Indiana bat - *Myotis sodalis*

I. STATUS OF THE SPECIES AND CRITICAL HABITAT

a. Species and Critical Habitat Description

Indiana bat is similar to other species of *Myotis* bats. It is distinguished by its keeled calcar, short, sparse hairs on the toes, and pelage coloration which ranges from light brown to nearly black. Pelage appears bicolored, but is not glossy. The ventral fur is usually lighter than the dorsal fur. The blunt tragus measures less than the total length of the ear. The head and body length is from 41 to 49 mm. The forearm length is 35 to 41 mm. The average weight for a male is 7.1g, while that of a female is 7.5g.

Concern about declines in the Indiana bat population led to listing the species as endangered on March 11, 1967 (32 FR 4001). A recovery plan was developed by the USDI Fish and Wildlife Service in 1976 and was revised in 1983. A draft revised recovery plan was released for review in 1999, and the final is expected to be completed this year.

There are 13 hibernacula (11 caves and two mines) in six states designated as critical habitat (41 FR 41914). Two of these are in Indiana in Crawford and Greene counties, both outside the Forest boundary. There are nine Priority One hibernacula (Indiana has 3, Kentucky 3, Missouri 3).[1]

Indiana bat ranges from northern New Hampshire, south to the Florida panhandle, and west to southern Iowa and eastern Oklahoma.

b. Habitat Requirements

Hibernation

Indiana bats hibernate in caves and mines (hibernacula) that meet their narrow temperature requirements (3 to 6°C). They need cooler conditions than other *Myotis* species.

Humidity at hibernation roosts is usually above 75 percent (recorded as low as 54 percent), but is not saturated (USDI Fish and Wildlife Service 1999a).

Summer Habitat

Wooded riparian habitat was once considered the most important habitat used by this species (Brady *et al*. 1983, USDI Fish and Wildlife Service 1999a). Recent evidence indicates that male, female, and juvenile Indiana bats forage in the canopy of both riparian and nonriparian woodlands (Tyrell and Brack 1990, 3D/International 1998, USDI Fish and Wildlife Service 1999a). Over most of the species range, the bats have a preference for forests with old growth characteristics, *i.e.* large trees, scattered canopy

[1] Priority One hibernacula are defined as hibernation sites with recorded populations of more than 30,000 bats since 1960. Priority Two hibernacula have record of between 500 and 30,000 bats since 1960. Priority Three hibernacula have records of 500 or fewer bats. Although these have no legal standing, they are used to measure the species recovery progress.

gaps, and open understories. In parts of its range, it was probably a species of open woodlands and savannas. They have been found using stands of large, widely-spaced, native pines in eastern Kentucky (J. MacGregor pers. comm., Smith 1997, S. Olson pers. obs). Pine plantations on the Hoosier which have been used by the bats have canopy gaps where pines have died (S. Olson pers. obs., 3D/International 1998). There is evidence that Indiana bat responds favorably to habitat disturbance (Gardner *et al.* 1991, J. MacGregor pers. comm., USDI Fish and Wildlife Service 1999a).

Roosts - Suitability of roost trees is determined by its dead or live condition, the amount of loose bark, its location relative to other trees and solar exposure, and its relationship to water and foraging habitat (USDI Fish and Wildlife Service 1999a). Shagbark hickory (*Carya ovata*) is a preferred roost tree (Brady *et al.* 1983), but other trees having flaking or exfoliating bark are also used, especially members of the white oak group. Snags provide important roosts and are naturally ephemeral. They provide suitable roost characteristics for only a few years, depending on tree species. Individual roosts are only suitable until bark sloughs off or the tree falls. Within an individual's home range there are several roost trees. Bats which depend on these roosts have developed a natural survival mechanism to find alternate roost trees when a suitable roost tree becomes unsuitable.

Summer Roosts - Summering bats are known to roost in shagbark hickory, white oak (*Quercus alba*), red oak (*Q. rubra*), post oak (*Q. stellata*), slippery elm (*Ulmus rubra*), bitternut hickory (*C. cordiformis*), sassafras (*Sassafras albidum*), and sugar maple (*Acer saccharum*), among others (Gardner *et al*. 1991, Hudak 1996). Male Indiana bats have been found roosting in trees as small as three inches in diameter (Romme *et al*. 1995, J. MacGregor pers. comm.). This has led Romme, *et al*. (1995), to speculate that the presence of loose bark is a more important criteria for use than tree species for male bats. Within the past three years, Indiana bats were found for the first time roosting in dead shortleaf and Virginia pines (*Pinus echinata* and *P. virginiana*) in native stands in Kentucky (J. MacGregor pers. comm.). During the summer of 1998, they were found roosting in dead shortleaf pines in plantation settings on the Hoosier (S. Olson pers. obs., 3D/International 1998). To date, no study has found them using downed trees as roosts (Brady *et al.* 1983, Gardner *et al*. 1991, Callahan 1993, Romme *et al*. 1995, Callahan *et al*. 1997).

Male Indiana bat roosts have been found where various types of disturbances were occurring, including grazing and timber harvest. Several known roost trees have been located near lightly travelled, low maintenance roads (Gardner *et al*. 1991, Callahan 1993). One roost found on the Hoosier during the summer of 1998 was located within the easement of I-64 (3D/International 1998).

Maternity roosts have been large, standing dead trees of several species or living shagbark hickory or rarely other living tree species located in these floodplain or near floodplain forests (Gardner *et al*. 1991, Callahan 1993, Callahan *et al.* 1997). It appears that Indiana bats select maternity roost trees based more on structure (*i.e.* presence of flaking bark), size, and location than tree species. There is at least one primary roost (located at the edges of stands or in openings) and several alternate roosts (in the open or in interiors of stands) used by maternity colonies (USDI Fish and Wildlife Service 1999a). With few exceptions, maternity colonies have been found within forests which are streamside ecosystems or are within one kilometer of permanent streams (Gardner *et al*. 1991, Callahan 1993, Kurta *et al.* 1993). Most known maternity roosts have been found in forest types similar to the elm-ash-cottonwood community. Callahan (1993) found that maternity colonies move frequently between primary and several alternate roosts depending on disturbance or climatic changes, particularly solar radiation. He

also noted that the bats were locating new roost sites into late summer. Indiana bat maternity roosts have been found in areas where various types of human disturbance were occurring, including cattle grazing, swine feedlot, row-crops, hay fields, residence, and clear-cut harvest (Gardner *et al*. 1991, Callahan 1993). Several known roost trees have been located near lightly travelled, low maintenance roads (Gardner *et al*. 1991, Callahan 1993).

Fall and Spring Roosts - Roosts used by Indiana bats in spring and fall are similar to those used during the summer (USDI Fish and Wildlife Service 1999a). Kiser and Elliott (1996) found that in autumn, Indiana bats roosted primarily in standing dead trees of various sizes and species found in canopy gaps created by some type of natural or human-caused disturbance, *i.e.* logging, windthrow, and prescribed burning. Bats used roost trees in the autumn for an average of two to three days before moving to another roost tree (Kiser and Elliott 1996).

Foraging - Optimum foraging habitat for Indiana bats is considered to be forests with canopy closure of 50 to 70 percent and relatively open understories, *i.e.* less than 40 percent of the trees in an area are 5 to 12 cm diameter at breast height (Romme *et al*. 1995). They will forage within the canopy, over early successional vegetation, and over pastures and cropland. Their foraging height ranges from 2 to 30 m above the ground (USDI Fish and Wildlife Service 1999a).

Indiana bats forage on flying insects from dusk to dawn. They appear to prefer moths as their primary prey items, but they will also take night-flying flies, beetles, caddisflies, and mayflies, among others (3D/International 1998). This varies with season, habitat, and range. Reproductive females and juveniles have a greater diversity in diet than males and non-reproductive females due to their higher energy demands (USDI Fish and Wildlife Service 1999a).

Indiana bats use small impoundments and water-filled road ruts, as well as permanent streams for drinking water.

Behavior - Site fidelity, the tendency for individuals to return repeatedly to the same area, is well documented for Indiana bats. This applies to both hibernacula and summer range.

Hibernation may begin as early as October and remain through April. This species roosts in dense clusters having as many as 480 individuals per square foot (USDI Fish and Wildlife Service 1999a).

Upon leaving hibernacula in late March to April, Indiana bats migrate to their summering grounds. Females emerge from hibernation before males and migrate north to establish maternity colonies, sometimes hundreds of miles to the north of hibernacula (Romme *et al*. 1995). Less is known about migration patterns among male bats, but they have been found almost ten miles from hibernacula during spring staging (3D/International 1998).

Adult males use forests near their hibernacula for roosting and foraging spring through fall. Indiana bats are capable of migrating long distances and regularly do so in spring after emergence from hibernacula. Therefore, during spring dispersal males are likely to be found much farther from hibernacula (as they disperse from hibernacula to summer habitats) than in summer or during fall swarming.

In late spring and summer, pregnant females congregate at maternity colonies. Known maternity colonies have been found primarily in the prairie ecoregions of Iowa, Illinois, Indiana, and northern Missouri (Tyrell and Brack 1990, Gardner *et al.* 1991, Romme *et al*. 1995). In southeastern Ohio, four reproductively active females were mist-netted in a bottomland hardwood forest, and another was captured in an upland forest. Females have a single young in June or early July which are volant in about a month.

During the summer, Indiana bats typically roost beneath the loose bark of dead or living trees, or more rarely within cavities in dead trees (Gardner *et al*. 1991, Kurta *et al.* 1993). They may use the same roost trees in successive years as long as they remain standing (Brady *et al*. 1983, Gardner *et al*. 1991) and are known to move from one roost tree to another if the previously used tree is no longer useable (Gardner *et al*. 1991).

In August and September, Indiana bats migrate from their summering grounds toward hibernacula for fall swarming. Over a period of several weeks, bats arrive at hibernacula and fly in and out during the night, but only a few roost in the caves during the day. The fall swarming period is considered a critical part of the bat's life cycle since it is when bats are putting on weight for hibernation and males are staying near the caves to mate with females as they arrive (Brady *et al*. 1983).

While work is still needed to determine how far male bats will roost and forage, bats have been found up to 4.2 miles from hibernacula in the fall (3D/International 1996). Most of the bats tracked in summer and fall have stayed within two to three miles of hibernacula (Clawson and Titus 1992, Hobson 1993, Kiser and Elliott 1996). Males generally remain active later in the season than females.

c. Population Dynamics

Since Indiana bats have a low natural reproductive rate, it takes several years for them to rebound from significant population declines (Romme *et al*. 1995). The natural mortality rate for this species is about 24 to 34 percent per year (Clawson and Titus 1992). Large congregations of hibernating bats are very susceptible to natural or human-caused disturbances. Single events can cause catastrophic losses in cave populations.

d. Status and Distribution

Indiana bat ranges throughout the eastern half of the United States (Figure 4). In addition to hibernating populations found in Indiana, Kentucky, and Missouri, populations and individuals have been reported hibernating in 26 states mostly associated with well developed cave systems. Summering individuals have been found in 16 states.

There are ten counties having hibernacula in Indiana (Table 21), four of which are within Hoosier National Forest boundaries. There are 53 counties where summer foraging has been recorded, eight of which are within the Hoosier National Forest boundary (Appendix F). In addition there are several nearby counties in Kentucky where known hibernacula are documented or summer foraging has been recorded.

Figure 4. Indiana Bat Range Map.

Source of map: 3D/International, Inc. Mist Net Survey and Telemetry Study of Indiana bats, 30 September, 1998

Table 21. Indiana counties with known Indiana bat hibernacula.

County	NFS land
Clark	no
Crawford	yes
Greene	no
Harrison	no
Jefferson	no
Lawrence	yes
Monroe	yes
Orange	yes
Owen	no
Washington	no

Indiana bat populations have declined by about 60 percent since the 1960's (as recorded from hibernaculum counts). Since listing as endangered in 1967, declines in population have continued. It is generally agreed that the major causes of historic Indiana bat population declines have been deliberate and unintentional human disturbance in hibernacula and human alteration of cave microclimates (Brady *et al*. 1983, Clawson and Titus 1992). In 1997, the total Indiana bat population was estimated to be about 353,000 individuals, and over half of these hibernate in nine Priority One hibernacula, of which three are in Indiana (USDI Fish and Wildlife Service 1999a).

Reasons for the continued decline of this species are not clear. Most bat experts thought that the population would stabilize or increase following protection of major hibernacula from human disturbance. However, that has not been the case, leaving some bat researchers to believe the answer to continued declines may lie in summer habitat conditions (Evans and Drilling 1992a, Romme *et al*. 1995, Callahan *et al*. 1997). Environmental contaminants are also suspected to cause population declines.

Bats enter hibernation with only enough fat reserves to last until spring. Each disturbance can cause a bat to use up as much as 10 to 30 days of fat reserves. If this happens too often, the bats will leave the cave before there is an adequate food supply and die. Vandalism has also been documented where bats have been torn from the cave ceiling, trampled and stoned to death.

Bats hibernating in mines are vulnerable to ceiling collapse. This has occurred in Illinois and is a serious concern in Missouri (Brady *et al*. 1983). Other documented cases of natural hazards to hibernating Indiana bats are drowning or freezing to death. This results in a few to several thousands of Indiana bats being lost each year.

There is evidence that restoration of cave microclimates by removing artificial barriers from natural entrances may allow wintering populations to increase. Work in Indiana showed that at least some hibernacula had increases in Indiana bat population even when commercial tours were conducted during the winter, while relatively unvisited caves nearby had population decreases (Johnson *et al*. 1993). The authors postulated that the bats may become accustomed to frequent, low-intensity visits, but fewer visits in which bats are more accessible to human visitors may be more detrimental. Richter, *et al*.

(1993), showed that improved thermal regimes in one cave resulted in increases in population, even where commercial tours continued. Another study suggested that increases in another cave's population was related to improved winter airflow after enlargement of a secondary, upper level entrance (Johnson *et al*. 1993).

Permanent conversion of forest habitat to non-forest uses, particularly along stream channels, is suspected of reducing available habitat. Simplification of habitat structure (e.g., conversion of forest to agriculture) can lead to reduced food availability in those areas (USDI Fish and Wildlife Service 1999a). Loss of standing dead trees, especially known maternity sites, can be detrimental. Certain forest structure may be unsuitable for Indiana bat foraging and roosting. Dense canopy closures make it difficult for bats to navigate and find insects.

Roosting and foraging summer habitat around hibernacula is postulated to be a limiting factor. There is recent evidence that bats which stay near hibernacula in summer may roost in dead trees or living trees with flaking bark that are as small as three inches in diameter.

Working in Illinois, Gardner, *et al*. (1991), raised concerns that disturbing roosts may cause bats to expend additional energy searching for new roosts at a time when the bats energies should be used for rearing young. They found a high degree of within-season site fidelity to specific trees by individual bats. However, they found no evidence that bats necessarily returned to the same trees in subsequent years.

Recent studies postulate that "factors other than those associated with habitat may be responsible for the Indiana bat's decline" (Clawson 1991). Pesticides have been implicated in the decline of a number of insectivorous North American bats (Brady *et al*. 1983). A recent study in Missouri on effects of pesticides on bat survival is inconclusive. However, the study showed that little brown bats (*Myotis lucifugus*) are accumulating sub-lethal amounts of organophosphate and or carbamate insecticides (McFarland *et al*. 1998).

e. Likely Affects on Habitat

The native vegetation of southern Indiana is managed in many different ways by various land-owning individuals, organizations, and agencies. This includes timber harvest of foraging and roosting areas. Past and present land use has caused local erosion. Numerous lakes and ponds have been constructed throughout the area. Disturbance to hibernacula (both caves and mines) through flooding, ceiling collapse, or by humans is a concern. Fires, both wild and prescribed, occur over the region. Many pesticides and herbicides are used in agricultural and residential areas. Air quality is affected by nearby urban areas and local industries. There are many federal, state, county and municipal roads crossing the Forest, as well as National Forest System (NFS) roads and trails. Private residences scattered among NFS land require narrow corridors to supply utilities. These require frequent maintenance. These activities are likely to continue.

The nine county (Brown, Crawford, Dubois, Jackson, Lawrence, Martin, Monroe, Orange, and Perry) area with NFS land contains about 2,249,300 acres. It is estimated that on average the land classification in these counties is about 59 percent forest land, 20 percent cropland, 18 percent pasture and other farmland, two percent urban, and one percent water (Berta *et al*. 1999). The landscape is

mostly a checkerboard of open farmland and forested land with single family residential development along roads. Forested land has been stable over the last 20 years because most development has occurred on cropland and some cropland is reverting to forested land. Within the national forest boundary there are more larger blocks of forested land.

II. ENVIRONMENTAL BASELINE

a. Status of Indiana Bat Within the Forest Planning Area

The Indiana bat is listed endangered in Indiana (Indiana Department of Natural Resources 1993). The total population has fluctuated, but has been increasing since the early 1980's (Dunlap 1997). Approximately 182,500 bats wintered in Indiana caves in 1997, accounting for half of the known Indiana bats (USDI Fish and Wildlife Service 1999a). Indiana bats have been captured during the summer in about 53 counties in Indiana. Ten counties are known to have hibernacula. Several counties in nearby portions of Kentucky also have hibernacula and summer records of Indiana bat.

There is no designated critical habitat and no known hibernacula on the Hoosier National Forest. The closest Priority One hibernacula are Ray's Cave in Greene County (18 miles from the nearest NFS land) and Twin Domes Cave in Harrison County (about 10 miles from the nearest NFS land). Wyandotte Cave in Crawford County is a Priority Two cave (about 8 miles from the nearest NFS land). Ray's and Wyandotte caves are listed as critical habitat for Indiana bat. In addition, there are seven other Priority Two hibernacula between one and ten miles of the Forest. Since there are a number of Indiana bat hibernacula within ten miles of the Hoosier National Forest and Indiana bat is a relatively wide-ranging species, it is possible that many parts of the Forest are used by male Indiana bats for roosting and foraging in the spring and fall.

As with other bats of the eastern deciduous forest, it is extremely difficult to accurately determine the numbers of individuals present during their summer foraging season. They are difficult to observe because of their nocturnal habits. A standard method for capturing and identifying bats during summer foraging, *i.e.* mist-netting, samples a very small and unknown fraction of the local population. It is impossible to know what percentage of the bats which approach mist-nets are actually captured (pers. comm. J.Whitaker). It is also unknown how large an area a single mist-net set is sampling. There are considerable differences in capture rates of species and individuals, some being more "net-wise" than others.

It is not known how many Indiana bats stay within the Forest boundaries during the non-hibernating season or their distribution across the Forest. Indiana bats have been identified at nine locations on the Hoosier, eight of these as individual males. Four male Indiana bats were captured during mist-netting on the Hoosier National Forest in the summer of 1998. Previous mist-netting and surveys in Indiana counties with NFS land have found single male Indiana bats during the spring through fall. One cave on NFS land has been noted having small numbers of summering male Indiana bats on two occasions. No maternity colonies have been documented as occurring on the Forest. The closest area with evidence of reproductive bats is in Bartholomew County, about 15 miles from the nearest NFS land. Based on very limited information on the presence and distribution of Indiana bats in summer on Hoosier, the Forest has made the assumption that Indiana bats may be present in appropriate habitat on the Forest from spring staging through fall swarming, and that a few may be hibernating in some caves on the Forest.

b. Potential Indiana Bat Roosting Habitat

Forest Inventory Assessment (FIA) data provides information that may be useful for estimating numbers of potential roost trees for Indiana bat. FIA is a national inventory system of permanent plots. The figures in the forest inventory data are estimates only. "A measure of reliability of these figures is given by sampling errors. These sampling errors mean that the chances are two out of three that if a 100-percent inventory had been taken, using the same methods, the result would have been within the limits indicated" (USDA Forest Service 1986). In Indiana, forest inventories were measured in 1950, 1967, 1986, and 1998. There has been considerable change in the amount of forested land in Indiana over recent years. Potential roost trees were estimated by using trees diameter and tree species. Data for individual tree species is contained in Appendix G. This data is available on-line at <http://www.srsfia.usfs.msstate.edu/ewdata/ewrec.htm>.

Appendix G contains an estimate of potential live roost trees based on plots from the Hoosier National Forest, the nine county area containing the Hoosier, and for the entire state of Indiana. In 1998, the Hoosier had an estimated 5,385,000 potential live roost trees. The state had an estimated 133,051,000 potential live roost trees.

Other national forests within the range of Indiana bat have calculated numbers of suitable roosts available to bats (Table 22). It must be noted, however, that these numbers are not comparable because of differences in how they were calculated. Some refer to only snags of certain dimensions while others are of all trees over a given diameter. Some were forest-wide numbers while others were limited to areas within a given distance from a known summer colony or hibernaculum.

Table 22. Number of bats and available roost trees on other national forests. (adapted from Mark Twain National Forest Biological Opinion, USDI Fish and Wildlife Service 1999b).

Forest	number of bats affected	Number of suitable roosts
Cherokee	200	51,320
Daniel Boone	1,600	8,440
George Washington/Jefferson	300	95,600
Mark Twain	300	10,500,000
Ouachita	9	1,810,640
Ozark/St. Francis	1,000	17,240

The Hoosier National Forest land base is about 96.5 percent forest cover. Oak-hickory forest at various successional stages is the dominant community comprising about 47 percent of the Hoosier. Yellow poplar stands comprise about 15 percent of the Forest. Another 15 percent is mixed upland hardwood (mostly sugar maple-beech or cove hardwood forest) communities and 17 percent is in pine plantations. Elm-ash-cottonwood and other bottomland hardwood forest communities comprise only about one percent of the Forest. The remaining 3.5 percent of the Forest is in open habitats, although only 2.58 percent of the acreage is maintained for those conditions.

Since acquisition of the majority of the Forest in the mid 1930's to late 1950's, when many trees were young saplings or poles, the forest has grown older and more dense. Today, approximately 65 percent of the forest stands are 61 years old or older. About 46 percent is over 80 years old. Regenerating forest (age 0 to 9 years) comprises less than one percent of today's Hoosier National Forest. Another 21 percent is young forest from 11 to 40 years old.

III. EFFECTS OF THE ACTION

Protect and Manage Ecosystems

Promote Natural Processes of Forest Succession - Structurally, potential old-growth areas are suboptimal as Indiana bat foraging habitat causing the bats to seek out other places to obtain food. As the forest in the potential old-growth areas including riparian areas mature, conditions for Indiana bat foraging will improve. Younger stands in these areas will take many years to attain conditions where the understory is open enough for foraging. The canopy closure in the old-growth areas will exceed the optimal range described for the bat except where it is adjacent to more open conditions of other management areas and private lands.

Changes in forest structure or composition are created by disturbances anywhere at any time. If a small number of trees are lost, canopy closures may be within the optimum 50 to 70 percent range. However, if an entire stand was affected by a natural event, canopy closures would more than likely fall below 50 percent and be less than optimum as foraging habitat. This could be a short-term reduction of foraging habitat, as the forest community regenerates and eventually returns to a mature forest community. Bats may have better foraging conditions and an increased number of prey items than nearby undamaged stands.

Maturing forest stands have higher numbers of large trees and snags than younger stands. Primary roosts are likely to be found around canopy gaps where trees have fallen. Alternate roosts may be scattered throughout stands.

Since riparian corridors within Hoosier National Forest are primarily forested, they would also be available as foraging habitat for Indiana bat. Large standing trees and snags which have structural characteristics of Indiana bat roosts are common in these corridors. These riparian forests are subject primarily to disturbance by natural forces, although limited tree removal is allowed in certain circumstances (*e.g.* public safety). Actions in these areas protect streams and their invertebrate communities which provide food and water for the bat.

Indiana bats would decline in potential old-growth areas because of a low food supply and a lack of suitable roosts until the subcanopy begins to open up and potential roosts develop at about 60 to 80 years. Because canopy closure exceeds that preferred by the species, Indiana bat populations may not be present except near open lands or in areas with disturbed canopies.

Protect Unique Features - Surveys for the presence of Indiana bats will generally be done between May 15 and August 15. Individual bats will be captured, identified, and in many cases radio-tagged. Should reproductively active females be discovered on NFS land, the USDI Fish and Wildlife Service will be

notified and radiotelemetry studies may be initiated to locate the maternity colony. If maternity colonies are discovered, roost trees used by the colonies will be protected by establishing a zone centered on the maternity roost site, not exceeding 3/4 mile in radius (Gardner *et al*. 1991). Within this area, an average of at least 24 potential roosts per acre will be retained including snags, live shagbark and shellbark hickories, and dead or dying trees with at least 10 percent exfoliating bark. Removal of any of these trees will be done in consultation with the USDI Fish and Wildlife Service. Those people doing this work are required to have all necessary federal and state permits. Radio-tagged animals would then be tracked for a short period (to about ten days). Handling of individuals to confirm identification may cause minimal stress, but will have no long-term effect on individuals.

Caves are being surveyed for hibernating bats during the winter. The direct effect of surveys is minimal but may include handling a few individuals to confirm identification. The beneficial effects determine the local abundance and distribution of Indiana bats allowing management of the landscape for the bats.

Cave management on the Forest is generally beneficial to Indiana bats. Cave locations are protected under the Federal Cave Resources Protection Act. They are also considered special features so limited activities occur near them. Activities may be proposed and implemented near, but not in close proximity to, cave entrances.

It is possible that entry into caves may adversely impact the bats by arousing them. It is also possible that people entering these caves may deliberately harm any bats they find. Disturbances by entry into caves is more likely to be detrimental to the bats because of longer duration and greater likelihood of acts of vandalism.

Continued implementation of the Forest Plan will maintain forest structure and composition around each cave similar to what it is currently. Caves on the Forest known to be used by Indiana bats have an abundance of forest cover and suitable roost trees around their entrances. The forest communities near hibernacula are generally a mosaic of ages and size-classes of oak-hickory and sugar maple-beech communities. These are being managed to increase the acreage of old-growth near the cave entrances.

Establish Plant Communities - Reforestation fills in gaps of canopy cover. This may locally reduce the amount of foraging habitat, but over time the stand will develop an open understory condition in which foraging conditions again improve. At the same time, additional roost sites will develop.

Planting trees in old fields on recent acquisitions benefits the bat by providing more roost sites in the future. If no additional treatments are conducted, there may be a long-term decline in the suitability of a particular area by increasing the overall canopy closure beyond what is considered optimal for the species.

Indiana bats would find suitable roosts in areas where trees with appropriate roost characteristics were planted sooner than if the sites had been left to naturally regenerate. The bats would continue to use snags retained on the Forest for roosting. Their local population would remain stable.

Use Timber Harvest to Manage Forests - The activity which has the highest potential to change Indiana bat habitat conditions is timber harvest. It is possible that any type of timber harvest would cut and remove potential roost trees. However, because a huge number of potential roost trees are available

across the Forest, and only a small amount of the Forest is harvested each year, loss of potential roost trees would be insignificant in terms of sustained roosting habitat. Some of the harvest techniques used on the Hoosier National Forest will improve foraging habitat by reducing dense forest canopies to the 50 to 70 percent canopy closure considered optimum for Indiana bat foraging habitat. Management proposed in hardwood areas for the next five years is based on the Indiana bat habitat suitability index model designed by Romme, *et al*. (1995).

Even-aged regeneration harvests would result in a short-term reduction of optimum foraging habitat, as canopy closures drop below 50 percent. The improvement will be short-term, one in each harvest unit, since canopies will eventually grow together again. However, a continued program of these types of harvest will ensure a long-term supply of optimum foraging habitat across the Hoosier National Forest into the future.

The changes in vegetation following timber harvest may shift the type of nocturnal flying insects in the area, but is not likely to cause a change in overall numbers of prey insects.

Bats will continue to roost and forage within hardwood timber harvest units. Bats may be attracted to uneven-age harvest areas because of the more open canopy and increased insolation of potential roosts. The bats may forage over the temporary opening created by removing the trees. They would also have more suitable roosts sooner. The bats will continue to use snags retained on the Forest for roosting.

The Hoosier is managing for a perpetual supply of potential roost trees across the Forest. Standing dead trees and live den trees of all diameters are retained in all timber harvests and other activities to meet the Forest Plan management direction and guidance. Maternity roost trees (if any are discovered on the Forest) would be protected from harvest or other disturbances. If it became necessary to remove such a tree, the Forest would first consult with USDI Fish and Wildlife Service to determine method and timing of removal.

Unless they pose a hazard to safe operations all shagbark hickories will be left in the areas. Unless they pose a hazard to safe operations, severely damaged trees over 16 inches (41 cm) in diameter at breast height and over 12 feet (3.7 m) high will be left if there are not at least six snags or other live trees per acre meeting this criteria. If there are not enough 16 inch (41 cm) diameter or larger trees to reach this density, trees over nine inches (23 cm) in diameter will be left instead. Shagbark and shellbark hickories are minor stand components and will not be cut. The following species are given priority for retention: green ash (*Fraxinus pensylvanica*), bitternut hickory, cottonwood (*Populus deltoides*), post oak, white oak, red oak, slippery elm, American elm (*Ulmus americana*), black locust (*Robinia pseudoacacia*), and silver maple (*Acer saccharinum*).

Tree removal does not discourage Indiana bats from using dead trees nearby as roosts and may make them more attractive since opening up the forest canopy to between 50 and 70 percent allows more sunlight to hit the tree and makes a warmer, more thermally stable roost. The results of larger tree size, older trees, and reduced canopy closures are all structural attributes which benefit Indiana bat by providing potential roost sites and preferred foraging habitat.

Removal of snags and hazard trees could affect Indiana bat in two ways. First, removing them during roosting season could potentially directly harm Indiana bats roosting in those trees. Second, removing

them will reduce roosting habitat within the area. The loss of a few potential roosts during timber harvest will cause bats to expend little additional energy locating new roosts, especially if done while the bats are in hibernation. The bats may come into the harvest units for improved foraging conditions and improved roost sites. There is a remote possibility of take of individuals if a roost with bats is removed. Their local population would remain stable.

It is possible that live trees with undiscovered maternity roosts could be removed. If that occurred during the time young bats were non-volant, some or all of the young or mothers could be harmed or killed.

Efforts will be made to decrease impacts to potential roosts. Many snags and den trees are included in groups of live trees left within the harvest unit. Snags and den trees within these groups, which are exposed to some sunlight, may actually be the types of trees most preferred by Indiana bat females for maternity roosts.

The over-stocked pine plantations lack roosts for summering males except where groups of pines have died but not yet lost their bark. Only two individuals have been confirmed using snags within these stands for roosts. Converting pine stands to native hardwoods over a period of years benefits the bat by creating more open conditions for foraging, producing more insects for feeding, and providing more roost sites.

Use Intermediate Silvicultural Techniques to Manage Forests - Thinning reduces canopy density temporarily until the remaining tree crowns grow together again. This will provide benefits to Indiana bat by reducing canopy closure to the range preferred by the species.

Bats will continue to roost and forage within hardwood timber harvest units. Bats may be attracted to uneven-age harvest areas because of the more open canopy and increased insolation of potential roosts.

Provide Openings & Shrubland - There is some benefit to Indiana bats by keeping an area's overall canopy closure within the optimal range described for the species. Conversion of fescue-dominated openings to native warm-season grasses has the indirect benefit of diversifying the potential prey items for the bats. Disturbances for any particular opening is once in one to five years. Because opening maintenance has little effect on the bats, their recovery period from this activity is very short.

Bats would continue to forage over and along the edges of maintained openings. They may prefer using openings which have been converted from fescue to native warm-season grasses because of the increased diversity of insects there. Their local population would remain stable.

Provide Aquatic Ecosystems - Watershed restoration, including recontouring and revegetating the landscape, may locally reduce the number of roosts and sites for drinking water for the bats. Work may require removing some potential roost trees. Removal of potential roosts could affect Indiana bat by potentially directly harming Indiana bats roosting in those trees and by reducing roosting habitat within the area. This could also cause returning bats to expend more energy to find a new roost. In the long-term, the benefits include clean water sources as runoff enters streams leading to a constant supply of food and water for the bats.

Management of riparian areas provides constant sources of food, water, and roosts, and provides travel corridors. Although activities associated with streambank stabilization and other riparian restoration projects may require the removal of a few potential roost trees, this activity is a benefit to the bats.

Bats would return to riparian areas because of the suitable habitat conditions present, including roost trees, foraging habitat, and travel corridors. They would find suitable roosts elsewhere in the forests nearby replacing those lost during construction.

Manage Plant Communities through Prescribed Burning - Prescribed fire may have beneficial effects on Indiana bat by creating more open understory within forest stands which improves foraging conditions for the bats. Fires of any type benefit Indiana bat and indirectly also benefit foraging by increasing the insect biomass in the area. The increased biomass resulting from fires begins to appear within two weeks and may last for up to three years.

Large snags which are currently suitable as roosts might be rendered unsuitable during a fire. They might catch fire, burn completely through, and fall to the ground. Most or all loose bark may be burned off the snag. Some snags may be cut down if they are burning sufficiently to throw embers over the established fireline. Live trees may also be killed by fires and, as the bark begins to fall off, can become roosts replacing others that were lost. Since Indiana bat is a disturbance adapted species, the creation of additional roosts and open canopied foraging habitat from prescribed burning would result in maintenance of high quality, long term foraging and roosting habitat for the bat.

Most Indiana bats enter hibernation by the end of November and emerge in April. It is possible, but not likely, that males may be roosting in trees outside caves when burns are prescribed. Heat or smoke from the burn could disturb roosting bats and cause them to fly to a tree outside the burn unit or back to the cave.

If a prescribed burn is conducted near an unknown hibernaculum during fall or winter, a wind shift or weather change could cause some smoke to enter into the cave causing accumulations of noxious gases.

Smoke from fires during spring emergence through fall swarming on the Forest could become trapped in valleys where bats may be roosting exposing the bats to predators while searching for other roosts.

Prior to implementation of prescribed fires, the Forest will provide the USDI Fish and Wildlife Service with an opportunity to review burn plans that could affect Indiana bats.

Apply Integrated Pest Management - Local outbreaks of insects and diseases causing mortality in trees may lead to a short-term improvement in foraging conditions for Indiana bats and also increase the number of suitable roosts. If harmful insects and diseases are not controlled, foraging and roosting habitat may become suboptimal leading to a decline in the bat population.

Indiana bats which may find alternate roosts in dead pines would continue to use adjacent hardwood areas for roosts if pines are salvaged. They will forage in the salvaged areas and canopy gaps of stand which are not salvaged as the stands naturally regenerate with native hardwoods.

The continued use of herbicides at the current low levels will not affect Indiana bat. Insecticides used for administrative site maintenance target day-flying bees and wasps, so will have no effect on Indiana bat.

Provide for Recreation Use in Harmony with Natural Communities

Develop and Maintain Recreation Facilities - Removal of hazard trees could reduce the local number of potential roost sites for Indiana bat. Removal of potential roosts could affect Indiana bat by potentially directly harming Indiana bats roosting in those trees and by reducing roosting habitat within the area. Indiana bats would continue roosting and foraging within the areas around the buildings.

Provide Trails for Hiking, Horseback, and Bicycling - Maintenance of trails beneath the forest canopy simulates conditions of open travel corridors above streams for bats travelling between roosts and foraging areas. This may marginally improve foraging habitat and provide travel corridors. Relocating trails, including recontouring and revegetating the landscape, may locally reduce the number of sites for drinking water for the bats. In the long-term, trail maintenance will benefit the species by diminishing disturbances.

Removal of hazard trees could reduce the local number of potential roost sites for Indiana bat. Removal of potential roosts could affect Indiana bat by potentially directly harming Indiana bats roosting in those trees and by reducing roosting habitat within the area. Most hazard trees are removed in late winter and early spring before the bats emerge from hibernation.

The loss of a few potential roosts along trails during construction and maintenance will cause bats to expend little additional energy locating new roosts, especially if done while the bats are in hibernation. Water sources are widely scattered across the Forest so bats would expend little energy finding replacements for those lost during trail construction and maintenance.

Provide a Useable Landbase

Manage a Public Landbase - Land acquisition brings habitat for Indiana bat into public ownership. It is beneficial to Indiana bat by ensuring that lands will not be lost as habitat by development. Bats would continue to use lands as long as the habitat remains suitable. If acquired for management by the Forest Service, this would continue indefinitely. Management activities on NFS land would allow bats to continue foraging and roosting.

Provide Road Access - Road and parking area construction may require removal of a few potential roost trees, but the areas will have a more open understory which may marginally improve foraging habitat. Removal of potential roosts could affect Indiana bat by potentially directly harming Indiana bats roosting in those trees and by reducing roosting habitat within the area. Relocating roads, including recontouring and revegetating the landscape, may locally reduce the number of sites for drinking water for the bats. In the long-term, however, this will benefit the species by diminishing the local disturbances. It may also improve conditions of roost trees by allowing sunlight to increase so that suitable temperature requirements are attained.

The loss of a few potential roosts along roads during construction and maintenance will cause bats to expend little additional energy locating new roosts, especially if done while the bats are in hibernation. The bats may come into the road right-of-way for improved foraging conditions and improved roost sites. Roads may provide travel corridors. Bats will continue to use these areas.

Close Roads - Closing roads, including recontouring and revegetating the landscape, may locally reduce the number of sites for drinking water for the bats. Installation of road closure devices rarely may require removing some potential roost trees. Removal of potential roosts could affect Indiana bat by potentially directly harming Indiana bats roosting in those trees and by reducing roosting habitat within the area. In the long-term, this will benefit the species by diminishing local disturbances. Bats will continue to use the areas where road closures have occurred.

Provide for Human and Community Development

Manage Wildfire - Wildfire suppression activities include fireline construction and burnout operations. It is possible that Indiana bats could be roosting in trees in a wildfire area from about April through October. Heat or smoke from the burn could disturb roosting bats and cause them to fly to a tree outside the burn. If a maternity colony was located within a wildfire area, and a wildfire occurred from May through June when young were non-volant, smoke, heat, or flames might harm or kill mothers or young.

Indiana bats may favor areas which have been burned because of the improved foraging conditions and increased insect biomass. Although some roosts may become unsuitable for the bats, others are created, so there is minimal effect on the bats ability to find roosting sites. Bats which are disturbed from their roosts by smoke and fire could be attacked by predators before finding another suitable roost. Accumulations of noxious gases could cause death in rare instances where fumes become trapped in hibernacula.

Manage Oil, Gas & Minerals - Because most mineral exploration and development sites are about an acre in size and temporary roads would be required, potential roost trees may need to be removed. Removal of potential roosts could potentially directly harm Indiana bats roosting in those trees and by reducing roosting habitat within the area. Potential roosts on the edges of these sites may be improved by increasing their exposure to sunlight. The effect on the species would be small because of the limited size of the disturbance area.

There is limited potential for beneficial effects associated with mining when mines could create conditions suitable for hibernation.

Indiana bats may be attracted to exploration sites and access roads because of their use as foraging areas or travel corridors. If roosts are lost, other potential roosts are nearby.

Permit Special Uses - Rights-of-way simulate windthrows or other canopy gaps found in mature forests which Indiana bats may use for foraging. Maintenance of various rights-of-way may be of marginal benefit to Indiana bat by keeping travel corridors open and by keeping an areas overall canopy closure within the optimal range described for the species. Removal of potential roosts could affect Indiana bat by potentially directly harming Indiana bats roosting in those trees and by reducing roosting habitat within the area. It has little effect on the bats and they would quickly recover from the disturbance.

The loss of a few potential roosts along rights-of-way during construction and maintenance will cause bats to expend little additional energy locating new roosts, especially if done while the bats are in hibernation.

IV. CUMULATIVE EFFECTS

Cumulative effects of continued Forest Plan implementation are summarized on Table 23.

Hibernation

There is a Forest-wide effort to map the interior of caves and inventory their fauna, including searches for bat hibernacula. If bats are awakened during a winter visit to the caves, they would use a portion of their fat reserves. To keep such disturbances to a minimum, surveys are conducted only every two or three years. However, entry into hibernacula may occur at any time. Various activities outside cave entrances occur. Sounds produced have no effect, but there is a small potential for smoke from fires to accumulate in caves. Land acquisition on the Hoosier targets endangered species habitat, and Indiana bat hibernacula would be a high priority if such properties became available.

Land uses and disturbances which may affect Indiana bat populations using caves off the Forest are out of the control of the USDA Forest Service. Cave entrances on private land have been altered in some cases. Known large hibernacula on state lands are protected and a few have "bat-friendly" gates. Caves on private land are often entered during the winter which may cause disturbance to hibernating bats. Landowners are also known to use caves for trash dumping which may include materials harmful to bats. Mines may create appropriate conditions for bat hibernacula.

Since most known hibernacula in Indiana are located on ownerships beyond the control of the Forest, land use decisions made by other owners affect Indiana bat populations more than activities carried out on the Hoosier.

There are no known Indiana bat hibernacula on NFS land, but several are nearby, including two Priority One hibernacula. The closest Priority One hibernacula are Ray's Cave in Greene County (18 miles from the nearest NFS land) and Twin Domes Cave in Harrison County (about 10 miles from the nearest NFS land). There is an unknown amount of activity on private land which may effect caves on or off the Forest because of their subterranean connections. Few activities implemented by the Forest Service adversely affect cave environments (e.g., smoke from fires), and protection and inventory of caves is beneficial. Adverse effects on local populations of Indiana bat by Forest Service activities are so unlikely to occur as to be discountable.

Summer Habitat

The Hoosier National Forest manages over 196,000 acres intermixed with lands owned by many other parties. About 20 small communities are within the Forest boundary. There are many isolated homes, and many of the flat ridgetops and creek bottoms in the region are farmed. Consolidating NFS land ownership through land purchase or exchange provides a way to acquire habitat for Indiana bat.

The Hoosier is creating conditions where there are large areas of mature, native trees. Without a continual loss of some overstory trees, by natural or human-caused disturbances, crown closures on most Hoosier lands would remain around 100 percent.

About one third of the Hoosier's 196,000 acres is considered suitable and appropriate for timber production. However, since 1994, only 51 acres have had a timber harvest, 50 acres have been thinned, and 324 acres have been salvaged due to storm or insect damage.

Some of the harvest techniques used on the Hoosier National Forest will improve habitat by reducing forest canopies to the 50 to 70 percent canopy closure considered optimum for Indiana bat. Bats will continue to roost and forage within hardwood timber harvest units. The bats may forage over the temporary openings created by removing the trees.

An average of 27 acres are treated each year to directly benefit soil and water resources. In the long-term, the benefits include clean water sources as runoff enters streams leading to a constant supply water for the bats. Stabilized, vegetated soils keep water clean for bats to drink and indirectly increase food biomass for the bats.

Local mortality in trees may lead to a short-term improvement in foraging conditions for Indiana bats. If the outbreaks occur in pine plantations, it may hasten the conversion of those stands to native hardwoods. If harmful insects and diseases are not controlled, however, foraging and roosting habitat may become suboptimal, leading to a decline in the bat population.

The bats may come into the road right-of-way for improved foraging conditions. Road construction and maintenance may benefit Indiana bat by maintaining travel corridors and improving foraging habitat. Road closures will benefit the species by diminishing local disturbances. Beneficial effects of utility right-of-way maintenance on Indiana bat include keeping general forest canopy closure within the preferred range.

The only insecticides used on the Forest are small quantities of commercially available household insect sprays to control wasp and bee infestations in recreation areas and administrative sites. Herbicide use on the Forest is limited to outstanding rights of overhead rights-of-way and for developed site housekeeping using the lowest effective rate. State forests probably use some herbicides during timber harvest operations. Both herbicides and insecticides are widely used in agriculture on private land.

From spring emergence through fall swarming, inversions may cause prescribed fire smoke to become trapped in valleys where bats may be roosting, exposing the bats to predators while searching for other roosts. However, few prescribed fires are conducted during this period. Local industry, and trash or woodland fires on privately owned lands, may affect air quality.

Lands around Monroe and Patoka lakes are managed by IDNR, Division of Fish and Wildlife, for a variety of wildlife species. State forests and parks are also managed for wildlife. Private land owners may manage some or all of their land for wildlife.

Few activities implemented by the Forest Service adversely affect summer habitat of Indiana bat, and protection and inventory of project areas is beneficial. Adverse effects on local populations of Indiana

bat by Forest Service activities are so unlikely to occur as to be discountable. When taken together, the Forest Service activities are insignificant in relation to the species population as a whole. Forest Service land management practices are not likely to adversely affect the bat.

Roosts

The Hoosier is attempting to manage for forest conditions where there are large areas of mature, large-diameter trees which are widely-spaced, and with a grassy or shrubby understory. Dead trees, trees with obvious den holes, and known live roost trees are retained as wildlife reserve trees. Primary roosts in potential old-growth areas are likely to be found only where crown closure has been reduced. Alternate roosts may be scattered throughout these stands.

Continued implementation of the Forest Plan would result in about 89 percent of the Forest remaining in oak-hickory and beech-sugar maple forest communities of varying ages, sizes, and species. Over half of the Hoosier National Forest will be in mature or old growth forest communities. Areas of the Hoosier that are near hibernacula on other ownerships would continue to provide forested areas suitable for summer roosting.

Species which are preferred by Indiana bat as roost trees are being preferentially left in the area. By leaving these trees, Indiana bats should need to expend only minimal energy in finding new roost trees if a previously-used tree has been cut. The proposed action should not significantly disrupt normal behavioral patterns.

Bats will continue to roost within hardwood harvest units. The bats will continue to use retained snags. The bats may come into the harvest units for improved roost sites. There is a remote possibility of take of individuals if a roost with bats is removed. Converting pine stands to native hardwoods benefits the bat by creating more roost sites. Removal of snags and hazard trees could affect Indiana bat in two ways. First, removing them during roosting season could potentially directly harm Indiana bats roosting in those trees. Second, removing them will reduce roosting habitat within the area causing returning bats to expend more energy to find a new roost. Because a huge number of potential roost trees are available across the Forest, and only a small amount of the Forest is harvested each year, loss of potential roost trees would be very small.

Harvest in upland forests within one kilometer of permanent streams may remove some trees which have characteristics of suitable maternity roost trees. It is possible that live trees with undiscovered maternity roosts could be removed. If that occurred when young bats were non-volant, some or all of the young or mothers could be harmed or killed.

Watershed restoration, including recontouring and revegetating the landscape, may locally reduce the number of roosts. A few potential roosts may be lost during construction or restoration of lakes, ponds and wetlands.

During wild fires or prescribed fires, standing snags might catch fire and fall to the ground, making them unsuitable as roost trees. However, this loss of standing snags would likely be offset by creation of additional snags as some living trees were killed by the fire. "Mop-up" of both wild and prescribed fires may require some potential roost trees to be cut down.

Removal of trees along roads and trails which may pose a public safety hazard may locally reduce the numbers of roost trees in an area by a small fraction. Construction and reconstruction of roads and trails may require the removal of some potential roosts. Beneficial effects of utility right-of-way maintenance on Indiana bat include improving temperature conditions of potential roosts. The adverse affect on the bat would be the loss of potential roosts.

About 100 caves are known on the Hoosier. Continued implementation of the Forest Plan will maintain forest structure and composition around each cave similar to what it is currently. The forest communities near caves are generally a mosaic of ages and size-classes of oak-hickory and sugar maple-beech communities. Activities may be proposed and implemented near, but not in close proximity to, cave entrances. Because of the limited management near cave entrances, ample numbers of fall roosts will remain.

In an area of about 640,000 acres (encompassing all lands within the Forest proclamation boundary), about 460,000 acres are within one kilometer of permanent streams. Since NFS lands account for only about 30 percent of the acreage in the area, a large majority of what could be considered potential Indiana bat maternity habitat is not on the Hoosier National Forest. Continued loss of bottomland forest to human development in the surrounding parts of Indiana would further decrease available maternity roosting habitat. These streamside forest communities, with their fertile soil and desirable location, have been converted to agriculture and developments. Maternity colonies of Indiana bats could find all their needs in close proximity: water in the nearby streams, a continuous supply of large, shaggy-barked or standing dead trees for roosts, and abundant and varied insect populations in the riparian forest. The dramatic decline in availability of this habitat may have made finding adequate maternity habitat very costly biologically for this species (3D/International 1995). While the continued loss of floodplain forest to urban or agricultural development continues on other ownerships, there are no activities implementing the Forest Plan which would convert riparian forests to non-forest.

Tree harvest on other ownerships has the same remote potential for direct "take" of Indiana bats as harvest on NFS land. Other ownerships may not protect standing snags and den trees to the extent the Hoosier National Forest does. Therefore, the potential for reducing the number of available maternity roost trees exists on other ownerships.

Foraging

The results of larger tree size, older trees, and reduced understory closures are all structural attributes which benefit Indiana bat by providing preferred foraging habitat.

Potential old-growth areas including riparian corridors are left essentially undisturbed allowing natural processes to take place. They will eventually develop a structure which includes many large diameter trees.

Conversion of non-native pine stands to native hardwood forest is beneficial in that it provides better foraging habitat. The changes in vegetation following timber harvest may shift the type of nocturnal flying insects in the area, but is not likely to cause a change in overall numbers of prey insects.

If an entire stand was affected by a natural event, canopy closures would more than likely fall below 50 percent and be less than optimum as foraging habitat. There could be a short-term reduction of foraging habitat, as the forest community regenerates and eventually returns to a mature forest community.

There is some benefit of opening maintenance to Indiana bats by keeping an area's overall canopy closure within the optimal range described for the species, simulating canopy gaps in mature forests. Conversion of openings to native warm-season grasses diversifies the potential prey for the bat.

Maintenance of various rights-of-way including trails and roads may be of marginal benefit to Indiana bat by keeping travel corridors open.

Small constructed waterholes, water-filled road ruts, and permanent streams would continue to be available as drinking water sources on the Hoosier National Forest. The majority of Indiana's permanent streams and rivers run through ownerships other than National Forest.

V. DETERMINATION

Because there is potential for adverse impacts which cannot be removed through informal consultation, continued implementation of the Forest Plan, MAY AFFECT - IS LIKELY TO ADVERSELY AFFECT populations of Indiana bat using the Hoosier National Forest.

A MAY AFFECT - NOT LIKELY TO ADVERSELY AFFECT determination is also made since there will be potential BENEFICIAL effects on Indiana bat habitat through continued implementation of the Forest Plan, as amended.

Rationale:

Non-public lands make up about 60 percent of the landbase within the Forest boundary. Land use activities on these ownerships are determined by the landowner. Some land use practices on these properties will benefit listed species, some will have no effect, and some will be detrimental. What happens on these lands may also affect federally listed species and habitat on the Hoosier. It is impossible for the Forest to acquire enough foraging habitat to guarantee the survival of bat populations. If all of the Hoosier National Forest were optimum foraging habitat, it would still not guarantee stabilization or an increase in Indiana bat populations. Habitat must be present on other ownerships to help Indiana bat population stabilize and eventually increase. However, the Forest Service is committed to providing quality habitat on the Hoosier National Forest for all native species, including Indiana bat. The Forest Service will also continue to cooperate with other agencies, individuals, and organizations to take actions in furtherance of responsibilities under sections 2(c)(1) and 7(a)(1) of the ESA to conserve listed species.

In each current project, effects to Indiana bat were assessed. It was determined that the effects to Indiana bat were insignificant or discountable in each project, and USDI Fish and Wildlife Service concurred with this finding.

Past activities on private land which have probably affected Indiana bat in the lower midwest include conversion of riparian foraging and roosting areas to agricultural or residential uses, timber harvest of foraging and roosting areas, and disturbance to hibernacula through flooding, ceiling collapse, or by human presence. Past activities on NFS land which have probably affected Indiana bats include timber harvest in both riparian and upland foraging and roosting habitat.

Present or reasonably foreseeable future activities on private land which may have an impact on this species include construction or use of roads, continued agricultural use of most of the riparian areas, timber harvest, and activities associated with nearby residences. Private lands near the proposed project areas will continue to be a mix of forest, open pasture, and crop fields.

Present or reasonably foreseeable future activities on NFS land include the conversion of non-native pines to native hardwoods either naturally or through vegetation management such as timber harvest. Native hardwood stands provide better foraging and roosting habitat than pine plantations, so this conversion should be beneficial for Indiana bat.

After considering past, present, and reasonably foreseeable future activities in the area, combined with the effects of the proposed action on the five habitat elements for Indiana bat, we have determined there are potential effects from this project on Indiana bat. Removing potential roost trees could decrease the amount of summer roost and maternity roost habitat, and cutting a standing tree could inadvertently cause a taking of Indiana bats currently roosting in it. However, with implementation of the recommended mitigation measures, these effects will be insignificant (cannot meaningfully be measured) or discountable (unlikely to occur).

The Hoosier National Forest has some of the best Indiana bat habitat in Indiana. Riparian corridors are primarily forested and subject to natural forces with a minimum of human manipulation.

Standing snags and den trees are available throughout the Forest and are retained in all Forest activities, ensuring a plentiful supply of potential roost trees into the future. There are a vast number of potential roost trees of all sizes and species available across the Forest.

If maternity roosts are located on the Forest, they will be protected from disturbance in accordance with recommendations of USDI Fish and Wildlife Service.

Since the entire Hoosier National Forest is within the range of Indiana bat, it is possible that Indiana bats could be anywhere on the Forest during spring through fall. The probability of encountering male roosting Indiana bats may be higher close to known hibernacula during the fall swarming period. Therefore, the potential for accidental direct take through removal of a male roost tree exists in any project which removes trees, and may be higher the closer the activity is to a hibernacula.

Similarly, the potential for accidental direct take of a maternity colony exists on the Forest. The risk of direct take for both occupied male and maternity roost trees is extremely low considering the vast number of potential roost trees available, the small percent of NFS affected by tree removal in a given year, the availability of forest lands other than Hoosier National Forest, and the fact that some tree-removal activities occur during the winter months when Indiana bats would be hibernating. However

insignificant or discountable the possibility is, it still exists and cannot be removed through informal consultation.

The potential for indirect effects, by removal of potential roost trees or stressing roosting bat(s) by activities near their roosts exists across the Forest. However, the potential for this type of impact is considered to be even less likely than the potential for direct take. There are an abundance of potential roost trees across the Forest, and removal of some of these each year would be offset by creation of new potential roost trees through natural mortality and fire. The potential for indirect effects is so low that it is considered discountable or insignificant.

Table 23. Cumulative Effects of Forest Plan Implementation on Indiana Bat
(assuming low-density of males and potential maternity roosts throughout the Hoosier National Forest).

	Foraging		Maternity Roosts		Summer Roosts		Fall Swarming		Hibernacula	
	short term	long term	short term	long term	short term	long term	short term	long term	short term	long term
Promote Natural Forest Succession	1	2	1	2	1	2	1	2	1	1
Protect Unique Features	2	2	2	2	2	2	2	2	2	2
Establish Plant Communities	1	2	3	2	3	2	3	2	1	1
Timber Harvest	3	2	3	2	3	2	3	2	1	1
Intermediate Silvicultural Techniques	3	2	3	2	3	2	3	2	1	1
Openings & Shrubland	1	2	1	1	1	1	1	1	1	1
Aquatic Ecosystems	3	2	3	2	3	2	3	2	1	1
Prescribed Burning	2	2	3	2	3	2	3	2	1	1
Integrated Pest Management	3	3	3	3	3	3	3	3	1	1
Maintain Recreation Facilities	1	1	1	1	1	1	1	1	1	1
Trails for Hiking, Horseback, & Bicycling	3	1	3	1	3	1	3	1	1	1
Manage a Public Landbase	1	2	1	2	1	2	1	2	1	2
Road Access	3	1	3	1	3	1	3	1	1	1
Close Roads	3	2	3	2	3	2	3	2	1	1
Manage Wildfire	4	2	4	2	4	2	4	2	4	1
Manage Minerals	3	1	3	1	3	1	3	1	1	2
Special Uses	3	1	3	1	3	1	3	1	1	1

1 - No Effect
2 - Beneficial
3 - Removable Adverse

4 - Non-removable Adverse

Gray bat - *Myotis grisescens*

I. STATUS OF THE SPECIES AND CRITICAL HABITAT

a. Species and Critical Habitat Description

Gray bat is the largest species of *Myotis* in the eastern United States. The forearm length is 40 to 46 mm. The average weight is from 7 to 16 grams. It is distinguished by its pelage coloration which is dark gray bleaching to chestnut brown. Dorsal pelage is one color. Unlike other *Myotis* species, the wing membrane connects to the ankle rather than the first toe.

The gray bat was listed as endangered on 28 April 1976 (41 FR 17740). A Recovery Plan was developed by USDI Fish and Wildlife Service dated 1 July 1982 (Brady *et al*. 1982). This range wide recovery plan outlines distribution, life history information, and management recommendations and recovery objectives. No critical habitat for this species has been identified.

Gray bat ranges from central Missouri to eastern Kentucky, south to northern Arkansas and the Florida panhandle.

b. Habitat Requirements

Hibernation

Gray bats hibernate in caves (hibernacula) that meet their temperature requirements (6 to 11°C). These are deep, vertical caves which trap large volumes of cold air (Brady *et al*. 1982).

Summer Habitat

Summer habitat requirements for gray bat include forests near permanent water and caves for roosting.

Roosts - Summering bats are known to roost in caves within one kilometer, rarely over four kilometers, of a stream or reservoir (Brady *et al*. 1982). Colonies occur in caves with warm-air traps where the temperature ranges from 14 to 25°C. Male gray bat roosts are usually found in separate sites from maternity roosts. Maternity roost caves often have streams flowing through them. Occasionally, summer roosts have been observed in storm sewers, mines, and very rarely in buildings (Evans and Drilling 1992b).

Foraging - Optimum foraging habitat for gray bats is considered to be forests along the banks of perennial streams and lakes. They sometimes use intermittent streams. They also occasionally forage in bottomland hardwood forests having little understory vegetation.

Gray bats forage on flying insects from dusk to dawn. They appear to prefer Ephemoptera (mayflies) as their primary prey items, but they will also take Coleoptera (beetles) and other night-flying insects. This

varies with season, habitat, and range. For example, Mumford and Whitaker (1982) report the bats diet included 60 percent Lepidoptera (moths) and 15 percent Trichoptera (caddisflies) in August 1974. Foraging generally occurs at about two to three meters above streams. Bats may travel more than 20 kilometers from their roosts to forage.

Gray bats use permanent streams for drinking water.

Behavior - Site fidelity, the tendency for individuals to return repeatedly to the same area, is well documented for gray bats. This applies to both hibernacula and summer range (Brady *et al*. 1982).

Hibernation may begin as early as September and continues through April. Hibernating bats roost in clusters of up to 170 individuals per square foot (Clawson and Titus 1992).

Upon leaving hibernacula in late March to April, gray bats migrate to their summering grounds which may be over 500 kilometers from hibernacula. Females emerge from hibernation before males and migrate north to establish maternity colonies (Brady *et al*. 1982). Adult males may not leave hibernacula until May (Evans and Drilling 1992b).

During summer, female gray bats form maternity colonies of a few hundred to many thousands of individuals in large caves, often containing streams (Clawson and Titus 1992). Known maternity colonies have been found in caves within one kilometer of streams or reservoirs (Brady *et al*. 1982). Females have a single young in late May or early June which are volant within a month. Juvenile growth rates are typically faster in larger colonies, attaining flight in 20 to 25 days (Evans and Drilling 1992b).

Male gray bats typically roost in separate sites from maternity roosts. Bats are known to move from one roost to another within the territory of the colony (Brady *et al*. 1982). After young are volant, males, females and young begin roosting together.

Each summer colony occupies a home range that often contains several roosting caves scattered along as much as 40 miles of river or lakeshore (Brady *et al*. 1982). Gray bats travel from roosts to foraging areas under forest canopy. Once at their foraging sites, they typically fly low over the water, often away from the protection of the forest canopy.

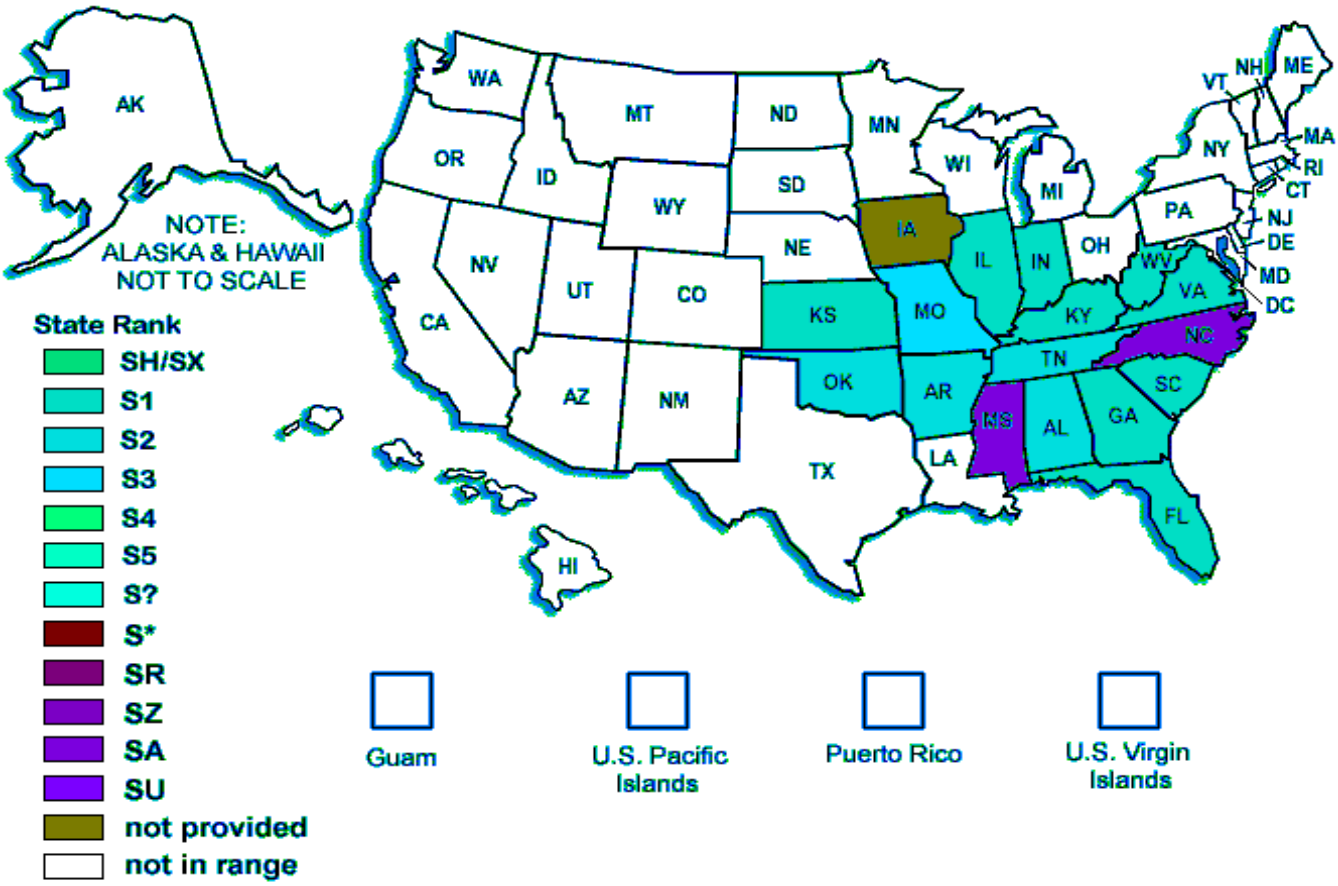
In September and October, gray bats migrate from their summering grounds toward hibernacula. Over a period of several weeks, male bats arrive at hibernacula to mate and restore fat reserves for hibernation (Brady *et al*. 1982). Mating takes place inside the cave. Juveniles and adult males enter hibernation several weeks later than adult females (Brady *et al*. 1982).

c. Population Dynamics

Since gray bats have a low natural reproductive rate, it takes several years for them to rebound from significant population declines. First year survival rates are up to 85 percent in undisturbed colonies, but only up to 66 percent in those that are disturbed (Evans and Drilling 1992b). Large congregations of hibernating bats are susceptible to natural or human-caused disturbances. Single events can cause catastrophic losses in cave populations. Colony size may also contribute to the reproductive and

overwintering success of the bats (Brady *et al*. 1982). A population may no longer be viable if numbers fall below a certain level.

Figure 5. Gray Bat Range Map.



Source: The Nature Conservancy. 1999. Natural Heritage Conservation Databases. Accessed by USDA Forest Service under grant no. 97-CCS-230.

d. Status and Distribution

The range of the gray bat is concentrated in the cave regions of Alabama, Arkansas, Kentucky, Missouri, and Tennessee, with occasional colonies and individuals found in adjacent states (Figure 5). The present total population of the species is estimated to number more than 1,555,000. However, about 95 percent hibernate in only eight caves: two in Tennessee, three in Missouri, and one each in Alabama, Arkansas and Kentucky.

Decline in gray bat populations began during the 19th century when cave exploitation began on a large scale (Brady *et al*. 1982). Gray bats roost in colonies in caves both summer and winter. Populations may have dropped as much as 70 percent across the range by 1975. Since then, populations appear to be steady or increasing across the range. The single most important cause of decline in gray bat populations has been human disturbance of both hibernating and maternity colonies (Brady *et al*. 1982, Clawson and Titus 1992). Because this species congregates in large groups both summer and winter, they are particularly vulnerable to indirect or direct mortality as a result of human visitation (Brady *et al.* 1982). Bats enter hibernation with only enough fat reserves to last until spring. Each disturbance can cause a bat to use up as much as 10 to 30 days of fat reserves. If this happens too often, the bats will leave the cave before there is an adequate food supply and die. Commercialization of gray bat caves has also reduced or eliminated populations in some caves (Brady *et al.* 1982, Clawson and Titus 1992). Protection from disturbance at both hibernacula and summer caves is needed to ensure the continued stability of the gray bat population.

Pesticide poisoning, particularly from chlorinated hydrocarbon pesticides, has impacted at least two known populations of gray bats and has been implicated in the decline of this species (Clawson and Titus 1992). Aldrin (the parent compound of dieldrin) and heptachlor were used from the 1960's through 1970's to control cutworms (larvae of several moths). These uses were banned in the mid to late 1970's, but residues are highly persistent in soil (Clawson 1991).

Permanent conversion of forest habitat to non-forest uses, particularly along stream channels, is suspected of reducing available foraging habitat. Certain forest structure may be unsuitable for gray bat foraging. Dense understories may make it difficult for bats to navigate and find insects.

Vandalism has also been documented where bats have been torn from the cave ceiling, trampled and stoned to death (Brady *et al*. 1982).

Other factors which have contributed to the bat's decline are improper gating or fencing of caves, impoundment of waterways which floods caves, water pollution, and siltation which reduces insect populations, conversion of riparian forest to other uses resulting in loss of foraging habitat, and pesticide use (Brady *et al*. 1982, Clawson and Titus 1992, Evans and Drilling 1992b).

The potential for recovery of gray bat is considered very good (Evans and Drilling 1992b) since populations have been steady or increasing in caves protected from human disturbance. Gray bat populations have increased about 30 to 40 percent from the mid 1970's to late 1990's (USDA Forest Service 1998). Protection of caves from human disturbance is probably the reason for recent increases in gray bat populations (Evans and Drilling 1992b, LaVal and LaVal 1980).

e. Likely Affects on Habitat

The landscape of southern Indiana is managed in many different ways by various landowning individuals, organizations, and agencies. This includes timber harvest of foraging areas. Past and present land use has caused local erosion. Numerous lakes and ponds have been constructed throughout the area. Disturbance to hibernacula (both caves and mines) through flooding, ceiling collapse, or by humans is a constant concern. Many pesticides and herbicides are used especially in agricultural and residential areas. Air quality is affected by nearby urban areas and local industries. There are many federal, state, county and municipal roads crossing the Forest, as well as National Forest System (NFS) roads and trails. Private residences scattered among NFS land require narrow corridors to supply utilities. These corridors require frequent maintenance. These activities are likely to continue.

The nine county (Brown, Crawford, Dubois, Jackson, Lawrence, Martin, Monroe, Orange, and Perry) area with NFS land contains about 2,249,300 acres. It is estimated that on average the land classification in these counties is about 59 percent forest land, 20 percent cropland, 18 percent pasture and other farmland, two percent urban, and one percent water (Berta *et al*. 1999). The landscape is mostly a checkerboard of open farmland and forested land with single family residence development along roads. Forested land has been stable over the last 20 years because most development has occurred on cropland and some cropland is reverting to forested land. Within the national forest boundary there are more larger blocks of forested land.

II. ENVIRONMENTAL BASELINE

Status of Gray Bat Within the Forest Planning Area

The gray bat is listed as Endangered in Indiana (Indiana Department of Natural Resources 1993).

Gray bat has been documented only one time on the Hoosier and once within a quarter mile of the Forest boundary. There are additional records from nearby in Breckenridge County, Kentucky.

III. EFFECTS OF THE ACTION

Analysis for Effects of the Continued Forest Plan Implementation on Gray Bat

Protect and Manage Ecosystems

Promote Natural Processes of Forest Succession - As the forest in riparian areas matures, conditions for potential gray bat foraging habitat and travel corridors will be maintained. Younger stands in these areas will take many years to attain conditions where the understory is open enough for foraging creating long-term benefits for the bat. Continued protection of forested riparian corridors will maintain these areas in structurally diverse riparian forest communities. Additionally, management direction and guidance allows natural processes to occur in streamside management zones. The majority of these areas will have canopy closure approaching 100 percent. Maintaining existing forests along streams and around caves will also have long-term beneficial effects on gray bat.

Because activities associated with promoting forest succession have beneficial effects on gray bat, any incidental use of these areas by the bats would continue.

Protect Unique Features - About 100 caves are known on the Hoosier. Caves on the Hoosier are available for recreational caving. None are commercialized, although many have been used by humans for a variety of purposes in the past. Cave locations are protected under the Federal Cave Resources Protection Act of 1988 (16 USC § 4301-4309). Much of the Forest where caves are likely to occur has been surveyed for their presence. No cave entrances on the Forest have been physically altered to change air flows in and out of the cave.

Continued implementation of the Forest Plan will maintain forest structure and composition around each cave similar to what it is currently. The forest communities are generally a mosaic of ages and size-classes of oak-hickory and sugar maple-beech communities. Activities may be proposed and implemented near, but not in close proximity to, cave entrances.

Over 3,000 acres have had mist net surveys for the presence of Indiana and gray bats. Only one male gray bat was found during these surveys.

Cave management on the Forest is beneficial to bats. They are also considered special features so limited activities occur near them. Any activities would be at least 100 feet away from the cave entrance where gray bats are found (Forest Plan, Appendix C).

Caves are being surveyed for hibernating bats during the winter, and maternity colonies in the summer. So far, no gray bats have been found using caves on the Forest. If gray bats are found, the USDI Fish and Wildlife Service will be notified.

Because activities associated with protecting caves on the Hoosier have beneficial effects on potential gray bat roosting and hibernating habitat, any incidental use of these areas by the bats would continue.

Establish Plant Communities - Reforestation fills in gaps of canopy cover. Planting trees in old fields on recent acquisitions Forest-wide has long-term beneficial effects on potential bat travel corridors and foraging areas because the vegetation would naturally succeed toward a forested condition. By planting, the species composition is determined at an earlier stage. There is a long-term improvement in the suitability of a particular area by creating a closed-canopy condition over streams.

Reforestation is usually accomplished by natural regeneration, which occurs when seedlings naturally establish themselves. Many old fields and pastures in riparian areas are being allowed to naturally succeed to hardwood forest. Some areas have been supplemented by planting where natural regeneration is below acceptable levels.

Because activities associated with establishing plant communities on the Forest have beneficial effects on gray bat, any incidental use of these areas by the bats would continue.

Use Timber Harvest to Manage Forests - In 1998, over 80 percent of the Hoosier had forest with crown closure approaching 100 percent. Without a continual loss of some overstory trees, by natural or human-caused disturbances, crown closures would remain around 100 percent.

Timber harvest in riparian areas and near caves would occur only rarely in very specific conditions. Management in streamside management zones is beneficial by providing constant sources of food, water, and travel corridors. The changes in vegetation following timber harvest may shift the type of nocturnal flying insects in the area, but is not likely to cause a change in overall numbers of prey insects.

Because activities associated with timber management on the Forest have no effect on gray bat, any incidental use of these areas by the bats would continue.

Provide Openings & Shrubland - Maintaining forest openings in riparian areas will not reduce potential travel corridor suitability because openings to be maintained have been in existence for many years, and may provide suitable foraging areas. Because activities associated with opening maintenance have no effect on gray bat, any incidental use of these areas by the bats would continue.

Provide Aquatic Ecosystems - There are approximately 925 acres of lakes, ponds, and waterholes on the Hoosier. Celina, Indian, Saddle, Tipsaw, and Tucker lakes are all over 40 acres and are entirely on NFS land. There are 512 miles of intermittent and perennial streams on NFS land within the proclamation boundary. The aquatic and riparian ecosystems, including all stream channels whether perennial, intermittent or ephemeral, are protected. Water quality is generally good across the Forest.

Portions of the Little Blue and Lost rivers have been determined to be potentially eligible in the Wild and Scenic Rivers System. Lost and Little Blue River's study areas have one quarter mile on both sides of the rivers. No timber harvest or other vegetation manipulation would occur in this corridor unless needed for public safety, salvage, or endangered species habitat improvement.

The 25-acre Moffitt Wetland was restored in the Lost River area in 1997. Another four wetlands totalling 105 acres, called the Roland Wetlands, are now under construction. Both projects are beneficial to the gray bat.

Protection of water quality and preventing water pollution or siltation of waterways are concerns since some forest activities have potential to create soil movement. Watershed restoration, including recontouring and revegetating the landscape ensures clean water sources as runoff enters streams maintaining a constant supply of food and water for the bats. Management of riparian areas provides constant sources of food, water, and travel corridors for bats.

Because activities associated with providing aquatic ecosystems have beneficial effects on potential gray bat foraging areas and travel corridors, any incidental use of these areas by the bats would continue.

Manage Plant Communities Through Prescribed Burning - Because activities associated with prescribed fire have beneficial effects on potential gray bat foraging conditions, any incidental use of these areas by the bats would continue. Smoke may potentially enter caves accumulating noxious gasses. However, since the likelihood of any gray bats using caves on the Hoosier is very small, this effect can be considered discountable.

Provide a Useable Landbase

Manage a Public Landbase - Land acquisition brings potential habitat for gray bat into public ownership. It ensures that lands will not be lost as habitat by development. Because activities associated with managing the public landbase have no effect on gray bat, any incidental use of these areas by the bats would continue.

Provide for Human and Community Development

Manage Wildfire - Because activities associated with wildfires have beneficial effects on potential gray bat foraging conditions, any incidental use of these areas by the bats would continue. Smoke may potentially enter caves accumulating noxious gasses. However, since the likelihood of any gray bats using caves on the Hoosier is very small, this effect can be considered discountable.

Manage Oil, Gas & Minerals - Mineral operations are compatible on about 7.75 percent of the Hoosier. There are currently no active mineral leases, no prospecting permits, and no prospecting permit applications filed with the USDI Bureau of Land Management. There is limited potential for mines creating conditions suitable for roosting.

IV. CUMULATIVE EFFECTS

Cumulative effects of continued Forest Plan implementation are summarized on Table 24.

Hibernacula and Summer Roosts

Management activities on the Hoosier National Forest that may affect potential hibernacula and summer roosts of gray bat include: cave management, prescribed fire, wildfire, roads and trails, and land adjustment.

The effects discussed under Indiana bat in most cases apply to the gray bat as well. Additional effects are discussed here and general cumulative effects are mentioned briefly.

Although caves are being surveyed for hibernating and summering bats, no gray bats have been found using caves on the Forest. It is possible that an unknown gray bat hibernaculum or summer roost may exist on the Forest. However, it is extremely unlikely that the type, amount, location and timing of prescribed burns as carried out on the Hoosier National Forest would result in smoke affecting gray bat caves. It is also very unlikely that wildfires would result in adverse affects.

Roads and trails are directed away from caves to keep entry to a minimum.

Land acquisition brings potential hibernacula and summer roosts for gray bat into public land ownership.

Since known hibernacula and summer roosts in Indiana are located well outside the Forest boundary on ownerships beyond the control of the Forest, land use decisions made by other owners affect gray bat populations more than activities carried out on the Hoosier. There is an unknown amount of activity on private land which may effect caves on or off the Forest because of their subterranean connections.

When added to all other landowner activities in southern Indiana, the cumulative effects of the Hoosier National Forest Land and Resource Management Plan's implementation on potential summer roosting and winter hibernacula caves for gray bat are discountable or insignificant.

Foraging

Management activities on the Hoosier National Forest that may affect potential summer travel corridors and foraging areas of gray bat include: vegetation management, fire, road and trail maintenance, and land adjustment.

The activity which has the highest potential to change gray bat habitat conditions is timber harvest. However, timber harvest in riparian areas would occur only rarely in very specific conditions. The changes in vegetation following timber harvest may shift the type of nocturnal flying insects in the area, but is not likely to cause a change in overall numbers of prey insects.

As the forest in potential old-growth riparian areas mature, conditions for gray bat travel corridors will be maintained. Existing forests along streams and around caves will also be maintained.

Prescribed fire may create a more open understory within forest stands, but travel corridors over streams are generally not affected. Fires of any type may increase the insect biomass in the area.

Land acquisition brings potential habitat for gray bat into public land ownership.

When added to all other landowner activities in southern Indiana, those cumulative effects of the Hoosier National Forest Land and Resource Management Plan's implementation on potential summer foraging habitat and travel corridors for gray bat are discountable or insignificant.

V. DETERMINATION

Continued implementation of the Forest Plan and projects predicated upon it have a MAY AFFECT, NOT LIKELY TO ADVERSELY AFFECT determination on gray bat habitat and populations.

Rationale:

Gray bat populations across this species' range has increased 30 to 40 percent since the mid 1970's (USDA Forest Service 1998). There are indications that gray bat has good potential for recovery (Evans and Drilling 1992b). There are very few records of gray bat on or near the Hoosier National Forest.

There will be no conversion of forested riparian corridors to other uses. Some currently non-forested riparian corridors will be planted to bottomland hardwood trees or allowed to succeed naturally to a forested condition. Forested corridors from known caves to foraging areas are provided. Riparian

foraging areas are primarily forested and will be allowed to age naturally, with natural disturbances determining future forest structure.

Activities which occur on Hoosier National Forest are designed to minimize soil movement off-site, thereby not adding to the sediment load of area waterways. Road and trail construction and maintenance will have no effect on gray bats.

Monitoring of human visitation to caves potentially used by gray bat will continue. Monitoring of bat populations on the Forest will continue in cooperation with the IDNR and USDI Fish and Wildlife Service.

The possibility that gray bats would be harmed by smoke or noise outside caves is so remote as to be considered discountable.

There is no use of pesticides on the Forest which would affect either the bats or their insect prey.

Activities which occur on Hoosier National Forest are designed to minimize soil movement off-site, thereby not adding to the sediment load of area waterways.

Table 24. Cumulative Effects of Forest Plan Implementation on Gray Bat.

	Foraging		Summer Roosts		Hibernacula	
	short term	long term	short term	long term	short term	long term
Promote Natural Forest Succession	2	2	1	1	1	1
Protect Unique Features	2	2	2	2	2	2
Establish Plant Communities	1	1	1	1	1	1
Timber Harvest	1	2	1	1	1	1
Intermediate Silvicultural Techniques	1	1	1	1	1	1
Openings & Shrubland	1	1	1	1	1	1
Aquatic Ecosystems	1	1	1	1	1	1
Prescribed Burning	2	1	1	1	1	1
Integrated Pest Management	1	1	1	1	1	1
Maintain Recreation Facilities	1	1	1	1	1	1
Trails for Hiking, Horseback, & Bicycling	1	1	1	1	1	1
Manage a Public Landbase	1	2	1	1	1	1
Road Access	1	1	1	1	1	1
Close Roads	1	1	1	1	1	1
Manage Wildfire	2	1	4	1	4	1
Manage Minerals	1	1	1	1	1	1
Special Uses	1	1	1	1	1	1

1 - No Effect

Gray bat

2 - Beneficial
3 - Removable Adverse
4 - Non-removable Adverse

Bald Eagle - *Haliaeetus leucocephalus*

I. STATUS OF THE SPECIES AND CRITICAL HABITAT

a. Species and Critical Habitat Description

Bald eagle is a large (length 75 to 80 cm, wingspan 1.8 to 2.1 m) bird of prey having a dark brown body with a white head and tail in adult plumage. The hooked beak is heavy and yellow. Immature eagles are dark brown overall with scattered white patches, especially on the underside of the wings and belly. The beak is blackish.

Concern about declines in southern bald eagle populations led to listing the populations south of the 40th parallel as endangered on 11 March 1967 (32 FR 4001). The entire population in the lower 48 states was listed in 1978 (43 FR 6233). The USDI Fish and Wildlife Service divided the recovery of the bald eagle into five regions: Pacific, Southwestern, Northern, Southeastern, and Chesapeake. Indiana and the Hoosier National Forest are in the Northern Recovery Region, subject to the Northern Bald Eagle Recovery Plan. A recovery plan was developed by the USDI Fish and Wildlife Service for the Northern Region in 1983 (Grier *et al*. 1983). On 12 July 1995, the USDI Fish and Wildlife Service reclassified the bald eagle from endangered to threatened throughout the 48 contiguous states (60 FR 36000) (Figure 6). On 6 July 1999, a proposed rule to de-list bald eagle because it has been recovered was published in the Federal Register (64 FR 36454).

Critical habitat for bald eagle was not identified, but essential habitat requirements were defined in the Northern States Recovery Plan. These include space for population growth and normal behavior, nutritional and physiological requirements, cover and shelter, breeding habitat, and protection from disturbance.

Bald eagles range from central Alaska and Canada south to northern Mexico.

b. Habitat Requirements

Breeding Habitat

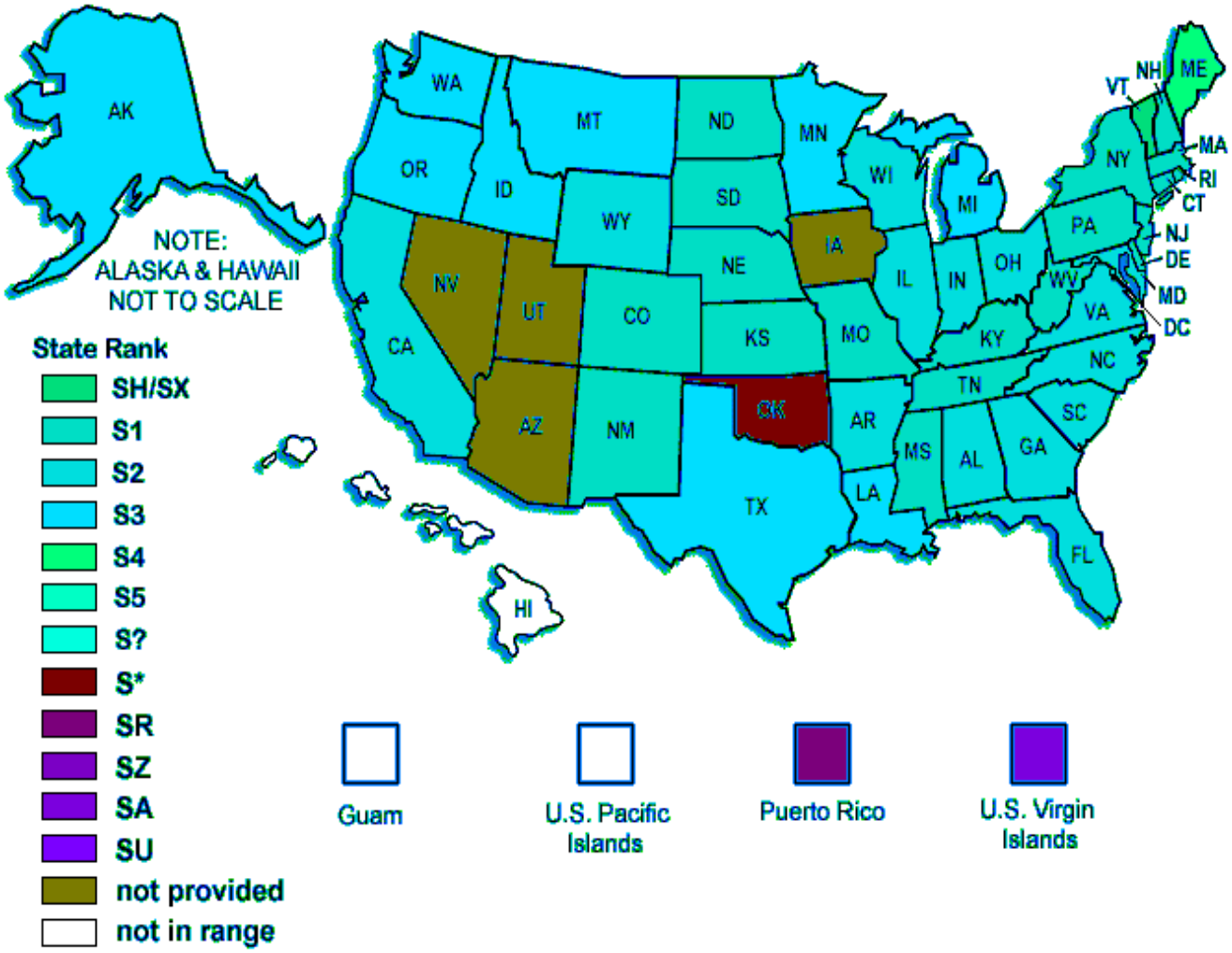
Breeding areas for bald eagles are very closely tied to lakes, rivers, and seashores. Nests are occasionally placed on cliffs, but are most frequent in large trees. Eagles prefer to nest in a floodplain forest and select the largest, stoutest tree in an area. They use trees higher than the surrounding canopy or those along the edge which allows better flight access. The nest site usually has a clear flight path to a water source and is within a half mile of water.

Essential habitat for nesting bald eagles is considered to encompass at least 640 acres including "aquatic and terrestrial habitat used for foraging, and essential features of air, water, land, and solitude necessary for the breeding pair at the site" (Grier *et al*. 1983). The nest structure does not need to be in the center of the area.

Locations Used by Non-breeding Eagles

Eagles tend to perch near their foraging areas during the day. Many species of trees are used for perching, and are usually along water within 30 meters of shore. Eagles use these perches for hunting, eating and resting. Eagles prefer to sit in tall dead trees or mature trees with stout horizontal branches bordering on at least one side by an open area. During severe wind chill periods, eagles prefer to roost in protected areas.

Figure 6. Bald Eagle Range Map.



Source: The Nature Conservancy. 1999. Natural Heritage Conservation Databases. Accessed by USDA Forest Service under grant no. 97-CCS-230.

Essential habitat used by non-breeding eagles is not necessarily associated with nest sites. It includes "terrestrial areas, lakes, coastal shorelines, or river segments associated with important food sources, and a zone for perching, feeding, or roosting that provides a visible screen from human disturbance" (Grier

et al. 1983). The importance of the areas depends on the number of birds using the site and the availability of other habitat.

Wintering Areas

At night, during winter, bald eagles roost singly or communally in trees that may be located up to 20 km from feeding areas. Abundant food, especially fish and waterfowl, and suitable night roosts are required by wintering eagles. These roosts may also be utilized during the day, particularly during inclement weather. They are sites protected from weather extremes by terrain and vegetation. In flat terrain, roosts are in clumps of trees.

Essential wintering areas in Indiana are defined as locations used annually for at least two weeks by birds probably from nearby breeding areas, or locations annually used by five or more eagles for two weeks or more (Grier *et al*. 1983).

Behavior

During the nesting season (mid-March through April), mature eagle pairs establish a territory and select a nest site near or bordering water.

Bald eagles roost in deciduous and mixed forest types near open water for foraging. Eagles may be also found in upland areas, especially when water is frozen over. They feed mostly on shallow-water fish species, taking waterfowl and mammals mainly when water is frozen.

During winter, eagles concentrate near rivers with open water and in areas with large numbers of wintering waterfowl. Although eagles may feed by wading in water, they usually hunt from a perch (large tree, snag or cliff) to spot prey. They also prefer areas with limited human activities.

Wintering eagles can be expected to arrive in Indiana around October, numbers peak in January, and the birds normally depart by mid-March. They begin communal roosting in December.

Eagles may be tolerant of human activity or may be easily disturbed (Grier *et al*. 1983). Reports of farmers and fishermen going about their daily activities close to perching or foraging eagles indicate a degree of tolerance on the part of some birds. Anglers and boaters may flush eagles from daytime perches along lake or streams.

Availability of food is the primary factor which determines if bald eagles will use an area for wintering. Eagles congregate where open water provides access to prey. Common food sources include dead or dying fish and waterfowl. Eagles may also scavenge dead domestic livestock and wildlife.

c. Population Dynamics

Bald eagles reach sexual maturity at about four to six years. They may live as long as 30 years. Mortality is probably relatively high for immature birds. Stable populations can be maintained when there is an average of 0.7 young per nest produced per year. Currently, the average exceeds 1.0 per year (64 FR 36454).

d. Status and Distribution

Bald eagles breed from central Alaska east through Canada to Newfoundland, south to northern Mexico and Florida. From southern Canada to the Gulf Coast, distribution is very local. Birds winter throughout the breeding range but mostly from the Great Lakes to the south, especially along major rivers and coasts (Figure 6).

Bald eagle populations probably began declining in the mid to late 1800's coinciding with declines of shorebirds and waterfowl (60 FR 36000). Rapid clearing of land for agriculture and housing and the reduction of food supplies due to water pollution have been documented as having an indirect effect on lowering eagle numbers. People killed eagles to protect livestock, collect eagle feathers, and for sport. Indiscriminate poisoning and shooting of all predators, including eagles, has also had a serious effect on eagle numbers in the past (60 FR 36000). The primary decline of bald eagles during the 1950's and 1960's was accumulation of pesticides, particularly DDT and DDE, and heavy metals which reduced reproductive success. The primary potential habitat threat to the bald eagle in the Northern Region Recovery Area today is urban development near breeding territories (60 FR 36000).

Nest site disturbances have caused eagles to abandon them. Human disturbance of a night roost may cause abandonment. Eagles may be more sensitive to disturbance at night roosts than at other sites.

With the banning of DDT and other organochlorine insecticides in the early 1970's, reproductive success and subsequently eagle populations have climbed (Grier *et al*. 1983). In 1963, only 417 active nests producing 0.59 young per nest were known in the lower 48 States, but by 1994, there were about 4,450 occupied territories producing 1.17 young each (60 FR 36000).

By 1995, the Northern Region had the highest number of territories and young produced in the lower 48 states with 1,860 occupied territories and 2,205 young produced (1.18 young per nest). This exceeds the recovery objective of the Plan which was 1,200 occupied breeding areas over 16 States with an annual productivity of at least 1.0 young per occupied nest (60 FR 36000). The USDI Fish and Wildlife Service has recently published a proposed rule to de-list bald eagle because recovery goals have been exceeded in all recovery regions (64 FR 36454).

e. Likely Affects on Habitat

The native vegetation of southern Indiana is managed in many different ways by various land-owning individuals, organizations, and agencies. This includes timber harvest of foraging and roosting areas. Past and present land use has caused local erosion. Numerous lakes and ponds have been constructed throughout the area. Fires, both wild and prescribed, occur over the region. Many pesticides and herbicides are used in agricultural and residential areas. Air quality is affected by nearby urban areas and local industries. There are many federal, state, county and municipal roads crossing the Forest, as well as National Forest System (NFS) roads and trails. Private residences scattered among NFS land require narrow corridors to supply utilities. These require frequent maintenance. These activities are likely to continue.

The nine county (Brown, Crawford, Dubois, Jackson, Lawrence, Martin, Monroe, Orange, and Perry) area with NFS land contains about 2,249,300 acres. It is estimated that on average the land

classification in these counties is about 59 percent forest land, 20 percent cropland, 18 percent pasture and other farmland, two percent urban, and one percent water (Berta *et al*. 1999). The landscape is mostly a checkerboard of open farmland and forested land with single family residence development along roads. Forested land has been stable over the last 20 years because most development has occurred on cropland and some cropland is reverting to forested land. Within the national forest boundary there are more larger blocks of forested land.

II. ENVIRONMENTAL BASELINE

Status of Bald Eagle Within the Forest Planning Area

The bald eagle is listed as endangered in Indiana (Indiana Department of Natural Resources 1993). A population restoration project at Monroe Lake in the late 1980's led to the first successful nesting of bald eagles in Indiana in about 90 years (Castrale *et al.* 1998). There were 15 active territories by 1996. Bald eagles now have 20 known active nests in the state, mostly in the southern part, but a few are in the north. Approximately 200 eagles winter in Indiana.

There is one known nest location on the Forest near Monroe Lake. It has been successfully producing young birds for several years.

Most of the bald eagles sighted on Hoosier National Forest have been wintering individuals seen singly or in small groups. Water bodies on the Forest which receive the most consistent use are Monroe Lake, Patoka Lake, and the Ohio River. Other lakes and streams on the Forest also support some eagles during the winter. Eagles also use private lands and other ownerships intermixed with NFS, particularly near steady food sources.

There is one possible overwintering night roost site on Hoosier National Forest land near Lake Monroe. Because of the typically mild winters of southern Indiana, this site rarely meets the criteria of a winter roost as defined in the recovery plan. However, the Forest is treating the site as if it were a winter bald eagle roost.

III. EFFECTS OF THE ACTION

Analysis for Effects of the Continued Forest Plan Implementation on Bald Eagle

Protect and Manage Ecosystems

Promote Natural Processes of Forest Succession - Over 45.3 percent of the Forest is allowed to succeed towards potential old-growth conditions without significant human influence. Maturing forest stands have higher numbers of large trees and snags than younger stands. Each year, part of the Forest is affected by strong winds, tornados or other natural disturbances. These are generally left to naturally decay in the areas listed above. Continued protection of forested riparian corridors will maintain these areas in structurally diverse communities. Additionally, management direction and guidance allows natural processes to occur in streamside management zones.

In remote areas near large bodies of water, roosting and nesting conditions will improve as the stands mature. Eagles would return to streamside management zones because of the suitable habitat conditions present.

Protect Unique Features - The Forest has 12 designated special areas encompassing 12,803 total acres. The forest communities are generally a mosaic of ages and size-classes of oak-hickory and sugar maple-beech communities. Protection of features within large areas provides remote sites where eagles may find adequate conditions for roosting or nesting. Activities which occur within special areas, such as prescribed fires and timber harvest, are done to further the goals of the area.

Bald eagle nests are monitored annually in cooperation with IDNR. Project areas are reviewed for BE clearance before project implementation.

If bald eagles nests or winter roosts are found, the USDI Fish and Wildlife Service will be notified. Entry into nesting areas is discouraged within one quarter mile of active nests (Forest Plan, Appendix C).

Establish Plant Communities - Plant communities are established through reforestation and planting. Reforestation fills in gaps of canopy cover. Over time, additional roost sites will develop.

Bald eagles would find suitable roosts in areas where trees with appropriate roost characteristics were planted sooner than if the sites had been left to naturally regenerate. The eagles would continue to use snags retained on the Forest for roosting. Their local population would remain stable.

Use Timber Harvest to Manage Forests - About 33 percent of the Hoosier National Forest is considered suitable and appropriate for timber production. The Hoosier National Forest timber program is based on an 80 to 90 year rotation cycle for hardwoods and 40 to 60 years for pines.

A variety of harvest methods under both the even-aged and uneven-aged systems are used to meet management objectives. Even-aged harvests (clearcut, shelterwood, seedtree) may result in canopy closures below 50 percent. Uneven-aged harvest by either the single-tree or group selection methods results in less dense canopy closures and an area of various ages and sizes of trees. The predominant treatment for hardwood stands is stand improvement cutting using best tree selection. Small group selections will be used to regenerate pockets of senescent trees which exist within these stands.

Standing dead trees will be retained to provide habitat for wildlife. Long term snag recruitment will be provided by leaving a portion of the senescing trees, such as black oak or scarlet oak to die over a period of years. Areas with less than six snags over 8.7 inches in diameter per acre will be prioritized for snag creation through girdling of live trees. Snag creation activity will concentrate on areas with the lowest snag densities. Girdling will target large hardwood trees (with at least 2 trees per acre 20 inches or larger where available). Enough trees will be girdled to bring the stands to at least six snags per acre.

Small group selections (one acre or less) will be used to regenerate senescent hardwood species. All merchantable live trees within each group will be removed. Every third group will be retained to provide gradual inputs of snags over time. Existing snags will be retained unless safety considerations preclude keeping them.

Shortleaf pine and mixed pine stands will be treated with a mix of shelterwoods and thinning. Existing snags will be retained unless it is unsafe to do so.

Permits are issued for collection of miscellaneous forest products including pine house logs. House log sales are infrequent but are likely to continue. They average about three acres per year. Only live trees are cut from selected pine plantations.

The activity which has the highest potential to change bald eagle habitat conditions is timber harvest. Selective harvest does not directly alter roosting habitat. Harvest in upland forests within one kilometer of permanent streams may remove some trees which have characteristics of suitable nest trees. Removal of standing dead or damaged trees would be a short-term loss of a small amount of potential roosting habitat. However, even in these cases, snags are retained to meet Forest Plan management direction and guidance. Because a huge number of potential roost trees are available across the Forest, and only a small amount of the Forest is harvested each year, loss of potential roost trees would be insignificant in terms of sustained roosting habitat.

Tree removal does not discourage bald eagles from using dead trees nearby as roosts. The results of larger tree size, older trees, and reduced canopy closures are all structural attributes which benefit bald eagle by providing potential roost sites. Their local population would remain stable.

Provide Aquatic Ecosystems - Aquatic habitats such as wetlands, marshes and ponds occupy a small part of the Hoosier, but occur in all parts of the Forest. There is approximately 925 acres of lakes, ponds, and waterholes on the Hoosier. Celina, Indian, Saddle, Tipsaw, and Tucker lakes are all over 40 acres and are entirely on NFS land. Monroe and Patoka Lakes are Corps of Engineers projects which the Hoosier manages only a small portion of the shoreline.

Riparian ecosystems, including all stream channels whether perennial, intermittent or ephemeral, are protected. There are 512 miles of intermittent and perennial streams. Protection of water quality and preventing water pollution or siltation of waterways are also concerns since some forest activities have potential to create soil movement. Activities outside of riparian corridors are designed and implemented to minimize soil movement. Water quality is generally good across the Forest.

Given that soil loss caused by timber harvest is well within the allowable limits set in the Forest Plan, and that management direction and guidance for buffer and filter strips are applied along streams, excess sedimentation of area waterways has not occurred as a result of timber harvest as practiced on Hoosier National Forest in the past ten years.

Eagles would return to riparian areas because of the suitable habitat conditions present, including roost trees and foraging habitat.

Manage Plant Communities Through Prescribed Burning - Prescribed fires are performed on the Forest for a variety of reasons, including wildlife habitat improvement, forest regeneration, and fuel reduction. The number of prescribed fires has decreased, but the average size of individual prescribed burns has increased over the past several years. In the past five years, about 10 prescribed fires were conducted annually for a total of about 2,000 acres. Prescribed burns on Hoosier National Forest take place mostly

in late winter and spring months. Prescribed burns are generally of the type, size, intensity, location, frequency and execution that there is little, if any, soil exposed after the burn is completed. Control lines for prescribed burns are laid out along natural fuelbreaks where possible, minimizing the need for line construction. Trees and snags which may fall across firelines are cut as necessary.

Large snags which are currently suitable as roosts might be rendered unsuitable during a fire. They might catch fire, burn completely through, and fall to the ground. Some snags may be cut down if they are burning sufficiently to throw burning embers over the established fireline. Although some roosts may become unsuitable for eagles, others are created, so there is minimal effect on the eagles ability to find roosting sites. Their local population would remain stable.

Apply Integrated Pest Management - Silvicultural techniques are used to maintain the health of forest stands which makes individual trees less susceptible to the effects of insects and disease. If outbreaks occur, then pesticides may be used to reduce the adverse effects of pests. Local outbreaks of insects and diseases causing mortality in trees may lead to an increase the number of suitable roosts.

Herbicide use on the Forest is expected to remain at the current low levels. To control aquatic weeds, especially algae blooms and naiads at swimming beaches and boat launches, diquat and Cleargate (a copper compound) is used. The continued use of herbicides at the current low levels will not affect bald eagle. Because plant species targeted by the Forest are primarily poison ivy and exotic species in developed areas and woody species in rights-of-way, and pesticides are used on only a very small percent of Hoosier National Forest each year, there are unlikely to be any short- or long-term impacts to bald eagle prey.

Provide for Recreation Use in Harmony with Natural Communities

Provide Remote Recreation Habitat - The Hoosier comprises about 27 percent of the public land in Indiana which is available for recreation. Over 36 percent of the Forest provide large areas for remote recreation activities.

Develop and Maintain Recreation Facilities - There are ten developed recreation areas on the Forest, including campgrounds, picnic areas, and access points on lakes. Removal of hazard trees could reduce the local number of potential roost sites for bald eagle. However, eagles are unlikely to roost or nest in developed areas because of the frequent disturbances.

Provide Trails for Hiking, Horseback, and Bicycling - The Forest has about 233 miles of hiking and multiple-use trails. Standing dead trees, are generally retained for wildlife purposes except where they pose a hazard to public safety to meet Forest Plan management direction and guidance.

Provide a Useable Landbase

Manage a Public Landbase - The Hoosier National Forest manages over 196,000 acres in nine southern Indiana counties. The gross area of the Forest proclamation boundary encompasses approximately 644,129 acres. Thus, NFS lands are surrounded by and intermixed with lands owned by many other parties. Consolidating NFS land ownership through land purchase or exchange helps improve the efficiency of Forest Service management. It is beneficial to bald eagle by ensuring that lands will not be

lost as habitat by development. Eagles would continue to use lands as long as the habitat remains suitable. If acquired for management by the Forest Service, this would continue indefinitely. Management activities on NFS land would allow eagles to continue foraging and roosting.

Provide Road Access - The majority of roads within the Forest boundary are under county or state jurisdiction. There are 236 miles of paved and 198 miles of gravel roads on NFS land within the Forest boundary. Arterial and collector roads are open to public use at all times. Most road work done by the USDA Forest Service consists of maintaining or reconstructing existing roadways. Activities consist of surface grading, minor realignment of existing roadways, cleaning out ditches, waterbarring, and pruning or removing trees encroaching on right-of-way. These activities have some potential for soil movement off-site. However, if maintenance is not done, erosion from poorly maintained roads can continue for many years.

Standing dead trees, are retained for wildlife purposes under Forest Plan management direction and guidance, except where they pose a hazard to public safety.

Road and parking area construction may require removal of a few potential roost trees. In the long-term, this will benefit the species by diminishing the local disturbances. However, eagles are unlikely to roost or nest in developed areas because of frequent disturbances.

Close Roads - Roads may be closed to protect resources such as soil, water and wildlife, and limit access to edges of large tracts. Activities to close roads include gate or mound installation, and seeding and mulching earthwork to prevent erosion. Recontouring and revegetating abandoned roadbeds may also occur. Installation of road closure devices rarely may require removing some potential roost trees reducing roosting habitat within the area. In the long-term, this will benefit the species by diminishing local disturbances. However, eagles are unlikely to roost or nest in developed areas because of frequent disturbances.

Provide for Human and Community Development

Manage Wildfire - Unplanned fires that threaten life and private development are suppressed. Suppression activities include hand-worked fireline construction and burning out. Presuppression activities, such as constructing firebreaks and fuel load reduction, are designed to reduce acreage affected by wildfires.

Large snags which are currently suitable as roosts might be rendered unsuitable during a fire. Some snags may be cut down if they are burning sufficiently to throw burning embers over the established fireline. Live trees may also be killed by fires and can become roosts replacing others that were lost. Roosts, once created, last for several years.

IV. CUMULATIVE EFFECTS

Cumulative effects of continued Forest Plan implementation are summarized on Table 25.

Private lands and other ownerships in, and adjacent to, the Forest have varying amounts of forest cover. As timber prices have increased in the past several years, more private forest is being harvested and much is being converted to non-forest land uses.

Much of the watershed of the rivers and lakes frequented by bald eagles is in private or other ownerships. Land use activities which occur on other ownerships can also affect water quality in rivers and lakes which pass through or are adjacent to NFS lands.

There are three septic systems on NFS lands near lakes at three campgrounds, but these are not believed to contribute to any water quality problems and are frequently monitored.

The amount of Hoosier National Forest which is suitable for eagle wintering and breeding habitat will increase as acres of bottomland forest increase and mature. Potential nest sites, roost trees, and foraging opportunities are available within the riparian corridors found on the Hoosier National Forest.

In vegetation management, such as timber harvest, a minimum of six snags of varying sizes are retained per acre of NFS land. Many are located in drainages or other areas protected from wind which are preferred night roost locations. All harvest units are visited several times by various Forest Service employees prior to harvest. If eagles or signs of eagle roosting were found during any of these field inspections, the project would be altered to protect the roost site.

Recreation use is permitted on all 196,000+ acres of Hoosier National Forest. However, hunting is excluded from developed recreation sites or other administratively closed areas, including the known eagle nest (Order No. 09-12-15). Since management activities are limited in riparian corridors and floodplains, most activity occurs outside areas where eagles are likely to be. While human activities of this nature have been occurring in the past 10 years, it would be impossible to prevent occasional disturbances to individual eagles on the Hoosier National Forest. Human disturbance during foraging, feeding or daytime perching can cause eagles to flush or temporarily interrupt their normal activity. Recreationists and forest employees may inadvertently flush eagles from roosts or disturb them while foraging outside of the closed areas. People boating or fishing during the winter months may flush perching or foraging eagles. Because they are usually low intensity, infrequent, and last only a few minutes to a few hours, these types of disturbances are not likely to permanently alter eagle use of these areas or disrupt their normal behavior to the point that it results in death or injury to individual birds.

The potential for human and eagle interactions will probably remain steady. Recreational use of the lakes is high, but decreases during winter. Campgrounds and lake access points are open to the public, but are infrequently used in the winter. Encounters between residents or recreationists and eagles will likely continue at the same or increased level as occurs today.

Breeding Habitat

Maturing forest stands have higher numbers of large trees and snags than younger stands. In remote areas near large bodies of water, nesting conditions will improve as the stands mature. Protection of features within large areas provides remote sites where eagles may find adequate conditions for roosting or nesting.

Harvest in upland forests within one kilometer of permanent streams may remove some trees which have characteristics of suitable nest trees. Because a huge number of potential roost trees are available across the Forest, and only a small amount of the Forest is harvested each year, loss of potential nest trees would be insignificant.

Large snags which are currently suitable as potential nest sites might be rendered unsuitable during a fire. Although some potential nest sites may become unsuitable for eagles, others are created, so there is minimal effect on the eagles.

Land acquisition brings habitat for bald eagle into public land ownership. It is beneficial to bald eagle by ensuring that lands will not be lost as habitat by development.

Locations Used by Non-breeding Eagles

Maturing forest stands have higher numbers of large trees and snags than younger stands. In remote areas near large bodies of water, roosting conditions will improve as the stands mature. Protection of features within large areas provides remote sites where eagles may find adequate conditions for roosting.

Selective harvest does not directly alter roosting habitat. Removal of standing dead or damaged trees would be a short-term loss of a small amount of potential roosting habitat. Because a huge number of potential roost trees are available across the Forest, and only a small amount of the Forest is harvested each year, loss of potential roost trees would be insignificant in terms of sustained roosting habitat.

Large snags which are currently suitable as roosts might catch fire and fall to the ground. Live trees may also be killed by fires and can become roosts replacing others that were lost. Although some roosts may become unsuitable for eagles, others are created, so there is minimal effect on the eagles ability to find roosting sites.

Land acquisition is beneficial to bald eagle by ensuring that lands will not be lost as habitat by development. Eagles would continue to use lands as long as the habitat remains suitable. If acquired for management by the Forest Service, this would continue indefinitely.

Wintering Areas

Maturing forest stands have higher numbers of large trees and snags than younger stands. In remote areas near large bodies of water, roosting conditions will improve as stands mature. Protection of features within large areas provides remote sites where eagles may find adequate conditions for roosting.

Selective harvest does not directly alter roosting habitat. Removal of standing dead or damaged trees would be a short-term loss of a small amount of potential roosting habitat. Because a huge number of

potential roost trees are available across the Forest, and only a small amount of the Forest is harvested each year, loss of potential roost trees would be insignificant in terms of sustained roosting habitat.

Large snags which are currently suitable as roosts might catch fire and fall to the ground. Live trees may also be killed by fires and can become roosts replacing others that were lost. Although some roosts may become unsuitable for eagles, others are created, so there is minimal effect on the eagles ability to find roosting sites.

Land acquisition is beneficial to bald eagle by ensuring that lands will not be lost as habitat by development. Eagles would continue to use lands as long as the habitat remains suitable. If acquired for management by the Forest Service, this would continue indefinitely.

Behavior

Protection of features within large areas provides remote sites where eagles may find adequate conditions for roosting or nesting. Areas around significant features may provide remote enough areas with little human disturbance for eagles to nest. Eagles are unlikely to roost or nest in developed areas because of the frequent disturbances.

Land acquisition is beneficial to bald eagle by ensuring that lands will not be lost as habitat by development. Eagles would continue to use lands as long as the habitat remains suitable. If acquired for management by the Forest Service, this would continue indefinitely.

V. DETERMINATION

Continued implementation of the Forest Plan, as amended, MAY AFFECT - IS NOT LIKELY TO ADVERSELY AFFECT bald eagle wintering habitat.

Forest activities will have a BENEFICIAL EFFECT on habitats traditionally used by eagles on the Forest. Activities with potential adverse impacts are conducted in such a manner as to remove those potential impacts. Forest activities are NOT LIKELY TO ADVERSELY AFFECT nests since only one is known to occur on the Forest, and that receives protection from a Forest closure order.

Rationale:

Bald eagle populations across the range of this species are stable or increasing, so much so that the species has been proposed for de-listing because of recovery. Bald eagle populations in Indiana are increasing.

Recreational use of National Forest System lands and some administrative activities may result in temporary disturbance to individual birds. However, due to management restrictions, patterns of recreation use, and timing of administrative activities, the possibility that individual eagles would actually be harmed in some way by being flushed along riparian corridors or along lakeshores is considered so remote as to be discountable. In the general forest area, the possibility of individual eagles being flushed at all is considered so remote as to be a

discountable impact. In addition, this type of effect would be essentially unmeasurable and so would be an insignificant impact.

With the small amount of harvest or tree removal done in areas where eagles are likely to roost, protection of snags across the Forest, the large amount of mature forest cover on the Hoosier National Forest, the availability of a large number of alternate roost trees, and field inspections of project sites, it is highly unlikely that inadvertent harvest of a communal night roost tree would occur. However, it is remotely possible that even with future site-specific field surveys of proposed project areas, a communal night roost would be missed. Therefore, the possibility exists that Forest activities might adversely impact communal night roosts.

Most recreation and administrative use occurs during the day, making it extremely unlikely that eagles on communal night roosts would be disturbed. Most recreation use takes place spring-summer when wintering eagles have already left the area. Most administrative use takes place outside of forested riparian corridors where eagles are most likely to be during the day. Therefore, it is unlikely that eagles would be disturbed during daytime foraging and perching.

Breeding and nesting activities are protected in accordance with Recovery Plan recommendations.

The continued availability of food will more than likely be the determining factor in future eagle use and population expansion. Forest Plan direction as implemented through management direction and guidance, protects and enhances riparian areas, potential roost trees, water quality, and eagle food sources, and ensures good quality habitat for continued eagle recovery. Riparian areas are primarily forested and will be allowed to age naturally, with natural disturbances determining future forest structure. Watersheds of streams and lakes on the forest are protected from soil loss or contamination. There is no use of pesticides on the Forest which would affect either the eagles or their fish prey.

Monitoring of eagles on the Forest will continue in cooperation with the IDNR.

Table 25. Cumulative Effects of Forest Plan Implementation on Bald eagle.

	Breeding Habitat		Non-Breeding Habitat		Wintering Habitat	
	short term	long term	short term	long term	short term	long term
Promote Natural Forest Succession	1	2	1	2	1	2
Protect Unique Features	1	1	1	1	1	1
Establish Plant Communities	1	1	1	1	1	1
Timber Harvest	1	1	1	1	1	1
Intermediate Silvicultural Techniques	1	1	1	1	1	1
Openings & Shrubland	1	1	1	1	1	1
Aquatic Ecosystems	2	2	2	2	2	2
Prescribed Burning	1	1	1	1	1	1

Integrated Pest Management	1	1	1	1	1	1
Maintain Recreatio n Facilities	1	1	1	1	1	1
Trails for Hiking, Horseback, and Bicycling	1	1	1	1	1	1
Manage a Public Landbase	2	2	2	2	2	2
Road Access	1	1	1	1	1	1
Close Roads	2	2	2	2	2	2
Manage Wildfire	4	1	4	1	4	1
Manage Minerals	1	1	1	1	1	1
Special Uses	1	1	1	1	1	1

1 - No Effect
2 - Beneficial
3 - Removable Adverse
4 - Non-removable Adverse

Fanshell mussel
Cyprogenia stegaria (= *C. irrorata*)

I. STATUS OF THE SPECIES AND CRITICAL HABITAT

a. Species and Critical Habitat Description

Freshwater mussels are described and identified by the shape, color, and texture of their shells. The fanshell mussel is described by Cummings and Mayer (1992) and Watters (1995) as a medium-sized mussel which has a greenish to tan shell, with numerous green rays made up of smaller broken lines. Its shell reaches lengths up to three inches. The fanshell has a round- to globose-shaped shell with numerous pustules over the center of the shell or sometimes occurring over the entire shell. The hinge and pseudocardinal teeth are well developed, and the nacre is white.

No critical habitat was established or identified when this species was listed as endangered by the USDI Fish and Wildlife Service.

b. Habitat Requirements

The fanshell is considered to be a medium to large river species (Cummings and Mayer 1992, Watters 1995). It does not occur in small tributary streams. The fanshell occurs in coarse sand-gravel-cobble substrates, moderate currents, and depths to about one meter (Gordon and Layzer 1989).

Mussels, like the fanshell, spend most of their lives buried at least partially in the substrate (Cummings and Mayer 1992). Movement is accomplished by contractions of the foot, a muscle which can extend outside of the shell. Freshwater mussels are filter-feeding animals. Fine organic detritus and plankton are acquired by taking in water through the branchial siphon, passing it across an extensive gill system, and releasing the water back out through the anal siphon into the water column (Pennak 1989). Respiration is accomplished in the same manner.

c. Population Dynamics

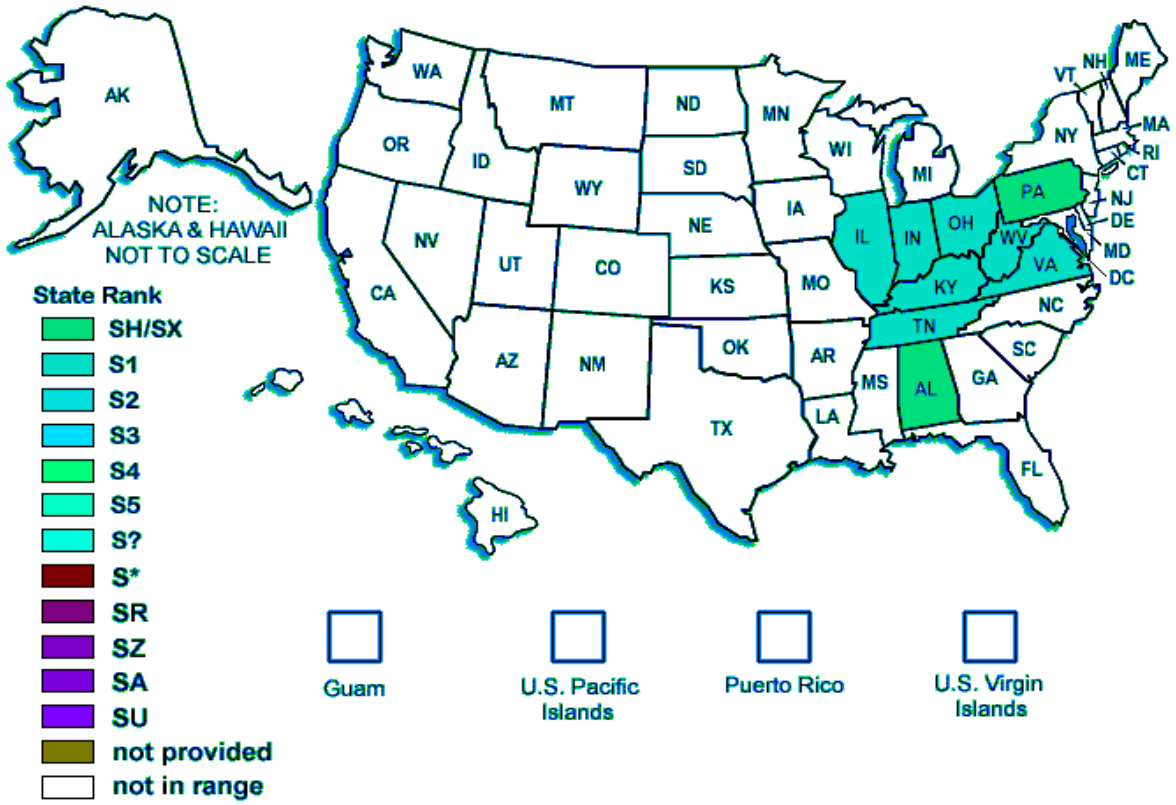
Watters (1995) described the typical reproductive strategy for bivalves, in detail. Males release sperm into the water, and females take in the sperm through their siphon while feeding and respiring. The female retains the fertilized eggs in specialized regions of the gills, known as marsupia. Small bivalved larvae, or glochidia, develop over a period of days to months, depending on the species. The glochidia are shed by the female, and the glochidia must acquire a suitable vertebrate host (*i.e.*, fish) within about 24 hours, or die. The glochidia attach to the host, either on the gills, fins, or skin. The larvae will grow and transform into juveniles, then release themselves from the host and burrow into the substrate.

The fanshell's reproductive biology is not fully known, however it is believed to be similar to other bivalves where sexes are separate (USDI Fish and Wildlife Service 1991). However, ongoing research has shown that hosts for the fanshell mussel are believed to be the logperch (*Percina caprodes*), blotched side logperch (*P. burtoni*), greenside darter (*Etheostoma blennoides*), banded darter (*E.*

zonale), Roanoke darter (*E. roanoka*), Tennessee snub nose darter (*E. simoterum*), and sculpins (pers. comm., L.A. McDougal, Forest Service Region 8 Mussel Coordinator).

The life-span of the fanshell is not known, but freshwater mussels are long-lived animals. Cummings and Mayer (1992) reported that mussel life-span may range from 10 years to more than 100 years for some species.

Figure 7. Fanshell Mussel Range Map.



Source: The Nature Conservancy. 1999. Natural Heritage Conservation Databases. Accessed by USDA Forest Service under grant no. 97-CCS-230.

d. Status and Distribution

The fanshell historically occurred in the Ohio River and many of its large tributaries in Alabama, Illinois, Indiana, Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia (Figure 7). According to the USDI Fish and Wildlife Service (1991), the fanshell was believed to be reproducing in only three rivers, the Green and Licking Rivers in Kentucky and the Clinch River in Tennessee and Virginia. However, Ball and Schoenung (1996) discovered an age two individual in the Tippecanoe River in Indiana which they surmised as an indication that reproduction is likely occurring in this system.

Small, remnant, non-reproducing populations may still persist in the Muskingum River in Morgan and Washington Counties, Ohio; the Walhonding River in Coshoctan County, Ohio; the Wabash River in White County, Illinois, and Posey and Wabash Counties, Indiana; the East Fork of the White River in Martin County, Indiana; the Tippecanoe River in Tippecanoe County, Indiana; the Kanawha River in Fayette County, West Virginia; Tygart's Creek in Greenup and Carter Counties, Kentucky; the Barren River in Allen and Barren Counties, Kentucky; the Cumberland River in Smith County, Tennessee; and the Tennessee River in Rhea, Meigs, and Hardin Counties, Tennessee (USDI Fish and Wildlife Service 1991).

In Indiana, the fanshell appears to have been a more common species historically, based on the number of old shells found during recent mussel surveys of the Wabash, Tippecanoe, and White Rivers (Cummings *et al*. 1987, 1988, 1991). A handful of live individuals and fresh dead shells have been discovered since the mid-1980's in the Wabash, Tippecanoe, and East Fork of the White River (Cummings *et al*. 1987, 1988, 1991, Ball and Schoenung 1996, Indiana Department of Natural Resources 1999).

Ball and Schoenung (1996) collected 11 live individuals in a reach located upstream of the confluence of Indian Creek to the confluence of Salt Creek during the study years of 1992 to 1994. This reach includes that portion of the East Fork which flows through the Hoosier National Forest proclamation boundary. Robert Anderson, former Indiana Division of Fish and Wildlife Nongame Biologist, found two live specimens in this same reach during 1991 and 1992 (Indiana Department of Natural Resources 1999). Fresh dead shells were found at Hindostan Falls in Martin County in 1985 (Cummings *et al*. 1991). Cummings *et al*. (1991) reported that commercial shell collectors had knowledge of the fanshell living in the East Fork of the White River in Lawrence County.

e. Likely Effects on Species and Habitat

Range-wide, the distribution and reproductive capacity of this species has been impacted by impoundments, navigation projects, pollution, and habitat alterations such as dredging for sand and gravel mining (USDI Fish and Wildlife Service 1991, Lauritsen and Watters 1986).

Impoundments and navigation projects historically have been the most serious threat to riverine mussels (Lauritsen and Watters 1986). These structures alter the morphology of the natural river, changing the flow, oxygen levels and substrates. They can also impede passage of fish hosts. As an example, Hoggarth (1994) found only dead shells of the fanshell below a dam on the Walhonding River in Ohio, where live specimens had previously been collected before the dam was constructed. In addition, only silt-tolerant mussel species were found above the dams in that river.

Mussels are susceptible to pollution from various sources: runoff from coal mines; runoff containing pesticides, fertilizers, animal waste and heavy metals; and discharges of water with temperature extremes (Lauritsen and Watters 1986, Endangered Species Technical Bulletin 1990). Siltation from mining, dredging, road construction, farming and logging can bury shells and impact feeding and respiration (Lauritsen and Watters 1986).

Other potential threats to this species include reduction of water flows, runoff from oil and gas exploration, toxic spills, water development projects, and collectors in the rivers where mussels remain (Endangered Species Technical Bulletin 1990).

A relatively new threat to this species is the zebra mussel (*Dreissena polymorpha*), an exotic species which has extended its range to the Ohio River basin. Berg *et al*. (1993) found that zebra mussels encrust native unionids and effect their fitness.

The mainstem of the East Fork of the White River in Martin and Lawrence counties, Indiana, is the only location where the fanshell is known to occur within the Hoosier National Forest proclamation boundary. The East Fork is a large river system by the time it reaches Williams Dam, the only dam on its mainstem, draining approximately 4,720 square miles of land at this point (Hoggatt 1975). The East Fork basin is a combination of the following sub-basins: Driftwood, Flatrock, Muscatatuck, Upper East Fork, and Lower East Fork. The landscape of the entire basin is managed in many different ways by various land-owning individuals, organizations, and agencies.

According to the 1992-1993 Indiana 305 (b) Report, agriculture is prominent in the portions of the basin with flatter terrain, but much of the hillier areas are forested. Numerous miles of state, county, and federal roads are found within the basin. There are municipal water supply intakes on the mainstream and on some tributaries. The 1998 Indiana State of the Environment Report shows that there are 14 municipal and five industrial wastewater treatment facilities within the East Fork of the White River basin. The Indiana Division of Fish and Wildlife has issued Fish Consumption Advisories for the East Fork in Lawrence and Martin Counties. The advisories pertain to mercury and PCB contamination of various species of fish. There is one hydropower dam on the mainstem of the East Fork, Williams Dam. The Forest Service administers approximately 168 square miles of land (3.6 percent) in the East Fork basin.

II. Environmental Baseline

a. Status of Fanshell Within the Forest Planning Area

The fanshell is listed as Endangered in Indiana (Indiana Department of Natural Resources 1993).

The fanshell has been documented from the mainstem of the East Fork of the White River in Martin and Lawrence counties, Indiana. This portion of the East Fork flows through the Lost River Unit of the Brownstown Ranger District. Individuals and or shells have been found in the Tippecanoe River and Wabash River basins in Indiana, but no National Forest System (NFS) lands are located within these basins. The small and isolated fanshell population found in the East Fork of the White River is not considered to be a reproducing population (USDI Fish and Wildlife Service 1991).

b. Factors Affecting the Fanshell Habitat Within the Forest Planning Area

For purposes of this assessment, the Forest planning area includes the portion of the Hoosier National Forest located within the East Fork of the White River basin. This area includes the Pleasant Run Unit and the Lost River Unit of the Brownstown Ranger District, and the very northern portion of the Patoka River Unit of the Tell City Ranger District.

There are approximately 107,520 acres of NFS lands within the East Fork basin. There is a total of 0.08 miles (466 feet) of NFS land adjoining the mainstem of the East Fork. The remaining NFS lands are located within tributary watersheds of the East Fork (*i.e.*, Salt Creek, Lost River, Plaster Creek, and Beaver Creek). Most of these NFS lands are many miles away from the East Fork.

Protect and Manage Ecosystems

Protect and Restore Aquatic and Riparian Ecosystems - Forest-wide, there are approximately 925 acres of lakes, ponds, and waterholes, and about 500 miles of intermittent and perennial streams.

Management direction and guidance allows natural processes to occur in streamside management zones. Protection and restoration of forested riparian corridors will result in the protection of the aquatic ecosystem from siltation, and will make organic detritus available to aquatic organisms. Riparian forests also maintain suitable water temperatures for warmwater aquatic species.

Restoration of wetland habitats restores the natural hydrology to tiled and ditched floodplains. A 25 acre wetland was restored along the Lost River in the mid-1990's, and another 30 to 40 acres of wetland habitat has been identified for restoration along the Lost River. Wetland restoration work of this type includes using heavy equipment to locate and remove any field drain tiles, repair natural levees by filling and armoring them as necessary, and constructing low dikes with water level control structures at natural outlets to facilitate maintenance and repair work. Seeding and mulching immediately follow construction to mitigate soil erosion.

There are instances when special permits are requested for utility lines that must cross streams. In these cases, the permit applicant must comply with dredge and fill activities regulated by Section 404 of the Clean Water Act, Section 10 of the Rivers and Harbor Act as administered by the Corps of Engineers, and Indiana's Flood Control Act of 1945 as administered by the Indiana Department of Natural Resources.

Restoration of riparian areas on NFS lands contributes to long-term beneficial effects to water quality and aquatic habitats. Riparian forests serve as sediment and nutrient filters, and as sources of organic debris. Restoration of wetlands in floodplain fields improves water quality and aquatic habitats since these wetlands serve as filters and sponges for nutrients and sediments in flood waters. Wetlands also help to store flood waters for longer periods of time, which help to stabilize downstream flows.

There are many mitigation and protective measures outlined in the Forest Plan designed to protect soil-riparian-aquatic resources from various management activities. Forest Plan, Appendix J outlines protective measures to implement when working in streamside management zones.

Lake Management - Small lakes, 5 to 15 acres in size, may be constructed on some NFS lands within the East Fork basin. All potential small lake sites are found on 1st or 2nd order headwater streams, and the majority of these sites are in the Salt creek watershed. These headwater streams do not contain suitable habitat for the fanshell. The Forest Service would not construct a dam on the mainstem of the East Fork, or on the mainstem of larger tributaries. There would be no effect on the fanshell in the event the Forest Service constructed small lakes.

Protect and Manage Soil Resources - About 27 acres are treated annually on the Hoosier National Forest to directly benefit soil and water resources. A portion of these activities are conducted on National Forest lands within the East Fork of the White River watershed. Road and trail rehabilitation includes the use of hand labor or machinery to ensure culverts are placed appropriately, water bars and water diversions are working properly, and stream crossings and their approaches are not contributing to the siltation of aquatic habitats. Some areas are planted with native species by hand either to provide a vegetative cover on unstable or erosive soils.

Obliteration of roads, revegetation of trails, rehabilitation of trails and roads are all beneficial practices which lead to improved water quality and aquatic habitats. These activities eliminate sediment sources in the basin which could otherwise lead to siltation of stream substrates.

Planting trees along streams, and on erosive or unstable soils provides long-term benefits to water quality and aquatic habitats. Tree roots hold soils together on hillsides and streambanks, thus reducing the potential for siltation of stream substrates. Trees also provide organic detritus to the streams, which serves as food to aquatic organisms like the fanshell.

Manage Vegetation to Provide Diverse Ecosystems - Timber harvest could occur in riparian areas for the purpose of enhancing or maintaining riparian-dependant resources. In the event of a natural catastrophe, salvage of timber in riparian areas would be considered on a case-by-case basis. When harvesting trees, heavy machinery must access the harvest area to remove trees. Planning is done to identify where harvesting will occur, and where to allow skid trails or log landings. Stream crossings are identified and appropriate methods are used to mitigate impacts to aquatic resources. However Forest Plan management direction and guidance and Standard Mitigation and Protection Measures ensure stream crossings and skid trails are designed to minimize the amount of sediment which can enter a stream.

Use of the mitigation and protection measures in the Forest Plan minimizes the amount of sediment which can enter a stream. Small amounts would likely move off-site and into streams, however it would need to travel several miles before it entered the East Fork. The sediment would likely settle out into these tributary streams, or be deposited onto floodplains, and thus the effects on the fanshell would be discountable.

Fire Management - Firelines have the potential to introduce sediment into streams because construction of firelines can be a soil disturbing activity. In the majority of cases, firelines are constructed by raking or blowing organic matter from a lineal segment of ground. In some circumstances, firelines are constructed by discing or rotovating the soil. In either case, firelines are placed outside of riparian areas and in places where forest cover can help filter any sediment before it can be introduced into streams. When possible, streams are used as natural firebreaks. The moist nature of the riparian area serves to extinguish fires.

Mitigation measures, and management direction and guidance, incorporated into the Forest Plan serve to protect aquatic resources from siltation. In the event small amounts of sediment moved off-site and into streams, it would need to travel several miles before it entered the East Fork. The sediment would

likely settle out into these tributary streams, or be deposited onto floodplains, and thus the effects on the fanshell would be discountable.

Integrated Pest Management - Pesticides are used at very low levels on the Hoosier National Forest. Aquatic herbicides have been applied in developed recreation areas outside the East Fork basin. Herbicides and insecticides will likely be used for the same purposes in the future. Rotenone may be prescribed by the Indiana Division of Fish and Wildlife to renovate fisheries in selected fishing ponds and lakes in the future.

Runoff carrying pesticides has been listed as a potential threat to the fanshell. Pesticides used on the Hoosier National Forest are registered with the U. S. Environmental Protection Agency. Because of the low level of use, and the care taken to avoid drift, the low potential for these pesticides to enter streams, the effect on the fanshell can be considered discountable.

Rotenone may be prescribed by the Indiana Division of Fish and Wildlife to renovate fisheries in selected fishing ponds and lakes in the future. Rotenone is known to be lethal to mussels. In the event rotenone is applied, it would be done on small fishing ponds and lakes in the headwaters of the East Fork's tributaries. Rotenone is a biological compound which breaks down rapidly when exposed to sunlight and oxygen. It is applied when conditions are stable, such as water flow out of impoundments is low. Potassium permanganate is used to negate the effects of rotenone if it flows from the treatment site. Only one lake, Grouse Hollow Lake, is slated for renovation because its dam has failed and needs repair. The use of rotenone is a decision made by the Indiana Division of Fish and Wildlife. Because of the low level of use, the care taken to avoid drift, the low potential for rotenone to enter to enter headwater streams, and the rapid deterioration of the compound, the effect on the fanshell can be considered discountable.

Hazardous Material - Hazardous materials, when discovered, are removed or treated. Acid mine drainage has been considered a hazardous material; it is basically sulfuric acid. One abandoned coal mine has been located on NFS lands in the East Fork basin. This site discharges water with a pH of 2 to 3 into the headwaters of Plaster Creek. Data shows that water quality improves and supports aquatic life approximately two miles downstream from the mine, or about four miles above its confluence with the East Fork. The water from the mine discharges at a slow rate and is naturally diluted by Plaster Creek so there is no effect to water quality in East Fork, and no effect to the fanshell.

Provide for Recreation Use in Harmony with Natural Communities

Trails - A Forest trail system has been developed for hikers, equestrians, and mountain bikers. Forest Service crews will continue to conduct maintenance on the trails to prevent soil erosion. Maintenance includes hardening of trail surfaces, installation of water bars, repair of culverts, and maintenance of stream crossings.

Stream crossings occur on these trails, and these crossings could serve as a source of sediment introduction into streams. However, trails are constructed to ensure the approaches and crossing have the least impact to the aquatic system. Use of mitigation measures and management direction and guidance help to prevent soil movement into watercourses (Forest Plan, Appendix J and K). In the event small amounts of sediment moved off-site and into streams, it would need to travel downstream several

miles before it entered the East Fork. The sediment would likely settle out into these tributary streams, or be deposited onto floodplains, and thus the effects on the fanshell would be discountable.

Provide an Useable Landbase

Management of a Public Landbase - Consolidating NFS land ownership through land purchase or exchange helps improve the efficiency of Forest Service management. Land acquisition brings unique ecosystems into public land ownership and provides a way to acquire habitat for endangered and threatened species. It ensures these habitats are protected, stabilized, and restored. Land acquisition can have long-term beneficial effects on water quality and aquatic habitats.

Prior to agreeing to exchange land, the Forest Service performs a biological evaluation of the lands involved. If federally listed species are known to occur, the USDI Fish and Wildlife Service is consulted regarding potential impacts.

Provide and Manage a Transportation System - A Forest Service transportation system is an essential part of natural resource and recreation management on the Hoosier National Forest. Roads are constructed and maintained to specific standards and levels, based on the necessary uses of the roads. The transportation system in this basin is primarily composed of Federal-State-County roads, and private driveways or roads.

Most road work done by the Forest Service consists of maintaining or reconstructing existing roadways. Temporary roads are constructed to access timber harvest units.

Aquatic resources are protected by various measures. The Forest Service locates the roads on gentle slopes, and will include grading breaks at frequent intervals on steep grades. Culverts and temporary bridges that do not block fish passage are used to protect streams at road crossings. Vegetation is left along the streams to trap sediment, and water is diverted off roads and away from waterways. In the event small amounts of sediment moved off-site and into streams, it would need to travel downstream several miles before it entered the East Fork. The sediment would likely settle out into these tributary streams, or be deposited onto floodplains, and thus the effects on the fanshell would be discountable.

Provide for Human and Community Development

Manage Oil, Gas, and Minerals - Exploration and development of gypsum in the Lost River Unit is the only mineral activity allowed on NFS lands, except for any outstanding or reserved oil and gas rights. There are currently no active mineral leases, no prospecting permits, and no prospecting permit applications filed with the USDI Bureau of Land Management.

All mineral operating plans will contain steps to protect soil stability and water quality. No surface disturbance is allowed without required mitigating measures which may include seasonal restrictions, road construction and maintenance requirements, and setbacks from streams and wetlands.

Permit Special Uses - Utilities, buried or overhead, may be placed in right-of-ways along roads, across streams, or through forested areas. Maintaining these corridors generally involves pruning or limbing overhanging tree branches, mowing or brushhogging, road blading, and occasional removal of trees

which pose a hazard to permit holders. Permittees are required to meet the same environmental standards as those applied to the Forest Service. Special uses that allow discharge of any pollutant will have the required certification by Indiana Department of Environmental Management. Revegetation of disturbed areas is required as described in Forest Plan, Appendix K.

In the event small amounts of sediment moved off-site and into streams, it would need to travel downstream several miles before it entered the East Fork. The sediment would likely settle out into these tributary streams, or be deposited onto floodplains, and thus the effects on the fanshell would be discountable.

IV. CUMULATIVE EFFECTS

Cumulative effects of continued Forest Plan implementation are summarized on Table 26.

National Forest System lands comprise about 3.6 percent of the East Fork basin. The Hoosier National Forest is surrounded by and intermixed with lands owned by many other parties.

The DOD Department of Navy, and Department of Army, USDI Fish and Wildlife Service and Indiana Department of Natural Resources manage federal and state lands, respectively, within the East Fork basin (*i.e.*, Naval Surface Warfare Center - Crane Division, Monroe Reservoir, Muscatatuck National Wildlife Refuge, Indiana State Parks and State Forests). These agencies have conservation and protection of federally endangered species as part of their goals. The needs of federally endangered species are considered prior to implementation of actions on those lands.

Non-public lands make up the majority of the East Fork basin. These lands are owned by individuals, local governmental agencies, universities, industrial corporations and companies, and others. All of these landowners have different goals and objectives for their properties. Continued development of private forest lands for homes, recreation residences, timber harvest and other activities may add to the sediment and pollution loads in the East Fork. Some land uses require special permits from State regulatory agencies, such as wastewater treatment facilities or industrial discharges. Some land uses will benefit the fanshell, some activities will have no effect on the fanshell, and others could cause adverse effects to this species.

Regulation of industrial and wastewater discharge has helped to improve water quality in the East Fork basin. Assistance is provided to private landowners by the Natural Resources Conservation Service and local soil and water conservation district offices to help implement soil and water conservation projects on private lands.

One small tract of National Forest System land adjoins the mainstem of the East Fork. Primarily, National Forest System lands are found along tributaries to the East Fork, and in most cases are many miles from the East Fork. Activities which occur on the Hoosier National Forest are designed to minimize soil movement off-site, thereby not adding to the sediment load of the East Fork. Because protection and restoration of aquatic and riparian ecosystems is such an integral part of the Forest Plan, soil movement into streams would be minimized during forest activities. Use of pesticides is extremely low on the Forest, and when used, the protection measures outlined in the Forest Plan reduce the potential for introduction into waterways flowing into the East Fork.

When added to other landowner activities on the land in the East Fork basin, cumulative effects associated with implementation of the Hoosier National Forest Land and Resource Management Plan on fanshell habitat in the East Fork mainstem are discountable or insignificant.

Table 26. Cumulative Effects of Forest Plan Implementation on Fanshell.

	short term	long term
Promote Natural Forest Succession	1	1
Protect Unique Features	1	1
Establish Plant Communities	3	3
Timber Harvest	3	3
Intermediate Silvicultural Techniques	3	3
Openings & Shrubland	3	3
Aquatic Ecosystems	1/2	1/2
Prescribed Burning	3	3
Integrated Pest Management	3	3
Maintain Recreation Facilities	1	1
Trails for Hiking, Horseback, & Bicycling	3	3
Manage a Public Landbase	1/2	1/2
Road Access	3	3
Close Roads	3	3
Manage Wildfire	3	3
Manage Minerals	3	3
Special Uses	3	3

1 - No Effect 3 - Removable Adverse
2 - Beneficial 4 - Non-removable Adverse

V. Determination

A MAY AFFECT-NOT LIKELY TO ADVERSELY AFFECT determination is made for habitat of the fanshell mussel.

Rationale

No projects implemented under the current Forest Plan would alter channel structure or substrate composition in the mainstem of the East Fork of the White River, or its tributaries. Forest cover would be maintained in riparian areas along streams where they pass along National Forest System lands. The

potential for introduction of pesticides or hazardous materials into waterways flowing into the East Fork mainstem is small due to stringent protection measures outlined in the Forest Plan. Guidance provided in Appendices J and K of the Forest Plan ensures that movement of soil off-site is minimized and that there is minimal addition of sediment to area streams as a result of forest management activities. The potential for sedimentation from forest management activities to reach the mainstem of the East Fork is very small and the potential for excess sediment to be enough to adversely affect fanshell habitat is so remote as to be discountable.

LITERATURE CITED

3D/International. 1995. Environmental technical report: 1995 field studies for interim Indiana bat habitat mitigation at the Indianapolis International Airport in Marion County, Indiana.

3D/International. 1996. Biological Assessment of the master plan and ongoing mission, U.S. Army Engineer Center and Fort Leonard Wood. Cincinnati, OH.

3D/International. 1998. Mist net survey and telemetry study of Indiana bats (Myotis sodalis) on the Tell City Ranger District of the Hoosier National Forest in Crawford and Perry counties, Indiana. Cincinnati, OH. 38 pp. + Appendicies

Ball, R. L., and B. M. Schoenung. 1996. Status of mussel populations in the primary harvest areas. Indiana Department of Natural Resources, Division of Fish and Wildlife Final Research Report, Indianapolis. 72 pp.

Berg, D. J., W. R. Haag, D. W. Garton, and J. L. Farris. 1993. Responses of native unionids to encrustation by zebra mussels. Page 178 *in* K. S. Cummings, A. C. Buchanon, and L. M. Koch, editors. Conservation and Management of Freshwater Mussels. Proceedings of a UMRCC symposium, 12-14 October 1992, St. Louis, Missouri. Upper Mississippi River Conservation Committee, Rock Island, Illinois.

Berta, S., C. Cowell, J. Wilson, and D.Wiseman. 1999. State-wide vegetation classification procedures for Indiana: satellite data analysis of the Indiana GAP project. Unpublished. 4pp with attachment.

Brady, J., T. Kunz, M.D. Tuttle, and D. Wilson. 1982. Gray bat recovery plan. USFWS. 22 pp. + appendices.

Brady, J.T., R.K. LaVal, T.H. Kunz, M.D. Tuttle, D.E. Wilson, and R.L. Clawson. 1983. Recovery plan for the Indiana Bat. U.S. Fish and Wildlife Service. Rockville, MD. 80pp.

Braun, E.L. 1950. Deciduous forest of eastern United States. New York. Hafner Publishing Company.

Brewer, L.G., and S.M. Lane. 1996. Inventory of rare plants and animal species in the tornado blowdown area of the Pleasant Run Unit in the Brownstown District of the Hoosier National Forest. Unpublished report from 3D/Environmental, 37 pp.

Callahan, E.V. III. 1993. Indiana bat summer habitat requirements. Master of Science thesis, University of Missouri, Columbia.

Callahan, E.V., R.D. Drobney, and R.L. Clawson. 1997. Selection of summer roosting sites by Indiana bats (*Myotis sodalis*) in Missouri. Journal of Mammalogy, Vol 78, No. 3, pp. 818-825.

Castrale, J.S., E.M. Hopkins, and C.E. Keller. 1998. Atlas of breeding birds of Indiana. Indiana Department of Natural Resources. Indianapolis. 388 pp.

Clawson, R.L. 1991. Pesticide contamination of endangered gray bats and their prey in Boone, Franklin, and Camden counties, Missouri. Transactions Missouri Academy of Science. pp. 13-19.

Clawson, R.L. and R.R. Titus. 1992. Management plan for the Indiana and gray bat in Missouri. Missouri Department of Conservation, Jefferson City. 39 pp.

Cummings, K. S., and C. A. Mayer. 1992. Field guide to the freshwater mussels of the Midwest. Illinois Natural History Survey Manual 5. 194 pp.

Cummings, K. S., C. A. Mayer, L. M. Page, and J. M. K. Berlocher. 1987. Survey of the freshwater mussels (Mollusca: Unionidae) of the Wabash River Drainage, Phase 1: Lower Wabash and Tippecanoe Rivers. Illinois Natural History Survey Technical Report 1987 (5).

Cummings, K. S., C. A. Mayer, and L. M. Page. 1988. Survey of the Freshwater Mussels (Mollusca: Unionidae) of the Wabash River Drainage, Phase II: Upper and Middle Wabash River. Illinois Natural History Survey Technical Report 1988 (8).

Cummings, K. S., C. A. Mayer, and L. M. Page. 1991. Survey of the freshwater mussels (Mollusca: Unionidae) of the Wabash River drainage, Phase III. White River and selected tributaries. Illinois Natural History Survey Technical Report 1991 (3).

Dunlap, K. 1997. Population trends of Indiana bats in Indiana. Indiana Karst Conservancy Update No. 46, pp. 14-19.

Ecosearch, Inc. 1999. A freshwater mussel inventory of the Tell City Ranger District, Hoosier National Forest, Perry and Crawford counties, Indiana. Portland, TX. 21 pp. + Appendices.

Ecosearch, Inc. in prep. Freshwater mussel inventory of tributaries of the East Fork of the White River on the Brownstown Ranger District of the Hoosier National Forest.

Endangered Species Technical Bulletin. 1990. Vol. xv, No. 7. pp 5-6.

Evans, J.E., and N. Drilling. 1992a. Element stewardship abstract for Indiana bat. The Nature Conservancy. 10 pp.

Evans, J.E., and N. Drilling. 1992b. Element stewardship abstract for gray bat. The Nature Conservancy. 9 pp.

Gardner, J.E., J.D. Garner, and J.E. Hofmann. 1991. Summer roost selection and roosting behavior of *Myotis sodalis* (Indiana bat) in Illinois. Unpublished report for U.S.F.W.S., 56 pp.

Gordon, M. E., and J. B. Layzer. 1989. Mussels (Bivalvia: Unionidae) of the Cumberland River - Review of life histories and ecological relationships. U. S. Fish and Wildlife Service Biological Report 89 (15). 99 pp.

Grier, J.W., J.B. Elder, F.W. Gramlich, N.F. Green, J.V. Kussman, J.E. Mathison, and J.P. Matteson. 1983. Northern states bald eagle recovery plan. U.S. Fish and Wildlife Service, Denver, CO. 122 pp.

Hobson, C.S. 1993. Status, distribution, and summer ecology of bats in Western Virginia: A survey for the endangered Indiana bat, *Myotis sodalis*, Report to Virginia Dept. of Game & Inland Fisheries, Non-game Division. Richmond, VA. 18 pp.

Hoggarth, M. A. 1994. The Unionidae (Mollusca: Bivalvia) of the Walhonding River, Coshoctan County, Ohio, including a survey for the atspaw (Epioblasma obliquata) and the fanshell (Cyprogenia stegaria). Report prepared for the Ohio Division of Natural Areas and Preserves and U. S. Fish and Wildlife Service. 37 pp.

Hoggatt, R. E. 1975. Drainage areas of Indiana streams. U. S. Geological Survey, Water Resources Publication. 231 pp.

Hoosier National Forest. 1991. Amendment to the Hoosier National Forest land and resource management plan.

Hudak, D.C. 1996. Letter to Cid Morgan containing Indiana bat survey report and consultation information on Pleasant Run Emergency Hardwood Salvage Project. 17 pp.

Indiana Department of Natural Resources. 1993. Indiana's rare plants and animals: a checklist of endangered and threatened species. Division of Fish and Wildlife General Publication. 26 pp.

Indiana Department of Natural Resources. 1999. Indiana natural heritage data center.

Jackson, B. 1993. A review of Bachman's sparrow habitat in Indiana. Indiana Department of Natural Resources, Indianapolis, IN. 80 pp.

Johnson, S. A., V. Brack, Jr. and R. E. Rolley, 1993. Overwinter Weight Loss of Indiana Bats from Hibernacula Subject to Human Visitation, Final Project Report, Indiana Department of Natural Resources, Division of Fish & Wildlife, Endangered Species Program, Project E-1-6, Study No. 9, Job No. 3, 16 pp.

Keys, J.E., C.A. Carpenter, S. Hooks, F. Koenig, W.H. McNab, W. Russel and M.L. Smith. 1995. Ecological units of the eastern United States: first approximation (map and booklet of map unit tables), Atlanta, GA. USDA, Forest Service. Presentation scale 1:3,500,000; colored.

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 Jackson County, Kentucky. Unpublished report to the Nongame Program, Kentucky Department of Fish and Wildlife Resources, Frankfort, KY. 58 pp.

Kurta, A., D. King, J.A. Teramino, J.M. Stribley, and K.J. Williams, Eastern Michigan University. 1993. Summer Roosts of the Endangered Indiana Bat (Myotis sodalis) on the Northern Edge of Its Range. American Midland Naturalist, pp 132-138.

Lauritsen, D. and G. T. Watters. 1986. Element stewardship abstract for general unionid mussel. The Nature Conservancy, Minneapolis. 9 pp.

LaVal, R.K. and M.L. LaVal. 1980. Ecological studies and management of Missouri bat, with emphasis on cave-dwelling species. Terrestrial series No. 8. Missouri Department of Conservation. 53 pp.

McComish, T.S. and M.C. Brown. 1980. Distribution and life history notes for fishes of the Hoosier National Forest, Indiana. unpublished report from Department of Biology, Ball State University, Muncie, IN for USDI Forest Service. 225 pp.

McFarland, C.A., R.D. Drobney, S. Jones, C. Reddy, and R.L. Clawson, 1998. Pesticide Contamination of Little Brown Bats, A Surrogate for the Endangered Indiana Bat, in Missouri. Paper Presented at Missouri Natural Resources Conference, February 18-20, 1998.

Mc Nab, W.H. and P.E. Avers. 1994. Ecological subregions of the United States: section descriptions. Administrative Publication WO-WSA-5. Washington, DC: USDA, Forest Service. 267 pp.

Minton, S.A. 1972. Amphibians and reptiles of Indiana. Indiana Academy of Science, Indianapolis, IN. 346 pp.

Mumford, R.E. and J.O. Whitaker. 1982. Mammals of Indiana. Indiana Univ. Press. 537 pp.

Mumford, R.E. and C.E. Keller. 1984. The birds of Indiana. Indiana University Press, Bloomington, IN. 376 pp.

Olson, S.D. 1996. The historical occurrence of fire in the central hardwoods, with emphasis on southcentral Indiana. Natural Areas Journal 16:248-256.

Olson, S., C.L. Hedge, M.A. Homoya, and C.M. LeBlanc. 1990. Inventory of endangered, threatened, and rare plant species in the Tell City District of the Hoosier National Forest. Indiana Department of Natural Resources, Division of Nature Preserves. vi + 322 pp.

Olson, S., C.L. Hedge, M.A. Homoya, and C.M. LeBlanc. 1991. Inventory of endangered, threatened and rare plant species in the Pleasant Run unit Brownstown District of the Hoosier National Forest. Indiana Department of Natural Resources, Division of Nature Preserves. iii + 93 pp.

Pennak, R. W. 1989. Fresh-water Invertebrates of the United States, Protozoa to Mollusca. John Wiley and Sons, New York. 628 pp.

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*), Conservation Biology, Volume 7, No. 2, June 1993, pp 407-415.

Romme, R.C., K. Tyrell, and V. Brack. 1995. Literature summary and habitat suitability index model: components of summer habitat for the Indiana bat, *Myotis sodalis*. Federal Aid Project E-1-7, Study No. 8. 3/D Environmental. 38 pp. + appendices.

Scoles, S., S. Anderson, D. Turton, and E. Miller. 1995. Forestry and water, a review of watershed research in the Ouachita Mountains. Circular E-932 Water Quality Series. Oklahoma Cooperative Extension Service, Division of Agricultural Sciences and Natural Resources. Oklahoma State University, Stillwater, Oklahoma.

Scott, P., H. Starcs, C.L. Hedge, M.A. Homoya, and C. Baker. 1996. Inventory of endangered, threatened and rare plants in the Lost River Unit, Brownstown District of the Hoosier National Forest. Indiana Department of Natural Resources, Division of Nature Preserves. Indianapolis, IN. 19 pp.

Smith, R.G. 1997. Potential new information submitted by RACE in their supplement to their NOI on Indiana bats and the OA-6 restoration project. Memo dated September 12, 1997. Shawnee National Forest.

Tiedman A.R., C.E. Conrad, J.H. Dieterich, J.W. Hornbeck, W.F. Megahan, L.A. Viereck, and D.D. Wade. 1979. Effects of fire on water. USDA Forest Service. General Technical Report WO-10. 28 pp.

Tyrell, K. and V. Brack, Jr. 1990. A survey for the endangered Indiana bat (Myotis sodalis) on Hoosier National Forest, Indiana. Unpublished final report for IDNR, Division of Fish and Wildlife, and USDA, Forest Service funded study. 93 pp.

USDA Forest Service. 1986. Indiana forest statistics, 1986. North Central Forest Experiment Station. Resource Bulletin NC-108. 139 pp.

USDA Forest Service. 1998. Mark Twain National Forest biological assessment. Rolla, MO. 201 pp. + 7 Appendices.

USDA Forest Service. in press. Indiana forest statistics, 1998. North Central Forest Experiment Station.

USDI Fish and Wildlife Service. 1984. Letter to Larry Henson, Regional Forester, on results of formal consultation. 8 pp.

USDI Fish and Wildlife Service. 1989a. Letter dated June 28, 1989, to Gary Peters, Hoosier National Forest wildlife biologist. 1 p.

USDI Fish and Wildlife Service. 1989b. Letter dated December 15, 1989, to Gary Peters, Hoosier National Forest wildlife biologist. 1 p.

USDI Fish and Wildlife Service. 1991. Fanshell (*Cyprogenia stegaria* (=*C. irrorata*) recovery plan. Atlanta, GA. 37 pp.

USDI Fish and Wildlife Service. 1995. Letter dated February 24, 1995, to Ken Day, Hoosier National Forest supervisor. 3 pp.

USDI Fish and Wildlife Service. 1996. Biological Opinion on the effects of the new missions on Indiana bat, gray bat, and bald eagle in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended, (16 USC 1531 et seq.), 104 pp.

USDI Fish and Wildlife Service. 1999a. Agency Draft Indiana bat (Myotis sodalis) revised recovery plan. Prepared by the Indiana Bat Recovery Team for Region 3 U.S. Fish and Wildlife Service. Ft. Snelling, MN. 53 pp.

USDI Fish and Wildlife Service. 1999b. Biological opinion on the impacts of forest management and other activities to the gray bat, bald eagle, Indian bat, and Mead's milkweed on the Mark Twain National Forest, Missouri. Prepared by Paul M. McKenzie, Ph.D., USDI Fish and Wildlife Service, Columbia, MO. 101 pp.

Van Kley, J.E., G.R. Parker, D.P. Franzmeier, and J.C. Randolph. 1994. Field guide: ecological classification of the Hoosier National Forest and surrounding areas of Indiana. USDA Forest Service. Bedford, IN. 75 pp.

Wade and Lunsford. 1989. A guide for prescribed fire in southern forests. USDA Forest Service Southern Region. Technical Publication R8-TP 11. 56 pp.

Watters, G. T. 1995. A guide to the freshwater mussels of Ohio. Ohio Department of Natural Resources, Division of Wildlife, Columbus. 122 pp.

Wells, C.G., R.E. Campbell, L.F. DeBano, C.E. Lewis, R.L. Fredriksen, E.C. Franklin, R.C. Froelich, and P.H. Dunn. 1979. Effects of fire on soil. USDA Forest Service. General Technical Report WO-7. 34 pp.