protection and monitoring efforts at hibernacula; and (D) focus new recovery efforts toward research in determining the factor or factors causing population declines. The main recovery actions identified in the revised recovery plan are to:

1. Conduct research necessary for the survival and recovery of the Indiana bat.
2. Obtain information on population distribution, status, and trends for the Indiana bat.
3. Protect and maintain Indiana bat populations.
4. Provide information and technical assistance outreach.
5. Coordinate and implement the conservation and recovery of the Indiana bat.

To date, conservation efforts have concentrated on protection of winter habitat, although there has been some research into the life history of the Indiana bat. Active programs by state and federal agencies have led to the acquisition and protection of a number of Indiana bat hibernation caves. Of 127 caves/mines with populations >100 bats, 54 (43%) are in public ownership or control. Most of the 46 (36%) that are gated or fenced are on public land. Given the divergent population trends throughout the range of the Indiana bat, however, it is evident that these measures have not produced the desired result of recovery of the species.

Species/Critical Habitat Description

The Indiana bat is a medium-sized monotypic species (no subspecies) of the genus *Myotis*. It is migratory and occurs over much of the eastern half of the United States. Head and body length ranges from 1 5/8 to 1 7/8 inches, and forearm length ranges from 1 3/8 to 1 5/8 inches (USFWS 1983). This species is similar in appearance to both the little brown bat *(M. lucifugus*) and the northern long-eared bat (*M. septentrionalis*) but has several distinct morphological characteristics (Barbour and Davis 1969, Hall 1981).

Critical habitat has been designated at 13 Indiana bat hibernacula in six states. These hibernacula are critical to the survival of the species because they winter nearly 90 percent of the known population. These critical habitat units contain the shelter and unique climatic conditions that allow Indiana bats to survive the winter.

Life History and Population Dynamics

Chronology of Activity

Typically, Indiana bats hibernate from October through April (see "Hibernation"), depending on local weather conditions (see Table 4 for a depiction of the annual cycle). Upon arrival at hibernating caves from August through September, Indiana bats "swarm," a behavior in which "large numbers of bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in the caves during the day" (Cope and Humphrey 1977). Swarming continues for several weeks, and mating occurs during the latter part of the period (see "Fall Roost and 'Swarming'"). A majority of bats of both sexes hibernate by the end of November.

Table 4. Indiana Bat Annual Chronology (from USFWS 1999).

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Both sexes:											
Hibernation											Hibernation
Females:				Emerge	Pregnant			Swarming			
"						Lactating					
Young:						Born	Flying				
Males:				Emerge				Swarming			
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

Adult females store sperm through the winter and become pregnant via delayed fertilization soon after emergence. Young female bats can mate in their first autumn and have offspring the following year, whereas males may not mature until the second year. Limited mating activity occurs throughout the winter and in late April as the bats leave hibernation (Hall 1962).

Females emerge from hibernation ahead of males; most wintering populations leave by early May. Females may arrive in their summer habitats as early as April 15 in Illinois (Gardner *et al*. 1991a, Brack 1979). Humphrey *et al*. (1977) determined that Indiana bats first arrived at their maternity roost in early May in Indiana, with substantial numbers arriving in mid-May. Birth occurs in late June and early July (Easterla and Watkins 1969, Humphrey *et al*. 1977), and the young are able to fly between mid-July and early August (Mumford and Cope 1958, Cope *et al*. 1974, Humphrey *et al*. 1977, Clark *et al*. 1987, Gardner *et al*. 1991a, Kurta *et al*. 1996).

Survivorship

Humphrey and Cope (1977) determined that female survivorship in an Indiana population of Indiana bats was 76 percent for ages 1 to 6 years, and 66 percent for ages 6 to 10 years; for males, survivorship was 70 percent for ages 1 to 6 years, and 36 percent for ages 6 to 10 years. The maximum age for banded individuals was 15 years for females and 14 years for males. Mortality between birth and weaning has been estimated at 8 percent (Humphrey *et al.* 1977).

12

By extending the expected survivorship rates beyond 10 years (Humphrey and Cope 1977) so that the same rate of survivorship found between ages 6 and 10 is extended to their estimated maximum ages (see Appendix C), the survivorship between birth and 1 year can be estimated at about 50 percent by using a standard life table and assuming a stable population (Appendix C). Current research has yet to determine when (or why), in the Indiana bat's life, that survivorship has decreased and resulted in the current rate of decline.

Food Habits

Indiana bats feed strictly on flying insects, with prey items reflecting the environment in which they forage (most often terrestrial insects). Indiana bats typically feed in the subcanopy of forests with 60 to 80 percent canopy cover (Garner and Gardner 1992, Romme *et al.* 1995), especially in riparian woodlands (Brack 1983, Gardner *et al.* 1991b, Humphrey *et al.* 1977, LaVal *et al.* 1977), though they also feed in upland areas. Diet varies seasonally and differs with age, sex, and reproductive status (Belwood 1979, Lee 1993). Reproductively active females and juveniles exhibit the greatest dietary diversity, likely because of increased energy needs. Reproductively active females consume more aquatic insects than males or juveniles (Lee 1993).

Moths (Lepidoptera) are major prey items (Belwood 1979; Brack and LaVal 1985; Lee 1993), but caddisflies (Trichoptera) and flies (Diptera) are also documented as major food items (Kurta and Whitaker 1998). Mosquitos and midges are also major food items, especially those species that form large mating aggregations over water (Belwood 1979). Male Indiana bats summering near hibernacula feed primarily on moths and beetles (USFWS 1999). Other food items include bees, wasps, and flying ants (Hymenoptera), beetles (Coleoptera), stoneflies (Plecoptera), leafhoppers and treehoppers (Homoptera), lacewings (Neuroptera), and true bugs (Hemiptera) (Whitaker 1972, Belwood 1979).

Indiana bats require open water for drinking. Streams, ponds, wetlands, and road ruts serve as important sources of drinking water during summer months. Upland water sources appear to be important for all bat species, including Indiana bats. In Indiana, where a habitat model was developed, the highest values were achieved when permanent water sources were available within 66 feet of roosting sites. Habitat suitability values decline slightly, but are constantly high, from 66 feet to 0.6 mile from roost sites. The maximum travel distance reported for Indiana bats is about 2.5 miles. Roosting sites more than 2.5 miles from water were assumed to be unsuitable (Romme *et al.* 1995). Studies in the Cumberland Plateau and Cumberland Mountains of eastern Kentucky (MacGregor *et al.* 1996) show that ponds and water-filled road ruts in forest uplands are primary water sources, while stream corridors received little use.

Hibernation

Indiana bats hibernate in winter and are restricted to a few suitable hibernacula (typically caves, but also abandoned mines and even a tunnel and a hydroelectric dam) that are primarily found in the karst region of the Eastern United States. Generally, Indiana bats hibernate from October through April (Hall 1962, LaVal and LaVal 1980), depending on local weather conditions. They hibernate in large, dense clusters, ranging from 300 to 484 bats per square foot. Indiana bats have very specific habitat requirements for a hibernation site to be suitable, with temperature being the most notable. In the southern part of their range, hibernacula trap large volumes of cold air, and the bats hibernate where resulting rock temperatures drop; in the northern part of

the range, the bats avoid the coldest sites. In both cases, the bats are choosing cold sites with a low risk of freezing. Stable low temperatures allow the bats to maintain a low metabolic rate that will conserve energy reserves through the winter until spring emergence (Humphrey 1978, Richter *et al.* 1993). Ideal sites are 50°F (10°C) or below when the bats arrive in October and November. Early studies identified a preferred mid-winter temperature range of 39 to 46°F (4 to 8°C), but a recent examination of long-term data suggests that a slightly lower and narrower range of 37 to 43°F (3 to 6°C) may be ideal for the species (USFWS 1999). Further, relative humidity at hibernacula is usually above 74 percent but below saturation (Hall 1962, Humphrey 1978, LaVal *et al.* 1976, Kurta and Teramino 1994), although relative humidity as low as 54 percent has been observed (Myers 1964). Humidity may be an important factor in successful hibernation (Thomas and Cloutier 1992). Specific cave configurations determine temperature and humidity microclimates and thus determine the suitability of a cave for Indiana bats, but only a small percentage of available caves provide these conditions.

Indiana bats often hibernate in the same hibernacula with other species of bats and are occasionally observed clustered with or adjacent to other species, including gray bats (*Myotis grisescens*), Virginia big-eared bats (*Plecotus townsendii virginianus*), little brown bats, and northern long-eared bats (Myers 1964, LaVal and LaVal 1980, Kurta and Teramino 1994).

The Indiana Bat Recovery Plan (USFWS 1999) ranks hibernation sites into three tiers. More than 85 percent of the range-wide population occupies nine Priority I hibernacula (hibernation sites with a recorded population >30,000 bats since 1960), three each in Indiana, Kentucky, and Missouri. Priority II hibernacula (between 500 and 29,999 individuals) are found in the previously mentioned three States and in Arkansas, Illinois, New York, Ohio, Tennessee, Virginia, and West Virginia. Priority III hibernacula (1 to 499 individuals) have been reported from 17 States, including all of the aforementioned, as well as Alabama, Connecticut, Florida, Georgia, Iowa, Maryland, Massachusetts, Michigan, Mississippi, New Jersey, North Carolina, Oklahoma, Pennsylvania, South Carolina, Vermont, and Wisconsin (USFWS 1999).

Although hibernating populations are reported to be stable or increasing in some portions of its range (e.g., in Indiana, Illinois, New York, Pennsylvania, and West Virginia), Indiana bat numbers have continued to decline range-wide. The most precipitous declines have occurred in Kentucky and Missouri (USFWS 1999).

Fall Roosts and "Swarming"

Before hibernation, Indiana bats undergo "swarming," an activity in which the bats congregate around the hibernacula or other non-hibernation caves, flying into and out of the cave, but typically roosting outside the cave during the day (Cope and Humphrey 1977). Swarming continues for several weeks, during which time the bats replenish fat reserves before hibernation (USFWS 1983) and mate. Adult female Indiana bats store sperm through the winter and become pregnant, via delayed fertilization, soon after leaving the hibernacula. Indiana bats tend to hibernate in the same cave in which they swarm (LaVal *et al*. 1976), although swarming has occurred in caves other than those in which the bats hibernate (Cope and Humphrey 1977; John MacGregor, USFS, personal observation, 1996). Depending on local weather conditions, swarming may continue through October, or even longer. Males generally remain active longer than the females during this pre-hibernation period (LaVal and LaVal 1980), probably to

14

maximize their mating possibilities and replenish fat reserves used in pursuit of females. After mating, females enter directly into hibernation. Most individuals (both sexes) are hibernating by the end of November (by mid-October in northern areas [Kurta *in litt*.]), but hibernacula populations may increase throughout the fall and even into January (Clawson *et al*. 1980).

During the fall "swarm," male Indiana bats roost in trees during the day. In Kentucky, male bats have been found roosting primarily in dead trees on upper slopes and ridgetops within 1.5 miles of their hibernaculum. During September in West Virginia, males have been found roosting in trees near ridgetops within 3.5 miles of their hibernacula, often switching roost trees from day to day (Craig Stihler, West Virginia Division of Natural Resources, personal observation, 1996). Fall roost sites tend to be more exposed to sunlight than roost sites used at other times of the year (MacGregor, personal observation, 1996).

Spring Roosts

Females emerge from the hibernacula ahead of males, generally in late March or early April, and most wintering populations have dispersed by early May, migrating varying distances to their summer habitats. Spring roosting is, in some respects, not a valid habitat descriptor; because, in part, post-emergence movement is mostly directional (i.e., the bats are moving toward their summer habitat), brief, and essentially occurs in summer habitat except, during the time it takes to fly from the hibernacula to their summer habitat. Females dispersing from a Kentucky hibernaculum in the spring moved 4 to 10 miles within 10 days of emergence (MacGregor, *in litt*., 1999). Therefore, spring roosting requirements are likely similar to summer roosting habitat requirements. However, because the bats use some areas only briefly as they move towards their summer habitat, these requirements may be less specific. During this early spring period, females may use several roosts (i.e., small cavities) temporarily, until a roost with larger numbers of bats is established (see maternity roosts). Some males spend the summer near their hibernacula (LaVal and LaVal 1980) while others migrate out of the area. Movements of 2.5 to 10 miles have been reported in Kentucky, Missouri, and Virginia (MacGregor, *in litt*., 1999; Hobson and Holland 1995; 3D/International 1996). Males roost in both trees and caves during the summer; presumably, spring habitat requirements are similar to those of summer.

Migration Patterns

Sparse band recovery records, all from the Midwest, indicate that females and some males migrate north in the spring upon emergence (Hall 1962, Barbour and Davis 1969, Kurta 1980, LaVal and LaVal 1980), though there is evidence of movement in other directions. However, though it appears likely that the majority of individuals migrate north, because of the limited amount of data available on migration and the recent discoveries of reproductive activity further south than previously suspected, interpretation of current data should be cautious.

Summer Habitats

Researchers are still learning about the summer needs of this endangered species, and the perception of what constitutes good habitat and the quantities and the extent of this habitat has evolved over the past few years. Early researchers considered flood-plain and riparian forests to be the primary roosting and foraging habitats used in the summer by the Indiana bat (Humphrey *et al*. 1977), and these forest types are unquestionably important. More recently, upland forests were shown to be used for roosting (Clark *et al*. 1987, Gardner *et al*. 1991b, Callahan *et al*. 1997,

MacGregor, *in litt*., 1999), and upland forests, old fields, and pastures with scattered trees have been shown to provide foraging habitat (Gardner *et al*. 1991b; MacGregor, *in litt*., 1999).

Throughout the species' range, the presence of the Indiana bat in a particular area may be governed by the availability of natural roost structures, primarily standing dead trees with loose bark. The suitability of any tree as a roost site is determined by (A) its condition (dead or alive); (B) the quantity of loose bark; (C) its solar exposure and location in relation to other trees; and (D) its spatial relationship to water sources and foraging areas.

A number of tree species have been reported as roost trees by Indiana bats. These include: American beech (*Fagus grandifolia*), ashes (*Fraxinus* spp.), black gum (*Nyssa sylvatica*), black locust (*Robinia pseudo-acacia*), cottonwood (*Populus deltoides*), elms (*Ulmus* spp.), hickories (*Carya* spp.), maples (*Acer* spp.), oaks (*Quercus* spp.), pines (*Pinus* spp.), sassafras (*Sassafras albidum*), sourwood (*Oxydendrum arboreum*), sweet birch, and yellow buckeye (*Aesculus octandra*) (Cope *et al*. 1974, Humphrey *et al*. 1977, Gardner *et al*. 1991a and b, Garner and Gardner 1992, Kurta *et al*. 1993, Romme *et al*. 1995, Kiser and Elliott 1996, Kiser *et al*. 1996, Kurta *et al*. 1996, Callahan *et al*. 1997). Morphological characteristics of the bark of several trees make them suitable as roosts for Indiana bats; that is, when dead, senescent, or severely injured (e.g., lightning), trees possess bark that springs away from the trunk upon drying. Additionally, the shaggy bark of some living hickories (*Carya* spp.) and large white oaks also provide roost sites. The persistence of peeling bark varies with the tree species and the severity of environmental factors to which it is subjected. While some tree species are undoubtedly more often suitable as roosting habitat, structure (exfoliating bark with space for bats to roost between the bark and the bole of the tree) is more important than the species of the tree.

Indiana bat maternity colonies have multiple roosts, in both dead and living trees. "Primary" roosts are generally in openings or at the edge of forest stands, while "alternate" roosts (based upon the proportion of bats in a colony occupying the roost site) can be in either the open or the interior of forest stands. Maternity colonies have at least one primary roost (up to three have been identified for a single colony) used by most of the bats. Colonies may also have multiple alternate roosts used by small numbers of bats intermittently during the summer (USFWS 1999). Kurta *et al.* (1996) studied a maternity colony in northern Michigan over a 3-year period and noted that bats changed roost trees an average of every 2.9 days and that the number of roosts used by the colony ranged from 5 to 18. Other studies have shown that adults in maternity colonies may use as few as 2, or as many as 33, alternate roosts (Humphrey *et al*. 1977, Gardner *et al.* 1991a, Garner and Gardner 1992, Callahan 1993, Kurta *et al.* 1993, Romme *et al.* 1995).

Indiana bats move from one roost to another within a season, as well as in response to changes in environmental conditions (temperature and precipitation) or when a particular roost becomes unavailable (Gardner *et al*. 1991a, Callahan *et al*. 1997). Therefore, the importance of an individual roost site may not be as important as some researchers have suggested (Humphrey *et al.* 1977), and the Indiana bat may be more adaptable concerning roosting habitats than previously believed. However, though the species appears to be an adaptable animal that takes advantage of the ephemeral habitat available to it, it is apparent that a variety of suitable roosts within a colony's occupied summer range should be available to assure the continuance of the colony in that area (Kurta *et al*. 1993, Callahan *et al*. 1997).

16

Most roost trees used by a maternity colony are close to one another, and the spatial extent and configuration of a colony's regular use area is probably determined by the availability of suitable roosts. The distances between roosts occupied by bats within a single maternity colony have ranged from just a few yards to several miles and, in one case, 3.1 miles (Callahan 1993, Callahan *et al*. 1997, USFWS 1999).

Thermoregulation may be a factor in roost site selection. Exposure to sunlight and location relative to other trees are likely important factors in suitability and use. Because cool temperatures can delay the development of fetal and juvenile young (Racey 1982), selection of maternity roost sites may be critical to reproductive success. Primary roosts are generally not surrounded by a closed canopy and can be warmed by solar radiation, thus providing a favorable microclimate for the growth and development of young during normal weather. Additionally, dead trees with east-southeast and south-southwest exposures may allow solar radiation to warm nursery roosts effectively. Conversely, roosts in some species of living trees (e.g., shagbark hickory [*Carya ovata*]) may provide better protection from rain and unfavorable environmental conditions because the greater thermal mass of live trees can maintain favorable temperatures for roosting bats during cool periods (Humphrey *et al*. 1977). The tight bark of these trees may shield bats from water into the roost during rain events (Callahan *et al*. 1997). Snags exposed to direct solar radiation were used most frequently by Indiana bats as summer roosts, followed by snags not fully exposed to solar radiation and live trees not fully exposed (Callahan 1993).

Alternate roosts tend to be more shaded, are frequently within forest stands, and are selected when temperatures are above normal or during periods of precipitation. Shagbark hickories again seem to provide particularly good alternate roosts because of the factors listed above. Roost site selection and use may differ between the northern and southern parts of the species' range, but, to date, such analyses have not been undertaken.

Known primary roost trees have ranged in size from 12.2 to 29.9 inches diameter at breast height (dbh) (summarized in Romme *et al*. 1995). Miller (1996) compared Indiana bat habitat variables for sites in northern Missouri and noted that significantly larger trees (>12 inches dbh) were found where reproductively active Indiana bats had been netted than at sites at which bats had not been captured. Alternate roost trees also tend to be large, mature trees, but the range in size is somewhat wider than that of primary roosts (7.1 to 32.7 inches dbh) (Romme *et al.* 1995).

Because some characteristics of roosting habitat preferred by Indiana bats are ephemeral, it is difficult to generalize or estimate their longevity due to the many factors that influence them (bark may slough off completely or the tree may fall over). Although roosts may only be habitable for 1 to 2 years under "natural conditions" for some tree species (Humphrey *et al*. 1977), others with good bark retention, such as slippery elm (*Ulmus fulva*), cottonwood, green ash (*Fraxinus pennsylvanica*), and oaks, may provide roosting habitat 4 to 8 years (Gardner *et al*. 1991a, Callahan *et al*. 1997, USFWS 1999). Hickories also retain bark well.

Indiana bats exhibit varying degrees of site fidelity to summer colony areas, roosts, and foraging habitat. Females have been documented returning to the same roosts from 1 year to the next (Bowles 1981, Humphrey *et al*. 1977, Gardner *et al*. 1991a and b, Callahan *et al*. 1997). Kurta *et al*. (1996), however, noted that individuals in a maternity colony in northern Michigan "were not

highly faithful to a particular tree." In Illinois, male Indiana bats exhibited some site fidelity to summering areas they had occupied during previous years (Gardner *et al*. 1991b).

Most maternity records for the Indiana bat originated in the Midwest (southern Iowa, northern Missouri, northern Illinois, northern Indiana, southern Michigan, and western Ohio). The first maternity colony was found, and several studies of Indiana bat maternity habitat were conducted, in this Midwest region. Although the woodlands in this glaciated region are mostly fragmented, it has a relatively high density of maternity colonies. Today, small bottomland and upland forested tracts with predominantly oak-hickory forest types and riparian/bottomland forests of elm-ash-cottonwood associations exist in an otherwise agriculturally dominated (non-forested) landscape (USFWS 1999). Unglaciated portions of the Midwest (southern Missouri, southern Illinois, southern Indiana), Kentucky, and most of the eastern and southern portions of the species' range appear to have fewer maternity colonies per unit area of forest. However, this may be an artifact in comparing these areas with the highly fragmented midwestern forests.

Indiana bats occupy distinct home ranges during the summer (Gardner *et al.* 1990). Average home range sizes vary from about 70 acres (juvenile males) to more than 525 acres (post-lactating adult females). Roosts occupied by individuals range from 0.33 mile to more than 1.6 miles from preferred foraging habitat but are generally within 1.2 miles of water (e.g., stream, lake, pond, natural or manmade water-filled depression).

Foraging habitat and behavior

Indiana bats forage in and around the tree canopy of floodplain, riparian, and upland forests. In riparian areas, Indiana bats primarily forage around and near riparian and floodplain trees; e.g., sycamore (*Platanus occidentalis*), cottonwood, black walnut (*Juglans nigra*), black willow (*Salix nigra*), and oaks, as well as solitary trees and forest edge on the flood plain (Belwood 1979, Cope *et al*. 1974, Humphrey *et al*. 1977, Clark *et al*. 1987, Gardner *et al*. 1991b). Within floodplain forests where Indiana bats forage, canopy closures range from 30 to 100 percent (Gardner *et al*. 1991b). Cope *et al*. (1978) characterized woody vegetation within a width of at least 30 yards on both sides of a stream as excellent foraging habitat. Streams, associated floodplain forests, and impounded bodies of water (e.g., wetlands, reservoirs) are preferred foraging habitats for pregnant and lactating Indiana bats, some of which may fly up to 1.5 miles from upland roosts (Gardner *et al*. 1991b). Indiana bats also forage within the canopy of upland forests, over clearings with early successional vegetation, along the borders of croplands, along wooded fencerows, and over farm ponds in pastures (Clark *et al*. 1987, Gardner *et al*. 1991b).

Indiana bat maternity colony foraging areas have ranged from a linear strip of creek vegetation 0.5 mile in length (Belwood 1979, Cope *et al*. 1974, Humphrey *et al*. 1977) to a foraging area 0.75 mile in length, within which bats flew over a wooded river or around the riverside trees (Cope *et al*. 1978). Indiana bats return nightly to their foraging areas (Gardner *et al*. 1991b). Indiana bats usually forage and fly within an air space from 6 to 100 feet above ground level (Humphrey *et al*. 1977). Most Indiana bats caught in mist nets are captured over streams and other flyways at heights greater than 6 feet (Gardner *et al*. 1989).

During summer, male Indiana bats that remained near their Missouri hibernacula flew cross-country or upstream toward narrower, more densely wooded riparian areas during nightly

18

foraging periods, perhaps due to interspecific competition with gray bats. Some male bats also foraged at the edges of small floodplain pastures, within dense forests, and on hillsides and ridgetops; the maximum reported distance of these foraging efforts was 1.2 miles (LaVal *et al*. 1976, LaVal *et al.* 1977, LaVal and LaVal 1980). In Kentucky, MacGregor (*in litt*., December 1998) reported that the maximum distance males moved from their hibernaculum in the summer was about 2.6 miles. In the fall, male Indiana bats tend to roost and forage in upland and ridgetop forests, but may also forage in valley and riparian forests; movements of 1.8 to 4.2 miles have been reported in Kentucky and Missouri (Kiser and Elliott 1996, 3D/International 1996, MacGregor, *in litt*., June 1997).

Indiana Summer Habitat Model

Romme *et al.* (1995) developed a habitat suitability index (HSI) model for the Indiana bat that identified nine variables believed to be the major components of its summer habitat. The model was developed for use in southern Indiana, but it may also be applicable in other areas within the species' range. The five variables considered important for roosting habitat within the analysis areas included: (A) the amount of overstory canopy, (B) the diameter of overstory trees, (C) the density of potential live roost trees, (D) snag density, and (E) the amount of understory cover. Variables considered important foraging habitat components included the amount of overstory canopy and the percentage of trees between 2 and 4.7 inches dbh. Distance to water and percentage of the analysis area with forest cover are also considered to be important habitat variables. The habitat model also classifies species of trees that may provide roosts for Indiana bats (Class I through Class III, with Class I being the most important). Class I trees include:

silver maple	shagbark hickory	shellbark hickory
bitternut hickory	green ash	white ash
eastern cottonwood	red oak	post oak
white oak	slippery elm	American elm

These species are likely to develop the loose, exfoliating bark preferred by Indiana bats as roosting sites as they age and/or die. Class II trees were identified (including sugar maple, shingle oak [*Quercus imbricaria*], and sassafras) as species believed to be of somewhat lesser value for roosting Indiana bats. Class III trees are all other species of trees not included in the other two classes. Class II and III trees are species that are less likely to provide optimal roosting habitat but may develop suitable cracks, crevices, or loose bark after the trees die.

In southern Indiana, where the HSI model was developed, optimal Indiana bat roosting habitat consists of areas that are within 0.6 mile of open water and contain at least 30 percent forest cover that meets the following requirements: (a) roosting habitat consisting of overstory canopy of 60 to 80 percent, overstory trees with an average dbh of 15.7 inches at a density of at least 16 or more per acre, snags with a dbh of at least 8.7 inches at a density of at least six snags per acre, understory cover (i.e., from 2 meters above the forest floor to the bottom of the overstory canopy) of 35 percent or less and (b) foraging habitat consisting of overstory canopy cover of 50 to 70 percent, with 35 percent or less of the understory trees between 2 and 5 inches dbh (Romme *et al.* 1995).

Status and distribution

Reasons for Listing

When originally listed on March 11, 1967, the decline of the Indiana bat was attributed to the commercialization of roosting caves, wanton destruction by vandals, disturbances caused by increased numbers of spelunkers and bat banding programs, use of bats as laboratory experimental animals, and possibly insecticide poisoning. Some winter hibernacula have been rendered unsuitable as a result of blocking or impeding airflow into the caves and thereby changing the cave's climate. The Indiana bat is nearly extinct over most of its former range in the northeastern states, and since 195O, the major winter colonies in caves of West Virginia, Indiana, and Illinois have disappeared. A high degree of aggregation during winter makes the species vulnerable. During this period approximately 87 percent of the entire population hibernates in only seven caves.

Threats to the Species

Not all of the causes of the Indiana bat population decline have been determined. Although several known human-related factors have caused population declines in the past, they may not be entirely responsible for recent declines. Several known and suspected causes of decline are discussed below.

Disturbance and vandalism - A serious cause of Indiana bat decline has been human disturbance of hibernating bats during the 1960s through the 1980s. Bats enter hibernation with only enough fat reserves to last until spring. When a bat is aroused, as much as 68 days of fat supply is used in a single disturbance (Thomas *et al.* 1990). Humans (including recreational cavers and researchers) passing near hibernating Indiana bats can cause arousal (Humphrey 1978, Thomas 1995, Johnson *et al.* 1998). If this happens too often, a bat's fat reserves may be exhausted before the species is able to forage in the spring, which may cause mortality of the bat.

Direct mortality due to human vandalism has been documented. The worst known case occurred in 1960 when an estimated 10,000 Indiana bats were killed in Carter Caves State Park, Kentucky, when three youths tore masses of bats from the ceiling and trampled and stoned them to death (Mohr 1972). Another incident was reported from Thornhill Cave in Kentucky, where at least 255 Indiana bats were killed by shotgun blasts in January 1987 (Anonymous 1987).

Improper cave gates and structures - Some hibernacula have been rendered unavailable to Indiana bats by the erection of solid gates in the entrances (Humphrey 1978). Since the 1950s, the exclusion of Indiana bats from caves and changes in air flow and distribution patterns are the major causes of loss in Kentucky (an estimated 200,000 bats at three caves) (USFWS 1999). Other cave gates have modified the climate of hibernacula so that Indiana bats are unable to survive the winter because changes in air flow elevated temperatures, which caused an increased metabolic rate and a premature exhaustion of fat reserves (Richter *et al.* 1993; Merlin Tuttle, Bat Conservation International, *in litt*., 1998).

Conversely, an Indiana bat population may be restored if an improper gate is replaced with one of appropriate design or if proper air flow and distribution patterns are restored. In Wyandotte Cave in Indiana, dramatic population increases followed gate replacement and the restoration of

20

traditional air flow (Richter *et al*. 1993). Improved air flow facilitated by the enlargement of an upper level entrance was apparently responsible for a three-fold increase in Indiana bat numbers in Ray's Cave in Indiana (Brack *et al*. 1991). The recovery of hibernating populations to historic levels, however, has not been as successful elsewhere. At Hundred Dome Cave in Kentucky, predicted population gains have never been realized, although air flow obstructions have been removed and gates suitable for the species have been installed (USFWS 1999).

Natural hazards - Indiana bats are subject to a number of natural hazards. River flooding in Bat Cave at Mammoth Cave National Park in Kentucky caused large numbers of Indiana bats to drown (Hall 1962). Other cases of hibernacula flooding have been recorded by Hall (1962), DeBlase *et al*. (1965), and the Service (USFWS 1999).

Bats hibernating in mines are vulnerable to ceiling collapse (Hall 1962), and this is a concern at Pilot Knob Mine in Missouri, once the largest known Indiana bat hibernating population. To a lesser extent, ceiling collapse in caves is also possible.

Another hazard exists because Indiana bats hibernate in cool portions of caves that tend to be near entrances, or where cold air is trapped. Some bats may freeze to death during severe winters (Humphrey 1978, Richter *et al.* 1993). Indiana bats apparently froze to death in Bat Cave (Shannon County, Missouri) in the 1950s (USFWS 1999). The population at this site was 30,450 in 1985, when the bats were observed roosting on a high ceiling, presumably to escape severe cold at their traditional roosting ledges 7 to 9 feet above the cave floor. In a 1987 survey, the population had plummeted to 4,150 bats, and the cave floor was littered with bat bones, suggesting that the bats died during hibernation, apparently freezing to death (USFWS 1999).

At Missouri's Great Scott Cave, average mid-winter temperatures appear to have risen 8^{o}F (4.4^{o}C) from the mid-1980s through the present, compared with temperatures in the 1970s and early 1980s. A major population loss occurred between the mid-1980s and 1998. A detailed analysis is needed, along with detailed temperature profiles of this and other hibernacula, to better understand the relationship(s) between climate, air flow, and hibernation microclimates within important hibernacula.

Indiana bats are vulnerable to the effects of severe weather when roosting under exfoliating bark during summer. For example, a maternity colony was displaced when strong winds and hail produced by a thunderstorm stripped the bark from their cottonwood roost and the bats were forced to move to another roost (USFWS 1999).

Other - Other documented sources of decline include indiscriminate collecting, handling and banding of hibernating bats by biologists, and flooding of caves due to rising waters in reservoirs (Humphrey 1978).

Microclimate effects - Changes in the microclimates of caves and mines may have contributed more to the decline in population levels of the Indiana bat than previously estimated (Tuttle, *in litt*. August 4, 1998). Entrances and internal passages essential to air flow may become larger, smaller, or closed, with concomitant increases or decreases in air flow. The blockage of entry

points, even those too small to be recognized, can be extremely important in hibernacula that require chimney-effect air flow in order to function.

Hibernacula in the southern portions of the Indiana bat's range may either be near the warm edge of the bat's hibernating tolerance or have relatively less stable temperatures. Hibernacula in the northern portion of its range may have passages that become too cold, and the bats must be able to escape particularly cold temperatures. In the former case, bats may be forced to roost near entrances or floors to find low enough temperatures, thus increasing their vulnerability to freezing or predation. In both cases, modifications that obstruct air flow or bat movement could adversely affect the species (USFWS 1999).

Recent analysis of mid-winter temperature records obtained during hibernacula surveys, especially of Priority I caves, suggests that unacceptable deviations in roost temperatures may account for some of the overall population decline (M. Tuttle, *in litt*., August 4, 1998). Although scanty, the data suggest that when populations roost mostly at temperatures below 35°F or above 47°F (2°C and 8°C), they usually decline, and when roosting between 37°F and 45°F (3°C and 7.2°C) they tend to grow.

To test the hypothesis that changes in the microclimates of Indiana bat hibernation sites may be contributing to the recent downward trend in this species, the temperature and relative humidity of 13 major hibernacula in Indiana, Kentucky, Missouri, Tennessee, and Virginia were monitored. Investigations revealed that crucial air flow had been interrupted at some sites, and the air temperature had risen a few degrees above optimal levels in others, providing additional initial evidence that changes in microclimates may be contributing to this species' drastic decline (Tuttle, *in litt*., August 4, 1998). Additional years of monitoring at these sites will be necessary to further evaluate any changes in hibernation conditions.

Land-use practices - Habitat within the Indiana bat's maternity range has changed dramatically since pre-settlement times (Schroeder 1981, Giessman *et al*. 1986, MacCleery 1992, Nigh *et al.* 1992). Most of the forest in the upper Midwest has been fragmented, fire has been suppressed, and native prairies have been converted to agricultural crops or to pasture and hay meadows for livestock. Native species have been replaced with exotics in large portions of the maternity range, and plant communities have become less diverse than occurred prior to settlement. Additionally, many chemicals are applied to these intensely agricultural areas. The changes in the landscape and the use of chemicals (McFarland 1998) may have reduced the availability and abundance of the bat's insect forage base.

Conversely, regions surrounding hibernacula in the Missouri Ozarks and elsewhere are now more densely forested than they were historically (Sauer 1920, Ladd 1991, Jacobson and Primm 1997). Consequently, the open, savanna-like conditions that may have been important to the species maternity habitat (Romme *et al.* 1995) in part of its range are much less abundant today than occurred historically (USFWS 1999).

In the eastern United States, the area of land covered by forest has been increasing in recent years (MacCleery 1992) but these forests are still young by historical standards. Whether this is beneficial to the Indiana bat is unknown. The age, composition, and size-class distribution of the

22

woodlands will have a bearing on their suitability as roosting and foraging habitat for the species outside the winter hibernation season. An understanding of the factor or factors responsible for the continued decline of the species is needed before it can accurately be determined whether the loss of roosting habitat is limited to regional or range-wide populations (USFWS 1999).

Chemical contamination - Pesticides have been implicated in the declines of a number of insectivorous bats in North America (Mohr 1972; Reidinger 1972, 1976; Clark and Prouty 1976; Clark *et al*. 1978; Geluso *et al*. 1976; Clark 1981). The effects of pesticides on Indiana bats have yet to be studied. McFarland (1998) studied two sympatric species--the little brown bat and the northern long-eared bat--as surrogates in northern Missouri and documented depressed levels of acetylcholinesterase, suggesting that bats there may be exposed to sub-lethal levels of carbamate and/or organophosphate insecticides applied to agricultural crops. McFarland (1998) also showed that bats in northern Missouri are exposed to significant amounts of agricultural chemicals, especially those applied to corn. BHE Environmental, Inc. collected tissue and guano samples from five species of bats at Fort Leonard Wood, Missouri, in 1999 and documented the exposure of bats to p,p'-DDE, heptachlor epoxide, and dieldrin.

Status and Distribution of the Species in Kentucky

Several documented and unverified Indiana bat records exist for the last 60 years in Kentucky. According to records available to the Service, the Indiana bat has been documented from 52 counties distributed throughout the Commonwealth. Summer habitat for the species is found throughout Kentucky. Two of the eleven caves, range-wide, that are designated as Critical Habitat for the Indiana bat occur in Kentucky [Bat Cave (Carter County) and Coach Cave (Edmonson County)]. In addition to these caves, another cave in Edmonson County is also listed as a Priority I hibernacula (> 30,000 individuals). There are also 15 Priority II hibernacula (> 500 but < 30,000 individuals) and 78 Priority III hibernacula (< 500 individuals) documented from the Commonwealth.

Historic hibernating population levels within Kentucky were estimated to be at 241,335 individuals in the Agency Draft Indiana Bat Revised Recovery Plan (USFWS 1999). Between 1960 and 1975, Kentucky had the greatest Indiana bat hibernating population decline among the states, an estimated 145,000 bats. Losses were attributable to exclusion and changes in microclimate at two of the three most important hibernation sites; most were caused by poorly designed cave gates (Humphrey 1978) and by construction of a building over the upper entrance to one of the hibernacula (John MacGregor, pers. obs., October 1996). Although not as dramatic as earlier losses, many of the most important remaining hibernating populations have declined steadily during the past 15 years. During this period, populations in west-central, northeastern, and extreme southeastern Kentucky have declined, while the populations in east-central Kentucky and those in western Kentucky have increased.

Analysis of the species/critical habitat to be affected

In the Introduction to this biological opinion, the Service concurred with the DBNF's determinations of effect on 31 listed species and four critical habitat units that occur on or in the vicinity of the action area. These concurrences were based on the fact that nine listed species are likely extirpated from the action area and 22 species and four critical habitat areas would

continue to be subject to project-specific section 7 consultations. These 31 species will not be considered further. However, based on the DBNF's need to remove green and damaged trees and conduct prescribed burns during the summer roosting period of the Indiana bat and based on the fact that conducting these activities during the summer roosting period could result in the harm, harassment, or mortality of Indiana bats due to the potential effects of timber harvest and burning activities on the Indiana bat and its habitat, only the Indiana bat will be considered further in this biological opinion.

ENVIRONMENTAL BASELINE

Under section 7(a)(2) of the Act, when considering the "effects of the action" on federally listed species, the Service is required to take into consideration the environmental baseline. The environmental baseline includes past and ongoing natural factors and the past and present impacts of all Federal, State, or private actions and other activities in the action area (50 CFR 402.02), including Federal actions in the area that have already undergone section 7 consultation, and the impacts of State or private actions that are contemporaneous with the consultation in process. The environmental baseline for this biological opinion considers all DBNF projects approved prior to the initiation of formal consultation with the Service.

According to the known and suspected range of the Indiana bat (USFWS 1983), the Indiana bat ranges over an area of approximately 580,550 square miles in the eastern one-half of the United States. The DBNF's surface land area is approximately 1,050 square miles, which represents less than two-tenths of one percent (0.18 percent) of the total range of the species.

Status of the species within the action area

The Indiana bat is known from throughout the DBNF, with over 90 records forest-wide, mostly from hibernation caves which harbor anywhere from a few occasional individuals to several thousand Indiana bats each winter. Although the DBNF does not contain any designated critical habitat or any Priority I hibernacula (defined as harboring 30,000 or more Indiana bats since 1960), it does contain 8 Priority II winter caves (harboring 500 to 30,000 bats), 16 Priority III caves (with < 500 bats) that regularly support 100 or more through each winter, and approximately 30 more Priority III caves that contain fewer than 35 Indiana bats in winter. Seven of the 8 Priority II caves and 7 of the top 16 Priority III caves located within the proclamation boundary are on National Forest System lands, and most of the others are on private tracts immediately adjacent to the Forest. The nearest designated critical habitat, Bat Cave, is located about ten miles east of the DBNF, in Carter County, Kentucky.

Indiana bat winter populations are censused every 2nd year in the hibernacula. Since 1985, the DBNF area has harbored 20 to 25 percent of the total known Indiana bat winter population in Kentucky, which has remained relatively stable or exhibited a slight increase. Some of the Indiana bats that hibernate on the DBNF migrate to other areas in summer. A female that had been banded at a maternity site in extreme northern Indiana was observed during two winters at a Lee County hibernaculum on the DBNF and a male banded in Michigan in July 1998 was recorded in a hibernation cave on the DBNF in October 1999. Other Indiana bats apparently

24

remain on the DBNF year round. Summer maternity colonies, consisting of females and their young, have been documented by mist netting on the Morehead (2 sites), Somerset (1 site), and Redbird (3 sites) Ranger Districts (RD), and might be expected to occur anywhere on the DBNF. An additional summer maternity colony was documented in 2001 near the Morehead RD, just off National Forest System land, but well within the proclamation boundary. Summer resident male Indiana bats have been captured or observed on the Morehead, Stanton, London, Somerset, and Redbird RDs and a single Indiana bat was found in an abandoned coal mine in Big South Fork NRRA (near the Stearns RD) during the fall migration period (USFS *et al*. 1988, 1989, 1990, 1992, 1993;1995; K. Huie field notes; J. MacGregor field notes).

On the DBNF, suitable winter habitat for Indiana bats is largely confined to areas where limestone caves occur, which includes large sections of the Stanton RD, the northern part of London RD, and smaller portions of the Morehead, Somerset, Stearns, and Redbird RDs. Sandstone caves (rock shelters with well developed dark zones), underground workings in limestone quarries, and abandoned coal mines may also provide suitable winter habitat and can be found in varying numbers on all RDs.

In October 1996, following a 2-year study of autumn Indiana bat roosting and foraging habitat that took place on the London RD (Kiser and Elliott 1996), the DBNF began monitoring roost tree use by Indiana bats during the fall on the Somerset RD. The majority of the roost trees used by Indiana bats during the autumn months were located in stands greater than 50 years old with relatively closed canopies (80 to 93 percent canopy cover), in natural canopy gaps that had been formed by the death of one or more canopy trees (primarily from wind or ice damage), and in areas subjected to prescribed burns which had been conducted primarily for red-cockaded woodpecker habitat management. Indiana bats also roosted extensively in 2-age shelterwood harvest areas within which snags and other potential roost trees had been retained, and in high-graded stands with many snags and culls. Similar roost tree use was reported by Gumbert (2001) on the Somerset RD during the spring and summer months.

Suitable roosting and foraging habitat and potential maternity habitat for the Indiana bat occur throughout the Forest. At least a portion of the Indiana bats that spend the winter in the large and medium-sized hibernacula on the Stanton, London, and Somerset RDs remain in the vicinity of these areas through the summer. Some of the Indiana bats from hibernating sites on Pine Mountain (adjacent to the Redbird RD), Carter Caves (not far from the Morehead RD), and caves in Campbell and Fentress Counties in Tennessee (near the Stearns RD), and perhaps from other areas, may also occur on the DBNF in summer. Recent work in Missouri (Romme et al. 2002) and Kentucky (Kiser and Elliott 1996; Gumbert 2001) have found that Indiana bats range up to 5 miles from hibernacula during autumn and spring swarming activity periods.

Factors affecting the species' environment within the action area

The DBNF owns and manages nearly 700,000 acres of the proclamation area's over two million acres. The federally owned tracts are discontinuous and scattered within the proclamation boundary. Individuals hold most of the privately owned land within this boundary in tracts of 100 to 300 acres. A number of activities occur on these private in-holdings that may affect the Indiana bat. The most significant of these activities include (A) timber harvest; (B) off-highway

vehicle recreational use; (C) recreational use of caves (potential hibernacula); (D) rock climbing, and (E) development associated with road, residential, industrial, and agricultural construction and activities. Long-term land use and demographic trends may also play a key role in any effects that may occur to the Indiana bat if these trends result in destruction and/or modification of Indiana bat habitat. Other private and federal actions are likely to occur within the action area, but the Service is unaware of any such projects at the current time. However, actions like highway construction are very likely to occur.

EFFECTS OF THE ACTION

Analyses for effects of the action

Beneficial Effects

General - Some activities that have associated negative impacts may also have commensurate beneficial effects. Management practices that create small forest openings may foster the development of suitable roosting and foraging habitat (Krusic and Neefus 1996). Activities that involve tree and sub-canopy vegetation removal, which could adversely affect roosting habitat, may at the same time improve foraging and/or roosting habitat conditions by opening the canopy and exposing potential roost trees to a greater amount of sunlight (see thermoregulatory needs in "Summer Habitats"). Romme *et al*. (1995) reported that stands with closed canopy conditions (>80% canopy closure) provide less than optimal roosting habitat conditions. Callahan (1993) stated that manmade disturbances unintentionally created nine maternity roost trees suitable for Indiana bats. These were in areas that had been heavily logged within the past 20 years and had been used as a hog lot in recent years. Callahan also stated, "those activities probably benefited Indiana bats by removing most of the canopy cover and leaving behind many standing dead trees." Gardner *et al.* (1991b) found that the selective harvesting of living trees did not directly alter summer roosting habitat. Individual Indiana bats have also been found roosting in trees within active timber harvest projects on the DBNF (MacGregor, personal communication). Thus, even active harvests may still serve as suitable roosting habitat for the Indiana bat. The development of infrequently used or closed logging roads and small wildlife openings may also improve foraging habitat conditions by providing narrow foraging corridors within a larger network of mature closed canopy forest.

Potential roosting habitat (i.e., forests with trees having exfoliating bark) and tree species of the size and type known to be used by the Indiana bat exists across the DBNF. Previous and planned pond/waterhole construction will increase the number of upland water sources available for Indiana bats. Persistence of early successional habitats and forests with an open understory and patchy overstory would create insect-rich foraging areas and flight corridors leading to any potential roost trees. Harvests would produce a mosaic of regeneration areas intermixed with mature and late successional forests. Likewise, prescribed fire would also create a mosaic of forest habitat conditions resulting from varying fire intensities. This will indirectly benefit Indiana bats by providing feeding areas since bats are known to forage within the canopy openings of upland forests, over clearings with early successional vegetation, and over ponds. Prescribed fire will result in the creation of snags. While some snags will be created others will be consumed as a result of prescribed burning. Prescribed burning for fuel reduction will

26

minimize the occurrence of catastrophic wild fires which are much more likely to damage existing habitat (i.e., consume snags).

Current USFS Indiana Bat Conservation Measures - Conservation measures represent actions pledged in the project description that the action agency would implement to further the recovery of the species under review. Such measures should be closely related to the action and should be achievable within the authority of the action agency. The beneficial effects of conservation measures are taken into consideration in our conclusion of a jeopardy versus a nonjeopardy biological opinion and in the analysis of incidental take. However, such measures must minimize impacts to listed species within the action area in order to be factored into our analyses.

The proposed action includes ongoing conservation measures that will be implemented through standards and prescriptions outlined in the revised LRMP to reduce or minimize adverse effects on the Indiana bat. The DBNF has designed Objectives, Standards, and Prescription Areas specifically to protect, maintain, or enhance summer or winter Indiana bat habitat or prevent impacts to Indiana bats roosting in trees. Thus, impacts to Indiana bats resulting from the implementation of land management activities, such as green tree harvests, salvage/sanitation harvests, and prescribed burning, may be coincidentally reduced through forest-wide standards and/or the implementation of standards and prescriptions specific to those activities.

The direction contained in the revised LRMP, particularly the creation of several Prescription Areas, should provide programmatic, long-term benefits to Indiana bat populations on the DBNF. For example, the Cliffline Community (111,200 acres), Riparian Corridor (155,370 acres) and Significant Bat Cave (6,100 acres) Prescription Areas were created, in part, with habitat maintenance and/or improvements for the Indiana bats in mind. Generally, habitat management in these areas is limited and is primarily designed to improve conditions for species associated with these prescription areas. For example, an objective (1.J-Objective 1.B) within the Significant Bat Cave Prescription Area specifically limits the occurrence of prescribed burning within five miles of these cave openings during the fall swarming season (September 1 to December 1). Therefore, in the long-term, management actions in these areas should move the habitat conditions toward the desired future condition and provide beneficial effects to the Indiana bat. Standards within these Prescriptions Areas are also expected to provide additional protective measures and/or habitat enhancement direction for the species.
Additionally, the Habitat Diversity Emphasis Prescription Area (376,000 acres) is an area of active forest management that should continue to provide for a mosaic of habitats that can be occupied by Indiana bats within the general forested community. Standards in the revised LRMP, particularly DB-WLF-1 through DB-WLF-15, are designed to retain and/or create habitat conditions particularly suitable for the Indiana bat and should provide long-term beneficial effects for the species. These Standards focus on avoiding the cutting of trees that are most likely to contain a maternity colony or a roosting bat.

Thus, the Standards may minimize negative impacts to and, in some cases, potentially improve Indiana bat habitat. These Standards and Prescription Areas were developed to meet specific resource objectives, to serve as avoidance, minimization, and/or mitigation measures, and to

provide for population viability for native wildlife species, including the Indiana bat. The Standards that likely pertain to the Indiana bat are listed in Appendix B.

Direct Effects of Green Tree and Salvage/Sanitation Harvests

During the non-hibernation season Indiana bats, especially females, often roost in live, damaged, and/or dead trees with naturally exfoliating bark (e.g., oaks, elms, and hickories). These trees are defined as Potential Roost Trees in the LRMP and BA. Of the 20 tree species commonly harvested on the DBNF, 13 are considered potential roost tree species. Based on information provided in the BA for an average timber harvest, these 13 species (e.g., mostly oaks, elm, and yellow poplar) make up approximately 89 percent of the trees cut. With regard to the damaged and/or dead trees, it is the physical condition of the tree, rather than the tree species itself, that makes these trees suitable roosting habitat for the Indiana bat. Stochastic events, in part, distribute trees in this condition across the forest. When any of the previously mentioned stands are selected for harvest operations, programmatically, the following effects can be expected.

In any green tree and/or salvage/sanitation harvest on the DBNF, a number of activities that occur may cause direct or indirect effects to the Indiana bat. Some of these activities, by themselves, may not result in the take of an Indiana bat; however, when they are considered as one programmatic action, take may occur. These interrelated or interdependent activities include: (A) Timber Appraisal, Advertisement, Bidding, Award Of Sale and Closing the Sale; (B) Sale Area Layout/Designation of Timber to be Harvested; (C) Felling of Trees; (D) Skidding of Cut Trees; (E) Decking/Landing of Cut Trees; and (F) Transporting of Logs. These activities are listed in the order in which they typically occur and are further discussed in the BA and its supplements.

The direct effects that may occur will typically result from the felling, skidding, decking/landing, and/or transport of trees. These effects can be separated into the felling of a tree and the removal operations that occur once the tree is on the ground. Trees are either felled through the selection and subsequent dropping of that tree or the accidental felling of an adjacent tree. Regardless of the felling method (i.e., direct or accidental), a maternity colony or individual Indiana bats could be harmed or killed when the tree strikes the ground. While male bats can fly away from a tree during the felling process, females would be less likely to leave if they have flightless young present (usually between May 1 and July 31). Flightless young in a maternity colony would not leave their roost tree and may be killed. Once the young bats become volant their likelihood of surviving the felling of a tree in which they are roosting likely increases. Project level monitoring on the DBNF indicates that there is no known occurrence of Indiana bat mortality associated with the felling of trees. Likewise, regardless of the activity responsible for the removal of the felled tree (i.e., skidding, landing/decking, or transporting), it could result in take of an Indiana bat that survived the felling operation and remained in the log.

Another direct effect that may occur is the disturbance of a roosting bat that causes the bat to flush from the roost tree during daylight. This type of effect could result from any of the activities mentioned previously, excluding the administrative activities. Disturbing a roosting Indiana bat may alter its normal behavioral pattern. The noise or disturbance is generated by a variety of activities ranging from human presence in the area to the loud noises associated with the use of equipment on or near the roosting bat (e.g., axes, chain saws, skidders, loading

28

equipment, and trucks). The flushing of an Indiana bat could result in harm or harassment by altering its normal behavioral pattern and possibly making it more susceptible to various predators during the daylight hours or result in mortality. While these types of disturbances can occur, they present a very minimal risk to the Indiana bat when considered individually; however, programmatically these activities could result in the take of an Indiana bat.

With regard to the likelihood that non-target trees could be cut or the selected tree could, in the process of falling, accidentally knock down a non-target tree, the DBNF's monitoring over the last four years (2000 – 2003) indicates that between 1 and 17 reportable roost trees are accidentally felled on an annual basis. Reportable roost trees are defined in the BA and LRMP. Inspection of these trees has determined that no known harm or mortality has occurred.

The major difference between green tree timber sales and those associated with salvage/ sanitation operations is the condition of the individual trees that are selected for removal. In salvage/sanitation sales, it is the highly damaged trees that are selected for removal and, thus make up the majority of trees cut in a project area. These damaged trees usually meet the physical condition of what have been defined in the LRMP and protected through standard DB-WLD-7 as immediate roost trees. Thus, salvage/sanitation harvest projects usually are designed to remove the specific trees identified as desirable roosting sites for the Indiana bat. If the stochastic event is severe enough or if enough time passes prior to management action, the resulting trees within the salvage/sanitation project area may be dead (snags). These trees have also been recognized, through Standard DB-WLD-1, as potentially having characteristics that make them desirable for Indiana bat roosting.

Specifically to the Indiana bat, the LRMP provides standards to protect, maintain and/or enhance Indiana bat habitat associated with timber sale projects involving green tree cutting (DB-WLD-1 through 9, 11, and 12). With the exception of DB-WLD-1 and DB-WLD-7, other 2004 Forest Plan standards (DB-WLD-2, 3, 4, 5, 8, 11, 12) designed to protect the Indiana bat or enhance its habitat remain in affect during salvage/sanitation project implementation. Thus, suitable roosting habitat is retained within the green tree and/or salvage/sanitation project areas and is generally not considered to be a limiting factor for the Indiana bat on the DBNF.

The LRMP contains no programmatic prohibitions preventing the cutting of green trees or damaged or dead trees between April 1 and September 15, thus, programmatically this action may directly and/or indirectly affect the Indiana bat on up to 4,000 acres of green tree and 350 acres of salvage/sanitation harvests annually. Most standing trees selected for harvest in salvage/sanitation sales may provide suitable roosting habitat for the Indiana bat. While the probability of taking an individual Indiana bat remains low, it is likely to be somewhat higher, at least on a per acre basis, than that which occurs on 4,000 acres of green tree cutting activities. Overall, the DBNF has no known occurrence of taking an Indiana bat during tree felling or associated operations.

Direct Effects of Prescribed Burning

In any prescribed burn, a number of activities that occur may directly impact the Indiana bat. Some of these activities, by themselves, may not result in the take of an Indiana bat; however, when they are considered as one programmatic action, take may occur. These associated

activities include: (A) Burn Plan Preparation/Layout; (B) Fire Line Construction; (C) Ignition of the Burn; and (D) Mop-Up after the burn is completed. These activities are listed in the order in which they typically occur and are further discussed in the BA and its supplements.

The direct effects that may occur as a consequence of prescribed burns could result from the fire line construction, ignition of the burn, and/or mop-up after burn is completed. These effects can be separated into the felling of trees associated with the construction of the fire line and/or mop-up of the site once the burn is completed and the smoke and heat produced from the fire. Similar to timber harvest actions, trees within and adjacent to the fire line are either felled through the selection and subsequent dropping of that tree or the accidental felling of an adjacent tree.

Fire line layout and construction attempt to avoid the removal of any large trees including snags. However, in some instances related to fire control and/or human safety, the direct or accidental removal of trees suitable for Indiana bat roosting, including snags, may occur. If the removal of these trees is not avoided or completed when the bats are hibernating, then take could occur. Additionally, standing snags that are on fire or smoldering could be felled during mop-up operations if they pose a threat to human safety or pose a threat to loosing control of the prescribed fire outside the fire lines. If an Indiana bat remained in such a tree, then the felling of that tree, or the accidental felling of an adjacent tree, could also result in take of an Indiana bat.

Roosting Indiana bats have the potential to be harmed by both the smoke and fire associated with prescribed burns. Roosting bats may flush from their roost trees in response to smoke or the heat from the fire, but flushing may not occur if certain situations (i.e., the bats are roosting high in a tree and are not affected by smoke or heat). This flushing activity could result in harm and harassment to the Indiana bat by altering its normal behavior pattern and possibly making it more susceptible to various predators during the daylight hours or result in mortality. However, it should be noted that fire is part of the natural disturbance regime for forest communities on the DBNF, as are rain and windstorms. Historically, management actions have combined to suppress the occurrence of fire on the DBNF. Prescribed burning is an action that attempts to restore a natural disturbance that Indiana bats have evolved with over time.

If Indiana bats do not flush from their roosting sites, they may become subject to both heavy smoke and high heat conditions. Either condition could result in the take of an Indiana bat. During the portion of the year that young Indiana bats are flightless, the potential for take to occur would increase. Juvenile bats would be incapable of flushing from a roost tree and would not have the opportunity or option of avoiding the effects of smoke and fire by flying away. To minimize the potential for this type of take to occur the LRMP has a Standard designed to protect young Indiana bats during their flightless period (DB-FIRE-8). The likelihood of harming a bat would depend on how high up in a tree it was roosting and the intensity of the fire and/or smoke in that location. Radio-telemetry data indicates that Indiana bats roost at various heights ranging from as low as six feet to over 50 feet from the ground. Even higher roosting is possible, depending on the physical condition of the roost tree.

The DBNF also attempts to avoid impacting roosting bats by determining if roosting occurs in the area. This monitoring is done as part of the project-specific analysis associated with each prescribed burning project from May 1 to July 31. Known roosting areas are determined in

30

several ways prior to conducting burns in suitable roosting habitat during the above time period. If Indiana bats are present in the area, it is assumed that they are females and, during this period of the year, have young. Methods include, but are not limited to: (A) reviewing past research and monitoring records for Indiana bat roosting areas; (B) on-site review of the project area to determine if suitable roosting habitat is currently present; (C) monitoring the area according to the Service's protocols to determine if Indiana bats are using the area.

Additional direct effects that may occur as a result of prescribed fire could result from the disturbance of roosting Indiana bats. The noise or disturbance is generated by a variety of activities ranging from human presence in the area to the loud noises associated with the use of equipment on or near the roosting bat (e.g., axes, chain saws, bulldozers). Noise associated with activities within a burn unit can cause a bat to flush. This flushing activity could result in harm or harassment of the Indiana bat by altering its normal behavioral pattern and possibly making it more susceptible to various predators during the daylight hours or result in mortality. While these types of disturbances can occur, they would only occur for a relatively short period of time and would present a very minimal risk to the Indiana bat when considered individually; however, programmatically these activities could result in the take of an Indiana bat.

Additionally, spot fires can and do occasionally occur outside of planned fire lines. These spot fires usually result from burning embers blowing across the fire lines. During the prescribed burn and mop-up operations, fire crews are in the immediate area and these unplanned burn areas seldom exceed ¼ acre. Should these spot fires continue to grow in size, they are declared a wildfire and additional resources brought into the area to bring the escaped fire under control. Actions taken during wildfire control are not required to adhere to Standards established in the LRMP. In such occurrences, the loss of roost trees could cause additional harm, harassment or mortality to the Indiana bat. Indiana bats flushed from trees could result in harm and harassment by altering its normal behavior pattern and possibly making it more susceptible to various predators during the daylight hours or result in mortality.

Indirect Effects

The implementation of management activities that involve the removal (harvest) or destruction (burning) of suitable roost trees has the potential for adverse effects by removing these trees and reducing tree density levels and subsequent canopy closure levels, which results in less than optimal or suitable summer roosting or foraging habitat conditions. When these activities occur near known or potential maternity sites, they could result in adverse stress to roosting bats. However, the overall potential impact is somewhat lessened by at least five factors: (A) approximately 50 percent of the DBNF would be unsuitable for timber production under the LRMP; (B) a high percentage of the DBNF is projected to provide at least suitable snag habitat conditions, with a projected increase in the number of acres meeting suitable snag habitat conditions over the life of the LRMP; (C) at projected harvest rates, the creation of roosts through annual natural tree mortality will offset any subsequent loss of live potential or dead roost trees; (D) the overall forest stand age of the DBNF is increasing, which indicates that as these stands get older there will be a greater number of larger-diameter potential roost trees available; and (E) the Standards appear to provide for more than adequate numbers of potential roost trees.

If green tree harvests, salvage/sanitation harvests, and prescribed burning were implemented at the proposed maximum thresholds, approximately 54,350 acres would be impacted each year. However, we believe that this overestimates potential impacts to Indiana bat habitat, because it assumes that (A) all activities occur in forest types that can be immediately occupied by Indiana bats, (B) all of the habitat within a project area is potentially suitable and/or occupied habitat, and (C) all activities are completely deleterious resulting in complete loss of habitat values for Indiana bats within a project area. Obviously, this would not be the case, and, further, this acreage would represent only 8 percent of the potentially suitable habitat (663,682 acres) on the DBNF if maximum management targets are achieved.

Indiana bats should also benefit from increased foraging opportunities and increased insect populations following prescribed burns. Burned areas tend to have more herbaceous biomass due to reduced competition from trees and shrubs and the removal of leaf litter from the forest floor. In turn, this increase in herbaceous biomass will support more Indiana bat prey items and more species of prey items. Many activities, such as thinning and burning, may actually improve foraging habitat by opening dense stands that may hamper movement of bats through the stand or improve potential dead-tree roosting habitat by creating new snags. It is also important to recognize that the prescribed burning, the most significant action impact, would not occur on 50,000 different acres each year. Instead, prescribed burning would often involve replicated burns on the same sites at re-occurring intervals, which would shift forest stands to the Desired Future Condition.

Interrelated and Interdependent Effects

An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification (USFWS and National Marine Fisheries Service [NMFS] 1998). An interdependent activity is an activity that has no independent utility apart from the action under consultation (USFWS and NMFS 1998). A determination of whether other activities are interrelated to, or interdependent with, the proposed action under consultation is made by applying a "but for" test. That is, it must be determined that the other activity under question would not occur "but for" the proposed action under consultation (USFWS and NMFS 1998). For example, private timber-harvesting activities outside the DBNF would only be considered as interrelated or interdependent if a determination was made that these activities would not occur but for implementation of the LRMP. There is no justification for claiming that other harvesting activities on adjacent land occurred due to the implementation of the LRMP; therefore, these actions outside the boundaries of the DBNF cannot be considered as an interrelated or interdependent action that should be considered in this biological opinion. Further, any unforeseen activity that may occur as a result of the proposed actions would receive a second level, project-specific analysis and subsequent section 7 consultation with the Service through the BA/BE process.

CUMULATIVE EFFECTS

Cumulative effects include the combined effects of any future State, local, or private actions that are reasonably certain to occur within the action area covered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section

because they require separate consultation under section 7 of the Act. Additionally, any future Federal, State, local, or private actions that are reasonably certain to occur in the action area, and which are considered in this biological opinion, will either be carried out by, or will require a permit from, the USFS; they will, therefore, require compliance with section 7 of the Act. Because the Service is not aware of any future State, local, or private actions that are reasonably certain to occur within the action area and which would not be subject to USFS section 7 review, cumulative effects, as defined by the Act, will not occur and will not be addressed further in this biological opinion.

CONCLUSION

After reviewing the current status of the Indiana bat; the environmental baseline for the action area; the effects of the proposed forest management activities associated with green tree harvests, salvage/sanitation harvests, and prescribed burning and the cumulative effects, it is the Service's biological opinion that proposed forest management activities associated with green tree harvests, salvage/sanitation harvests, and prescribed burning, as proposed, are not likely to jeopardize the continued existence of the Indiana bat. Critical habitat for the Indiana bat has been designated at a number of locations throughout its range, however, this action does not affect any of those designated critical habitat areas and no destruction or adverse modification of that critical habitat is expected.

This conclusion is based on the DBNF's stated commitment to protect and conserve Indiana bat summer and winter habitat through implementation of the LRMP and its protective Standards that benefit Indiana bats and our analysis of the effects of the proposed action. These effects show that Indiana bats may be incidentally taken during green tree harvests, salvage/sanitation harvests, and/or prescribed burning at levels that are unlikely to result in jeopardy to the species. Furthermore, the expected outcome of the DBNF's proposed management direction under the LRMP would be beneficial effects to Indiana bats and their habitat through the protection of hibernacula, the improvement of summer roosting and foraging habitat across the DBNF, and the continual replacement of potentially suitable forested habitat on the DBNF (i.e., habitat alteration/loss will not be permanent).

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations under section 4(d) of the Act prohibit the taking of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part

of the agency action is not considered to be prohibited under the Act, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the DBNF so that they become binding conditions of any grant, contract, or permit issued to an applicant, contractor, or permittee, as proper, for the exemption in section 7(o)(2) to apply. The DBNF has the continuing duty to regulate the activity covered by this Incidental Take Statement. If the DBNF (A) fails to assume and implement the terms and conditions or (B) fails to require an applicant, contractor, or permittee to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the grant, contract, or permit document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the DBNF must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service anticipates incidental take of the Indiana bat will be difficult to detect for the following reasons:

1. The individuals are small and occupy summer habitats where they are difficult to find;

2. Indiana bats form small (i.e., 25-100 individuals), widely dispersed maternity colonies under loose bark or in the cavities of trees, and males and non-reproductive females may roost individually which makes finding the species or occupied habitats difficult;

3. Finding dead or injured specimens during or following project implementation is unlikely;

4. The extent and density of the species within its summer habitat on the DBNF is unknown; and
5. Implemented actions will not affect all of the available habitat within a project area (i.e., implementation of protective Standards and avoidance measures that the DBNF will implement on a project-specific basis will minimize the amount of incidental take).

6. Most incidental take will be non-lethal and undetectable.

However, incidental take of Indiana bats can be expected due to:

1. Loss of occupied and potential roosting trees and habitat (an indirect effect);

2. Modification and alteration of occupied and potential roosting trees and habitat (an indirect effect);

3. Modification and alteration of occupied and potential foraging habitat (an indirect effect);

4. Harm and harassment of Indiana bats resulting from activities associated with green tree harvests, salvage/sanitation harvests, and prescribed burning that will be conducted within potential and/or occupied Indiana bat habitat (an indirect effect); and

5. Mortality associated with the loss, modification, and/or alteration of occupied roost trees and occupied foraging habitat resulting from green tree harvests, salvage/sanitation harvests, and prescribed burning that will be conducted within occupied Indiana bat habitat (a direct effect).

The level of take identified below may result, because the DBNF anticipates that up to 4,000 acres of green tree harvest, 350 acres of salvage/sanitation harvest, and 50,000 acres of prescribed burning may occur per year during the summer roosting period of the Indiana bat and because these activities will likely occur within forest stands that contain potential habitat for Indiana bats. Because of the difficulty in determining a level of take based on the number of Indiana bats that will be adversely affected, the Service has decided that it is appropriate to base the level of authorized incidental take on the acreage that will be affected by green tree harvests, salvage/sanitation harvests, and prescribed burns on an annual basis. Therefore, the level of take authorized in this biological opinion is 4,000 acres of green tree harvest, 350 acres of salvage/sanitation harvest, and 50,000 acres of prescribed burns annually when accomplished during the summer roosting period of the Indiana bat (April 1 to September 15).

This incidental take statement anticipates the taking of Indiana bats only from the actions associated with green tree harvests, salvage/sanitation harvests, and/or prescribed burning activities as described in the DBNF's BA, as supplemented. Incidental take of Indiana bats is expected to be in the form of mortality, harm, and/or harassment and is expected to occur as a result of timber harvest; temporary road, skid-trail, fire line, and log landing construction and maintenance; smoke and fire resulting from prescribed burning; disturbance from people and machinery used during the preparation and implementation of these activities; and inter-related activities that are necessary to plan and implement these activities. Although mortality is the least likely form of take to occur, adult or juvenile Indiana bats may be killed (A) during green tree harvests and salvage/sanitation harvests due to the felling of trees, (B) by the effects of smoke and fire during prescribed burns, or (C) by other activities that are associated with green tree harvests, salvage/sanitation harvests, or prescribed burning. Harm may occur through the habitat alterations that are anticipated to occur as a result of the action which include, but are not limited to, removal of potential roost trees and the accidental scarring or knocking down of potential or occupied roost trees by personnel or equipment. Harassment may occur as a result of any number of indirect effects outlined in previous sections of this biological opinion. However, likely sources of harassment to Indiana bats include, but are not limited to, smoke and heat resulting from prescribed burning and noise and other disruptions (e.g., operations of personnel and equipment) within occupied habitat. Potential foraging habitat and potential summer roost trees for the Indiana bat are believed to be well-distributed across the DBNF. Thus, harassment has the potential to occur in any prescribed burn occurring between April 1 and September 15.

The level of take identified above, in acres, is authorized for a period of five years or until information on adverse effects and/or incidental take of Indiana bats arises that would cause the

reinitiation of the consultation on this action at an earlier date. The Service believes that reinitiation of consultation on this action after five years is necessary, because there is little specific information on the amount of incidental take that is likely to occur as a result of the action. In particular, specific information is lacking that would estimate the number of Indiana bats taken or the specific habitat elements (e.g., roost trees) that would be affected by the DBNF's proposed management actions in Indiana bat habitat. If available, these data would help estimate adverse effects to Indiana bats or if habitat has been improved or degraded as a result of the DBNF's actions. Because of this, it is prudent for the DBNF and the Service to re-visit this action once the DBNF has had an opportunity to more specifically monitor the effects of the action as required by the Reasonable and Prudent Measures and Terms and Conditions below.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of expected take is not likely to result in jeopardy to the Indiana bat or destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and proper to minimize impacts of incidental take of the Indiana bat associated with green tree harvests, salvage/sanitation harvests, and prescribed burning. These non-discretionary measures include, but are not limited to, the DBNF's implementation of the Standards found in the revised LRMP and the terms and conditions outlined in this biological opinion.

1. The DBNF must plan, evaluate, and implement the proposed management activities associated with green tree harvests, salvage/sanitation harvests, and prescribed burning in a manner that is consistent with Standards contained in the LRMP to protect the Indiana bat. Specific implementation of the measures designed to maintain, improve, or enhance habitat for Indiana bats will help avoid impacts to Indiana bats and their habitat and minimize incidental take of Indiana bats associated with green tree harvests, salvage/sanitation harvests, and prescribed burns.

2. The DBNF must monitor its activities associated with green tree harvests, salvage/sanitation harvests, and prescribed burning to determine if the LRMP Standards and the Terms and Conditions of this biological opinion are being implemented and provide an annual report of those activities to the Service.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the DBNF must comply with the following Terms and Conditions, which carry out the Reasonable and Prudent Measures described above and outline required reporting/monitoring requirements for actions on the

36

DBNF associated with green tree harvests, salvage/sanitation harvests, and prescribed burning. These Terms and Conditions are non-discretionary.

1. The DBNF will implement the Standards in a manner that is consistent with the LRMP and as they apply to forest management practices associated with green tree harvests, salvage/sanitation harvests, and prescribed burns that will be implemented annually on the DBNF between April 1 and September 15 of each year:

    a. The DBNF will make sure that immediate roost trees are available either within a proposed harvest or burn area or adjacent to a proposed harvest or burn area by conducting surveys of the available Indiana bat roosting habitat prior to implementation of the harvest or burn. If immediate roost trees are not available within a proposed harvest or burn area, or if immediate roost trees will not be available within the harvest or burn area after treatment, or if immediate roost trees are not and/or will not be available adjacent to a proposed harvest area, the DBNF must either create an immediate roost tree (e.g. girdle) or install one artificial structure (e.g. rocket-style bat box) per ten acres of proposed harvest area, but no fewer than two created roost trees and/or artificial bat structures must be installed per harvest area. If created or artificial structures are used, these habitat improvements must be implemented at least one year in advance of the harvest or burn and must be implemented as close as possible to the harvest or burn area, but must not be located within the harvest or burn area in order to avoid luring Indiana bats into areas that will be subsequently treated. This will make sure that immediate roosting habitat is available if Indiana bats are dislocated due to a proposed harvest or burn and associated activities. The DBNF should monitor, at least three times each summer so that monitoring will occur during the Indiana bat's early summer dispersal period, the maternity roosting period, and the late summer/early swarming period, the use of these created roost trees/artificial structures for use by Indiana bats for a period of five years beginning with the year of their installation.

    b. The DBNF will make sure that the following Standards designed to protect and conserve the Indiana bat and its habitat are incorporated into each green tree harvest and each salvage/sanitation harvest: DB-WLF-1 to DB-WLF-8 and DB-WLF-11 to DB-WLF-12 for green tree harvests, and DB-WLF-2 to DB-WLF-6, DB-WLF-8, DB-WLF-11 to DB-WLF-12 for salvage/sanitation harvests. Further, the DBNF will make sure that the following LRMP provisions, which are designed to protect and conserve the Indiana bat and its habitat, are incorporated into each prescribed burn: DB-Fire-8 and 1.J-Objective 1.B.

    c. During green tree harvests, salvage/sanitation harvests, and prescribed burns, the DBNF will take necessary precautions to protect designated trees and snags that are to be retained as Indiana bat roosting habitat and any tree known to be occupied by one or more Indiana bats. Further, all known roost trees will be protected until such time as they no longer serve as an Indiana bat roost (e.g., loss of exfoliating bark and/or cavities, blown down, or decay). This does not apply to any tree (live or dead) considered to be an immediate threat to human safety.

d. The DBNF will develop specific guidelines for use by DBNF personnel and contractors that provide guidance and instruction on marking or otherwise designating trees to be harvested and/or trees that will be retained in stands subject to green tree harvests and salvage/sanitation harvests. These guidelines will focus on making sure that trees that would be considered immediate Indiana bat habitat are retained or created within affected forest stands and that known, occupied roost trees are protected.

2. The DBNF will monitor its implementation of green tree harvests, salvage/sanitation harvests, and prescribed burns to make sure that the Standards are appropriately implemented and must provide the Service with an annual report of its monitoring activities by January 31 of each year:

   a. The DBNF will monitor selected project areas for characteristics associated with potential Indiana bat roost trees pre- and post-project implementation. Relative to Indiana bat roost trees, the DBNF will develop a sampling protocol that will determine (i) if potential roost trees are present within project areas, (ii) potential roost tree densities within project areas, and (iii) retention and creation rates of potential roost trees within project areas. Relative to habitat conditions and habitat quality, the DBNF will develop a sampling protocol that will provide information on the canopy closure, tree species composition, and understory density, and the stand age and distance to water. This information is necessary to show that the Standards and related provisions of the LRMP are having the expected effects on Indiana bat habitat by reducing the amount and effect of the take associated with Indiana bat summer roosting habitat. The information gathered will be provided to the Service in the annual report.

   b. The DBNF will annually monitor the number of acres that are subjected to green tree harvests, salvage/sanitation harvests, and prescribed burns during the summer roosting season of the Indiana bat (April 1 to September 15). The DBNF will then use these data to determine if the amount of authorized incidental take was exceeded. The DBNF will use the following table and annually provide the Service with this table in the annual report:

Table X. Estimate of Indiana bat incidental take that occurred during [Insert Year Monitoring Was Conducted] as a result of the implementation of the Daniel Boone National Forest's Land and Resource Management Plan (2004)

Species	**Habitat (acres)**	
	Authorized Level of Habitat Alteration	Actual Level of Habitat Alteration
Indiana bat - Green Tree Harvest (April 1 to September 15)	4,000	
Indiana bat – Salvage or Sanitation Harvest (April 1 to September 15)	350	

38

Indiana bat – Prescribed Burning (April 1 to April 30)*	50,000	
Indiana bat – Prescribed Burning (August 1 to September 15)*	50,000	

* Combined incidental take for prescribed burning from April 1 to April 30 and August 1 to September 15 cannot exceed 50,000 acres.

c. The above-listed Terms and Conditions do not take the place of the other Standards listed in the LRMP but are considered in addition to them.

The DBNF and its contractors must take care when handling dead or injured Indiana bats or any other federally listed species that are found in order to preserve biological material in the best possible state and to protect the handler from exposure to diseases, such as rabies. In conjunction with the preservation of any dead specimens, the DBNF and its contractors have the responsibility to ensure that evidence intrinsic to determining the cause of death or injury is not unnecessarily disturbed. The reporting of dead or injured specimens is required in all cases to enable the Service to determine if the level of incidental take authorized by this biological opinion has been reached or exceeded and to make sure that the terms and conditions are appropriate and effective. Upon locating a dead, injured, or sick specimen of any endangered or threatened species, prompt notification must be made to the Service's Division of Law Enforcement at 1875 Century Blvd., Suite 380, Atlanta, Georgia 30345 (Telephone: 404/679-7057). Additional notification must be made to the Service's Kentucky Ecological Services Field Office at 3761 Georgetown Road, Frankfort, Kentucky 40601 (Telephone: 502/695-0468).

The Reasonable and Prudent Measures, with their Terms and Conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes that an indeterminate number of Indiana bats will be incidentally taken as a result of the proposed action, with incidental take occurring on no more than 4,000 acres of green tree harvests, no more than 350 acres of salvage/sanitation harvest, and no more than 50,000 acres of prescribed burns annually. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the Reasonable and Prudent Measures provided. The DBNF must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the Reasonable and Prudent Measures.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. The following conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help carry out recovery plans, or to develop information.

1. The DBNF should pursue additional funding and partnership opportunities to complete any additional research, inventory, and monitoring work that is necessary to better

understand the ecology of the Indiana bat on the DBNF. In particular, selected project areas should be selected and monitored for Indiana bat roosting and foraging habitat use prior to project implementation and after project completion, which will provide information to compare and evaluate the effects of management activities on Indiana bat habitat use of project areas compared to non-project areas.

2. Where possible, the DBNF should work with landowners, the public, and other agencies to promote education and information about endangered bats and their conservation.

3. The DBNF hosts many visitors each year; therefore, the Service encourages the installation of informational/educational displays regarding all bats occurring on the DBNF. The Service believes that such information would be valuable in informing the public about the value of this misunderstood group of mammals. The Service also encourages the DBNF to develop an educational slide program on Indiana bats and threats to its existence.

4. The DBNF should provide training for appropriate DBNF staff and contractors on the bats (including the Indiana bat) that occur on the DBNF. Training should include sections on bat identification, biology, habitat requirements, and sampling techniques (including instructions on applicability/effectiveness of using mist-netting surveys versus Anabat detectors to accurately determine the presence of various bat species). The proper training of DBNF staff and contractors on bat identification and reliable methods for counting roosting bats will enable the USFS to better monitor the status of this species.

5. The demolition or removal of buildings or other manmade structures that harbor bats should occur while bats are hibernating. If public safety is threatened and the building must be removed while bats are present, a bat expert should examine the building to determine if Indiana bats are present. Consultation with the Service should be initiated if Indiana bats are found.
6. The DBNF should avoid converting occupied and/or suitable Indiana bat forest habitat to habitat that is unsuitable for Indiana bats.

7. The DBNF should control the spread of invasive species where invasion of such species is likely to result in the loss of suitable Indiana bat habitat.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the conservation recommendations carried out.

REINITIATION NOTICE

This concludes formal consultation on the implementation of the revised LRMP for the DBNF and its effects on the Indiana bat. As stated in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary DBNF involvement or control over the action has been retained (or is authorized by law) and if: (A) the amount or extent of incidental take is exceeded, (B) new information reveals effects of the DBNF's action that may affect listed species or critical habitat

40

in a manner or to an extent not considered in this consultation (e.g., range-wide monitoring shows, over a five-year period, a decline in hibernating Indiana bats), (C) the DBNF's action is later modified in a manner that causes an effect to the listed species or critical habitat not considered in this consultation, or (D) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease until reinitiation.

For this biological opinion, the authorized incidental take would be exceeded when the take exceeds 4,000 acres of green tree harvests, 350 acres of salvage/sanitation harvests, or 50,000 acres of prescribed burning per year during the summer roosting period of the Indiana bat (April 1 to September 15), which is the amount of take that has been exempted from the prohibitions of section 9 of the Act by this biological opinion. The Service appreciates the cooperation of the Daniel Boone National Forest during this consultation. We would like to continue working with you or your staff on this project. If you have any questions concerning this consultation, please contact me or Mr. Mike Armstrong at (502) 695-0468. This consultation was assigned Project No. 04-0227; please refer to this number in any correspondence concerning this consultation.

Sincerely,

Virgil Lee Andrews, Jr.
Field Supervisor

cc: Mr. Ben Worthington, Forest Supervisor-DBNF, Winchester, KY
Mr. Tom Bennett, Commissioner-KDFWR, Frankfort, KY
Regional Director, FWS, Atlanta, GA (Mr. Joe Johnston)

LITERATURE CITED

Anonymous. 1987. Vandals destroy hibernating Indiana bats. Bats (quarterly newsletter of Bat Conserv. Inter., Austin, TX). 5(2):5-8.

Barbour, R.W., and W.H. Davis. 1969. Bats of America. Univ. Press of Kentucky, Lexington. 286 pp.

Belwood, J.J. 1979. Feeding ecology of an Indiana bat community with emphasis on the endangered Indiana bat, *Myotis sodalis*. M.S. Thesis, Univ. Florida, Gainesville, FL 103 pp.

Bowles, J.B. 1981. Ecological studies on the Indiana bat in Iowa. Central College, Pella, IA. 28 pp.

Brack, V., Jr. 1979. Determination of presence and habitat suitability for the Indiana bat (*Myotis sodalis*) and gray bat (*Myotis grisescens*) for portions of three ditches, Big Five Levee and Drainage District, Union and Alexander Counties, Illinois. U.S. Army Corps of Engineers, St. Louis, MO. 23 pp.

------. 1983. The nonhibernating ecology of bats in Indiana with emphasis on the endangered Indiana bat, *Myotis sodalis*. Ph.D. Dissertation, Purdue University, Lafayette, IN. 280 pp.

Brack, V., and R.K. LaVal. 1985. Food habits of the Indiana bat in Missouri. J. of Mammalogy, 66:308-315.

Brack, V., Jr., K. Tyrell, and K. Dunlap. 1991. A 1990-1991 winter cave census for the Indiana bat (*Myotis sodalis*) in non-priority 1 hibernacula in Indiana. Ind. Fed. Aid Proj. E-1-6, Study No. 18, Ind. Dept. Nat. Resour., Indianapolis. 45 pp.

Callahan, E.V., III. 1993. Indiana bat summer habitat requirements. M.S. Thesis, Univ. of Missouri, Columbia. 74 pp.

Callahan, E.V., R.D. Drobney, and R.L. Clawson. 1997. Selection of summer roosting sites by Indiana bats (*Myotis sodalis*) in Missouri. J. of Mammalogy, 78:818-825.

Clark, B.L., J.B. Bowles, and B.S. Clark. 1987. Summer habitat of the endangered Indiana bat in Iowa. American Midl. Nat. 118:32-39.

Clark, D.R., Jr. 1981. Bats and environmental contaminants: a review. USDI Fish and Wildlife Service Special Scientific Report. Wildlife No. 235, 27 pp.

Clark, D.R., Jr., R.K. LaVal, and D.M. Swineford. 1978. Dieldrin-induced mortality in an endangered species, the gray bat (*Myotis grisescens*). Science 199:1357-1359.

Clark, D.R., Jr., and R.M. Prouty. 1976. Organochlorine residues in three bat species from four localities in Maryland and West Virginia, 1973. J. of Pesticide Monitoring, 10:44-53.

Clawson, R.L., R.K. LaVal, M.L. LaVal, and W. Caire. 1980. Clustering behavior of hibernating *Myotis sodalis* in Missouri. J. of Mammalogy, 61:245-253.

Cope, J.B., and S.R. Humphrey. 1977. Spring and autumn swarming behavior in the Indiana bat, *Myotis sodalis*. J. of Mammalogy, 58:93-95.

Cope, J.B., A.R. Richter, and R.S. Mills. 1974. Concentrations of the Indiana bat, *Myotis sodalis*, in Wayne County, Indiana. Proc. Indiana Acad. Sci. 83:482-484.

Cope, J.B., A.R. Richter, and D.A. Searly. 1978. A survey of bats in Big Blue Lake project area in Indiana. U. S. Army Corps of Engineers, 51 pp.

DeBlase, A.F., S.R. Humphrey, and K.S. Drury. 1965. Cave flooding and mortality in bats in Wind Cave, Kentucky. J. of Mammalogy, 46:96.

Easterla, D.A., and L.C. Watkins. 1969. Pregnant *Myotis sodalis* in northwestern Missouri. J. of Mammalogy, 50:372-373.

Gardner, J.E., J.D. Garner, and J.E. Hofmann. 1989. A portable mist netting system for capturing bats with emphasis on *Myotis sodalis* (Indiana bat). Bat Res. News 30(1):1-8.

------. 1990. Combined progress reports: 1989 and 1990 investigations of *Myotis sodalis* (Indiana bat) distribution, habitat use, and status in Illinois. Progress report for the U.S. Dept. of the Interior, Fish and Wildlife Service, Twin Cities, MN. 19 pp.

------. 1991a. Summer roost selection and roosting behavior of *Myotis sodalis* (Indiana bat) in Illinois. Final report. Illinois Natural History Survey, Illinois Dept. of Conserv.. Champaign, IL. 56 pp.

------. 1991b. Summary of *Myotis sodalis* summer habitat studies in Illinois: with recommendations for impact assessment. Special report. Illinois Natural History Survey, Illinois Dept. of Conserv. Champaign, IL. 28 pp.

Garner, J.D., and J.E. Gardner. 1992. Determination of summer distribution and habitat utilization of the Indiana bat (*Myotis sodalis*) in Illinois. Unpubl. Report. Endangered Species Coordinator, Region 3, USFWS, Twin Cities, MN. 28 pp.

Geluso, K.N., J.S. Altenbach, and D.E. Wilson. 1976. Bat mortality: pesticide poisoning and migratory stress. Science 194:184-186.

Giessman, N., T.W. Barney, T.L. Haithcoat, J.W. Meyers, and B. Massengale. 1986. Distribution of forestland in Missouri. Trans. Missouri Acad. of Sci. 20:5-14.

Gumbert, M.W. 2001. Seasonal roost tree use by Indiana bats in the Somerset Ranger District of the Daniel Boone National Forest, Kentucky. MS Thesis. Eastern Kentucky University. 134 pp.

Hall, E.R. 1981. The Mammals of North America. Vol. I. John Wiley and Sons, New York. 690 pp.

Hall, J.S. 1962. A life history and taxonomic study of the Indiana bat, *Myotis sodalis*. Reading Publ. Mus. Art., Gallery Publ. 12:1-68.

Hobson, C.R., and J.N. Holland. 1995. Post-hibernation and foraging habitat of a male Indiana bat, *Myotis sodalis* (Chiroptera: Vespertillionidae), in western Virginia. Brimleyana 23:95-101.

Humphrey, S.R. 1978. Status, winter habitat, and management of the endangered Indiana bat, *Myotis sodalis*. Florida Scientist 41:65-76.

Humphrey, S.R., and J.B. Cope. 1977. Survival rates of the endangered Indiana bat, *Myotis sodalis*. J. of Mammalogy, 58:32-36.

Humphrey, S.R., A.R. Richter, and J.B. Cope. 1977. Summer habitat and ecology of the endangered Indiana bat, *Myotis sodalis*. J. of Mammalogy, 58:334-346.

Jacobson, R.B., and A.T. Primm. 1997. Historical land-use changes and potential effects on stream disturbance in the Ozark Plateaus, Missouri. U.S. Geological Survey Water-Supply Paper 2484, Denver, CO. 85 pp.

Johnson, S.A., V. Brack, Jr., and R.E. Rolley. 1998. Overwinter weight loss of Indiana bats (*Myotis sodalis*) from hibernacula subject to human visitation. Am. Midl. Nat. 139:255-261.

Kiser, J.D., and C.L. Elliott. 1996. Foraging habitat, food habits, and roost tree characteristics of the Indiana bat (*Myotis sodalis*) during autumn in Johnson County, Kentucky. Final report, Kentucky Dept. of Fish and Wildl. Resources, Frankfort, KY. 65 pp.

Kiser, J.D., C.L. Elliott, and J. MacGregor. 1996. The use of roost trees by Indiana bats, *Myotis sodalis*, during autumn. Presented at the 6th colloquium on the Conservation of Mammals in the Southern and Central United States.

Krusic, R.A., and C. Neefus. 1996. Habitat associations of bat species in the White Mountains National Forest. Pp. 185-198 *in* Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada (R. M. R. Barclay and R. M. Brigham, eds.) Research Branch, British Columbia Ministry of Forests, Victoria, British Columbia, Working Paper 23/1996:1-292.

Kurta, A. 1980. Status of the Indiana bat, *Myotis sodalis*, in Michigan, Mich. Acad. 13:31-36.

44

Kurta, A., D. King, J.A. Teramino, J.M. Stribley, and K.J. Williams. 1993. Summer roosts of the endangered Indiana bat (*Myotis sodalis*) on the northern edge of its range. Am. Midl. Nat. 129:132-138.

Kurta, A., and J.A. Teramino. 1994. A novel hibernaculum and noteworthy records of the Indiana bat and eastern pipistrelle (Chiroptera: Vespertilionidae). Am. Midl. Nat. 132:410-413.

Kurta, A., and J.O. Whitaker, Jr. 1998. Diet of the endangered Indiana bat (*Myotis sodalis*) on the northern edge of its range. Am. Midl. Nat. 140:280-286.

Kurta, A., K.J. Williams, and R. Mies. 1996. Ecological, behavioral, and thermal observations of a peripheral population of Indiana bats (*Myotis sodalis*). Pages 102-117 *in* Bats and Forests Symposium (R. M. R. Barclay and R. M. Brigham, eds.). Research Branch, British Columbia Ministry of Forests, Victoria, British Columbia, Canada, Working Paper 23:1-292.

Ladd, D. 1991. Reexamination of the role of fire in Missouri oak woodlands. Pages 67-80 *in* G.V. Burger, J.E. Ebinger, and G.S. Wilhelm, eds.: Proceedings of the Oak Woods Management Workshop, Eastern Illinois Univ., Charleston, IL.

LaVal, R.K., R.L. Clawson, W. Caire, L.R. Wingate, and M.L. LaVal. 1976. An evaluation of the status of Myotine bats in the proposed Meramec Park Lake and Union Lake project areas, Missouri. Special Report. U.S. Army Corps of Engineers, St. Louis, MO. 136 pp.

LaVal, R.K., R.L. Clawson, M.L. LaVal, and W. Caire. 1977. Foraging behavior and nocturnal activity patterns of Missouri bats, with emphasis on the endangered species *Myotis grisescens* and *Myotis sodalis*. J. of Mammalogy, 58:592-599.

LaVal, R.K., and M.L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Missouri Dept. Cons. Terrestrial Series 8:1-53.

Lee, Y.F. 1993. Feeding ecology of the Indiana bat, *Myotis sodalis*, and resource partitioning with *Myotis keenii* and *Myotis lucifugus*. Unpubl. M.S. Thesis, the Univ. of Tennessee, Knoxville, TN. 146 pp.

MacCleery, D.W. 1992. American Forests - A History of Resiliency and Recovery. USDA Forest Service Publ. FS-540. Forest History Society, Durham, NC. 58 pp.

MacGregor, J., J. Kiser, and M. Gumbert. 1996. The use of road ruts as bat drinking water sources on the Cumberland Plateau of Eastern Kentucky. Presented at Sixth Colloquium on the Conservation of Mammals in the Southern and Central United States.

McFarland, C.A. 1998. Potential agricultural insecticide exposure of Indiana bats (*Myotis sodalis*) in Missouri. Unpubl. M.S. Thesis, Univ. of Missouri, Columbia. 256 pp.

Miller, N.E. 1996. Indiana bat summer habitat patterns in northern Missouri. Unpubl. M.S. Thesis, Univ. of Missouri, Columbia, Columbia, MO. 100 pp.

Mohr, C.E. 1972. The status of threatened species of cave-dwelling bats. Bull. Natl. Speleol. Soc. 34:33-37.

Mumford, R.E., and J.B. Cope. 1958. Summer record of *Myotis sodalis* in Indiana. J. of Mammalogy, 39:586-587.

Myers, R.F. 1964. Ecology of three species of Myotine bats in the Ozark Plateau. Unpubl. Ph.D. Dissertation, Univ. of Missouri, Columbia, Columbia, MO. 210 pp.

Nigh, T.A., W.L. Pflieger, P.L. Redfearn, W.A. Schroaeder, A. R. Templeton, and F. R. Thompson, III. 1992. The Biodiversity of Missouri - Definition, Status, and Recommendations for Its Conservation. Biodiversity Task Force, Jefferson City, MO. 53 pp.

Racey, P.A. 1982. Ecology of bat reproduction. Pages 57-104 *in* T. H. Kunz (ed.), Ecology of bats. Plenum Press, New York, NY. 425 pp.

Reidinger, R.F. 1972. Factors influencing Arizona bat population levels. Unpubl. Ph.D. Dissertation. Univ. of Ariz., Tucson, AZ. 172 pp.

------. 1976. Organochlorine residues in adults of six southwestern bat species. J. of Wildlife Management, 40:677-680.

Richter, A.R., S.R. Humphrey, J.B. Cope, and V. Brack, Jr. 1993. Modified cave entrances: thermal effect on body mass and resulting decline of endangered Indiana bats (*Myotis sodalis*). Conserv. Bio. 7:407-415.

Romme, R.C., K. Tyrell, and V. Brack, Jr. 1995. Literature summary and habitat suitability index model: components of summer habitat for the Indiana bat, *Myotis sodalis*. Report submitted to the Indiana Dept. of Natural Resources, Division of Wildlife, Bloomington, Indiana, by 3D/Environmental, Cincinnati, Ohio. Federal Aid Project E-1-7, Study No. 8, 38 pp.

Sauer, C.O. 1920. The geography of the Ozark highland of Missouri. The Geographic Society of Chicago Bull. No. 7. Univ. of Chicago Press, Chicago, IL. 187 pp.

Schroeder, W.A. 1981. Presettlement Prairie of Missouri. Missouri Dept. of Conserv., Jefferson City, MO. 35 pp.

Thomas, D.W. 1995. Hibernating bats are sensitive to non-tactile human disturbance. J. of Mammalogy, 76:940-946.

Thomas, D.W., and D. Cloutier. 1992. Evaporative water loss by hibernating little brown bats, *Myotis lucifugus*. Physiol. Zool. 65:443-456.

Thomas, D.W., M. Dorais, and J.M. Bergeron. 1990. Winter energy budgets and cost of arousals for hibernating little brown bats (*Myotis lucifugus*). J. of Mammalogy, 71:475-479.

3/D International, Inc. 1996. Biological Assessment of the Master Plan and Ongoing Mission, U.S. Army Engineer Center and Fort Leonard Wood, Missouri. Submitted to the U.S. Army Corps of Engineers, Kansas City District. 226 pp. + Appendices.

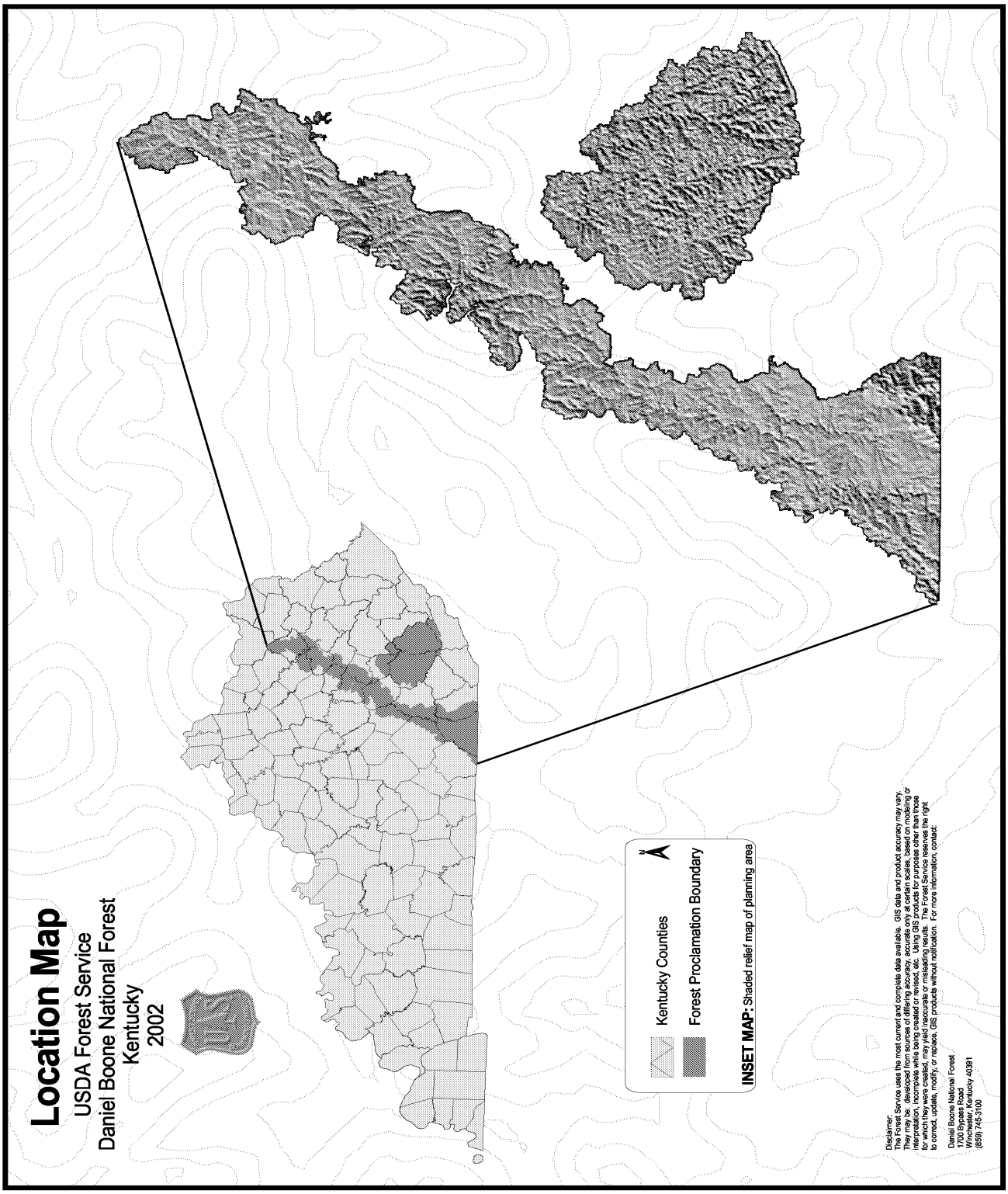
U.S. Fish and Wildlife Service. 1983. Recovery Plan for the Indiana Bat. Twin Cities, MN. 23 pp.

------. 1999. Agency Draft Indiana Bat (*Myotis sodalis*) Revised Recovery Plan. Fort Snelling, MN. 53 pp.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. Endangered Species Consultation Handbook - Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act. Washington, D.C.

Whitaker, J.O., Jr. 1972. Food habits of bats from Indiana. Canadian J. of Zoology, 50:877-883.

APPENDIX A



48

APPENDIX B

Standards – Daniel Boone National Forest
(From Revised Land and Resource Management Plan)

Minerals:

DB-MIN-2. Within 200 feet of any cave openings associated with karst systems: the surface is not to be disturbed during any federal mineral exploration or development activity; development of federally owned oil and gas is subject to the no surface occupancy stipulation.

DB-MIN-3. No drilling or mining is allowed into known cave voids (systems) where federal leasing is authorized.

Roads/Engineering:

DB-ENG-1. Subject to valid existing rights, no new roads, or trails will be built or maintained in protected zones around cave openings, associated sinkholes, or cave collapse areas, except for designated recreational caves.

Recreation:

DB-REC-1. Recreational activities inside caves will not be promoted except for designated recreational caves. Public information concerning location and access to non-recreational caves will be limited.

Wildlife:

DB-WLD-1. No snags equal to or greater than six inches in diameter at breast height (dbh) and equal to or greater than 10 feet in height are to be intentionally felled within timber harvest, regeneration and thinning projects, unless identified as an immediate threat to human safety. This standard does not apply to salvage or sanitation projects.

DB-WLD-2. Retain or create at least three snags per acre equal to or greater than 9 inches dbh within all timber harvest, regeneration, sanitation, salvage, or thinning project units when available.

DB-WLD-3. Retain enough live trees to provide partial shading of about one-third of all snags equal to or greater than 12 inches dbh and equal to or greater than 10 feet in height that are suitable for roosting by Indiana bats.

DB-WLD-4. In the two-aged shelterwood method, retain a minimum of 10 to 15 square feet of basal area per acre (average in stand) of live potential roost trees (Indiana bat).

DB-WLD-5. In harvest units equal to or greater than 10 acres that prescribe the two-age or even-age systems, leave some clumps or strips averaging at least 50 square feet of basal area (of trees equal to or greater than 9 inch dbh) per acre, or the density of the original stand if less. “Leave

areas" such as the Cliffline Community and Riparian Corridor Prescription Areas can provide this habitat based on site-specific conditions.

DB-WLD-6.In regeneration or thinning project areas, retain all shagbark, shellbark, and red hickories that are (equal to or greater than 6 inch dbh), unless the removal of these trees is specifically designed to improve habitat for PETS or Conservation species.

DB-WLD-7. During implementation of vegetation management, retain any immediate roost trees (Indiana bat) that are equal to or greater than 6 inches dbh. These trees must be designated prior to project implementation. This standard does not apply to salvage or sanitation projects.

DB-WLD-8. Tree cutting may not be conducted within 2.5 miles of any Indiana bat maternity colony from May 1 through August 15.

DB-WLD-9. For non-vegetation management projects, currently suitable Indiana bat roost trees may be felled only from October 15 through March 31, if they are more than five miles from a significant bat caves (Indiana bat). If tree removal occurs at other times, the trees must be evaluated for current Indiana bat use, according to U.S. Fish and Wildlife Service protocol.

DB-WLD-10. For non-vegetation management projects, removal of currently suitable roost trees (Indiana bat) within five miles of a significant bat caves (Indiana bat), may occur only from November 16 through March 15. If removal occurs at other times, the trees must be evaluated for current Indiana bat use, according to U.S. Fish and Wildlife Service protocol.

DB-WLD-11. Timber harvest will not occur on the DBNF within one mile of a known significant bat caves, or PETS bat staging cave (with the exception of the wooded grassland/shrubland habitat association), if this activity would result in more than 120 acres of forest less than 10 years of age on all ownerships (public and private).

DB-WLD-12. Within five miles of a significant Indiana bat hibernaculum, tree cutting is not to be conducted from September 1 through December 1)

DB-WLD-13. Where caves exist outside Cliffline Community Prescription Area a minimum zone of 200 feet is to be maintained around openings to caves, and mines suitable for supporting cave-associated species, as well as any associated sinkholes and cave collapse areas except for designated recreational caves. Prohibited activities within this protective area include use of motorized wheeled or tracked equipment (except on existing roads and trails), mechanical site preparation, recreation site construction, tractor-constructed fire lines for prescribed fire, herbicide application, and construction of new roads, skid trails or log landings. Vegetation in this buffer zone may be managed only to improve habitat for PETS or Conservation species.

DB-WLD-14. Activities that create a toxic water source (e.g. brine pits and oil catch basins) must be filled, covered, or otherwise modified in an environmentally appropriate manner to prevent contact with wildlife.

DB-WLD-15. Create, or retain where available, at least one snag 12 inches dbh or greater per acre in any area in which overstory trees are cut as part of habitat creation or maintenance, sanitation or salvage.

50

Vegetation:

DB-VEG-1. Hazard trees (dead or alive) considered to be an immediate threat to human safety may be removed anytime. Supercedes all other standards.

DB-VEG-14. Do not apply triclopyr within 60 feet, of known occupied gray, Virginia big-eared, or Indiana bat hibernacula or known maternity tree.

DB-VEG-22. The maximum size of a temporary opening created by even-aged or two-aged regeneration treatments is 40 acres. These acreage limits do not apply to areas treated as a result of catastrophic conditions such as wildland fire, insect outbreak, or windstorm. Areas managed as woodland, wooded grassland/shrubland, or non-forested areas (e.g., rights-of-way and grassy openings) are not subject to these Standards and are not included in calculations of opening size, even when within or adjacent to created openings.

DB-VEG-23. Temporary openings created by even-aged or two-aged regeneration treatments will be separated from each other by a minimum of 330 feet. Such openings may be clustered closer than 330 feet as long as their combined acreage does not exceed the maximum opening size. An even-aged or two-aged regeneration area will no longer be considered an opening when the certified re-established stand has reached an age of five years.

Prescribed and Wildland Fire:

DB-FIRE-8. Prescribed burning is not to occur within Indiana bat roosting areas between May 1 and July 31.

APPENDIX C

Indiana Bat Life Table
(Estimated)

Age (x)	Survivorship (l_x)	Fecundity (m_x)	Realized ($l_x m_x$)	Age Weighted by Realized ($x l_x m_x$)	Expectation of Life (E_x)	Reproductive (v_x)
0	1.0000	0.000	0.000	0.000	2.993	8.73
1	0.5200	0.500	0.260	0.260	3.833	9.45
2	0.3947	0.500	0.197	0.395	3.733	8.85
3	0.2996	0.500	0.150	0.449	3.601	8.22
4	0.2274	0.500	0.114	0.455	3.427	7.55
5	0.1726	0.500	0.086	0.431	3.197	6.82
6	0.1310	0.500	0.065	0.393	2.895	6.07
7	0.0864	0.500	0.043	0.303	2.871	5.54
8	0.0571	0.500	0.029	0.228	2.835	5.01
9	0.0377	0.500	0.019	0.169	2.781	4.45
10	0.0249	0.500	0.012	0.124	2.698	3.87
11	0.0164	0.500	0.008	0.090	2.573	3.24
12	0.0108	0.500	0.005	0.065	2.383	2.55
13	0.0071	0.500	0.004	0.046	2.096	1.77
14	0.0047	0.500	0.002	0.033	1.660	0.83
15	0.0031	0.500	0.002	0.023	0.000	0.50
		7.5	0.9967	3.4656		
		(GRR)	(Ro)	(T)		

52

APPENDIX D

Potential Indiana Bat Roost Tree Species List
for the Daniel Boone National Forest

Table of Potential Indiana Bat Roost Trees on the Daniel Boone National Forest .

Acer rubrum (red maple)
Acer saccarinum (silver maple)
Acer saccharum (sugar maple)
Carya cordiformis (bitternut hick.)
Carya glabra (pignut hickory)
Carya lacinosa (shellbark hick.)
Carya ovalis (red hickory)
Carya ovata (shagbark hickory)
Carya spp. (other hickories)
Fagus grandifolia (Am. beech)
Fraxinus americana (white ash)
Fraxinus pennsylvanica (green ash)
Liriodendrum tulipifera (tulip tree)
Nyssa sylvatica (blackgum)
Oxydendrum arboreum (sourwood)
Pinus echinata (shortleaf pine)
Pinus vigida (pitch pine)
Pinus virginiana (Virginia pine)
Platanus occidentalis (sycamore)
Populus deltoides (east. cottonwood)
Quercus alba (white oak)
Quercus coccinea (scarlet oak)
Quercus imbricaria (shingle oak)
Quercus prinus (chestnut oak)
Quercus rubra (northern red oak)
Quercus stellata (post oak)
Quercus velutina (black oak)
Robinia pseudoacacia (black locust)
Sassafras albidum (sassafras)
Ulmus americana (American elm)
Ulmus rubra (slippery elm)