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Forest Service

Eastern
Region

Final Environmental Impact Statement

Land and Resource Management Plan

Hoosier National Forest

Caring for the Land and Serving People

Hoosier National Forest
Land and Resource Management Plan
Final Environmental Impact Statement

Eastern Region
Milwaukee, Wisconsin
2006

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Hoosier National Forest
Land and Resource Management Plan
Executive Summary

of

Final Environmental Impact Statement

Brown, Crawford, Dubois, Jackson, Lawrence, Martin, Monroe, Orange, and Perry Counties, Indiana

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This Final Environmental Impact Statement documents the analysis of the Proposed Forest Plan and alternatives to it. Years of discussion and public involvement resulted in the identification of three issues that guided the analysis and development of the Forest Plan. These issues were:

- Watershed Health
- Ecosystem Sustainability (especially maintenance of viable populations of species and management of vegetation)
- Recreation Management (especially OHV use and trails of all types)

At the time of the analysis, the Hoosier National Forest (the Forest) contained approximately 199,150 acres in southern Indiana. The analysis and the FEIS pursued and were organized by eight goals:

- Conserve endangered and threatened species habitat
- Maintain and restore sustainable ecosystems
- Maintain and restore watershed health
- Protect our cultural heritage
- Provide for a visually pleasing landscape
- Provide recreation use in harmony with natural communities
- Provide a useable land base
- Provide for human and community development

The Forest developed Alternative 1 as a continuation of the 1991 major amendment to the previous Forest Plan. Representing no appreciable change in management from the previous Plan, Alternative 1 was considered the No Action alternative. The Forest created Alternative 2 as an approximation of what had been requested by local environmental organizations; it would allow virtually no vegetative management. Alternative 3 would increase vegetative management and provide for an ATV trail system. Alternative 4 would provide for multiple resources and uses but would emphasize early successional habitat and do more to revive fire-dependent forest species. The Forest developed Alternative 5 when modeling and analysis showed that with Alternative 1 viability of early successional species might not be maintained, so Alternative 5 was created, which includes, along with Alternatives 3 and 4, a 13,000-acre area where most even-aged management would be concentrated to benefit those species. Alternative 5 otherwise differs little from Alternative 1 and would implement the same acreage of vegetative management. The Forest Supervisor has identified Alternative 5 as the preferred alternative. For further information, contact Judi Perez at the Forest Supervisor's address shown above. Telephone: (812) 275-5987. E-mail: r9_hoosier_website@fs.fed.us. The full EIS is available on the web at: http://www.fs.fed.us/r9/hoosier/forestplaninfo.htm

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Chapter 1

PURPOSE AND NEED

Overview

This chapter explains the reasons for the preparation of the Final Environmental Impact Statement (FEIS) and includes an overview of:

- The nature of the decision to be made
- Purpose of and need for action
- The Forest planning documents
- The process used to prepare these documents
- The Forest's location
- Defining "overall best management"
- The identification of issues and concerns

Nature of the Decision

The Eastern Regional Forester approved the Hoosier National Forest (the Hoosier or the Forest) Land and Resource Management Plan (Forest Plan) in September 1985. In the years since the original plan, agency goals and objectives, along with other national guidance for strategic plans and programs, have changed. To comply with the Government Performance and Results Act, the agency completed the USDA Forest Service National Strategic Plan (2004 Revision); this document can be found electronically at http://www.fs.fed.us/plan. This plan documents the agency's commitment to sustainable forest management and lays out the goals and objectives for the USDA Forest Service for the next 5 years. The plan has four long-term goals: ecosystem health, multiple benefits to people, scientific and technical assistance, and effective public service. The strategic plan affects programs on the Hoosier. The document *Need for Change, Description of Proposal for Revising the Forest Plan of the Hoosier National Forest* provides more information (USDA FS 2000b).

The 2006 Land and Resource Management Plan (Forest Plan for the Hoosier is a companion document to this FEIS. The Hoosier developed the Forest Plan in accord with the Regional Forester's identified "preferred alternative," which is based on public input, legal requirements, and resource needs. The Forest Plan will guide all natural resource management activities, establish management goals and objectives, guide allocation of lands to different management emphases, and provide standards and guidelines for Forest Plan implementation.

Regulations implementing the 1976 National Forest Management Act (NFMA) require that Regional Foresters revise forest plans and provide the basis for revision. In 1982, the *Code of Federal Regulations* at 36 CFR 219 included instructions to revise forest plans. The Hoosier prepared the Final Environmental Impact Statement (FEIS) and Forest Plan under these regulations. Specific instructions found at 36 CFR 219.10(g) state:

> "A forest plan shall ordinarily be revised on a 10-year cycle or at least every 15 years. It also may be revised whenever the Forest Supervisor determines that conditions or demands in the area covered by the plan have changed

significantly, or when changes in RPA policies, goals, or objectives would have a significant effect on forest level programs."

In accordance with applicable Federal law, the Forest Service is proposing a revised planning framework to guide management of the Forest for the next 10 to 15 years. NFMA requires that Forest Plans be revised at least every 15 years (16 U.S.C. Sec. 1604(f)(5)). The Hoosier developed this Plan revision under the 1982 planning regulations at 36 CFR Part 219.

The National Environmental Policy Act (NEPA) incorporated environmental analysis and public participation requirements in 1969. National Environmental Policy Act procedures direct Federal agencies to make environmental information available to the public before making decisions and taking actions. The NEPA process helps public officials make decisions based on an understanding of environmental consequences and helps them take actions that protect, restore, and enhance the environment. Procedures in 40 CFR 1500-1508 require Federal agencies to use NEPA.

The purpose of this plan is to replace the 1985 Hoosier National Forest Land and Resource Management Plan as amended. The Forest Plan will guide all natural resource management activities on the Hoosier to meet the objectives from Federal law, regulations, and policy. The Forest Plan will address conditions and direction that have changed since the Forest published the original plan and subsequent amendments. The Forest has accomplished this by selecting a management strategy that best achieves a combination of these identified Forest goals:

- Conserve endangered and threatened species habitat
- Maintain and restore sustainable ecosystems
- Maintain and restore watershed health
- Protect our cultural heritage
- Provide for a visually pleasing landscape
- Provide recreation use in harmony with natural communities
- Provide a useable land base
- Provide for human and community development

Goals relate to the issues and the role of the Hoosier. Chapter 3 of the Forest Plan further explains and summarizes the Forest goals.

The Record of Decision (ROD) presents six key decisions for managing the Hoosier National Forest on a landscape scale in the long term. The six decisions are (36 CFR 219, 1982 regulations):

- Forest-wide multiple use goals and objectives
- Forest–wide management requirements for protecting resources
- Management area direction
- Land suited and not suited for timber management
- Monitoring and evaluating requirements
- Recommendations to Congress, such as Wilderness designations

Planning Documents

The Forest amended the original 1985 Forest Plan seven times. A significant amendment in 1991 changed the majority of the direction contained in the 1985 plan. This Forest Plan supersedes the 1985 Forest Plan and all amendments to it.

The FEIS and Forest Plan focus on the condition of the land as a basis for providing multiple use goods and services to the public. The Forest Plan embodies a multiple-use concept of natural resource management. The Forest has strived to balance competing uses across the Forest landscape. Not each use can or should occur on every acre of the Forest. The vision of this Plan is to blend multiple-use resource management in such a way that the Hoosier sustains and protects the overall health and condition of the land and best meets the needs of the American people.

This FEIS analyzes the net public benefits provided by each of the five alternatives considered in detail and the environmental effects of implementing them. The accompanying Forest Plan presents the alternative selected for management of the Forest. Based on its ability to meet the Forest goals, address the issues, and provide the greatest net public benefit, the Forest has identified Alternative 5 as the selected alternative.

The Forest Plan focuses on the decade beginning with the year 2006. We expect to revise the Plan again within 15 years or whenever conditions have changed significantly. Site-specific treatments and actions are not included in the Proposed Plan. The Forest will complete site-specific analyses for management actions at the project level.

The Forest Plan does not mandate any site-specific decisions, nor does it contain a commitment to propose or select any specific project. Site-specific decisions determine exactly where, when, and how projects will occur in accordance with the Forest Plan. These decisions are not included in this programmatic Plan but instead involve a separate level of decisionmaking. Thus, the environmental effects of future site-specific proposals are not analyzed in this FEIS. Subsequent site-specific environmental analysis will occur prior to any ground-disturbing, site-specific project proposal. Public involvement is a key part of site-specific project development. Site-specific actions must be consistent with the standards and guidelines of the Forest Plan. These standards and guidelines operate as parameters within which future projects must occur, unless the Plan is amended (like a zoning variance) to allow the site-specific action to be implemented.

The Notice of Intent (NOI) to prepare an EIS for Forest Plan revision identified six topics to be addressed. These topics were:

- Watershed Health
- Ecosystem Sustainability
- Recreation Management
- Roadless Area Inventory and Evaluation
- Recommendations concerning Wild and Scenic and Recreational Rivers
- Scenery Management

Later portions of this chapter include a discussion on how issues were determined for the plan revision effort and a list of those issues.

Although the Proposed Plan will provide guidance for the next decade, the planning team analyzed each alternative over a period of 150 years. The team used a 150-year projection to determine long-term effects including long-term sustained yield. Since the Forest will revise the Plan within 15 years, this document displays some indicators of response and other measures used in comparing the alternatives only for the first two decades.

Forest Planning Process

The planning process takes place at three different levels: national, regional, and forest. By separating the levels of planning, it becomes easier to put the national, regional, and local supplies and demands in more appropriate context.

The principal laws and regulations guiding all three levels of forest planning are:

- The Forest and Rangeland Renewable Resources Planning Act (RPA), as amended by NFMA
- NFMA– Planning Regulations; Title 36, Code of Federal Regulations, part 219
- The National Environmental Policy Act (NEPA)
- The Council on Environmental Quality NEPA Regulations, Title 40, Code of Federal Regulations, Part 1500

Forest level planning considers the long-term management of the lands and resources on a national forest. In developing the Proposed Plan, the Forest has followed 10 basic steps outlined in NFMA regulations:

1. Identification of Purpose and Need
2. Development of Planning Criteria
3. Inventory Data and Information Collection
4. Analysis of Management Situation
5. Developing Alternatives
6. Estimating Effects of Alternatives
7. Evaluation of Alternatives
8. Identification of the Preferred Alternative
9. Plan Approval
10. Monitoring and Evaluation

Forest plan direction provides management goals, desired conditions, objectives, standards and guidelines, and an overview of management practices expected to be used to move resources toward the desired condition. This EIS narrows the scope of future analysis by providing direction and an estimate of effects. Project level analyses will be tiered to the Forest Plan FEIS.

All of the documents, files, letters, and other documentation that comprise the planning records are available for review during regular business hours at the Hoosier National Forest Supervisor’s Office, 811 Constitution Avenue, Bedford, Indiana. The planning record details information and decisions made during development of the Proposed Plan, as required in the NFMA. Many of the major documents also appear on the Hoosier website: www.fs.fed.us/r9/hoosier/forestplaninfo.htm.

The FEIS incorporates comments received on the DEIS. The Forest Plan incorporates changes from the Proposed Plan made between Draft and Final EIS. The ROD records the decision and

is subject to administrative appeal in accordance with the Appeal Regulations 36 CFR 217 (1989), as amended.

Monitoring and evaluation are an important part of this planning framework. The monitoring strategy includes implementation, effectiveness, and validation monitoring. The process of plan approval, project decision-making, monitoring, evaluation, plan amendment, and revision allows a Forest Plan to be responsive to changing social and environmental conditions. This Forest Plan is a management guide that describes the Regional Forester's expectations for future conditions, and the Forest will amend and revise it as needed.

Forest Location

Located in southern Indiana, the Hoosier contains approximately 199,150 acres (as of November 2003) of National Forest System (NFS) land. The Forest was established by proclamation in 1935 and became a national forest in 1954. The land is located in two ranger districts: Tell City Ranger District and Brownstown Ranger District. There is a mix of public and private lands in each ranger district.

The Hoosier comprises approximately 25 percent of the public lands in Indiana, and is within a day's drive of several major metropolitan areas, including Chicago, Cincinnati, Evansville, Fort Wayne, Indianapolis, Louisville, and St. Louis. Principal routes to the Hoosier are State Highway 37 from the north and south, U.S. Highways 50 and 150, State Highway 64, 66, and 446, and Interstate 64 in an east-west direction.

Hardwood-covered rolling hills interspersed with small farms and pastureland characterize southern Indiana. Spring and fall color is often spectacular. The unglaciated karst topography, with cave formations and sinkholes, provides opportunity for unique scenic and recreational experiences.

Identifying Public Issues and Concerns

The Forest identified public issues through a variety of means. The Federal Register published the Notice of Intent (NOI) to prepare an EIS for Forest Plan revision on November 1, 2000. In addition, as part of the public involvement process, the agency held meetings for the public to gather input on the NOI and provide the public further explanation of the forest planning process. The Forest held the first meeting in Martinsville, Indiana on December 4, 2000 and a second meeting in Corydon, Indiana on December 6, 2000. The planning team then used the comments submitted from the public scoping process to refine the issues and to develop management indicators that would demonstrate how each alternative would address the issue and allow for comparisons between the alternatives.

The Forest also held public meetings prior to the development of alternative management strategies. The Forest designed the meetings to allow the public to assist in the development of alternatives for managing the Forest. These meetings provided the public with an overview of the process to date, a discussion of what was currently occurring in the process, and what they could expect to see in the future. The format of each meeting divided the public into working groups. Each group designed three alternatives for the planning team to consider. The alternatives were to address recommended minimum impacts on forest resources, maximum resource use they would want to implement, and something between the two. The Forest held three meetings to develop alternatives. The Forest held the first meeting to address input from

Forest employees on July 21, 2003 in Bedford, Indiana. The Forest held meetings for the public on August 2, 2003, in Jasper, Indiana, and on August 16, 2003, in Bedford.

Using these comments from the public, other agencies, and Hoosier employees, the interdisciplinary team analyzed five alternative proposals for managing the resources on NFS lands. Chapter 2 displays these alternatives.

Some issues are beyond the jurisdiction of the Forest Service, outside the scope of the planning process, or best handled case-by-case in site-specific evaluations. The planning team grouped the issues that they found to be within the scope of the planning process.

After completing the DEIS, the Forest conducted a 3-month public comment period. The Notice of Availability, published in the Federal Register (Volume 70, Number 57, March 25, 2005), stated that the comment period ended June 23, 2005. This notice was amended in the Federal Register (Volume 70, Number 102, May 27, 2005) which extended the public comment period to June 27, 2005. During this time members of the Planning Team conducted meetings for employees, the public and organizations. Three public meetings were held in Martinsville (May 10), Paoli (May 11), and Troy (May 12). The meeting in Paoli was attended by 32 people, and 43 people attended each of the other two meetings. Although not everyone in attendance claimed an affiliation with a organized group, several groups were represented at the meetings, including Monroe County 4x4, Fatboys (a 4 wheel drive group), IFWDA (Indiana Four Wheel Drive Association), the Ruffed Grouse Society, Hoosier Environmental Council, Heartwood, Backcountry Horseman Associations, Tree of Life Alliance, Midwest Trail Riders, Protect Our Woods, and Indiana Audubon Society.

By the close of the public comment period, approximately 1,545 letters were received. Approximately 1,010 of them were form letters. Appendix A contains a summary of the process used to define comments and Appendix J contains the responses to the comments and copies of the letters received from other agencies. Comments were used to modify alternatives, develop and evaluate alternatives not previously considered, supplement, improve or modify the analysis, and make factual corrections. Appendix J further addresses the comments received and how they were used,

Issues

The issues addressed in the Proposed Plan and this FEIS are:

- Watershed Health
- Ecosystem Sustainability
- Recreation Management

Appendix A further discusses public involvement, issues, and concerns. A number of concerns have been gathered and grouped into the three issue areas listed above. These are important challenges in managing the Hoosier resources for “the greatest good of the greatest number in the long run.”

Indicators of response are included for each of the issues presented. The planning team used indicators of response to measure how the alternatives respond to the issues. At least two points of view exist concerning how to address trade-offs among resources and how land should be allocated for various uses to maximize public benefits. The issues in this Proposed Plan focus on these larger differences in perspective and not on details of management, such as specifics of trail management.

One of the six topics identified in the Notice of Intent, Roadless Area Inventory and Evaluation, is required for consideration by regulation (36 CFR 219.17). Direction states that roadless areas should be evaluated and considered for recommendation as potential wilderness areas (36 CFR 219.17(a)). In 1978, the Secretary of Agriculture identified three roadless areas in the Hoosier: Cope Hollow, Grubb Ridge, and Mogan Ridge. In 1982, Congress designated the Charles C. Deam Wilderness in two units separated by the Tower Ridge Road. Cope Hollow is the southern unit of the wilderness while Grubb Ridge and Terrill Ridge comprise the northern unit. Mogan Ridge remained an inventoried roadless area. On June 29, 2002, the Hoosier sponsored a workshop to review criteria for further roadless designation. During the summer of 2002, the Forest compiled information gathered and produced a white paper (USDA FS 2002b). Based on this input, on December 20, 2002, the Forest Supervisor determined that no areas on the Hoosier qualified as roadless, including Mogan Ridge. Appendix D documents the analysis of areas considered as potentially suited for roadless.

In 1991, the USDA Forest Service determined the eligibility and potential classification of the Little Blue River and the Lost River for Wild and Scenic River status. During this Forest Plan revision, few comments concerning Wild, Scenic, and Recreational Rivers were received in response to scoping. Scattered land ownership complicates the ability to designate the identified rivers as Wild or Scenic. Following consideration and analysis, the Hoosier decided that the Proposed Plan would continue to maintain the rivers in Management Area 2.4 in a manner that provides protection to the values that might one day allow them to be designated Wild, Scenic, or Recreational.

Discussion occurred about reevaluating the scenery management system prior to initial scoping for Forest Plan revision. Since no one has demonstrated an overriding need to change the existing system of managing Visual Quality Objectives (VQO), the Forest will maintain the VQO system and considered it throughout this analysis.

The Hoosier considered the following issues in detail in the *Need for Change, Description of Proposal for Revising the Forest Plan of the Hoosier National Forest* (USDA FS 2000b).

Issue One: Watershed Health

The maintenance of watershed health has been an objective of the Forest Service since the beginnings of the agency. The Organic Act of June 1897 states that, “No national forest shall be established, except….for the purpose of securing favorable conditions of water flows….”

The Hoosier provides watershed protection where there are many private forests, small farms, livestock operations, pastures, cultivated fields, permanent homes, and small communities. Hardwood forests dominate the landscape and provide protection to the watersheds by reducing erosion and sedimentation. Natural succession maintains riparian vegetation along streams, lakes, and rivers. Roads and trails are located to minimize impacts to riparian areas. The Forest restores and creates wetlands where feasible.

Indicators of Response for Watershed Health

- Suitable Areas for Vegetation Management (acres in each management area)
- Roads (miles of construction and reconstruction)
- Vegetation Treatment (prescription and acres)

Vegetation management, road building, and other forest management activities can have both negative and positive effects on watershed resources. The indicators chosen cover a range of activities and features that could, without proper guidance and mitigation measures, result in impacts to watershed health. The management areas allow different levels and types of uses and management, including vegetation management, openings maintenance, and other activities that have potential to affect watershed health both positively and negatively. Even though some activities would benefit watershed health, the acreage suitable for management in each alternative provides a measure of the intensity of activities. Roads may contribute to watershed degradation. The amount, type, and location of roads in the watershed can cause the effects to vary. The effects of vegetation treatment on watershed health differ according to the type of treatment and the acreage involved.

Issue Two: Ecosystem Sustainability

Ecosystem sustainability is the maintenance of the various functions of different plant and animal communities and species and their interactions with the non-living components of the biosphere—air, geology, soil, water, and so forth. Like biological diversity, ecosystem sustainability is too complex to be evaluated, measured, or managed as a single entity. Biological communities, air quality, climate, genetic variability, habitat, interactions with humans, landscape, species, water quality, and weather events are all components of ecosystem sustainability.

Endangered, threatened, and sensitive plant and animal species, or species that warrant special attention, are important considerations for public land managers. The Hoosier provides a wide range of habitats including closed canopy hardwood forests, forest openings, cave and karst ecosystems, barrens, cliffs, riparian habitat, and limited amounts of early successional shrubland and young forested stands. These areas provide habitat for a wide variety of species. There are several large parcels of NFS land, but the majority is interspersed to varying degrees with private land. The resulting block size of suitable habitat for various species is small in many locations, which makes sustaining viable populations difficult.

A national forest identifies management indicator species (MIS), which are used to gauge management success and identify needed changes. The Forest developed a new list of MIS for this planning effort.

Historically, fire played a role in establishing and maintaining forest ecosystems and biological diversity. Direction in the 1985 Forest Plan, as amended, regarding the use of fire as a tool for maintaining ecosystem sustainability is limited. The Forest Service's Strategic Plan (2004 Revision) recognizes that maintaining or restoring sustainable forest ecosystems is an important element of the Forest Service mission. The reintroduction of fire into ecosystems on the Hoosier that evolved with fire will be an important tool.

A fundamental role of a national forest is supplying renewable natural resources to Americans while being sensitive to environment and social standards. Trees grow rapidly in the soils and climate of southern Indiana. How much, when, and where trees should be harvested, as well as which tree species the Forest should be managing, are basic questions that influence how the Forest responds to issues pertaining to ecosystem sustainability.

To best display the effects on ecosystem sustainability, this analysis focuses on the sustainability of viable populations of plant and animal species and the types and extent of vegetation management applied across the landscape.

The Hoosier proposes to enhance and protect population viability of plant and animal species over time. It will emphasize an ecosystem approach that emphasizes ecosystem integrity and complements the focus on species viability in assessment and management. Forest biologists used a species viability evaluation to compare alternatives and their contributions toward viability on NFS lands.

Vegetation management may affect habitat for wildlife species.

Indicators of Response for Ecosystem Sustainability

- Acres of Available Habitat (from species viability evaluation of plants and animals)
- Forest Openings Maintained (acres)
- Species Composition (acres and percent)
- Age Class Distribution (percent of forested area by age class)
- Vegetation Treatment (prescription and acres)

The analysis used “acres of available habitat” to indicate whether viable habitat components are maintained for plant and animal species. A shortage of early successional shrubland and young forest habitats exists on the Hoosier, and several species are largely dependent on such habitat. The Forest used “acres of maintained forest openings” as an indicator of the extent to which an alternative would maintain this type of habitat. A diversity of plant and animal species is preferred to a more simplified forest dominated by only a few climax species. A forest dominated by a few climax species would be more nearly homogeneous, potentially more severely damaged by a single disturbance element, and thus potentially less sustainable. A more diverse forest (both in species and structure) is better able to sustain itself in the face of change through time and better able to ensure that young trees are growing to replace older trees. To understand the nature of an alternative and its potential for effects, one also needs to consider the types and amounts of various vegetation treatments. The NFMA states that a forest should be able to maintain a sustained yield of forest products through time.

Issue Three: Recreation Management

The Hoosier provides recreational experiences on large blocks of public land and water based facilities. The Hoosier accounts for approximately one quarter of the public land available for outdoor recreation in Indiana. NFS land represents less than one percent of the State's total land base. Population growth, increased urbanization, and development of private land resources have resulted in increased use of the Hoosier for recreation.

Several factors limit the Hoosier’s ability to fulfill the public's recreation expectations for both developed and natural environments. Scattered land ownership patterns and a high density of roads limit opportunities for recreation or solitude. These same roads, however, provide access for people to drive for pleasure, view scenery and wildlife, camp, hunt, fish, and so forth.

Competing demands for space by a variety of forest users, such as horse riders, hikers, hunters, and mushroom and berry pickers, add to complex issues that forest managers face. Other forest management objectives, such as providing diverse ecosystems, wood, clean water, and wildlife, occasionally conflict with some recreational desires.

The Hoosier provides areas for mountain biking. Indiana also ranks high in equestrian use. The Forest and the Indiana Department of Natural Resources are the only two major providers

of these opportunities, and they complement each other by providing trails and horse camps at strategic locations in southern Indiana.

In a 1987 ROD for off-road vehicle (ORV) use, the Hoosier determined that no use areas would be provided on the Forest. In 1987, ORV was a general classification for motorized vehicles. The 1987 decision noted that all roads open to the public are available for use by ORV users.

Since 1987, terms defining vehicles have changed. For the purpose of this document, off-highway vehicle (OHV) is a general classification for a variety of vehicle types. Please refer to Chapter 3, Table 3.52 for vehicle definitions.

Over time, the popularity of OHV use has grown, and the public raised the subject during the scoping period for this analysis. For the purpose of this analysis, the term "ATV" (all-terrain vehicle) refers to motorized, floatation-tired vehicles with at least three but no more than six low-pressured tires, 50 inches or less in width. This analysis considers limited ATV use on the Forest.

Water-based recreation is at a premium due to the lack of natural lakes. Human-made lakes are extremely popular, and recreation facilities located adjacent to them are in high demand. The Forest's premier developed recreation facilities are located on reservoirs and provide swimming, boating, fishing, and camping opportunities.

The Forest provides other outdoor recreational opportunities, such as dispersed camping, hunting, fishing, and gathering forest products. Tourism is an important industry in southern Indiana. National Forest System lands provide the scenic backdrop for driving tours such as those promoted by Historic Southern Indiana. Visitor guides feature Hoosier campgrounds beaches, lakes, trails, sites for watching wildlife, scenic overlooks, scenic cliffs, and boat ramps.

The Hoosier manages the 12,953-acre Charles C. Deam Wilderness for wilderness values, and it offers the most primitive recreation.

Indicators of Response for Recreation Management

- Access/Transportation (miles of road)
- Output, Jobs, and Income Supported by Recreation
- National Forest Visits

These measures indicate important aspects of the effects an alternative would have on recreation. In this instance, the Forest uses "miles of road' as an indicator of access to NFS lands for enjoyment. The output, income, and jobs available from trail-related activities, approximate the value of an alternative. National forest visits indicate the expected use rate of the Forest by various user groups. Given the types of management proposed in the various alternatives, recreation use would vary by alternative.

Conclusion

The issues provide the threads that tie the subsequent analysis together. The following summary of the succeeding chapters depicts the way the issues contribute to the overall analysis.

Chapter 2, Alternatives, displays how each of the alternatives responds to the issues.

Chapter 3, Affected Environment and Environmental Consequences, shows the existing condition of the Forest as well as the expected results from implementing each of the alternatives.

Chapter 4, List of Preparers, displays contributors to the FEIS.

Chapter 5 is the FEIS/Forest Plan mailing list.

Chapter 6 is an index.

Chapter 7 lists references used in this analysis.

Appendices follow on various subjects of particular interest.

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Chapter 2

MANAGEMENT ALTERNATIVES

Overview

This chapter presents five alternatives for the future management of the Hoosier National Forest (the Forest or the Hoosier). These alternatives represent a reasonable range of management for the Forest.

This chapter describes the process used to develop the alternatives, describes the alternatives, and provides a tabular comparison of each alternative.

Developing Alternatives

The Forest Service issued a Notice of Intent (NOI) to prepare to revise the current Forest Plan in November 2000. The NOI described the Need for Change and outlined revision topics to be included in the Plan Revision. The Forest held meetings that provided input about issues (see Appendix A, Issues, Concerns and Opportunities, for further detail).

Using the input concerning issues, the Forest held public meetings in August of 2003. Members of the public who attended the meetings helped the Forest group activities in ways that could fit together in alternatives. The result was five alternatives, including the No Action Alternative, which would carry forward the emphasis and direction in the current Forest Plan. Although all alternatives would provide a wide range of multiple uses, goods, and services, they address the issues in different ways. All alternatives were required to meet certain minimum management requirements and provide for continued productivity of the renewable resources. Many possible alternatives could meet those requirements, but managers needed to consider conflicting or competing demands for resources, limited funding, and increased concern for cost efficiency. Public demands, land capabilities, the costs of management, and environmental effects were also included in the analysis.

Benchmarks

The Forest analyzed benchmarks to determine the limits of alternatives. Benchmarks define the limits of the reasonable range of timber outputs the Forest could provide. Rather than emphasize a single resource or use to the possible detriment of others, alternatives used "integrated management" or provided a blend of multiple uses for the Forest. Each alternative is a whole Forest solution, and each alternative provides for resources somewhere between the minimum and maximum.

An analysis of the benchmarks provides timber harvest volume and present net value based on a zero harvest or minimum benchmark and a maximum use benchmark. The planning record contains modeling results for the benchmarks.

Development of Alternatives

Benchmarks quantify the tradeoffs between maximizing a single use and balancing multiple uses. To achieve an overall balance, alternatives must use integrated or multiple-use management. Each alternative has different objectives or different responses to the issues. The approach of the alternatives differs so much that not all alternatives can satisfactorily maintain all resources. Nevertheless, all alternatives provide for protection of such resources as soil productivity and recreational opportunities.

The Forest Plan provides goals, objectives, and standards and guidelines that provide Forest-wide management direction. Goals are broad statements and describe overall conditions that managers will strive to achieve. They are not directly measurable and there are no timeframes for achieving them. Goals describe the ends the Forest hopes to achieve rather than the means to these ends; they serve as vision statements. In contrast, Forest objectives provide the means for goal achievements in the form of a measurable step the Forest may take.

The Forest has accepted a definition of a standard as a course of action that the Forest must follow, or a level of attainment that the Hoosier must reach to achieve Forest goals. Adherence to standards is mandatory. In general, the standards limit project-related activities, rather than compel or require them. The Forest must analyze and document in a forest plan amendment any proposed deviations in management activities from standards. Guidelines relate to activities where site-specific factors may require some flexibility. The Forest must analyze and document any proposed deviation from a guideline in a way that meets requirements of the NEPA, but this change would not require a forest plan amendment.

The Forest Plan establishes direction for individual management areas, as needed. Management area direction contains a set of statements describing desired condition including landscape patterns, site level characteristics, desired vegetative conditions, and disturbance regimes. In addition, management activities and additional standards and guidelines may be included to manage or protect specific resources.

The Forest Plan and the FEIS are programmatic documents. The FEIS discusses environmental effects on a broad scale. Over the lifetime of the Forest Plan, the selected alternative and the accompanying Forest-wide standards and guidelines will set Forest management direction by establishing and affirming rules and policies for use of natural resources.

Because this analysis contains a Forest-wide level of analysis, it only estimates what will happen when the Hoosier implements Forest-wide standards and guidelines on individual site-specific projects. This analysis does not convey the long-term environmental consequences of any site-specific project. These actual effects will depend on the extent of each project, environmental conditions at the site, site-specific mitigation measures, and their effectiveness, and the Forest will analyze such project and display the effects in future documents.

Management Areas

Each alternative includes a mix of forest environments. The Hoosier calls these different mixes management areas. The planning team considered 14 different management areas during this analysis. The following paragraphs and pages describe all of the management areas that the Forest considered.

The Hoosier has chosen to continue to use the numbering system developed by the Eastern Region for use in the Forest Plan. The first digit of a management area number identifies the overall management goal. The management goals describe the conditions needed to produce various combinations of goods and services. Within the broad goal, the Hoosier elected to have variations that provide similar land conditions. A second digit following a decimal identifies subparts of the overall management goal.

Management Goal 1

This goal emphasizes small trees for intensive timber production, wildlife game species, and a motorized recreational environment. The Hoosier does not consider the type and level of intensive management associated with this management goal appropriate for the Forest.

Management Goal 2

This goal emphasizes:

- A continuous forested scene
- Wildlife species primarily associated with shade-tolerant vegetation
- Fuelwood and pulpwood from intermediate cuttings
- Large, high-quality hardwood trees
- The reintroduction of fire into the ecosystem to maintain and enhance biological diversity and ecosystem sustainability

Management Area 2.4 Desired Condition

This management area provides a variety of vegetative conditions. Closed canopy hardwood forests provide habitat for plant and animal species that prefer these forest habitats.

This management area protects and enhances water-based recreation experiences, visual quality, riparian values, and riparian habitat. The area is associated with canoeable and fishable streams, rivers, lakes, and reservoirs. Forested shorelines or corridors up to one mile or more in width create an appearance of an unbroken canopy of large diameter trees of a variety of species. Limited vegetation management is appropriate to create and improve habitat for wildlife and plant species in riparian corridors. There is frequent interaction among visitors on system trails and occasional interaction among visitors in other areas.

Key recreation activities include birding, boating, canoeing, fishing, hiking, hunting, trapping, and viewing scenery. The Forest is accessible by canoeable streams or lakes, trails, and State or county roads.

Alternatives 1, 3, 4, and 5 include this management area

Management Area 2.8 Desired Condition

This management area provides a mix of habitats and increased biodiversity. This management area provides a continuous canopy with scattered openings. It is associated with a variety of forest plant communities and has a high degree of vertical and horizontal vegetative diversity.

Human activities include recreation, vegetation management to maintain and enhance wildlife habitat, special uses, and transmission lines and utility corridors. Most activities blend with the natural environment. There is frequent interaction among visitors on system trails and occasional interaction among visitors in other areas.

Various habitat types are present, but late seral habitat may dominate over time. This area provides a variety of forest types, reflecting different ecological sites and management activities.

Openings in the canopy result in different canopy levels and animal communities associated with vertically diverse vegetation, as well as different successional stages of vegetation. Habitat in these areas is best suited to animals that use large hardwood trees and a mosaic of different-aged hardwood forests. There is more early successional habitat in these areas than in most other areas of the Forest.

Fishing, gathering forest products, trail use, hunting, bird watching, and viewing scenery are key recreation activities. Some of the areas are landlocked by private lands, but most are generally accessible by trails and State or county roads.

Alternatives 1 and 5 include this management area.

Management Goal 3

This goal emphasizes:

- A variety of forest views and a feeling of openness in older stands of trees
- Wildlife species associated with a variety of forest habitats
- Large, high-quality hardwood trees
- The reintroduction of fire into the ecosystem to maintain and enhance biological diversity and ecosystem sustainability

Management Area 3.1 Desired Condition

This management area provides a variety of vegetative types and age classes. The area is associated with a mosaic of forest conditions predominated by hardwoods trees and their associated understory, which provides habitat for wildlife species. Management is intensive but is generally not obvious from existing roads and trails.

Over time, stands of large trees will dominate the area, with areas along riparian corridors and inaccessible areas developing into late seral stage habitat.

This management area emphasizes tree species such as ash, cherry, oak, hickory, yellow poplar, and walnut. The predominant management technique applied in this area will be even-aged management and will provide valuable habitat for an array of wildlife and plant species. This management provides an emphasis on wildlife species associated with diverse forested habitats, particularly species that are dependent on young forested stands. The Forest can use a variety of methods to convert pine stands to native hardwoods.

Openings for wildlife are of a variety of sizes, well dispersed, and in character with the landscape. Canopy openings result in different canopy levels. This management area allows for maintaining and providing fishing lakes, marshes, ponds, and waterholes.

Trail use, hunting, bird watching, and viewing scenery are key recreation activities. The Forest is generally accessible by trails and a network of roads.

Alternative 4 includes this management area.

Management Area 3.3 Desired Condition

This management area emphasizes diversity for wildlife species requiring a mix of early and late successional vegetative types and age classes. It is associated with a mosaic of forest conditions predominated by hardwoods trees and their associated understory, to provide habitat for wildlife species. Horizontal and vertical diversity are present in the forest. In general, one finds early and late successional stands close together to provide for those non-migratory species that require a mix of both of these habitats. Management is more intensive than in other management areas, but blends with the natural environment.

Hardwood management is by even-aged methods, emphasizing a diversity of species such as ash, cherry, hickory, oak, yellow poplar, and walnut to provide valuable habitat for wildlife and plant species. Vegetation management is more intense in this area than elsewhere in the Forest with as much as 16 percent of the management area in the 0-9 age class. The Forest can use a variety of methods to convert pine stands to native hardwoods.

Maintained openings for wildlife are of a variety of sizes, well dispersed, and in character with the landscape. This management area also allows for maintaining and providing fishing lakes, marshes, ponds, and waterholes.

Viewing scenery, bird watching, hunting, and trail use are key recreational activities. The Forest is generally accessible by trails and a network of roads.

Alternatives 3, 4, and 5 include this management area.

Management Area 3.5 Desired Condition

This management area provides a variety of vegetative types and age classes. The area is associated with a mosaic of forest conditions predominated by hardwood trees and their associated understory to provide habitat for wildlife species. Horizontal and vertical diversity are present in the forest. Management is intensive but generally not obvious. The Forest may allow limited all-terrain vehicle access and use.

Over time, stands of large trees dominate the area, with areas along riparian streams and inaccessible areas developing into late seral stage habitat.

This management area emphasizes tree species such as ash, cherry, oak, yellow poplar, and walnut. The Forest uses both even-aged and uneven-aged management to provide valuable habitat for wildlife and plant species. The Forest can use a variety of methods to convert pine stands to native hardwoods.

Openings for wildlife are of a variety of sizes, well dispersed, and in character with the landscape. This management area allows the maintenance and creation of fishing lakes, marshes, ponds, and waterholes.

Hunting, trail use, and viewing scenery are key recreation activities. The Forest is generally accessible by trails and a network of roads.

Alternative 3 includes this management area.

Management Goal 4

This goal emphasizes a variety of coniferous views and scenes. It provides a primarily motorized environment and habitat associated with coniferous vegetation. This management goal is not applicable to habitats and ecosystems on the Hoosier.

Management Goal 5

This goal is for Congressionally designated wilderness areas. This goal protects the wilderness character of the land, provides for wilderness experiences, and preserves the natural ecosystems.

Management Area 5.1 Desired Condition

This management area is for the Charles C. Deam Wilderness. *"It is managed to promote and perpetuate the wilderness character of the land and its specific values of solitude, physical and mental challenge, scientific study, inspiration and primitive recreation…" (Eastern Wilderness Act, P.L. 93-622).*

Over time, habitat changes to late successional habitat. Stands are then characterized by large mature or over-mature trees. Some younger trees and openings occur as a result of natural processes.

Evidence of human development includes trails, old roads, stone walls, and cellar holes that have been overgrown and dilapidated by natural forces. Some cemeteries are present.

The size of the area is sufficient to allow users to be reasonably isolated from the sights and sounds of people. There may be occasional interaction between users.

Key recreation activities include backpacking and trail use. The wilderness is generally accessible by trails.

All alternatives include this management area.

Management Goal 6

This goal emphasizes:

- Lands primarily closed to public motorized vehicles
- A mix of forest conditions
- A reintroduction of fire into the ecosystem to maintain and enhance biological diversity and ecosystem sustainability

The Hoosier has two areas under Management Goal 6--Management Areas 6.2 and 6.4. Management Areas 6.2 and 6.4 are quite similar, but there are important differences between the two. The differences include:

- In Management Area 6.2, the Forest creates no forest openings, waterholes, lakes, or ponds, and since the Hoosier does not maintain these existing features, they revert naturally.
- Visual quality objectives are more restrictive in Management Area 6.2, since Management Area 6.4 allows some vegetative management.
- Management Area 6.4 allows some management of pine.
- The Mogan Ridge area occurs in Management Area 6.4. Mogan Ridge is open to motorized vehicles a portion of the year.

Both management areas create physical settings that provide an opportunity for solitude and a feeling of closeness to nature. Both areas are general forestland with the appearance of extensive stands of forest dominating the landscape.

Management Area 6.2 Desired Condition

Over time, extensive stands of natural-appearing forests of shade-tolerant species will characterize the area. Stands will be dominated by large mature and over-mature trees and will provide habitat for late-successional species. Some younger trees and openings will result from natural causes. Removal of commercial products is not appropriate except timber salvage or sanitation harvest.

Key recreation activities include backpacking, hunting, nature watching, and trail use. The Forest is generally accessible by trail and from county or State roads around the perimeter of these areas.

Roads in the interior are closed to public motorized vehicles.

Interaction between users is low, and there is only subtle evidence of other users. Tranquility and solitude are likely.

This management area applies in all alternatives.

Management Area 6.4 Desired Condition

Over time, extensive stands of natural-appearing forests of shade-tolerant species will characterize the area. Stands will be dominated by large mature and over-mature trees and will provide habitat for late-successional species. Some younger trees and openings will result from natural causes. Commercial removal of vegetation is not appropriate except for pine removal with existing access and salvage or sanitation harvest.

Key recreation activities include backpacking, trail use, hunting, and nature watching. The Forest is generally accessible by trails, and from county or State roads around the perimeter.

Roads in the interior are closed to public motorized vehicles, except Mogan Ridge, which is open to motorized vehicles a portion of the year.

Interaction between users is low, and there is only subtle evidence of other users. Tranquility and solitude are likely.

This management area applies in Alternatives 1, 3, 4, and 5.

Management Goal 7

This goal provides for recreation facilities and highly developed areas, including campgrounds, swimming beaches, and other areas intended to serve large numbers of people.

Management Area 7.1 Desired Condition

This management area emphasizes high-density, self-contained recreational experiences. It provides recreation facilities and highly developed areas, including boat ramps, campgrounds, and swimming beaches.

These areas vary in size and offer high-density, destination type use. In general, fees are collected at these areas. Developments are evident and may dominate the landscape. Design, building materials, and placement of facilities and structures are such that they are in harmony with the environment.

This management area applies in all alternatives.

Management Goal 8

This goal emphasizes:

- Preservation of unique ecosystems for scientific purposes
- Areas for research

- Protection of unique areas of national significance
- Reintroduction of fire into the ecosystem to maintain and enhance biological diversity and ecosystem sustainability

Management Area 8.1 Desired Condition

These are Research Natural Areas (RNAs). This designation allows unique ecosystems to follow natural processes for scientific purposes. Research may be conducted in these areas to better understand natural processes and enhance the benefits of our forests.

The only MA 8.1 area on the Forest is the Pioneer Mothers Memorial Forest, an 88-acre old-growth hardwood forest.

The size of the area, type of vegetation, wildlife habitat, and recreational opportunities provided depend on the uncommon or outstanding characteristics to be protected. A natural-appearing condition exists although evidence of humans is occasionally noticeable.

The rare or outstanding values of the areas are the primary consideration. Other resource values and uses are secondary to the protection of the area's special values for public education and enjoyment.

Key recreation activities include hiking and nature watching.

All alternatives include this management area.

Management Area 8.2 Desired Condition

These Special Areas include unique or unusual botanical, ecological, geological, historic, prehistoric, scenic, zoological, or other values that merit special recognition and management. Management of these areas emphasizes the protection, perpetuation, or restoration of their special features and values.

These regionally or locally significant areas must meet one or both of these criteria:

- Be representative of unusual cultural, ecological, geological, or other scientific values; or
- Have the potential to be a regional or national landmark based on natural or cultural values.

Across the Hoosier, the Forest has currently designated 24 of these areas. These special characteristics include a variety of ecosystems, forest conditions, cultural history, and scientific and scenic values. Plant and animal species and communities vary depending on the characteristics of each area.

The rare or outstanding values of the areas are the primary consideration. Other resource values and uses are secondary to the protection, maintenance, and restoration of an area's special values for public education, enjoyment, and study.

A management plan identifies special features of the area, boundaries, desired conditions, and specific management direction. Management plans have been prepared

for some areas, and others are being or will be prepared. Eventually each area will have a management plan.

All alternatives include this management area.

Management Area 8.3 Desired Condition

This management area provides areas for research and scientific study of forest ecosystems.

The Paoli Experimental Forest is a 632-acre area located southwest of Paoli on the Tell City Ranger District.

All alternatives include this management area.

Management Goal 9

This goal emphasizes:

- Minimal management and investment
- Protection and maintenance of environmental values
- Protection of public health and safety

Management Area 9.2 Desired Condition

This designation serves as a holding category until further study and recommendations on specific designations can be made, or conditions warrant a change in management. These areas receive little or no vegetation manipulation, development, or capital investment. Natural forces maintain and influence existing conditions. Management activities and facilities ensure the protection of public health and safety and the prevention of significant loss of existing resources or productivity of the area.

Existing roads and trails provide access to the areas. The Forest maintains existing facilities but additional facilities or improvements are provided only for the protection of the land and public health and safety. Utility corridors and other special-use applications are permitted on a case-by-case basis. There may be evidence of human activities.

This management area applies in all alternatives, but only Alternatives 2, 3, and 4 have acres allocated.

Management Area 9.3 Desired Condition

This management area emphasizes the protection and maintenance of environmental values associated with unique ecosystems. These areas receive little or no vegetation manipulation, development, or capital investment for reasons other than low impact recreation uses (for example, trails and trail improvements) and public health and safety. Guidance emphasizes dispersed recreation activities. Natural forces maintain and influence existing conditions. Management activities and facilities ensure the protection of public health and safety and the prevention of significant loss of existing resources or productivity of the area.

Existing roads and trails provide access to the areas. Existing facilities are maintained, but additional facilities or improvements are provided only for the protection of the land or public health. Utility corridors and other special-use applications are permitted on a case-by-case basis. Evidence of human activities may be present.

This management area applies in Alternative 2.

Alternatives Eliminated from Detailed Study

NEPA requires Federal agencies to explore and objectively evaluate a range of reasonable alternatives and briefly discuss the reason for eliminating alternatives that the Hoosier did not consider in detail (40 CFR 1502.14). Alternatives not considered in detail:

- may be illegal
- may not meet the purpose and need
- may be technologically or clearly infeasible
- may be a duplication of an alternative considered in detail
- may be one on which a decision has already been made at a higher level
- may be determined to cause unreasonable environmental harm
- may be impossible to implement
- may be remote or speculative in nature

The paragraphs below summarize the reasons the Forest considered some alternatives but dismissed them from detailed consideration.

The Forest Service considered but did not analyze an alternative that combined elements of Alternatives 1, 3, and 4 as displayed. The alternative would have resulted in effects already displayed in the analysis of Alternatives 1, 3, and 4. During development of the alternative, it became apparent that analysis of this alternative showed little difference in effects from the alternatives already being considered.

A Draft Conservationist's Alternative to the Hoosier National Forest Land and Management Plan (Conservationist's Alternative) was submitted by the Indiana Public Lands Coalition in September of 2000. This alternative was the "result of research, discussion, and labor by the environmental community of Indiana" (Conservationist's Alternative, September 2000). The alternative presented a "four-part framework of goals to be met for ecological and human interaction paradigms" on the Forest (Conservationist's Alternative, September 2000). Alternative 2 closely represents the idea and intent of the submitted alternative.

The Conservationist's Alternative presented the following:

- Prohibit commercial logging
- Discontinue commercial uses beyond existing commercial rights and leases
- Discontinue the forest openings program
- Restrict the use of prescribed fire to barrens
- Designate additional wilderness areas
- Designate identified roadless areas

- Prevent further road construction
- Emphasize high quality, primitive recreational experiences
- Continue to exclude off-road vehicle use
- Develop a system of hiker only trails
- Place a moratorium on land exchange until a plan is in place that assures the public of fair compensation for Federal lands.

This alternative was not carried further into analysis because it would closely match the expected outcomes of Alternative 2. The main difference is that the Conservationist Alternative allowed for burning of barrens. Prescribed burning of barrens was analyzed in other alternatives.

During the public comment period held from March to June of 2005, two additional alternatives were submitted for consideration. The Planning Team considered both alternatives and determined neither should be carried forward in detailed study. A few aspects of these alternatives were, however, incorporated, mainly in Alternative 5.

The first alternative would have applied the following changes to the current Alternative 4:

- Shift MA 6.2 and 6.4 into either a modified MA 2.8 or a proposed Research MA 8.3 for ruffed grouse and early successional species. The desired condition would be to maintain 8 to 12 percent of the areas in early successional forest habitat (0 to 9 years), with 1 to 2 percent in openings. For group selection, temporary opening size should be increased to 5 acres, and for even-aged management, increase the upper limit of temporary openings to 10 acres in hardwoods.
- MA 3.1 should have a desired condition maintained at 10 to 16 percent in early successional forest habitat (0 to 9 years), 2 to 3 percent in openings, temporary opening size for group selection of 2 to 4 acres, and the temporary openings for even-aged management should be 10 to 30 acres.
- In MA 2.4 the visual quality “retention” distances are excessive at 1,000 to 4,000 feet and would severely limit forest openings in riparian zones, which are important habitat for American woodcock. Visual retention parameters should be more consistent with the definition presented in the DEIS.
- Even-aged timber harvests should include 80 to 100-year as well as 120-year rotations, not just 120 year as inferred in the documents. Ruffed grouse will benefit most from 80-year rotations.

This alternative was not considered for detailed study because the shift of acres from Management Area 6.2 and 6.4 to MAs with completely different desired conditions and goals would not be appropriate. These lands provide for the continued development and enhancement of old growth characteristics and habitat conditions for old growth species such as some forest interior birds. These areas also provide non-wildlife values such as solitude and recreation values that do not coincide with active timber management. This change would also require creation of another management area. The Need for Change (November 1, 2000) stated, “The forest proposes to maintain the existing array of management areas; however, the boundaries may be modified. The current plan provides a blend of different desired conditions in management areas across the forest, with emphasis on native plant and animal communities and provisions for large forest ecosystems with relatively little manipulation. This blend has worked well and provides

for a diversity of plant and animal communities on both local and regional scales." Management Areas 6.2 and 6.4 are maintained to "provide an opportunity for solitude and a feeling of closeness to nature" (Need for Change 2000). One new MA (3.3) was included in the EIS to meet our legal requirement to "*maintain viable populations of existing native and desired non-native vertebrate species in the planning area*" (36 CFR 219.14). The Forest will maintain suitable habitat for these species without changing acres currently designated as 6.2 and 6.4.

The second alternative recommended that, if the above alternative were not developed, the acreage of Management Area 3.3 should be increased to four areas located throughout the Forest, each being equal to or greater than 10,000 acres.

The Planning Team considered this alternative and looked at some areas to see if implementation was possible. Following completion of a GIS analysis, it was determined that the Hoosier does not have a large enough land base to host three additional blocks of MA 3.3. Currently, Alternatives 3, 4, and 5 would implement MA 3.3 on the Tell City Ranger District. The areas were to be removed from existing MA 2.8 areas, as those areas were already deemed General Forest areas and would have similar management goals. The areas were mapped using GIS technology, and none of the additional three areas were shown to have land characteristics that would allow for creation of a contiguous block 10,000 acres or more in size.

The planning team looked closely at creating one additional area of MA 3.3 on the Brownstown Ranger District close to the Maumee Boy Scout camp. The largest area that could be moved into MA 3.3 amounted to approximately 7,840 acres. Limitations of the land base would not allow for creation of an additional 10,000-acre area of MA 3.3.

Some of the changes suggested in the alternatives above have been incorporated into the current Alternative 5 and included in the analysis and final decision. Some changes were made to VQO classification for all alternatives. Specifically, the changes are:

- Even-aged management treatments have been increased to a maximum size of 10 acres in MA 2.8. The effects of this change can be found in Chapter 3.
- VQO changes (for all alternatives), the effects can be found in Chapter 3:
    - The VQO map has been adjusted to modify MA 2.4 from retention to partial retention. This will allow managers to better provide habitat for wildlife dependent on early successional mesic areas.
    - The secondary roads were moved from partial retention to assume the VQO for the surrounding areas.
    - The Ohio River Scenic Byway along the Ohio river, Interstate 64, State Highways 37, 50, 60, 64, 66, 150, and 446, and the Tower Ridge Road all became retention.
    - Lost and Little Blue River corridors in MA 2.4 remained retention.
    - Areas immediately surrounding developed recreation areas are reclassified as modification while those farther away from the recreation areas are partial retention.

Alternatives Considered in Detail

This section describes the five alternatives that the planning team analyzed in detail.

The planning team designed each alternative to respond to comments and significant issues in a different way, providing a range of possible management approaches from which to choose.

- Alternative 1 would continue the current management direction.
- Alternative 2 considers what would occur on the Forest if management included no commercial timber harvest, prescribed burning, or openings maintenance and little to no vegetation management and most other forms of active management. It would be similar to the minimum management benchmark.
- Alternative 3 would emphasize management to obtain and maintain a diversity of forest size and age classes and would develop areas for ATV use.
- Alternative 4 would provide the most biological diversity and the most fire-dependent and early successional species habitat. It would maintain habitat for late successional species, provide habitat management for a wide spectrum of wildlife species, and encourage a high level of visitor use and economic return.
- Alternative 5 modifies the current management direction to reduce the risk to species viability by directing even-aged management into MA 3.3 to provide young forest habitat. This alternative would provide habitat for a wide spectrum of wildlife species while maintaining current types of recreational use.

Alternative 5 is the selected alternative.

Elements Common to All Alternatives

Certain elements remain the same across all the alternatives. These include:

The Charles C. Deam Wilderness legislation designated 12,953 acres on the Hoosier. The Hoosier makes no recommendation in this revision process for designating additional lands as wilderness.

All five alternatives consider the same eight goals.

All alternatives will follow recovery plans for Federally threatened and endangered species. The Hoosier follows guidance in the "Biological Opinion on Implementation of the Hoosier National Forest Plan" from the USDI Fish and Wildlife Service. The Hoosier's biological assessment, which preceded the Biological Opinion, addressed the five Federally listed threatened or endangered species found on the Forest.

The Paoli Experimental Forest would remain under the same management and in the same management area.

The 24 special areas and the one existing Research Natural Area are common to all alternatives. All candidate Special Areas and Research Natural Areas have been designated as the appropriate management area and their boundaries established.

Although the multiple-use philosophy guides each of the alternatives, multiple-use is not interpreted as meaning every use is appropriate for every area or even for every national forest.

No alternative considers surface disturbing leasing of Federal oil and gas resources.

All alternatives encourage partnerships to complete fisheries, recreation, vegetation, and wildlife projects when possible.

All alternatives would provide motorized vehicle access to the perimeter of large tracts of NFS land, where parking areas may be provided.

The Hoosier would manage areas that surround the Lost and Little Blue Rivers to protect their future eligibility as Wild, Scenic, or Recreation Rivers.

The Hoosier would provide for the protection of heritage resources.

Alternative 1– No Action (Current Forest Plan)

This alternative represents the 1985 Forest Plan, as amended. This alternative would provide a strategy to create areas reserved for continuous canopy mature forests and areas managed to provide recreation opportunities, wildlife habitat, and other opportunities. See Figure 2.1 in the map folder for a map of the alternative.

This alternative would maintain a designated trail system, with most trails providing for multiple users – hikers, mountain bikers, and horseback riders. It would allow no off-highway vehicle (OHV) use. The Forest would continue to manage developed and dispersed recreation use.

Alternative 1 would restore streams and historic wetlands where possible, and new lakes and ponds may be constructed. It would also maintain current forest openings and promote native grasses, forbs, and shrubs. The alternative would continue to convert openings featuring fescue and other nonnative species to native ecosystems. With this alternative, the Hoosier would use prescribed fire to maintain fire-dependent ecosystems or reduce fuel buildup. This alternative would maintain openings with a variety of management tools that include removing trees, disking, mowing, burning, and chemical controls. This alternative would use integrated pest management to control and limit nonnative invasive species.

This alternative would maintain biological diversity and forested habitat for wildlife using a variety of methods including timber harvests. Where even-aged harvests are used, they would provide young forest habitats. Prescribed burning is also an appropriate tool for maintaining biological diversity and forested habitats for wildlife. The Forest would maintain the current burning program including the reduction of hazardous fuels created by emergency situations, such as tornadoes.

Timber management would take advantage of opportunities to create and maintain wildlife habitat. The alternative would classify approximately 41 percent of NFS land on the Hoosier as suitable for timber production. Possible harvest methods could include thinning, single-tree selection, group selection, shelterwood, and clearcutting. Uneven-aged management would predominate. Many consolidated areas of the Forest are not suitable for timber production, and harvesting would be restricted on areas most able to provide opportunities for solitude and large areas of natural-appearing forests. The size of even-aged management treatments would be limited to a maximum of 10 acres in pine stands and 5 acres in hardwood stands.

Oil and gas activities would be restricted, but the alternative would allow some activities on a portion of the Forest.

The Forest would maintain the management area prescriptions identified in the 1985 Forest Plan as amended. The alternative would include the following management areas: 2.4, 2.8, 5.1, 6.2, 6.4, 7.1, 8.1, 8.2, 8.3, and 9.2.

Alternative 1 addresses the following issues addressed in the Need for Change:

- Watershed Health - Continues protection and enhancement of watersheds
- Ecosystem Sustainability - Maintains habitat for wildlife populations by providing a variety of habitat types including forest openings and all forest seral stages. Allocates significant acres to management areas that exclude almost all vegetative management.
- Recreation Management - Provides dispersed, developed, and trail opportunities. Does not provide an OHV trail system, but licensed OHVs may continue to be used on public roads.

Alternative 2

This alternative represents a preservation theme for management of the Hoosier. The focus on limited vegetation management would encourage the development of large areas of continuous forest canopy. This continuous canopy would provide a progression toward old growth characteristics typical of species associated with late successional habitat. See Figure 2.2 in the map folder for a map of the alternative.

Alternative 2 would maximize areas that provide a degree of solitude. Other than trails, these areas would exhibit little visible signs of vegetation management, and natural processes would predominate. With this alternative, management would maintain and enhance recreation development as appropriate. The Forest would construct no additional major recreation sites. Alternative 2 would maintain existing trail systems and trailhead facilities and may construct additional hiking trails. This alternative would seasonally close selected trails to horse and mountain bike use to minimize impacts to the resources during inclement weather. The Forest would implement no off-highway vehicle trail system.

This alternative would designate developed horse camps and other developed recreational sites on the Forest as Management Area 7.1, developed recreation. This would add approximately 30 acres to Management Area 7.1.

This alternative would not construct new ponds or lakes and would not maintain existing ponds except as necessary to protect public safety. It would not maintain or develop wetlands or allow for stream restoration. This alternative would provide habitat for wildlife species requiring high forest canopy and little disturbance and emphasize mature forest interior species. However, this alternative does not provide early successional shrubland or young forest habitats for viable populations of many species.

Alternative 2 would allow mowing or manual pulling of nonnative invasive plants, but it would use no chemical controls except in recreation areas.

Under this alternative, the majority of the wildlife habitat would move over time to a late successional seral stage. No commercial timber harvesting would occur. The Forest would allow tree removal only when the trees pose a threat to human health and safety. Only limited vegetation management or prescribed burning, if any, would occur with this

alternative and then only where there is clear and immediate need. In some cases, this alternative would allow native species to be planted or seeded to restore native ecosystems. This alternative would maintain no wildlife openings, so current openings would revert to forest, and it would close roads used only for access and maintenance of forest openings, wetlands, or ponds.

This alternative would classify no management areas as suitable for timber management or harvesting.

Oil, gas, and mineral activities are incompatible with the management philosophy of this alternative.

Alternative 2 proposes to change some management areas described in the 1985 Forest Plan as amended. It would include the following management areas: 5.1, 6.2, 7.1, 8.1, 8.2, 8.3, and 9.2. Additionally, this alternative would create Management Area 9.3, a land allocation associated with large blocks of continuous forest canopy emphasizing dispersed recreation in natural-appearing landscapes (see description in the section concerning management areas). The alternative would place most acres previously designated as Management Area 2.4 and 2.8 in Management Area 9.3.

This alternative addresses the following issues from the Need for Change:

- Watershed Health - Limits possible degradation of watershed by limiting management and impacts to the land. Does not allow for enhancement of watersheds by restoring or maintaining wetlands. Might close selected trails seasonally, based on impact.
- Ecosystem Sustainability - Provides habitat for species associated with late successional habitat. Depends on random actions of private landowners and off-Forest habitat and natural disturbances to provide early successional habitat. Does not meet NFMA requirements for providing habitat for viable populations of all native and desired non-native species in the planning area.
- Recreation Management - Optimizes opportunity for solitude. Does not provide an OHV trail system, but licensed OHVs may continue to be used on public roads.

Alternative 3

Alternative 3 emphasizes a diversity of forest size and age classes including areas of continuous canopy. Management Areas 2.4, 5.1, 6.2, 6.4, 7.1, some of 8.2; and some areas of consolidated ownership would be managed primarily for recreational uses and provide habitat for wildlife needing late successional habitat. The alternative would provide for construction of additional trails and development of an ATV trail system and associated facilities. See Figure 2.3 in the map folder for a map of the alternative.

The alternative would manage much of the Forest to provide wildlife habitat for a variety of species and areas for dispersed recreation. The alternative would provide natural-appearing forests while focusing on healthy and vigorous forests and biological diversity. This alternative would allow some expansion of existing recreational facilities and the development of additional areas, if needed.

The Forest trail system would primarily provide multiple-use trails open to hikers, mountain bikers, and horseback riders, although it would also provide single-use trails on a limited basis. It would also authorize closure of trails in the Charles C. Deam Wilderness to horseback riders seasonally to minimize resource damage and maintenance costs, based on impacts.

This alternative would add or expand developed recreation sites or improvements to increase the ability of Forest sites to better meet demand. The Forest could develop group sites where regular use increases the need for hardened sites to protect resources and provide for visitor health and safety concerns. The alternative would allow more hardened pull-off sites along public roads to provide better access to the Forest.

This alternative would designate developed horse camps and other developed recreational sites on the Forest as Management Area 7.1 developed recreation. This would add approximately 30 acres to Management Area 7.1.

Alternative 3 would provide wildlife habitat for all species, including forest interior and early successional species. It would maintain openings and could create new openings as the Forest acquires land, with the preference being larger openings or complexes of openings. It would maintain openings with a variety of management tools including removing trees, disking, mowing, burning, and chemical controls. This alternative would continue to eliminate openings from large areas of contiguous forest canopy. The alternative would restore streams and historic wetlands where possible and may construct new lakes and ponds.

Timber harvest to create young forested habitat would be a focus of MA 3.3, located on the Tell City Ranger District.

This alternative would consider approximately 56 percent of the NFS land suitable for timber management or production. This would provide a variety of forest age classes and species. The Forest would accelerate pine harvest in the first three decades to allow for regeneration of the sites to hardwoods. While even-aged treatments would occur throughout the Forest, the Hoosier would focus much of that treatment in Management Area 3.3. This management area would encompass approximately 13,000 acres of the Tell City Ranger District. No even-aged harvest in Management Area 3.3 would exceed 40 acres in size.

Timber stand improvement techniques would move stands toward native species and improve stand health and vigor, resulting in better disease resistance and better mast production.

Alternative 3 would use prescribed fire in conjunction with harvesting to increase oak-hickory regeneration. The use of prescribed fire would also maintain fire-dependent ecosystems and reduce fuel buildup. This alternative would use integrated pest management to control and limit nonnative invasive species.

This alternative would not allow oil, gas, and mineral activities.

Alternative 3 would include the following management areas: 2.4, 5.1, 6.2, 6.4, 7.1, 8.1, 8.2, 8.3, and 9.2. This alternative would implement Management Area 3.3 to provide

increased habitat for early successional species. Additionally, this alternative proposes to add Management Area 3.5, a designation associated with a mosaic of forest conditions and plant communities and emphasizing uneven-aged forest management techniques.

Alternative 3 responds to the following issues addressed in the Need for Change:

- Watershed Health - Continues protection and enhancement of watersheds. Closes trails seasonally in the Charles C. Deam Wilderness.
- Ecosystem Sustainability - Maintains viable populations by providing a variety of habitat types including forest openings and all forest seral stages. Increases habitat for species associated with early seral stages.
- Recreation Management - Provides for an ATV trail system.

Alternative 4

This alternative emphasizes fire-dependent and early successional habitat while maintaining habitat for late successional forest species. It would increase biological diversity, provide habitat management for a wide spectrum of wildlife species and a wide range of plant communities, and encourage a high level of visitor use and economic return. See Figure 2.4 in the map folder for a map of the alternative.

The alternative would maximize recreational opportunities such as fishing, hunting, trail use, and wildlife viewing but offer less area for solitude or closed-canopy forest conditions than the other alternatives. It would place priority on restoring native hardwood species and providing habitat for those species dependent on early-successional habitat.

Alternative 4 would maintain a designated trail system with opportunities for hikers, mountain bikers, and horseback riders. This alternative would not provide opportunity for off-highway vehicle use. Dispersed use would occur throughout the Forest, and the Forest would expand developed facilities as needed to meet increased demand.

This alternative would designate developed horse camps and other developed recreational sites as Management Area 7.1, developed recreation. This would add approximately 30 acres to Management Area 7.1.

This alternative would provide wildlife habitat for all species, including forest interior and early successional species. It would maintain openings and could create new openings, with the preference being larger openings or complexes of openings. It would maintain openings with a variety of management tools that include burning, disking, mowing, removing trees, and using chemical controls.

Timber harvest to create young forested habitat would be the focus of Management Area 3.3.

Alternative 4 would restore streams and historic wetlands where possible and could construct new lakes and ponds. It would maintain current forest openings with native grasses, forbs, and shrubs and would use prescribed fire to maintain fire-dependent ecosystems or to reduce fuel buildup.

This alternative classifies approximately 56 percent of the NFS land as suitable for vegetation management including timber harvesting. Even-aged management would predominate under this alternative. While even-aged treatments could occur throughout the Forest, the Forest would focus a portion of that harvesting in Management Area 3.3. Even-aged treatment in Management Area 3.3 would not exceed 40 acres each in size. The alternative would treat pine stands to regenerate the sites to native hardwoods. The Forest would accelerate pine harvest in the first three decades. Timber stand improvement techniques, including the use of herbicides, could be used to move stands toward native species, to improve the vigor and health of a forest stand, or to improve mast production.

Alternative 4 would use a prescribed fire program in conjunction with timber harvest. This would increase the presence of oak and hickory species and maintain fire-dependent ecosystems. It would also use prescribed fire to reduce fuel buildup.

This alternative aggressively treats nonnative invasive species and allows use of all available methods.

Alternative 4 would include the following management areas: 2.4, 5.1, 6.2, 6.4, 7.1, 8.1, 8.2, 8.3, and 9.2. This alternative would create Management Area 3.1, a designation associated with a mosaic of forest conditions and plant communities. Management Area 3.1 allows for both even-aged and uneven-aged forest management techniques but predominantly uses even-aged management techniques. Additionally, this alternative would implement Management Area 3.3 to provide habitat for early successional species. This management area would encompass approximately 13,000 acres.

The alternative would not allow oil, gas, or mineral activities.

Alternative 4 addresses the following issues identified in the Need for Change:

- Watershed Health - Protects and enhances watersheds.
- Ecosystem Sustainability - Maintains viable wildlife populations by providing a variety of habitat types including forest openings and all forest seral stages and increases habitat provided for early seral stage habitats.
- Recreation Management - Encourages a high level of visitor use and economic return while continuing to protect resources. Does not provide for an off-highway vehicle trail system.

Alternative 5

This alternative provides a strategy to create areas reserved for continuous canopy mature forests and areas managed to provide recreation opportunities, wildlife habitat for native species, and other opportunities. This alternative is similar to the existing Forest Plan, but it adds features such as a 13,000-acre area focused on providing early successional habitats. Even-aged management would predominate in this area. While even-aged treatments could occur throughout the Forest, the Hoosier would focus a portion of this harvest in Management Area 3.3. See Figure 2.5 in the map folder for a map of the alternative.

This alternative would maintain a designated trail system, with most trails providing for multiple users – hikers, mountain bikers, and horseback riders. It would allow no off-

highway vehicle (OHV) use. Developed and dispersed recreation use would continue to be managed. This alternative would designate developed horse camps and other developed recreational sites on the Forest as Management Area 7.1, developed recreation. This would add approximately 30 acres to Management Area 7.1.

Alternative 5 would restore streams and historic wetlands where possible, and new lakes and ponds could be constructed. It would maintain current forest openings with native grasses, forbs, and shrubs. The alternative would continue to convert openings featuring fescue and other nonnative species to native ecosystems. This alternative would maintain openings with a variety of management tools including burning, disking, mowing, removing trees, and using chemical controls. With this alternative, the Hoosier would use prescribed fire to maintain fire-dependent ecosystems or reduce fuel buildup.

In addition, this alternative would maintain biological diversity and forested habitat for wildlife using a variety of methods including timber harvests.

The alternative would classify approximately 41 percent of NFS land on the Hoosier as suitable for timber harvest. Timber management would be used to create and maintain wildlife habitat especially for species dependent on this type of disturbance. Harvest methods could include thinning, single-tree selection, group selection, shelterwood, and clearcutting. Uneven-aged management would predominate. Even-aged management treatments across most of the Forest would be limited to a maximum of 10 acres in MA 2.8, but such treatments could be up to 40 acres in size in MA 3.3.

Prescribed burning is an appropriate tool for use in maintaining biological diversity and forested habitats for wildlife. The Forest maintains the current burning program including the reduction of hazardous fuels created by emergencies, such as tornadoes.

This alternative would allow for oil, and gas leasing without surface disturbance and some gypsum mining activities.

The alternative would include the following management areas: 2.4, 2.8, 5.1, 6.2, 6.4, 7.1, 8.1, 8.2, 8.3, and 9.2. This alternative would create a new management area, 3.3, to provide habitat for early successional species.

Alternative 5 addresses the following issues addressed in the Need for Change:

- Watershed Health - Continues protection and enhancement of watersheds.
- Ecosystem Sustainability - Maintains viable habitat including forest openings and all forest seral stages, including the focus of MA 3.3 on providing early successional forest habitat.
- Recreation Management - Provides dispersed, developed, and trail opportunities. Does not provide an OHV trail system, but licensed OHVs may continue to be used on public roads.

We have made changes to Alternative 5 since the DEIS was made available. Based on public comments, we have modified Alternative 5 in two ways:

- Even-aged management treatments have been increased to a maximum size of 10 acres in MA 2.8, regardless of vegetation type. In the DEIS, openings were limited to 5 acres in hardwoods and 10 acres in pine stands.

- Mineral developments are allowed in the Crawford Uplands and Brown County Hills Ecotypes, in MAs 2.8 and 3.3 only, and only with no surface occupancy. In the DEIS, mineral development was prohibited except to prevent Federal mineral rights from being drained by adjacent development.

The upper limit of even-aged management treatments in MA 2.8 was increased in response to information concerning the need of specific species, especially bird species, for larger opening sizes and in response to input from State agencies and others concerning this habitat need and the importance of that habitat in ensuring the viability of those species. The slight relaxation in the general prohibition on mineral development was made in recognition of the increasing difficulties in supplying this nation with petroleum and the President's emphasis on such development.

Acreages of Management Areas

Different alternatives allocate land to the various management areas differently. Table 2.1 shows by alternative the acreage that would be in each management area.

Table 2.1

ACRES OF NFS LAND BY MANAGEMENT AREA

Management Area	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
2.4	16,900	0	11,238	11,238	16,900
2.8	102,127	0	0	0	88,919
3.1	0	0	0	88,919	0
3.3	0	0	13,178	13,178	13,178
3.5	0	0	88,919	0	0
5.1	12,953	12,953	12,953	12,953	12,953
6.2	18,564	41,885	18,564	18,564	18,564
6.4	23,321	0	23,321	23,321	23,321
7.1	6,291	6,321	6,321	6,321	6,321
8.1	88	88	88	88	88
8.2	18,274	18,274	18,274	18,274	18,274
8.3	632	632	632	632	632
9.2	0	5,662	5,662	5,662	0
9.3	0	113,335	0	0	0

Table 2.2 displays the activities allowed in the various management areas. Alternative 2, however, would allow no prescribed burning, openings maintenance, stream and aquatic habitat improvement or maintenance, or pesticide use, and allows almost no timber harvesting regardless of the management area considered.

Table 2.2

ACTIVITIES ALLOWED BY MANAGEMENT AREA

Projected Activities	**MA 2.4**[1]	**MA 2.8**[2]	**MA 3.1**[3]	**MA 3.3**[4]	**MA 3.5**[5]	**MA 5.1**	**MA 6.2**	**MA 6.4**[6]	**MA 7.1**	**MA 8.1**	**MA 8.2**	**MA 8.3**	**MA 9.2**	**MA 9.3**[7]
Even–aged Management		√	√	√	√							√		
Uneven-aged Management	√	√	√	√	√			√				√		
Conversion of pine stands to hardwood stands	√	√	√	√	√			√	√					
Oak - hickory Management	√	√	√	√	√							√		
Timber Stand Improvements		√	√	√	√				√		√	√		
Salvage/Sanitation Harvest	√	√	√	√	√		√	√	√		√	√		
Prescribed Burning	√	√	√	√	√			√	√		√	√		√
Forest Openings Maintenance	√	√	√	√	√			√	√		√			
Aquatic Habitat Improvements	√	√	√	√	√			√	√					
Road Construction Reconstruction	√	√	√	√	√				√					
Recreation Management Activities	√	√	√	√	√	√	√	√	√	√	√		√	√
OHV Trails					√									
Pesticide Use	√	√	√	√	√	√	√	√	√	√	√	√		

[1] Applies in Alternatives 1, 3, 4, and 5
[2] Applies in Alternative 1and 5
[3] Applies in Alternative 4
[4] Applies in Alternatives 3, 4, and 5
[5] Applies in Alternative 3
[6] Applies in Alternative 1, 3, 4, and 5
[7] Applies in Alternative 2

Comparison of Alternatives

This section provides a summary of the effects of implementing each of the alternatives.

Watershed Health

Maintenance of watershed health has been an objective of the Forest Service since its beginnings as an agency. The Hoosier provides watershed protection on NFS lands in an area where there are many cultivated fields, livestock operations, pastures, homes, private forests, small communities, and small farms, all in an area dominated by private land. Hardwood forests dominate the landscape and provide protection to watersheds by reducing erosion and sedimentation. The acreage suitable for management in each alternative provides an indication of the intensity level of that alternative's management activities. Road mileage, type, and location can have both positive and negative effects on watershed health and water quality. Implementation of management direction, site-specific mitigation, and Best Management Practices (BMPs) (IDNR 1998a) would result in minimal impacts to watershed resources. Table 2.3 displays indicators of response associated with the issue.

Table 2.3

WATERSHED INDICATORS AFTER 10 YEARS

Indicators	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Suitable Acres for Management	81,000	0	112,000	112,000	81,000
Road Reconstruction and Construction (miles)[1]	147	6	146	202	147
Even-aged Treatments (acres)	16,500	0	39,000	88,000	16,500
Uneven-aged Treatments (acres)	64,500	0	73,000	24,000	64,500

[1] Based on recent project planning, the Forest expects about 18% of the road reconstruction and construction to be construction.

Ecosystem Sustainability

Viable populations of species, as well as plant and animal communities, are important components of maintaining ecosystem sustainability. The wide range of habitats on the Forest supports an equally wide array of plant and animal species that use or are dependent on those habitats. The Forest considered an ecosystem approach to management that emphasizes ecosystem integrity and a focus on species viability. The LANDIS model was used to describe future forest conditions on the Forest under each proposed alternative. The Forest Service considered all principal habitats on the Forest, and selected 19 species to determine risk to viability. The 19 species selected for analysis use the following 10 principal habitats found on the Forest: wetlands, rivers, ponds, dry forest, mesic forest, barrens, cliffs, karst, open lands, and wide-ranging.

Based on functional relationships between wildlife and habitat requirements, Habitat Suitability Index (HSI) models provide an index of habitat quality ranging from 0 (not habitat) to 1 (habitat of maximum suitability). HSI models were developed for each of the 19 SVE species and were used to compare future conditions under each proposed alternative to the current conditions found on the Hoosier.

Although the approach used for plant species differed from animals, the analysis assessed the effects of alternatives on plant populations.

Table 2.4 summarizes the predictions the risk to viability determined by the results of the HSI models. Readers can find more information in Chapter 3.

Table 2.4

DETERMINATION OF VIABILITY RISK FOR EACH SVE SPECIES AT YEAR 150

Species	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
ANIMALS					
Cerulean warbler	LOW	LOW	LOW	LOW	LOW
Wood thrush	LOW	LOW	LOW	LOW	LOW
Worm-eating warbler	LOW	LOW	LOW	LOW	LOW
Henslow's sparrow	LOW	HIGH	LOW	LOW	LOW
Yellow-breasted chat	HIGH	HIGH	LOW	LOW	MEDIUM
Ruffed grouse	HIGH	HIGH	LOW	LOW	LOW
Northern bobwhite	MEDIUM	HIGH	LOW	LOW	LOW
American woodcock	HIGH	HIGH	LOW	LOW	LOW
Indiana bat	LOW	LOW	LOW	LOW	LOW
Spotted salamander	LOW	LOW	LOW	LOW	LOW
Northern river otter	LOW	LOW	LOW	LOW	LOW
Indiana crayfish	LOW	LOW	LOW	LOW	LOW
Northern cavefish	LOW	LOW	LOW	LOW	LOW
PLANTS					
Carolina thistle	LOW	LOW	LOW	LOW	LOW
Prairie parsley	LOW	HIGH	LOW	LOW	LOW
Yellow gentian	LOW	HIGH	LOW	LOW	LOW
Climbing milkweed	LOW	HIGH	LOW	LOW	LOW
Illinois wood-sorrel	LOW	LOW	LOW	MEDIUM	LOW
French's shootingstar	LOW	LOW	LOW	MEDIUM	LOW

The forest openings program manages areas in early successional shrubland habitat for wildlife that is dependent on this habitat. Table 2.5 summarizes percentages in maintained openings.

Table 2.5
PERCENTAGE OF THE FOREST IN MAINTAINED PERMANENT OPENINGS

Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
3	0	2.5	3	3

A shift in forest composition from oak-hickory to maple-beech dominated forest has implications for many wildlife species. This could result in a reduction of species richness and abundance in bird communities and is likely to negatively affect many species. Table 2.6 presents the expected oak-hickory component present in the Forest following 150 years of implementing the various management alternatives as contrasted to the existing condition.

Table 2.6
ACRES OF OAK-HICKORY PRESENT AFTER 150 YEARS

Existing	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
130,890	**87,610**	**63,570**	**104,600**	**135,340**	**87,610**

Table 2.7 portrays expected age class distribution following implementation of alternatives, while Figure 2.1 displays the dominant species composition predicted by the LANDIS model.

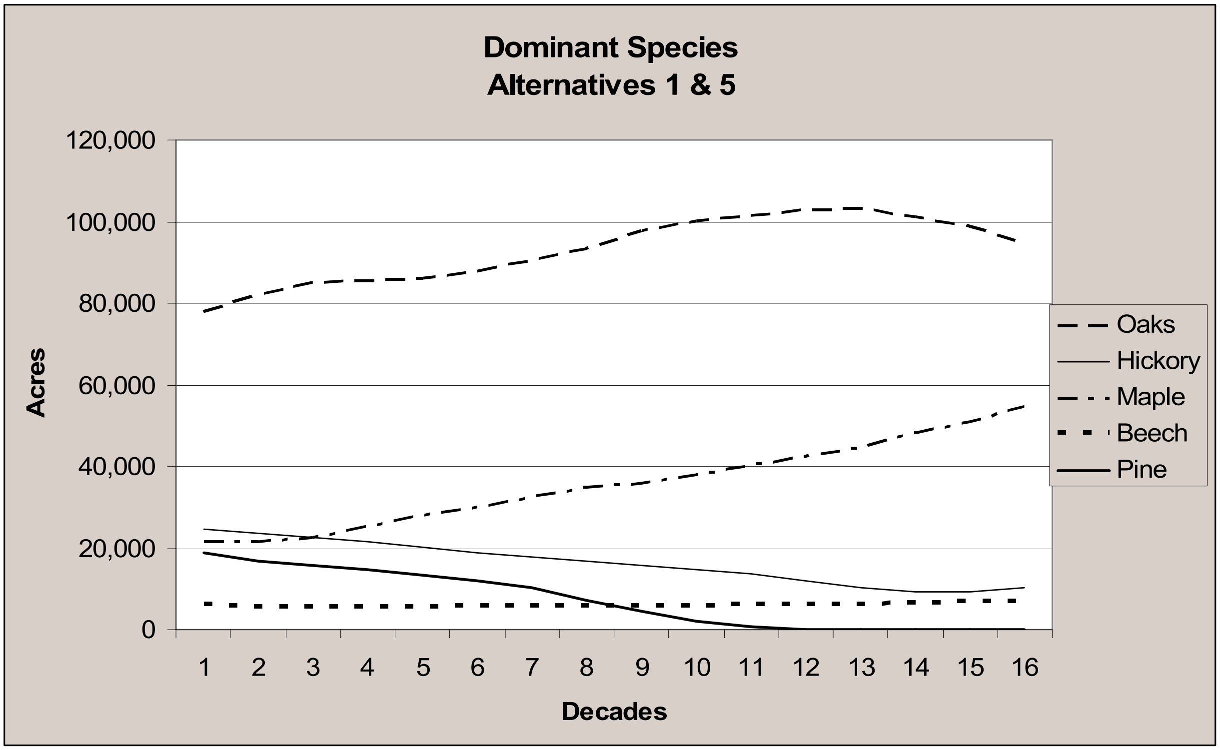
Table 2.7

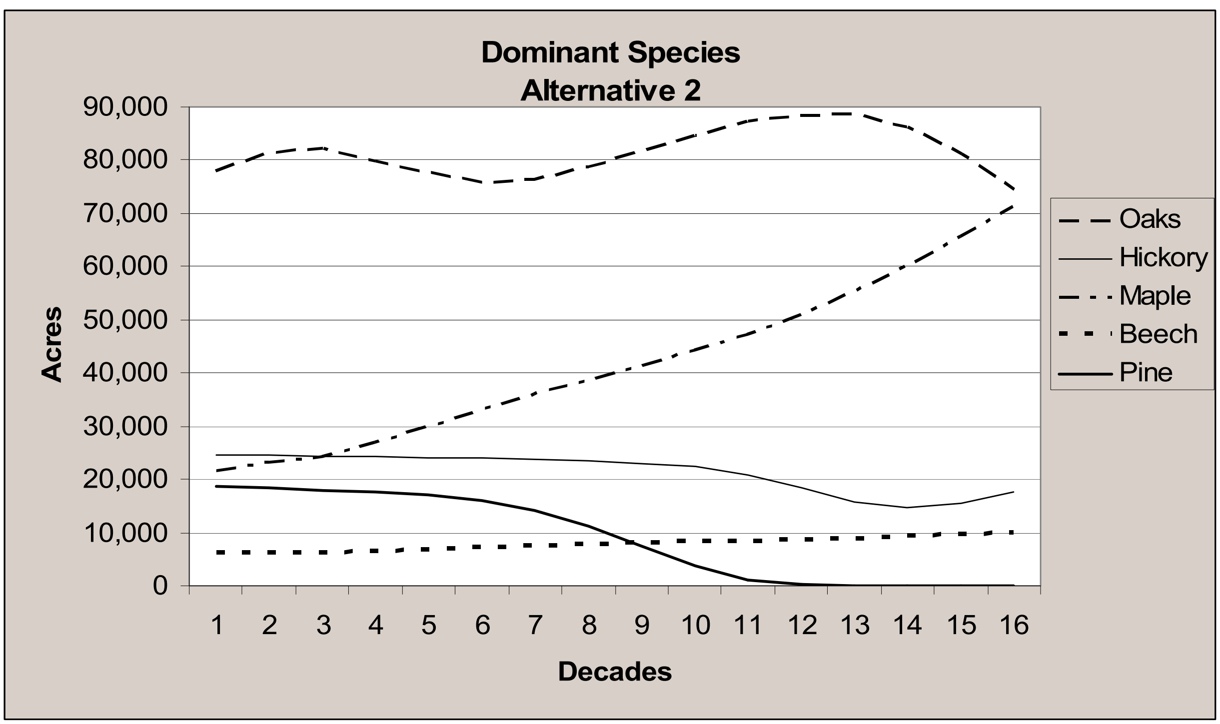
AGE CLASS DISTRIBUTION
Projection of 150 Years from Today (Percent)

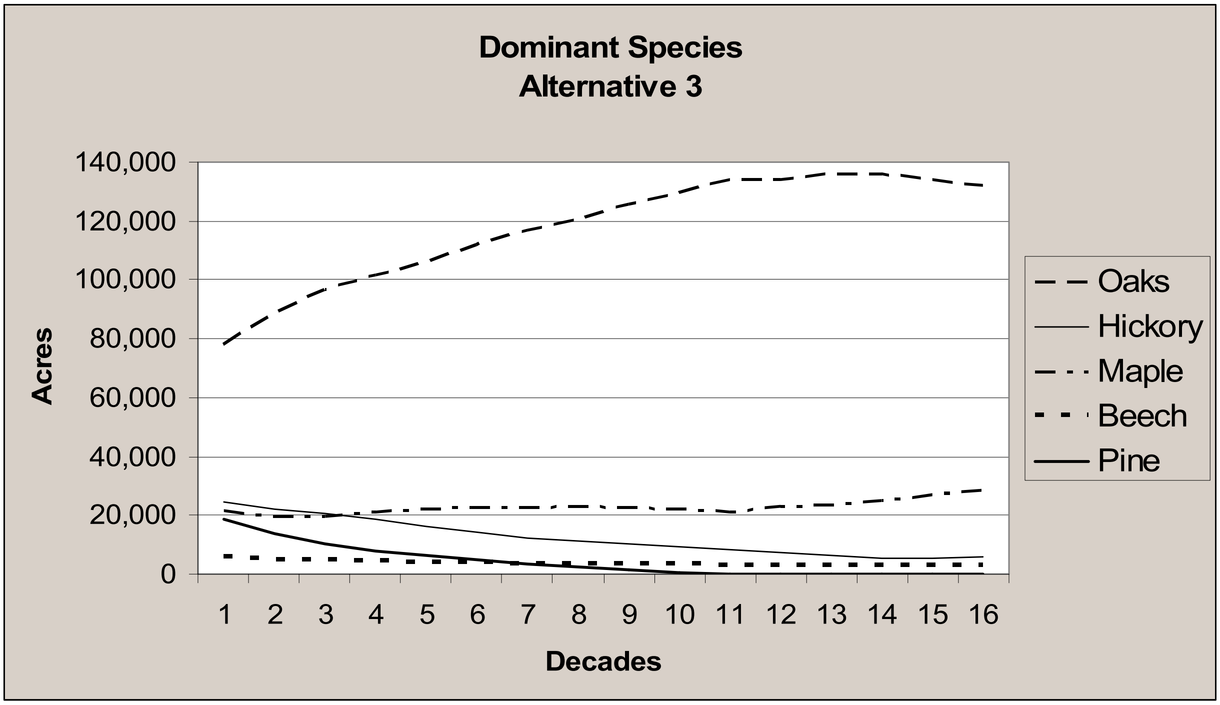
Age Class	Existing	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
0-9	1	1	0	2	3	1
10-39	19	5	3	6	11	5
40-59	12	4	0	3	8	4
60-79	14	3	2	4	7	3
80+	48	80	91	78	64	80
Non-Forested Areas[1]	6	7	4	7	7	7

1 Non-forested areas related to maintained forest openings, lakes, ponds, streams, and power line rights-of-way

Figure 2.1 Species Composition






Dominant Species
Alternative 3
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Decades
Oaks
Hickory
Maple
Beech
Pine

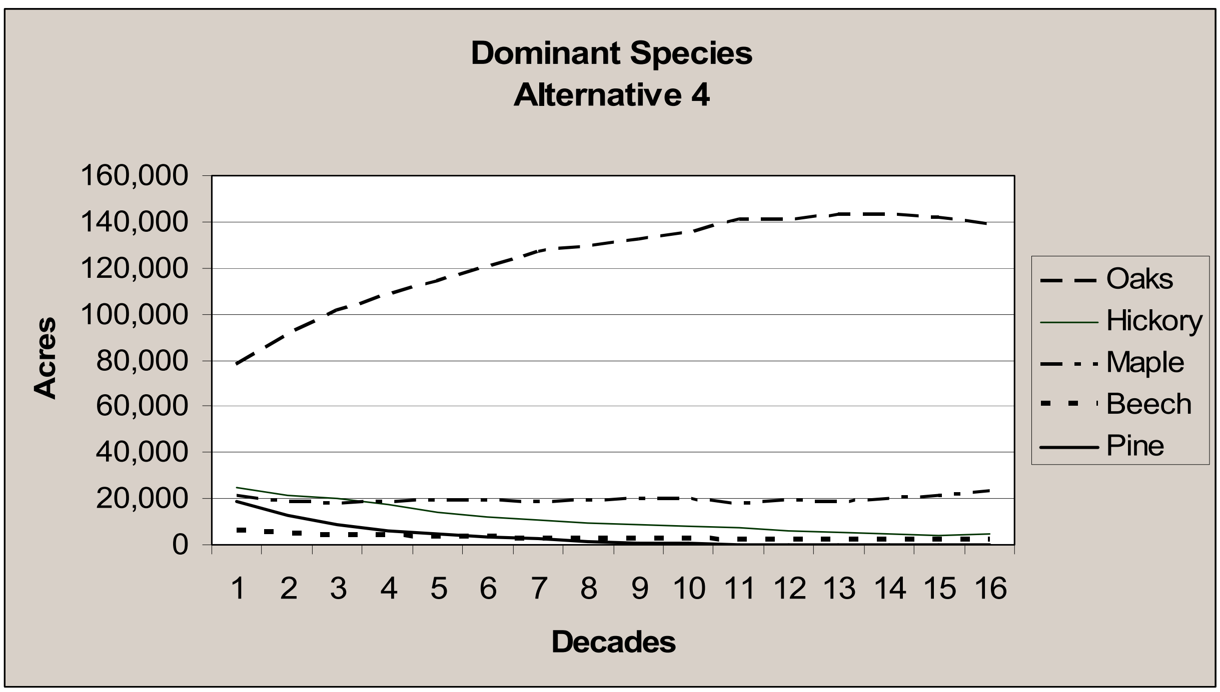

Dominant Species
Alternative 4
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Decades
Oaks
Hickory
Maple
Beech
Pine

Table 2.8
SUMMARY OF PROJECTED VEGETATION TREATMENTS (ACRES)

Activities in First Decade	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Prescribed Burning in Combination with Timber Harvest [1]	5,720	0	11,350	19,240	5,720
Prescribed Burning Not Accompanied by Timber Harvest	14,280	0	38,650	80,760	14,280
Total Clearcut Projected	2,020	0	1,600	6,020	2,020
Total Shelterwood Projected	840	0	4,070	3,600	840
Total Single-tree Selection	1,110	0	3,820	5,160	1,110
Total Group Selection	2,850	0	240	0	2,850
Total Harvest	6,820	0	9,730	14,780	6,820

[1] Burning with timber harvest would burn half the stated acres but burn each acre twice.

The National Forest Management Act (NFMA) states that a national forest should maintain the capacity to provide a sustained yield of forest products through time. The allowable sale quantity (ASQ) displays the non-declining sustained flow of forest products to the communities (Table 2.9).

Table 2.9
ALLOWABLE SALE QUANTITY BY ALTERNATIVE
(First Decade - MMBF)

Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
57.6	0	62.3	94.7	57.6

Recreation

Table 2.10 presents a summary of the recreation indicators, including the amount of output, jobs, and income determined by the IMPLAN analysis (Fox 2004).

Table 2.10

SUMMARY OF RECREATION INDICATORS

Indicator	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Miles of Road Open for Public Vehicle Travel	52	50	51	55	51
National Forest Visits	663,790	662,790	676,790	663,790	663,790
Output ($ millions)	$14.08	$14.05	$14.35	$14.08	$14.08
Employment (jobs)	185	184	189	185	185
Income ($ millions)	$3.618	$3.608	$3.702	$3.618	$3.618

Selected Alternative

Alternative 5 as described in this analysis is the Selected Alternative. Management direction for implementing Alternative 5 is included in the Hoosier National Forest Proposed Land and Resource Management Plan.

Chapter 3

AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Planning the best way to manage the Hoosier National Forest is like charting a path to move through time. Past, present, and future actions influence the path chosen.

This chapter describes the existing condition of the resources and estimates the effects the five alternative management scenarios would have on the resources. The information in this chapter provides a baseline against which readers and the decision maker can evaluate each alternative. It focuses on the resources and issues that management decisions are most likely to affect. The Forest does not describe in detail the environmental conditions that would have limited change. All resources are interrelated, so the condition of one tends to affect the others. The discussion of each resource begins with the current condition and then shifts to the effects on that resource of implementing the various management alternatives.

Management activities would affect the condition of several environmental factors to varying degrees. Knowing which environmental factors could be significantly affected and the nature of those effects is essential to understanding the differences in the cumulative environmental consequences of each alternative. The Forest studied the relationship between management activities and environmental factors to assess the effects. The Forest also developed guidance, displayed in the Forest Plan, to mitigate potential adverse effects of implementing the alternatives on various resources. There can be beneficial as well as harmful effects that result from implementing any of the alternatives.

Some effects cannot be displayed numerically. Consequences of some actions are subjective and not conducive to measurement.

After presenting information about ecological context and geographical location, this chapter is arranged by Forest goal. Goals are broad statements that, along with desired condition, describe the situation that managers are trying to achieve. Following each goal is a discussion concerning the existing condition of the applicable resources and the environmental consequences of implementing the alternatives. Specific resource areas and issues related to them are found under the appropriate goal. The major issues and indicators of response are identified, when appropriate, after the existing condition discussion. For more discussion on Forest goals, please refer to Chapter 1 and 2 of the Forest Plan.

Some resource areas would remain essentially unchanged in all alternatives. These include the management of all caves on the Hoosier and designation of Charles C. Deam Wilderness. Thus, differences in effects vary little among alternatives for these resource areas.

Ecological Context

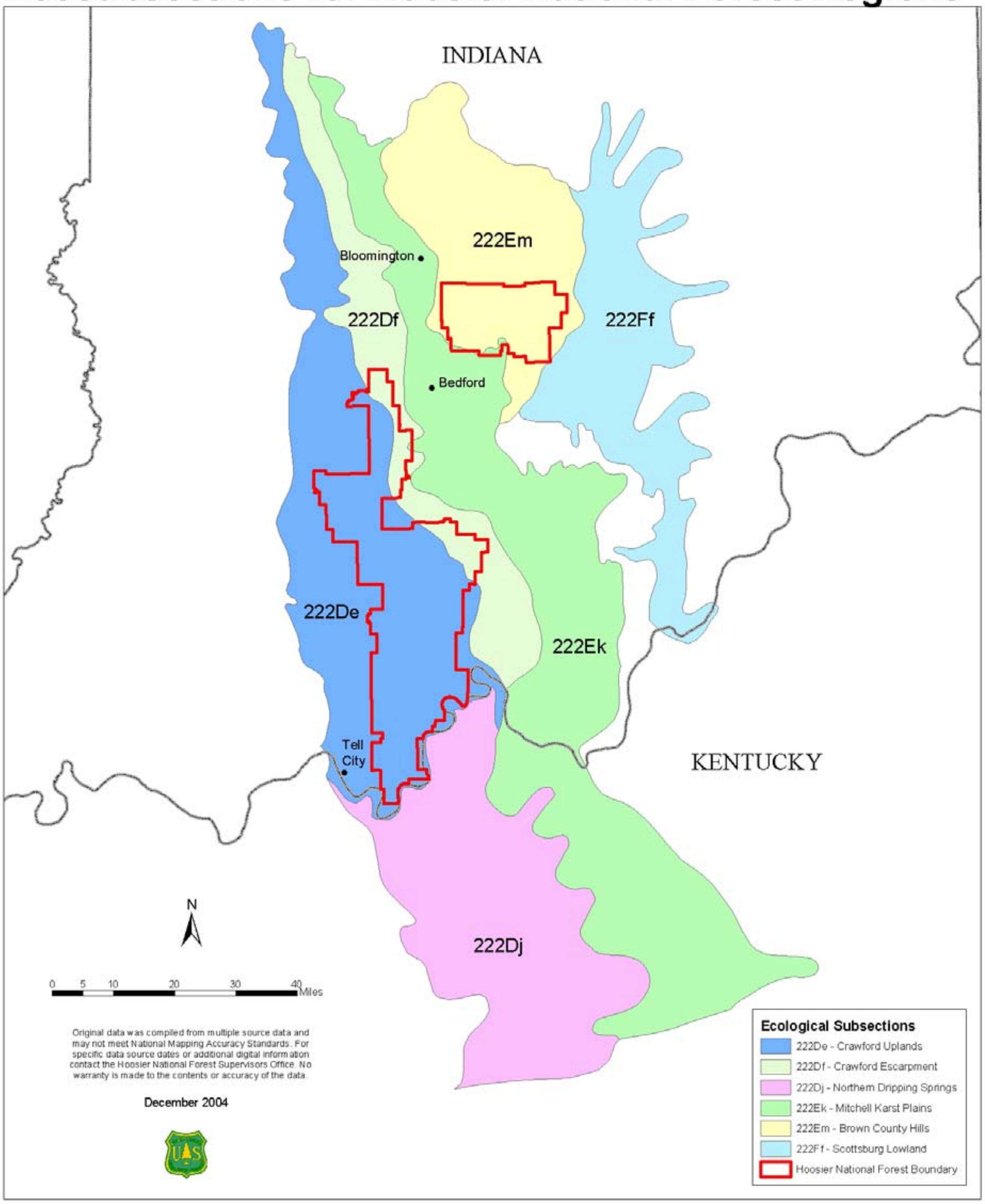
The ecological context of the Forest follows the structure of the National Hierarchical Framework of Ecological Units as adopted by the Forest Service on November 5, 1993 (ECOMAP 1993).

This land classification system sets the context of the landforms, natural vegetation, and soil resources in the Forest region, at multiple scales. At the ecoregion scale, the Forest is in the Eastern Broadleaf Forest (Continental) Province, along with portions of Illinois, Kentucky, Missouri, Ohio, and Tennessee (ECOMAP 1993). At the subregion scale, the Forest is divided into two sections and four subsections based on climate, glacial geology, soils, and potential plant community information (McNab and Avers 1994) and (IDNR 1995). At a landscape scale, land type associations (LTAs) are ecological units delineated on similar patterns of landforms, topography, soil complexes, and associated patterns of vegetation and succession in a particular climatic region. The Forest contains portions of 10 LTAs. Zhalnin (2004) characterized Hoosier LTAs by their disturbance patterns, existing and potential vegetation, fauna, geology, historical vegetation, hydrology, soils, and other ecological attributes.

The sections and subsections of the National Hierarchical Framework of Ecological Units (ECOMAP 1993) constitute the foundation of the approach taken to characterize the landscape of the Forest. The subsections are based on the natural regions of Indiana (Homoya *et al.* 1984) as described in the structure of the National Framework of Ecological Units (IDNR 1995). Subsections are areas with similar geomorphic processes, rock formations, potential natural communities, soil groups, subregional climate, and surface geology. Subsection boundaries usually correspond with discrete changes in geomorphology (ECOMAP 1993). *The Hoosier-Shawnee Ecological Assessment* (Thompson, ed. 2004) provides further information.

Figure 3.1

Ecosubsections for Hoosier National Forest Regions



Geographical Location

The Hoosier is located in south central Indiana in an unglaciated, upland area. Unlike the flat glaciated northern part of the State, the south central area is characterized by rolling hills. Slopes are moderately steep averaging about 25 percent, with topographic relief seldom exceeding 300 feet.

The Forest overlaps two sections: the Interior Low Plateau, Shawnee Hills Section and the Interior Low Plateau, Highland Rim Section. The Interior Low Plateau, Shawnee Hills Section, is divided into two subsections, the Crawford Uplands subsection and the Crawford Escarpment subsection (McNab and Avers 1994).

- Crawford Upland subsection - This area's most distinctive features are the rugged hills with sandstone cliffs and rockhouses. Most of the cliffs in the eastern portion of the section are composed of Mississippian sandstone, as are outcrops at lower elevations to the west. Pennsylvanian sandstone dominates the western portion and higher hills.
- Crawford Escarpment subsection – This subsection includes the rugged hills situated along the eastern border of the region. It is a blend of the Crawford Upland subsection and the Mitchell Karst Plain subsection of the Highland Rim Section. Sandstone cliffs and rockshelters are virtually unknown, but limestone crops out to form large cliffs, especially along waterways. Karst features are common, especially in the lower and middle elevations.

The Highland Rim Section is a part of the Interior Low Plateau that occurs in a discontinuous belt from northern Alabama through Tennessee and Kentucky, and into Indiana. The region is mostly unglaciated except for relatively unmodified glaciated area at the northern and eastern boundary. A distinct feature of this region is the extent of karst topography, but cliffs and rugged hills are also common. This natural region is divided into three subsections, two of which are within the Forest boundary:

- Brown County Hills subsection - This subsection is characterized by deeply dissected uplands underlain by siltstone, shale, and sandstone. Bedrock is near the surface but rarely crops out.
- Mitchell Karst Plain subsection – This subsection is most known for the relatively level karst plain. Numerous sinkholes characterize the area. The Lost River, which flows through a portion of the Forest, is a classic example of a sinking river with associated karst features.

Land Cover Change over Time

The Hoosier is a constantly evolving, dynamic system affected by many human and natural disturbances. Wind, fire, ice, snow, and floods have all helped shape the current vegetation found on the Hoosier. *The Hoosier-Shawnee Ecological Assessment* (Thompson 2004) contains a detailed discussion of current and historical forest conditions and disturbance regimes on the Forest.

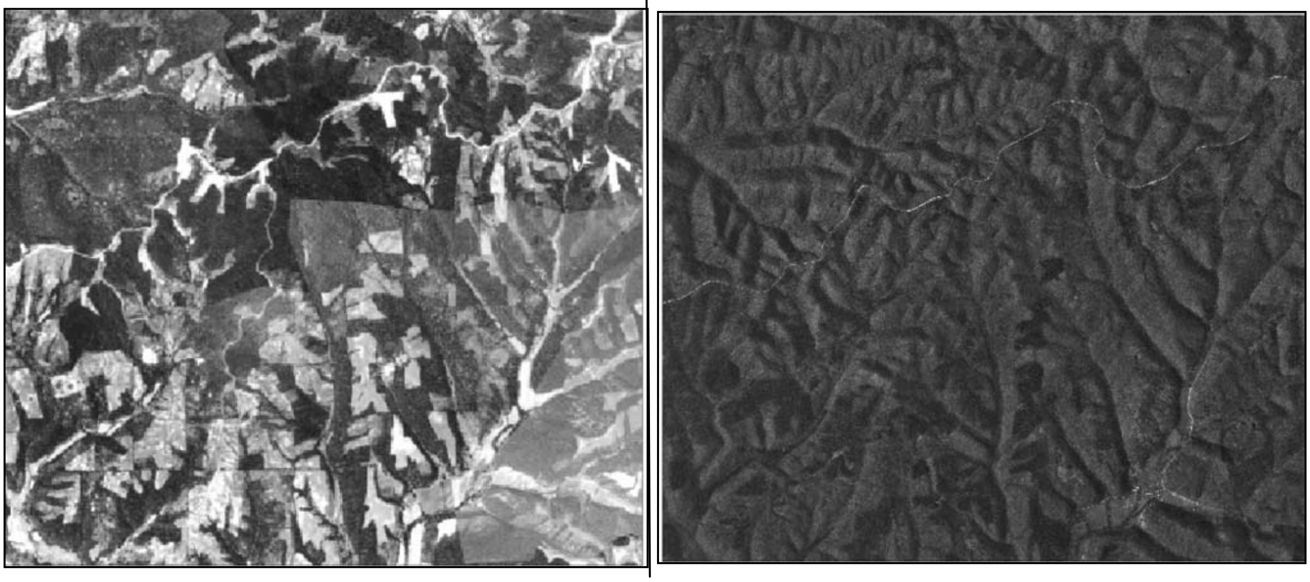
In addition to the natural forces that shape the forests of today is the long history of disturbance by Native Americans and European settlers. People have occupied the area that makes up the Hoosier for thousands of years. Prior to European settlement, vegetation on the Hoosier was predominantly forested with significant areas of prairie and disturbed and open forest

(Thompson 2004). Oak and hickory species were dominant on the Brown County Hills and Crawford Uplands, and mixed forests of American beech, sugar maple, oaks, and hickories were dominant on the limestone soils of the Mitchell Karst Plain and Crawford Escarpement (Parker and Ruffner 2004). Historically, fire was an important ecological factor throughout the Forest and maintained the oak/hickory forests.

Active European settlement began in southern Indiana during the early 1800's and resulted in the clearing of land for crops and extensive livestock grazing. By the late 1800's, drainage of wetlands and the farming of prairies were common practices. Most of the forest had been cut and all forests had been subjected to fire and grazing by domestic livestock by 1900.

The Great Depression of the 1930's caused many people currently farming land in the area of the Hoosier to abandon their farms to seek employment elsewhere. The Federal government began purchasing abandoned parcels of land that would comprise the Hoosier in 1935. These lands had been inhabited for many years and extensively modified. Most of the acquired lands contained small farms devoted to growing crops or pasture and hay, and raising livestock. The history of disturbance by humans impacted the land through repeated clearing, or burning, depletion of soil fertility, increased erosion, and extraction of natural resources. This trend was reversed as the Forest Service began acquiring lands and providing management of forested landscapes. While some openings were maintained, the majority of the purchased land was left to naturally succeed to forested environments. The condition of these lands when they came into Federal administration during and since the 1930's is an essential reference point for understanding the present condition of the Hoosier National Forest. Such understanding can be increased by studying 1930's aerial photographs. At this time, most of the forests in Indiana had been fragmented by agricultural and urban land uses. Nearly all lands had been logged, grazed, burned, farmed, and abandoned, and "virgin" forests were extremely rare (Openlands Team 1995). Figure 3.1a shows historical aerial photos of a select area of the forest taken between 1937 and 1940 compared with the same area in 1999.

Figure 3.1a Aerial photo comparison showing the increase in forested areas between the 1930's and 1990's on one area in the Hoosier.



Land Cover (1937- 1940)   Land Cover (1999)

Common species found on the Forest include oaks, hickories, pines, yellow poplar, maples, ash, and walnut. With fire suppression and minimal vegetative management over the last few decades, the character of the Forest is drastically changing as the Forest moves toward a late-successional beech-maple forest type. Forest management, specifically timber harvest and prescribed burning, are important factors in reducing the loss of oak-hickory habitat over time.

The Hoosier has attempted to consolidate ownership, especially by exchanging isolated parcels with willing owners. Thus the Hoosier has consolidated forestlands and reversed the trend of coarse-level fragmentation by acquiring isolated parcels within the Hoosier's boundaries and re-vegetating denuded areas. Within this boundary, there is a much greater percent of forest today than prior to Federal ownership. An evaluation of land use aerial photos shows the change in forest composition over time for the planning area (Table 3.0). Data from this evaluation revealed that forested landscapes have increased substantially since the 1930's.

Table 3.0.

PERCENT OF LAND USES DURING THE 1930's AND 1990's.

Classifications	1937-40	1999
Closed Canopy – areas with more than 60% of land covered with tree canopies	55	79
Open Canopy – areas with 25 to 60% of lands covered in tree canopies	2	>1
Row crops or agriculture	2	3
Grass – areas with less than 25% tree canopies, no clear residential or agriculture use	41	13
Water – lakes, ponds, or rivers	> 1	2
Residential or urban – areas with clearly defined buildings, including mown areas around them, all major roads and their medians, and any developed areas	> 1	2
Wetlands – areas with clear signatures of land that contains wetland vegetation or seasonal flooding	> 1	> 1
Cloud Cover	> 1	0

Changes in forest composition over time for two areas on the Forest can be seen in Figures 3.1b (located in the Brownstown Ranger District) and 3.1c (located in the Tell City Ranger District). Both of these figures show the change of forest cover that has occurred in the planning area over the last several decades. The top blocks depict the aerial photographs for two periods, and the bottom blocks are land cover types from Geographic Information System (GIS) of the same area.

Figure 3.1b

Land Cover Change

Map 1

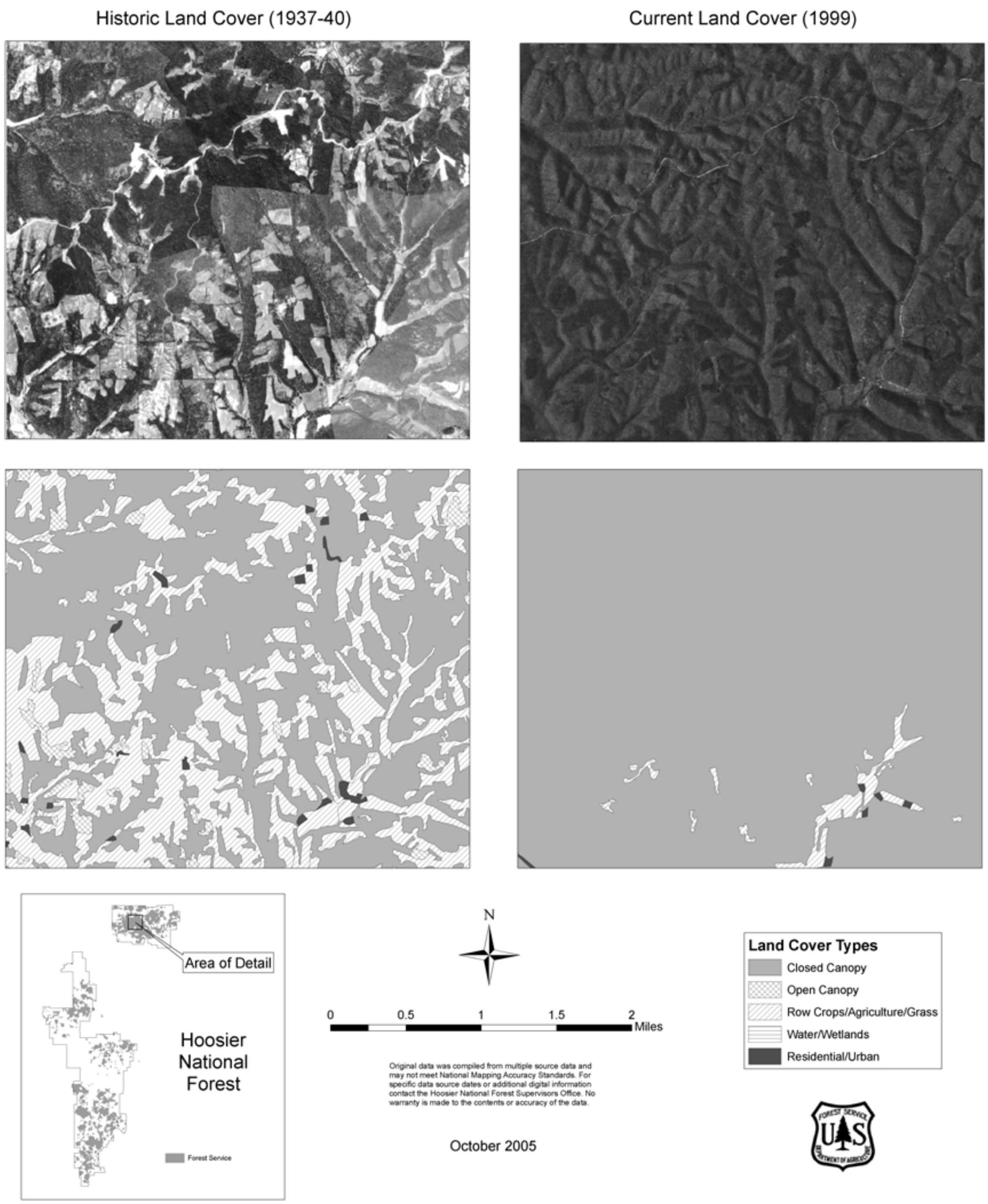
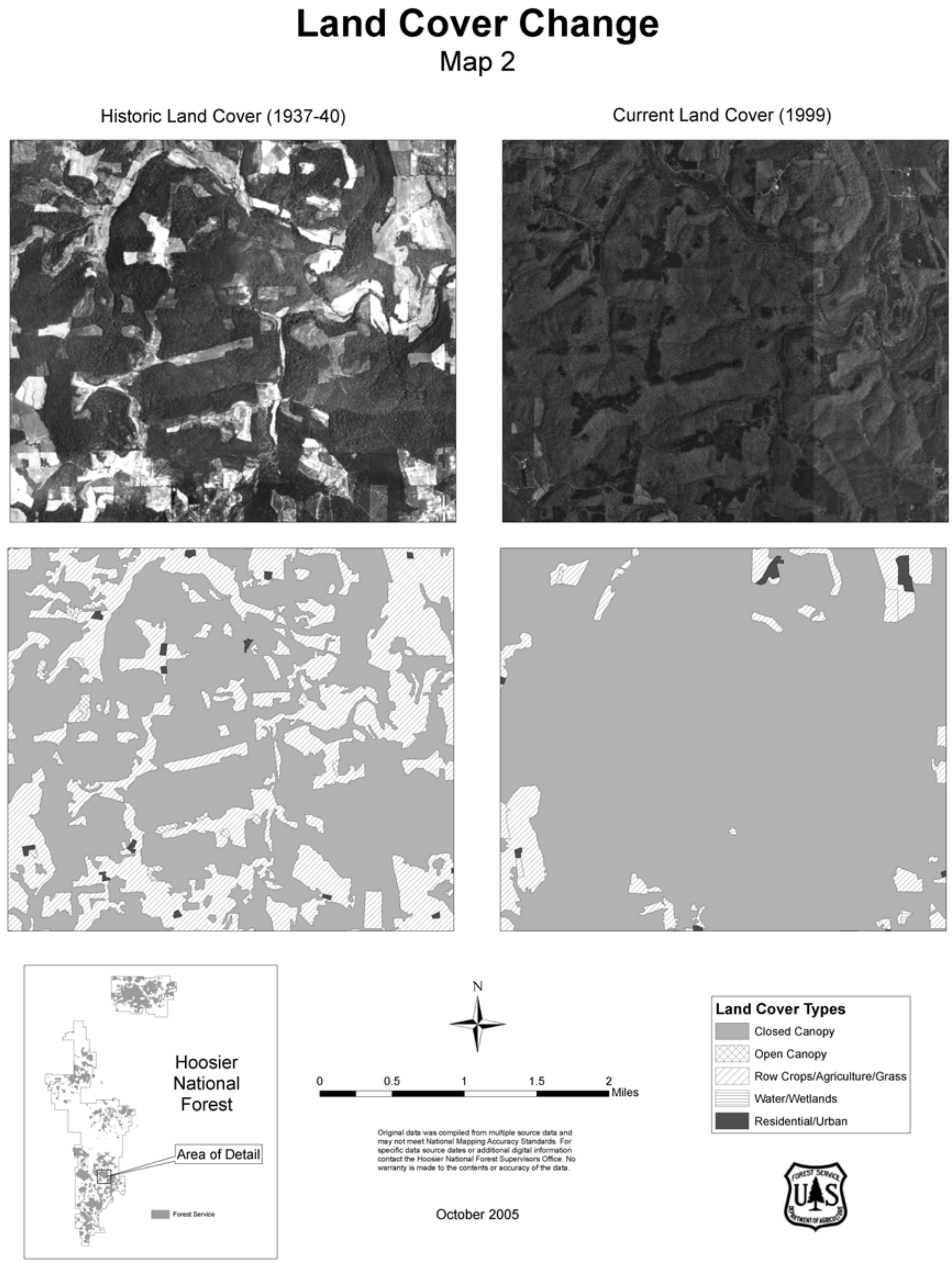


Figure 3.1c


Land Cover Change
Map 2
Historic Land Cover (1937-40)
Current Land Cover (1999)
Hoosier National Forest
Area of Detail
Forest Service
N
0
0.5
1
1.5
2
Miles
Original data was compiled from multiple source data and may not meet National Mapping Accuracy Standards. For specific data source dates or additional digital information contact the Hoosier National Forest Supervisors Office. No warranty is made to the contents or accuracy of the data.
October 2005
Land Cover Types
Closed Canopy
Open Canopy
Row Crops/Agriculture/Grass
Water/Wetlands
Residential/Urban

Conservation of Endangered and Threatened Species Habitat

This goal emphasizes a commitment to conserving and protecting habitat for endangered and threatened species. The USDI Fish and Wildlife Service has identified five Federally listed species as having ranges that likely include the Hoosier:

- the endangered fanshell mussel (*Cyprogenia stegaria*)
- the endangered gray bat (*Myotis grisescens*)
- the endangered Indiana bat (*Myotis sodalis*)
- the endangered rough pigtoe (*Pleurobema plenum*)
- the threatened bald eagle (*Haliaeetus leucocephalus*)

This goal responds to Issue 2 (see Chapter 1) which expressed concern that management activities may reduce habitat for Indiana bat. A Programmatic Biological Assessment (BA) of the Hoosier National Forest Land and Resource Management Plan (USDA FS 2006) was prepared in accordance with the Endangered Species Act. This document analyzes the expected effects of implementing the selected alternative. This analysis incorporates the BA by reference. For additional information on the response of the Indiana bat and other Federally endangered and threatened species to management activities proposed in the Forest Plan, please refer to the BA.

Affected Environment

Fanshell Mussel

The fanshell historically occurred in the Ohio River and its larger tributaries in Alabama, Illinois, Indiana, Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. As far as is known, the fanshell reproduces in only three rivers, the Green and Licking Rivers in Kentucky and the Clinch River in Tennessee and Virginia (Biggins 1991).

No critical habitat was identified when this species was listed as endangered by the U.S. Fish and Wildlife Service in 1990. In Indiana the species is listed as endangered (IDNR 2003). A limited section of 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 inside the Forest boundary. Biggins (1991), among others, does not consider this small isolated group of individuals a reproducing population.

Cummings and Mayer (1992), as well as Watters (1995) consider the fanshell a species of medium to large rivers. 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 (about 39 inches) (Gordon and Layzer 1989).

Threats jeopardizing population stability and recovery of the fanshell include habitat degradation, which results from altered stream flow and reduced water quality. Rangewide, impoundments, navigation projects, pollution, and habitat alterations such as dredging for sand and gravel mining have affected the distribution and reproductive capacity of this species

(Biggins 1991, Lauristen and Watters 1986). Mussels are susceptible to pollution from discharges of water with temperature extremes and from runoff containing pesticides, fertilizers, animal waste, and heavy metals (Lauristen and Watters 1986, USDI Endangered Species Technical Bulletin 1990). A relatively new threat to this species is the zebra mussel (*Dreissena polymorpha*), an exotic species that has extended its range to the Ohio River basin.

Live fanshells currently occur in the East Fork White River within the reach extending from Williams Dam to the confluence of the East and West Fork White Rivers. In 2003 live fanshells were found in this reach downstream of Shoals, Indiana (Fisher 2004, pers. comm.).

Readers can consult the BA for additional information about this and other Federally threatened or endangered species.

Gray Bat

The gray bat is Indiana's only true cave bat, requiring caves for both roosts and hibernation. USDI Fish and Wildlife Service (FWS) listed the gray bat as endangered in 1976 but identified no critical habitat for this species at that time. From the 1960's to early 1970's, this species declined in abundance by at least 50 percent, but the 1976 listing arrested its decline (Brady *et. al* 1982, Tuttle 1979). Although rangewide populations are not secure, they do appear stable and may have increased (Bat Conservation International 2001). Recent estimates of wintering gray bats suggest an increase in numbers from a 1982 estimate of 1,657,900 to an estimated 2,678,137 wintering bats in 2002 (Harvey and Currie 2002).

Indiana lists the gray bat as endangered (IDNR 2003). Whitaker (1996) captured a single male adult gray bat outside, but near, the Forest boundary in Perry County in August of 1996; another was captured within the Forest boundary in 1998 (3/D International 1998). ThirdRock Consultants (Table 3.1) made one more capture within the Forest boundary in 2004. However, there are no known records of gray bats using caves located on the Forest.

Table 3.1

GRAY BAT CAPTURES ON THE HOOSIER

County	USGS Quadrangle	Year	Sex	Age
Crawford[1]	Beechwood	1998	Male	Adult
Crawford[2]	Beechwood	2004	Male	Adult
Perry[3]	Derby	1996	Male	Adult

[1] 3D/International, Inc. Environmental Group. 1998. Mist net survey and telemetry study of Indiana bat (*Myotis sodalis*) on the Tell City Ranger District of the Hoosier National Forest in Crawford and Perry counties, Indiana. Cincinnati, OH: 3D/International, Inc.

[2] ThirdRock Consultants. In prep. Mist net survey and telemetry study of Indiana bat (Myotis sodalis) in the Buzzard Roost Project Area of the Tell City Ranger District, Crawford and Perry counties, Indiana. Lexington, KY: ThirdRock Consultants.

[3] Whitaker, J.O., Jr.; Gummer. S.L. 2001. Bats of the Wabash and Ohio River basins of southwestern Indiana. Proceedings of the Indiana Academy of Science. 110:126-140.

Gray bats hibernate in caves that meet their temperature requirements of 43 to 52 degrees Fahrenheit. In September and October, gray bats migrate from summer habitats toward hibernacula. Over a period of several weeks, bats arrive at hibernacula, mate, and forage to restore fat reserves for hibernation (Brady *et al.* 1982). Hibernation may begin as early as September and continues through April.

Summer habitat requirements for the gray bat include forests near permanent water and caves (LaVal *et al.* 1977, Tuttle and Stevenson 1977). Gray bats typically use multiple roost sites (caves) and travel from roosts to foraging areas under the forest canopy. Once they arrive at their foraging sites, gray bats typically fly low over the water, often away from the protection of the forest canopy.

Throughout the summer, gray bats roost in caves within 0.6 mile to rarely over 2.5 miles of a stream or reservoir (Brady *et al*. 1982). Occasionally, people have observed summer roosts in storm sewers, mines, and very rarely in buildings. The bats use a wide variety of caves during spring and fall transient periods.

Gray bats forage in riparian areas as far away as 12 miles from their summer roost. They appear to prefer to forage over perennial streams and lakes. Gray bats may feed in groups during periods of prey abundance; however, as prey abundance declines, they may avoid competition by foraging alone.

Decline in gray bat populations began during the 19th century when cave exploitation began on a large scale (Brady *et al*. 1982). Commercialization of gray bat caves has also reduced or eliminated populations in some caves (Brady *et al.* 1982, Clawson and Titus 1992). Pesticide poisoning has affected at least two known populations of gray bats, and some researchers have implicated pesticides in the decline of this species (Clawson and Titus 1992). Site fidelity, the tendency for individuals to return repeatedly to the same area, is well documented for gray bats (Brady *et al.* 1982), making them particularly vulnerable to human disturbance and vandalism. Due to their tendency to form large aggregations, disturbance of maternal colonies and hibernating bats remain the most substantial threats to gray bat populations. Documented vandalism shows where people have pulled bats from the cave ceiling and crushed them. Other factors that have contributed to the bat's decline are improper gating or fencing of caves, impoundment of waterways, and water pollution and siltation (Brady *et al.* 1982, Clawson and Titus 1992). The large proportion of the population that now occupies comparatively few hibernacula further endangers this species.

The closest area with evidence of reproductive gray bats in Indiana is Clark County (Brack *et al.* 2004; Whitaker *et al.* 2001, 2002, 2003). Bat specialists have reported two additional maternity colonies from Breckenridge County, Kentucky (Whitaker and Gummer 2001). The Yellowbank Creek site in Breckenridge County, Kentucky lies across the Ohio River to the east of Rome, Indiana.

Perhaps more so than other bats, the gray bat may be associated with streams and wetlands (Brady *et al.* 1982, Clawson and Titus 1992). Consequently, recovery of gray bat populations may necessitate associated stream and wetland protection or enhancement. Permanent conversion of forest habitat to non-forest uses, particularly along stream channels, is expected to reduce available foraging habitat.

Indiana Bat

Of the Federally listed species that occur on the Forest, the Indiana bat (*Myotis sodalis*) is the most broadly distributed. Concern about declines in the Indiana bat population led to the Federal listing of the species as endangered in 1967. The State of Indiana has also listed the Indiana bat as endangered (IDNR 2001). The total population has fluctuated, but has generally been increasing since the early 1980's (Brack and Dunlap 2001). Approximately 173,000 bats wintered in Indiana caves in 2001, down slightly from the previous census (Brack and Dunlap 2001).

The USDI Fish and Wildlife Service designated critical habitat for the species in 1976. The designated critical habitat includes 11 caves and 2 abandoned mines in Illinois, Indiana, Kentucky, Missouri, Tennessee, and West Virginia. Within particular climatic constraints, the winter range of the Indiana bat is restricted to regions of well-developed karst, such as limestone caverns, which serve as hibernacula (Brack *et al.* 2002). Most hibernacula are in caves, but occasionally Indiana bats use abandoned mines.

Whitaker and Brack (2002) summarized the Indiana distribution of captures of both male and female Indiana bats, as well as known hibernacula. Table 3.2 summarizes captures of Indiana bats on NFS land. Given evidence of reproduction in Indiana and evidence of reproduction at latitudes south of the Hoosier in North Carolina (Britzke et al. 2003), Tennessee (Britzke *et al.* 2003), and Kentucky (Gumbert *et al*. 2002), it may be assumed that several maternal colonies may eventually be found in appropriate habitats on the Hoosier. The Forest encompasses at least one Priority III hibernaculum, and recent evidence confirms the presence of maternal colonies within the Forest boundary.

Table 3.2

SUMMARY OF INDIANA BAT CAPTURES ON THE HOOSIER

County	Year	Sex	Age	Reference
Crawford	1998	Male	Adult	3D/International
Crawford	1998	Male	Adult	3D/Internation
Crawford	2004	Male	Adult	Third Rock Consultants
Crawford	2004	Male	Adult	Third Rock Consultants
Crawford	2004	Male	Adult	Third Rock Consultants
Jackson	1996	Male	Adult	USDI F&WS
Martin	1990	Male	Adult	3D/International
Perry	1998	Male	Adult	3D/International
Perry	2004	Male	Adult	Third Rock Consultants
Perry	2004	Female	Adult	Third Rock Consultants
Perry	1998	Male	Adult	3D/International
Perry	2004	Male	Adult	Third Rock Consultants

Location of a capture in Table 3.2 does not reflect the distribution of the bat on the Forest, but rather more accurately reflects the distribution of the survey effort.

No designated critical habitat occurs on the Forest. The closest Priority I hibernacula, in Greene and Harrison counties, are listed as critical habitat for Indiana bat. Researchers and Forest Service professionals have found Indiana bats hibernating in two caves on the Forest. The first

location harbored 250 Indiana bats in 2003, and the second location held one Indiana bat during a survey in 2002 (Brack and Dunlap 2003). The occurrence of one Indiana bat in this cave may represent an exploratory event as opposed to a history of use as hibernacula (Brack *et al.* 2004).

Persecution, intentional and inadvertent human disturbance of hibernating bats, and vandalism to cave structures have all contributed to Indiana bat declines. Bats inhabiting mines have been lost in collapse of mine ceilings (Brady *et al.* 1983). In addition to the apparent sensitivity of cave microclimate and the role of disturbance, simplification of landscape (USDI Fish and Wildlife Service 1999b) and accumulation of pesticide residues may also influence Indiana bat populations (Brady *et al.* 1983).

Indiana bats forage in upland and floodplain forests (Brack 1983, Gardner *et al*. 1991a, Murray and Kurta 2002). Foraging activity is concentrated around the foliage of upland and riparian tree crowns, and although the bats may forage in other areas, these are less important (Brack 1983). Contiguous closed-canopy forest may present less than optimal opportunity for foraging. Study has shown that Indiana bats use forests with canopy closure ranging between 30 and 100 percent (Gardner *et al*. 1991a). Rommé *et al.* (1995) described optimal foraging habitat for Indiana bats as forests with canopy closure of 60 to 80 percent and relatively open understories. Clawson (2000) described roosting and foraging habitats as having between 30 and 80 percent crown closure.

Pine plantations provide poor foraging habitats for numerous species of bats, including those of the genus Myotis (Tibbels and Kurta 2003). Preference for foraging along forest edge, in openings, or within broken canopy may be related to both greater insect abundance provided by these habitats and the limited insect fauna provided by pine plantations.

Indiana bats use ephemeral wetlands, small impoundments, and water-filled road ruts, as well as permanent streams for drinking water. Indiana bats often use stream corridors and other linear woodland corridors as flight paths between roosts and foraging areas. Studies confirm the importance of forested wetlands (Murray and Kurta 2004) and riparian corridors (Owen *et al.* 2004) as foraging habitats for the Indiana bat.

Due to their tendency to form large aggregations during hibernation, disturbance of hibernating bats, either deliberate or unintentional, remains a substantial threat to Indiana bat populations (USDI Fish and Wildlife Service 1999). Mortality due to natural disasters and alteration of cave entrances has also been documented (USDI Fish and Wildlife Service 1999). Chemical contaminants have been hypothesized to have affected other bats (Schmidt *et al.* 2002) as well as the Indiana bat (O'Shea and Clark 2002). Perhaps most substantially, changes in land use have resulted in simplification of the landscape in places now dominated by rowcrop agriculture, throughout much of the bats' maternal range. The Indiana bat tends to prefer prominent, decadent trees as maternal roosts in summer and uses caves during hibernation. During late spring and summer, breeding females form nursery colonies under the exfoliating bark of dead trees in upland or riparian deciduous forests. Maternal colonies locate a primary roost, or multiple primary roosts, but also use a number of secondary roosts. The suitability of a primary roost tree is determined by a number of factors, foremost among them the solar exposure of the roost area. Consequently, Indiana bats frequently select roosts in openings or on their edges, in canopy gaps, in trees that extend above the canopy, or in trees in wetlands. Amount of loose bark, flight path to the roost, foraging habitat, proximity to secondary roosts, relationship of the roost to water, tree condition (live or dead), and solar exposure all influence roost selection (Britzke *et al*. 2003, Carter 2003, Carter *et al*. 2002, Farmer *et al*. 2002).

Although primary roosts typically house substantial aggregations of female bats and their young, smaller numbers of these bats may use alternate trees as roosts depending on weather and ambient temperature (Callahan *et al*. 1997). In general, while primary roosts are typically exposed to solar radiation, alternate roosts may be located beneath the forest canopy. Alternate roosts may be widely distributed across the landscape in relation to a maternal colony's primary roost or roosts (Callahan 1993); presumably, this allows a maternal colony to select the most suitable microclimates or foraging area. Alternate roosts tend to be more variable in size than are primary roosts (Rommé *et al*. 1995), and a maternal colony may use as many as 33 alternate roosts in addition to a primary roost or roosts (Humphrey *et al*. 1977, Gardner *et al*. 1991b, Garner and Gardner 1992, Callahan 1993, Kurta *et al*. 1993, Rommé *et al.* 1995). Shagbark hickories (*Carya ovata*) may provide uniquely suitable alternate roosts, since beneath the canopy they may provide microclimates that moderate extreme temperatures and during precipitation they may adequately protect bats from exposure (Callahan *et al.* 1997). Indiana bats use a wide variety of tree species as maternal roosts, the strongest determinants of roost selection being the structure of the roost and its location in the landscape. Consequently, standing snags, notably temporary in nature, are an obviously important resource for the bat.

No study has found that Indiana bats use downed trees as roosts (Brady *et al.* 1983, Gardner *et al.* 1991b, Rommé *et al*. 1995, Callahan *et al*. 1997). Site fidelity, the tendency for individuals to return repeatedly to the same area, is well documented for the Indiana bat. Repeated use of these habitats demonstrates fidelity to both maternal roosting areas and hibernacula (Gardner *et al.* 1996, Gardner *et al*. 1991b, Gumbert *et al*. 2002, Kurta and Murray 2002, LaVal and LaVal 1980, USDI Fish and Wildlife 1999). Just over 50 percent of the known range-wide population of hibernating Indiana bats uses only seven caves and one abandoned mine (Clawson 2002).

Rough Pigtoe Mussel

The rough pigtoe (*Pleurobema plenum*) historically occurred in Alabama, Illinois, Indiana, Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia in the Cumberland, Ohio, and Tennessee river systems, and their larger tributaries. Widely isolated non-reproductive populations occur in the Clinch and Tennessee rivers. The rough pigtoe is also reported from the Barren and Green rivers in Kentucky. Evidence suggests that the rough pigtoe also occurred, or occurs, in the Wabash and East Fork White rivers in Indiana. The rough pigtoe may now be extirpated in the states of Illinois, Ohio, Pennsylvania, Virginia, and West Virginia.

The rough pigtoe was proposed for listing as Federally endangered in September of 1975 (40 FR 44330); the final rule recognizing the endangered status of the rough pigtoe was adopted in June of 1976 (41 FR 24064). A recovery plan for the species was approved in 1984 (USDI FWS 1984).

The current conservation status of the rough pigtoe is considered critically imperiled globally (G1), and critically imperiled nationally (N1). The rough pigtoe is considered endangered and critically imperiled in Indiana (S1). No critical habitat has been identified since the rough pigtoe was listed as endangered by the USDI Fish and Wildlife Service in 1976.

Threats jeopardizing population stability and recovery of this species include habitat degradation, due to altered stream flows and poor water quality, and reproductive isolation of

extant populations. Competition from nonnative mussels, such as the zebra mussel, is a comparatively recent threat to population recovery. Cummings and Mayer (1992) present a physical description of the rough pigtoe and a representative photograph.

The mainstem of the East Fork of the White River in Martin County, Indiana, is the only location where the rough pigtoe may occur within the Hoosier boundary. Records of occurrence consist of weathered or fresh dead shells collected by Indiana Department of Natural Resource biologist Brant Fisher (King 2004, pers. comm.). Surveys examining mussel distribution throughout southern Indiana, and including the mainstem of the East Fork White River and its tributaries include those of Clarke *et al.* (1999), Cummings *et al.* (1992), Harmon (1998), Meyer (1974), and Taylor (1982) Wiebaker *et al.* (1985). Burr *et al*. (2004) comprehensively reviewed aquatic resources in the Forest, particularly mussels.

No live rough pigtoe mussels are known to currently occur in the East Fork White River, although this remains a distinct possibility.

Bald Eagle

Prior to European settlement, the bald eagle likely nested throughout the state of Indiana, including the area that is now the Forest. The dependence of settlers on wood products and the clearing of land for agriculture resulted in widespread deforestation, which drastically altered and reduced habitat suitable for eagles (McCreedy *et al.* 2004). Advancing settlement resulted in the extirpation of nesting eagles in Midwestern states by the early 1900's (Iowa Department of Natural Resources 2001).

The widespread use of industrial pesticides, particularly dichloro-diphenyl-trichloroethane (DDT) in the 1950's and 1960's, contributed to the further decline of the eagle. Continental ban of the use of DDT in 1972 resulted in improved reproductive performance of eagles across their range. Indiscriminate persecution by shooting (Herkert 1992), and lead poisoning related to the ingestion of shot (Buehler 2000) remain sources of eagle mortality.

The entire population in the lower 48 states was listed as endangered in 1978. Critical habitat for the bald eagle was not identified, but essential habitat requirements were defined in the Northern States Recovery Plan (Grier *et al*. 1983). These include breeding habitat, cover and shelter, nutritional and physiological requirements, protection from disturbance, and space for population growth and normal behavior. As a result of rangewide resurgence of bald eagle populations, the status of the bald eagle was downgraded from endangered to threatened in 1995 (USDI Fish and Wildlife Service 1995). In 1999, the Fish and Wildlife Service proposed to delist the bald eagle (USDI Fish and Wildlife Service 1999b).

The State of Indiana has listed the bald eagle as endangered (IDNR 2001). A population restoration project at Lake Monroe in the late 1980's led to the first successful nesting of bald eagles in Indiana in about 90 years (Castrale *et al*. 1998). Eagles using this nest have been successfully producing young birds for several years. There are three active nests at Monroe Reservoir and two nests at Patoka Lake. In 2002, Indiana bald eagles fledged 45 young from 26 nests (IDNR 2003).

Threats to continued recovery of the bald eagle include primarily the loss of habitats associated with the development of riparian or coastal areas and, secondarily, the effect of persistent environmental contaminants, persecution, and inadvertent poisoning resulting from ingestion of

baits intended for other animals, or inadvertent lead poisoning resulting from ingestion of contaminated prey.

Inland breeding areas for bald eagles are closely tied to lakes and rivers. Nest sites usually have a clear flight path to a water source within a half mile of the nest. In the opinion of most who have studied the species, essential habitat for nesting bald eagles encompasses 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).

Eagles tend to perch near their foraging areas during the day. Trees used for perching are usually within approximately 100 feet of the shore. 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).

At night during winter, bald eagles roost singly or communally in trees that may be located up to 12.5 miles from feeding areas. They select sites protected from weather extremes by terrain and vegetation. Essential wintering areas in Indiana are 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).

Bald eagles remain particularly associated with major river systems such as the Illinois, Mississippi, and Ohio rivers; most nests in Indiana are located in the riparian areas of the Wabash and White rivers. Wetland restoration, including restoration of bottomland and floodplain forests, and land use planning designed to ensure the future viability of wetland and riparian areas likely provide the best long-term support necessary to maintain the resurgence of the bald eagle on the Hoosier.

Alternatives and Effects of Management on Endangered and Threatened Species

This section presents anticipated effects to Federally threatened and endangered species that may result from implementation of the alternatives. The consequences, or effects, discussed in this section provide a basis for understanding the implications of and differences among these alternatives. Site-specific biological evaluations and assessments would continue for all proposed projects on the Forest. For a more detailed analysis of the Indiana bat, refer to the SVE analysis in this chapter.

All Species

Because guidance for resource areas such as caves and the Charles C. Deam Wilderness is the same in all alternatives, the potential effects of the various alternatives do not differ for these areas. Restrictions on management near the known location of the fanshell mussell and rough pigtoe mussel would remain in effect in all alternatives.

Timber Harvest

Alternatives 1, 3, 4, and 5 would implement timber harvesting. Timber harvest reduces the number of trees per acre, resulting in a more open stand structure below the forest canopy. Increased sunlight encourages vigorous growth of tree seedlings, shrub species, and

herbaceous plants. Although the vegetative changes are more subtle under uneven-aged regeneration harvests, they tend to occur at intervals that are more frequent.

During actual harvest operations, noise, soil disturbance, and human contacts with Federally endangered or threatened species could be detrimental to individual animals. Harvest operations such as tree felling and equipment use could disrupt nests and disturb other animal activities. Adults of most species would likely vacate an area during such disturbance, but loss could occur during the nesting or birthing season if nests or young were abandoned due to the disturbance. Pre-harvest surveys to identify existing or potential endangered or threatened species habitats are generally effective in revealing ways to minimize adverse impacts and opportunities to enhance habitat through harvesting. Directions to reserve large diameter trees of preferred species, nest trees, snags, cavity or mast trees, or dead and down woody components would mitigate impacts and improve endangered and threatened species habitats. Fish and Wildlife Service would be consulted for any activity that could affect habitat or populations of Federally endangered or threatened species.

Of the four alternatives, Alternatives 1, 3, and 5 would apply more uneven-aged harvest methods than Alternative 4 (see Table 3.3*)*. No commercial timber harvest would occur if the decisionmaker selected Alternative 2 for implementation, except to provide habitat for threatened and endangered species. Table 3.3 displays data based on a 10-year increment. To determine how much acreage the Forest would treat per year, one must divide the total by ten. For example, the acreaged treated by only prescribed burning per year for the first decade would be approximately 1,428.

Table 3.3

PROJECTED HARVEST AND PRESCRIBED BURN ACRES

Activity	Alt. 1		Alt. 2		Alt. 3		Alt. 4		Alt. 5	
	1st 10 yrs	Avg 10-150	1st 10 yrs	Avg 10-150	1st 10 yrs	Avg 10-150	1st 10 yrs	Avg 10-150	1st 10 yrs	Avg 10-150
Prescribed Burning Following Harvest	5,720	5,720	0	0	11,350	10,240	19,240	19,240	5,720	5,720
Prescribed Burn Only	14,280	14,280	0	0	38,650	45,315	80,760	80,760	14,280	14,280
Even-aged Treatment (Clearcut and Shelterwood)	2,860	2,530	0	0	5,670	4,110	9,620	7,420	2,860	2,530
Un-even-aged Treatment (Group Selection[1] and Single Tree Selection)	3,960	9,660	0	0	4,060	4,702	5,160	4,710	3,960	9,660
Total Harvest Acres	6,820	12,190	0	0	9,730	8,810	14,780	12,130	6,820	12,190
Average Early Age Class (1-15)[2]	1,780	1,300	0	0	2,060	1,460	6,040	4,850	1,780	1,300

[1] Group selection acres shown are actual harvest acres, which would take place in stands totaling about three times as many acres.
[2]Early age class = clearcut plus shelterwood (but only those in hardwood acres).

Conversion of Nonnative Pines to Native Hardwoods

Pine plantations provide poor foraging habitats for numerous species of bats. Bats prefer to forage along forest edge, in openings, or within a broken canopy. This may be related to both greater insect abundance provided by these habitats and the limited insect fauna provided by pine plantations. Conversion of nonnative pines to native hardwoods would continue to improve opportunities for both foraging and roosting for the Indiana and gray bat.

Hardwood maturation would result in stands of large trees that may provide roosts when these trees senesce, are injured and subsequently die, or are intentionally killed to provide snag trees. It is likely that, without periodic disturbance, the number of suitable roost trees in appropriate proximity to one another and oriented in the landscape so that roosts receive sunlight (and also in reasonable proximity to water) would be insufficient to support maternal colonies of the Indiana bat. It is also likely that, without intervention or significant natural disturbance, an insufficient number of snags would develop in a forest, and the forest would likely progress to a degree of canopy closure that is less than optimal for the Indiana bat.

As the current overstory pine species age, they would be gradually replaced by hardwood species. However, management activities such as timber harvest and prescribed fire would hasten the conversion of this type to native hardwoods. Alternatives 3 and 4 would remove the greatest amount of pine, especially in the first 30 years. These alternatives would remove entire stands of pine and not just portions of stands, thus reducing the likelihood of pine seedlings becoming established in newly regenerated stands. Alternative 4 would convert pine plantations to hardwood stands more quickly than the other alternatives, followed by Alternatives 3, 5, and 1. Alternative 2 does not propose any pine conversion treatments.

Restoration and Enhancement of Natural Wetlands

Wetlands provide habitat for hundreds of species of both aquatic and terrestrial plants and animals in Indiana. Alternatives 1, 3, 4, and 5 allow for the restoration and enhancement of natural wetlands and streams. All five Federally listed species that have ranges including, or likely to include, the Hoosier would benefit from this management activity. Alternative 2 does not allow for the construction of new ponds, lakes, or wetlands.

Fanshell Mussel

All alternatives would have equal potential effect on any remaining populations in the East Fork of the White River or its tributaries with respect to the restoration of natural stream flows. Dams outside of the Forest impede natural stream flow in the White and East Fork White River basins. Consequently, none of the alternatives provide for restoration of natural stream flows, resulting from dam removal, in the East Fork White River.

Increased sediment loads could result from timber operations, fireline construction, road construction or reconstruction, or rights-of-way construction for utility placement. Implementation of Forest Plan guidance, Best Management Practices (BMPs) (IDNR 1998a), and site-specific mitigation would result in little to no sediment increase. Therefore, no alternative is expected to impact the fanshell mussel. Continued emphasis on watershed health, in particular the protection and development of mature forest in riparian corridors, may benefit any remaining population of the fanshell in the East Fork White River.

Cumulative Effects

Future land acquisition in these watersheds by the Forest is likely to result in improved water quality as lands are reforested and aquatic resources gain the protections provided to these resources by the standards and guidelines in all alternatives.

Retention of dams along the main stem of the White River and the East Fork of the White River would impede or prevent recovery of the fanshell in the White River basin. Removal of these dams, particularly those in the East Fork White River, or removal of a portion of these dams may improve sediment and nutrient transport (American Fisheries Society 2004, Bednarek 2001). This would benefit any remaining population of the fanshell within the East Fork White River.

Agriculture accounts for approximately 70 percent of the land use in the White River Basin (Crawford *et al.* 1996). In addition to agricultural inputs to the basin, the urban areas of Anderson, Indianapolis, and Muncie contribute municipal as well as industrial wastes to the White River Basin. Improvement of wastewater treatment, both municipal and industrial, may reduce contaminants associated with industry and sewage treatment. State and local efforts to improve implementation of conservation measures associated with rural development,

agriculture, or timber production may result in reduction of contaminants, including sediment, associated with these activities in the basin. Failure to implement effective conservation measures and failure to reduce point source municipal or industrial wastes may result in further loss of viability for the fanshell in the East Fork White River.

Gray bat

Gray bats hibernate in relatively few caves in the southeastern United States, and a few have been observed in Wyandotte Cave (Crawford County) and Twin Domes Cave (Harrison County). No caves near the Forest are known to be used as hibernacula or as maternity roosts by the gray bat.

Consequently, as the gray bat has not been known to use caves on the Forest and given that management direction presented in the Federal Cave Resource Protection Act of 1988 would be implemented in all alternatives, no alternatives are expected to impact hibernacula and maternal roosts of the gray bat.

Gray bats forage on flying insects from dusk to dawn over perennial streams, lakes, and ponds. These bats may forage over substantial distances from roosts (20 km, approximately 12 miles). Consequently, gray bats may benefit from wetland restoration and measures that improve water quality. Similar to potential effects to the bald eagle, the protection, maintenance, restoration, or creation of wetland habitats likely represent the most relevant criterion with which to evaluate the potential effects of alternatives with respect to the gray bat. Alternative 2 does not provide for the restoration or creation of wetlands; Alternatives 1, 3, 4, and 5 retain this management. Consequently, Alternative 2 would present the least benefit to the gray bat; the other alternatives would be approximately equal in their provision of wetland habitats on the Forest.

Although management direction and BMPs apply to Alternatives 1, 3, 4, and 5, timber harvest could temporarily decrease stream quality. Similar to effects on the bald eagle, potential effects on foraging habitat of the gray bat would only occur in those areas associated with riparian forest such as lands in Management Area 2.4. In Management Area 2.4, Alternatives 3 and 4 would allow limited timber management and harvesting in riparian areas. These are areas that likely provide foraging habitat for the gray bat.

Cumulative Effects

Past activities on NFS lands and adjacent private lands that have likely affected the distribution of the gray bat include human use of caves, conversion of riparian forests to agricultural or residential uses, and timber harvests in areas of riparian forest. Reforestation following establishment of the Hoosier likely has contributed to improvement in water quality on the Forest. Future acquisition of land within watersheds bounded by the Forest would likely result in improved water quality as lands are reforested and aquatic resources gain the protections provided by the standards and guidelines in the Proposed Forest Plan. Foraging habitat for the gray bat may improve due to protection of riparian areas. These activities would be similar in type and extent to those noted for both the fanshell mussel and the bald eagle. Non-forested riparian corridors in Forest ownership, or riparian areas acquired by purchase, planted to bottomland hardwood trees or allowed to succeed naturally to a forested condition, would maintain and enhance riparian corridors for the gray bat.

A substantial proportion of area watersheds likely used by gray bats near the Forest occurs in other ownerships. Activities such as timber harvest, road construction, and rural development on these lands may affect water quality and, subsequently, prey availability for the gray bat.

Agriculture is the primary land use in all counties that contain NFS land. Ongoing agricultural activities, timber harvesting, and rural development may result in sediment inputs to aquatic resources. Improvement of wastewater treatment, both municipal and industrial, may reduce contaminants associated with industry and sewage treatment. State and local efforts to improve implementation of conservation measures associated with rural development, agriculture, or timber production may result in reduction of contaminants, including sediment. Failure to implement effective conservation measures and failure to reduce point source municipal or industrial wastes may result in loss of habitat quality, particularly with respect to foraging for the gray bat.

Indiana bat

Most hibernacula are in caves, but occasionally Indiana bats use abandoned mines. Tuttle and Kennedy (2002) summarize information about the suitability of cave environments for the Indiana bat. Hibernacula in which ambient temperatures ranged between 37 and 45 degrees Fahrenheit housed stable or increasing numbers of Indiana bats. Tuttle and Kennedy (2002) further describe suitable hibernacula as having a chimney effect air flow between at least two entrances, the ability to store cold air, and the ability to buffer the internal environment and thus minimize the risk of bats freezing.

Protections provided in the Federal Cave Resource Protection Act of 1988 limit impacts to cave resources; therefore, the Hoosier expects no impacts in hibernaculum from implementing the alternatives.

During late spring and summer, breeding females form nursery colonies under the exfoliating bark of dead trees in upland or riparian deciduous forests. Indiana bats use a wide variety of tree species as maternal roosts, the strongest determinants of roost selection being the structure of the roost and its location in the landscape.

Maternal colonies select one or many primary roosts based primarily on the exposure of the roost to the sun and the presence of sheaths, or plates, of exfoliating bark. When looking for suitable maternal roosting habitat, one must consider the presence of canopy gaps as well as the presence of decadent trees that may be structurally suitable as primary roosts.

With the exception of developed areas, openings, roads, trails, and wetlands, the Hoosier is a relatively closed-canopy second growth forest. The lack of canopy gaps likely limits the suitability of some potential maternal roost trees. Timber management that emulates gap formation, such as single-tree or group selection harvest in conjunction with the retention of structurally suitable trees, would likely benefit the Indiana bat in terms of the suitability of maternal roosting habitat. Alternative 2 makes no provision for the improvement of maternal roosting habitat by harvest methods that may emulate gap formation. Alternatives 1, 3, and 5 are about equal in their use of uneven-aged timber management that may emulate gap formation. Alternative 4 would use less uneven-aged management than Alternatives 1, 3, or 5.

The LANDIS model was applied to all alternatives to show habitat change over time for the Indiana bat. A Habitat Suitablility Index model was used to determine future habitat suitability for the species, and the results are discussed later in this chapter.

See Table 3.3 for the projected acreages to be harvested by the alternatives in the first decades and as an average for decades 1 through 15. Alternatives 1 and 5 would implement roughly half of the projected even-aged harvesting of Alternative 3. Alternative 4 would use even-aged

management on more acres than Alternative 1, Alternative 3, or Alternative 5. Alternative 2 would not implement harvesting.

The feeding behavior of the Indiana bat suggests that the species prefers and possesses adaptations to forage in mature forested habitats with broken or open canopies. With the exception of lakes, rivers, streams, private in-holdings, roads, and trails, the Hoosier is characterized as a relatively closed-canopy second growth forest. These canopy conditions may present less than ideal opportunity for foraging by the Indiana bat.

Consequently, management activities, such as single-tree and group selection harvest, that result in broken canopies characterized by crown closures between 30 and 80 percent may improve foraging habitat for the Indiana bat. Conversely, even-aged management practices, such as clearcutting, may result in the reduction of foraging habitat for the Indiana bat.

Alternative 2 would not use single-tree or group selection harvests to improve foraging habitat for the Indiana bat. Across a few decades, Alternatives 1 or 5 would use uneven-aged techniques to harvest more than the total of Alternatives 3 and 4 combined.

With respect to even-aged harvest (Table 3.3), Alternative 4 would harvest more acres per decade than any of the other alternatives. Alternative 3 would harvest less acres per decade than Alternative 4 and Alternatives 1 and 5 harvest slightly less than Alternative 3. Alternative 2 provides for no even-aged harvest.

Because pine plantations provide poor foraging habitat, conversion of pines to native hardwoods by pine harvest would benefit the Indiana bat. Alternative 2 would not use pine harvest to improve foraging habitat for the Indiana bat. Alternatives 3 and 4 would be approximately equal with respect to acres of pine harvest; either providing for that treatment at about three times the rate of Alternatives 1 and 5.

Immediately following implementation of harvesting, insects are reduced in the affected areas. Prescribed fire may improve foraging for forest bats by increasing insect biomass following the regrowth of herbaceous vegetation (Smith 2000, Robbins *et al.* 1992, Whelan 1995). This may result partly from nutrient release and the subsequent increase of herbaceous forage quality. The alternatives vary widely in the acreage of prescribed fire: Alternative 2 does not use prescribed fire, while Alternatives 1 and 5 would burn roughly 20,000 acres per decade. Alternative 3 would burn about 50,000 acres per decade, and Alternative 4 would burn roughly 100,000 acres per decade. Although fire may improve foraging habitat for bats, given the nature of the low-intensity fires on the Forest, there is little probability that implementing prescribed fire would affect forest canopy structure.

The restoration and creation of wetlands is a management action carried forward in Alternatives 1, 3, 4, and 5; these alternatives would continue to provide enhanced areas of drinking water for bats. Alternative 2 makes no provision for the improvement of drinking water and foraging habitat through the restoration or creation of wetland habitats.

Effects of Management – Alternate Roosts

The Indiana bat uses maternal roosts, often referred to as primary roosts, as well as alternate roosts. The bats use primary roosts for incubation and nurturing their young. The bats appear to use alternate roosts only under certain conditions, such as when the primary roost is not providing the desired location, exposure to solar radiation, or protection. Alternate roosts typically house fewer bats and may occur beneath the forest canopy. Alternate roosts vary

widely in terms of tree structure and condition. These trees also serve as roosts for solitary males.

Forested stands on the Hoosier average 681 trees per acre compared to a statewide average of 553 trees per acre (Leatherberry 2003). Another measure of tree density, growing stock volume, is a useful indicator of forest condition. Eighty-one percent of the timberland (136,200 acres) on the Forest is considered moderately or fully stocked compared to 69 percent in the rest of the State; 13 percent of timberlands on the Hoosier are considered over-stocked compared to only 8 percent statewide (Leatherberry 2003). While the volume of all species has increased, the greatest increase in timber volume on the Hoosier between 1986 and 1998 occurred in these species or species groups: yellow poplar (*Liriodendron tulipifera*), soft maples (*Acer spp.*), hard maples (*Acer spp.*), and sycamore (*Platanus occidentalis*) (Leatherberry 2003). These are not preferred tree species for alternate roosts for the Indiana bat.

The Hoosier provides many opportunities for alternate roosts. The availability of alternate roosts would not be expected to vary appreciably, if at all, by alternative.

Cumulative Effects

The gradual consolidation of forest tracts through acquisition of private lands within the Forest boundary is likely to have an effect on the Indiana bat.

Actions on adjacent lands may affect Indiana bats as well. Actions could include the disruption of historic disturbance regimes that would result in the creation of habitat, actions resulting in habitat loss, and habitat modification resulting in a loss of habitat suitability for the Indiana bat.

Carter (2003) has described the Indiana bat as being associated with “highly disturbed late-successional habitats.” Carter has suggested that large-scale flood events in bottomland hardwood forests may have historically provided numerous standing snags and so provided maternal roosts for the Indiana bat. Flood control efforts and structures may now limit the historic role of this source of disturbance across the landscape. The distribution of the Eastern cottonwood (*Populus deltoides*) corresponds to flood-prone areas, and the tree develops ideal maternal roost characteristics. As a result, flood control, ditching, and installation of drainage tile may have inhibited cottonwood roost recruitment in the past. The same factors may presently be limiting the distribution of cottonwood and may inhibit future recruitment of the Eastern cottonwood as a source of maternal roosts for the Indiana bat.

The use of fire by Native Americans and European settlers may similarly have contributed to the recruitment of maternal roosts, particularly with respect to the now extirpated American chestnut (*Castenea dentata*). The suppression of wildfire across the landscape has resulted in this type of disturbance being unlikely to contribute to the recruitment of maternal roosts on non-National Forest System lands near the Hoosier.

The conversion of forested habitat to non-forest uses would also affect the amount of habitat available for Indiana bats in the future. A change in habitat structure, such as conversion of forest to agriculture, has likely influenced the distribution and abundance of the Indiana bat (Clawson 2000, USDI Fish and Wildlife Service 1999). Much of the land within and around the Forest boundary was historically converted from native ecosystems to nonnative or native plant monocultures. Nonnative pastures, such as those dominated by tall fescue (*Festuca arimdomacea*), persist in the area on both NFS lands and interspersed private in-holdings. Loss of habitat to rowcrops may continue to locally limit habitat used by Indiana bats. Nonnative pine

plantations scattered across various ownerships may continue to provide less than optimal foraging for the Indiana bat.

The wooded landscape around the Forest would continue to attract rural development that is likely to result in the loss or fragmentation of forested lands. Rural development of riparian areas or corridors, highly desirable as home sites, may fragment foraging areas or disrupt travel corridors for Indiana bats. Development of municipal or state infrastructure such as roads may similarly result in the loss or fragmentation of wooded acreage or riparian corridors.

Hardwood timber harvest would continue to be the dominant activity on adjacent lands that results in modification of habitat. Timber harvesting on private lands may not incorporate conservation measures that would result in the enhancement of habitats for the Indiana bat. Foraging habitat may be improved on private lands due to reduced crown closure following selective harvest, but some of the large trees that comprise the pool of potential maternal roost trees could be selected as valuable crop trees for harvest (for example, diameter-limit harvests that remove all trees of value over 12 inches in diameter). Riparian corridors on public and private lands, and uplands on public lands, may become important areas for management for Indiana bat habitat as these areas may continue to provide larger, older trees that may serve as maternal roosting habitat.

Rough Pigtoe Mussel

The Hoosier expects none of the alternatives to alter or affect restoration of natural stream flows in the East Fork White River or its tributaries.

Activities that may affect water quality are primarily those likely to increase stream sediment loads. This would include ground disturbance due to timber operations, construction of firelines as a result of either suppression or implementation of prescribed fire, and construction of rights-of-way either for utility placement or as road construction or reconstruction. Application of the Forest Plan direction and BMPs would ensure protection of aquatic resources. The potential for sediment from forest management activities to reach the main stem of the East Fork is remote; the likelihood that resulting sediments might adversely affect rough pigtoe habitat may be discountable.

Pesticide use on the Hoosier is currently limited. Previous, and anticipated, use has included application of aquatic herbicides in recreation areas outside the East Fork White River basin. Application in lakes associated with developed recreation is unlikely to result in leaching of aquatic herbicides into the White River Basin as application is specifically targeted to limited portions of recreational areas.

The Hoosier may use herbicides for the control of terrestrial nonnative invasive species, but it would not apply pesticides within riparian corridors of the sixth level watersheds of the East Fork White River where the species has known occurrences. Pesticide use would only occur following site-specific environmental analysis and public involvement.

The 2003 Biological Evaluation for Endangered and Threatened Species – Forest Plan Amendment 7 (USDA Forest Service 2003), disclosed the likely consequences of acid mine drainage from an abandoned coal mine on NFS land in the East Fork White River basin. Input to the East Fork White River is discountable as water from the mine discharges slowly and is diluted by Plaster Creek.

Cumulative Effects

Although no direct or indirect effects to the rough pigtoe are likely to result from implementation of any alternative, resources affected by, or managed by, private concerns, municipalities, or the State of Indiana may affect natural stream flows, water quality, and the distribution of nonnative species, all of which may cumulatively affect the rough pigtoe.

Bald Eagle

Inland breeding, foraging, and wintering areas for bald eagles are closely associated with wetlands, lakes, and rivers. Consequently, protection, maintenance, and restoration or creation of wetland habitats is one of the most relevant criteria for comparing alternatives with respect to the bald eagle. Alternative 2 does not provide for the restoration or creation of wetlands; Alternatives 1, 3, 4, and 5 retain this type of management. Therefore, Alternative 2 presents the least benefit to the bald eagle. The other alternatives are equivalent in their provision of wetland habitats on the Forest.

Areas containing existing aquatic habitats and adjacent forest buffers occur within Management Area 2.4 and Management Area 7.1. The forested buffers in these management areas provide nesting and roosting habitat for the bald eagle. Allowable management activities in Management Area 7.1 do not differ among the alternatives that retain wetland restoration as a management directive. In Management Area 2.4, however, Alternatives 3 and 4 include uneven-aged management within these forest buffers. All alternatives would retain trees for nesting and roosting habitat. Alternative 2 does not provide wetland restoration or creation.

Bald eagles may establish nesting territories and begin construction of nests as early as February. Potential exists for impacts from prescribed fires to occur during the nesting period. The Department of Natural Resources surveys previously known nesting sites of the eagle annually (McCreedy *et al.* 2004); therefore, project management would account for the nests and mitigate effects to them. All alternatives include standards and guidelines that provide protection of eagle nests.

Because of their propensity to nest near bodies of water, eagles could be disturbed by recreational activities. Though tolerant of some degree of activity in the proximity of nests, bald eagles are intolerant of deliberate disturbance directed toward them (Fraser *et al*. 1985). There are no foreseeable differences among the alternatives regarding this type of disturbance.

Eagles routinely nest in the Forest. Continued wetland development and restoration, as well as protection of adjacent woodlands, would provide considerable benefit to the bald eagle on the Hoosier.

Cumulative Effects

Timber harvesting and the conversion of riparian foraging and roosting areas on private lands to agricultural and residential uses have the greatest potential for effects.

Reforestation following establishment of the Hoosier likely has contributed to use of the Forest by the bald eagle in recent decades. According to an evaluation of land use change through time, closed canopy forests have increased by 24 percent on the Hoosier (Table 3.0). Future acquisition of land within watersheds bounded by the Forest would result in improved water quality as lands are reforested.

Other ownerships comprise a substantial proportion of watersheds frequented by bald eagles. Activities on these lands, such as timber harvest and development in riparian corridors, may affect the availability of roosts, the availability of nest sites, and water quality and subsequent prey availability for the bald eagle.

Improvements in water quality have substantially contributed to the range-wide recovery of the bald eagle. Certain persistent environmental contaminants, such as fish-borne mercury resulting from both point (for example, effluent) and non-point (for example, aerosols) sources would continue to affect the reproductive success of bald eagles. Many water bodies in Indiana are known to have an appreciable presence of mercury. Fish consumption advisories related to mercury levels are in effect for virtually every major river system in the State (Indiana Department of Environmental Management 2004).

Maintain and Restore Sustainable Ecosystems

Interaction among groups of organisms and their environment is termed an ecosystem. Typically, ecosystems include individual resources that interact and contribute to the complete natural environment. The ecosystem discussion for the Hoosier incorporates air quality, animal communities, fire and fuels, karst topography, and plant communities. Aquatic ecosystems are included under Maintain and Restore Watershed Health.

Air Quality

The Clean Air Act requires the United States Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards to protect public health and the environment. Hazardous air pollutants are those pollutants that cause or may cause cancer or other serious health effects or adverse environmental and ecological effects. EPA standards establish acceptable concentrations of six pollutants in the outdoor air. These pollutants are carbon monoxide, ground-level ozone, lead, nitrogen dioxide, particulate matter, and sulfur dioxide.

EPA designates areas that exceed these standards as non-attainment areas. For each such area, states are required to develop a detailed plan that lays out how attainment would be achieved. Except for Jackson County and Dubois County, the Hoosier is in an attainment area for these pollutants. This means that the level of these pollutants in the air over the Forest is below the ambient air quality standards set by EPA. Jackson County is a non-attainment area for the eight-hour ozone standard as of April 15, 2004: On certain days in the summer ozone levels measured in Brownstown, Indiana, exceed those set by EPA. By the spring of 2007, Indiana must submit ozone attainment plans to EPA and must reach attainment by 2009. Dubois County is a non-attainment area for PM 2.5 (particulate matter of mass median aerodynamic diameter less than or equal to 2.5 micrometers) as of April 2005. Attainment plans for PM 2.5 are to be submitted prior to January 2008.

Air management issues can be very complex. Air pollutants can be transferred to other resources such as soils and water. Three pollutants--sulfates, nitrates, and mercury--cause the overwhelming majority of the impacts to ecosystems. The Hoosier lies in a region characterized by some of the highest levels of air pollution in the nation (Sams 2002). As a result, this region also has some of the highest levels of acid rain and mercury deposition, which could contribute to a loss of ecosystem health. Sulfur dioxide and nitrogen oxides are precursors to important components of ozone and regional haze, resulting in inhibited visibility during hot sunny weather with stagnant atmospheric conditions. Sulfur dioxide and nitrogen oxide affect foliage and reduce the growth of species sensitive to these pollutants.

Nationally, the largest non-point source of nitrogen oxide is automobiles. The largest point sources of sulfur dioxide, nitrogen oxide, and mercury are fossil fuel fired power plants. The Tennessee Valley Authority's Paradise coal-fired power plant in Kentucky is the nation's second largest emitter of sulfur dioxide and the nation's largest point source of nitrogen oxide (Sams 2002). It is only 50 miles from the southern portion of the Forest. The Ohio River industrial corridor has some of the nation's highest concentrations of sulfur dioxide and nitrogen oxide. Sulfate deposition has shown a slight decrease in recent years, but nitrate deposition has not shown a decrease over the same time.

Mercury depositions can occur anywhere due to long-range atmospheric transport. Mercury deposition can lead to the formation of methyl mercury in the aquatic environment. Methyl

mercury is a potent neurotoxin, biomagnified in fish through the aquatic food chain. The State issues fish consumption advisories for lakes and streams where mercury levels are unhealthy.

Particulate matter is a mixture of solid particles and liquid droplets in the air including dust, soot, and other microscopic particles. Particulate matter is a major component of smoke and can come from internal combustion engines, power plants, burning, or windblown dust. Scientists have linked exposure to particulate matter to serious human health problems. In addition, particulate matter can impair visibility.

Alternatives and the Effects of Management on Air Quality

Alternatives 1, 3, 4, and 5

The major impact to air quality from management on the Hoosier would be from wildfires and prescribed burns. Both wildfires and prescribed burns generate smoke that includes particulate matter that can temporarily degrade visibility and ambient air quality. Other management practices on the Forest are not expected to affect air quality to any noticeable degree.

Alternatives 1, 3, 4, and 5 would all implement some form of timber management and prescribed burning. Of the management activities on the Forest, prescribed burning has the most potential for impacts to air quality. Table 3.4 displays the estimated acres of prescribed burning each alternative would propose for the first 10 years.

Table 3.4

ACRES OF PRESCRIBED BURNING

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Prescribed burning in combination with timber harvest*	5,720	0	11,350	19,240	5,720
Prescribed burning not associated with timber harvest[1]	14,280	0	38,650	80,760	14,280

[1] Figures estimated from SPECTRUM timber harvest model.

When considering the use of prescribed burning to restore the role of fire in the ecosystem and reduce fuels, the effects of smoke from wildfire and prescribed burning must be considered. Fires emit large amounts of particulate matter (particulate matter size classes: PM 10 and PM 2.5 (microns)) and carbon monoxide as well as nitrous oxides (NOx) and organic compounds. Smoke created from burning is generally temporary. It dissipates and is not considered a significant factor in local air quality. The Hoosier implements most prescribed burning in the spring and fall when smoke would dissipate quickly. Burning during spring and fall would not affect the attainment status for pollutants, as the non-attainment days normally occur during the summer or periods of stagnant air. To minimize air quality impacts, all prescribed burns would have an approved burn plan prepared. This plan would include measures to minimize and manage smoke. Burning would follow State regulations for open burning.

Alternative 2

This alternative implements no prescribed burning or timber harvest, thus having no increased impact on air quality. Most impacts to air quality resources would be from wildfires and driving on Forest roads. Use of Forest trails, trail maintenance, and trail construction could stir up dust and would have negligible impacts to the existing air quality condition. The other impacts to air quality would be from wildfires. Wildfires generally result in greater emissions per acre than do prescribed burns. Wildfires on the Hoosier have generally not been a problem for air quality or other resources. Hoosier policy calls for suppression of all wildfires that occur, and fires on the Forest are normally small.

Cumulative Effects

Timber harvest affects air quality from dust that occurs from skidding and hauling operations and the impacts of increased equipment emissions from increased activity levels. The Hoosier expects these impacts to be negligible. The Hoosier would complete prescribed burning of fuels in a controlled manner. Prescribed burn plans indicate the best conditions to conduct the burns, and include mitigations for air quality concerns.

Emissions from wildfire are expected to be constant across all alternatives and are outside the control of the Forest. The Hoosier expects the total effect of wildfires on air quality to be small because prompt suppression action would minimize the area burned.

Animal Communities

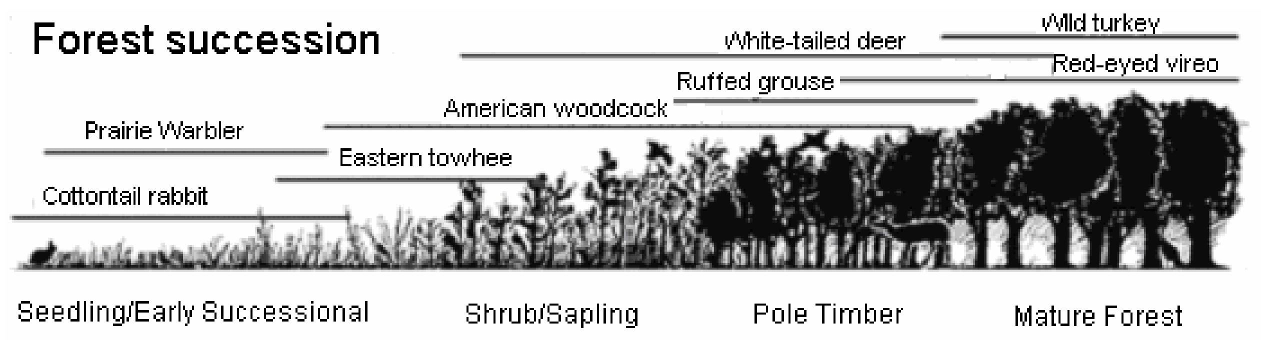
Succession is the relatively sequential process of change in community composition over time. Succession helps explain patterns of distribution and abundance of plant and animal species. Soon after a mature forest stand is disturbed, the land may have areas of bare soil and herbaceous vegetation, such as grass. Shade-intolerant or pioneer species often dominate this newly created early successional habitat. Because plants cast shade, after canopy closure, shade-intolerant species are at a competitive disadvantage with the seedlings of other species. Over time, these pioneer plant species are replaced by shade-tolerant, competitive, and longer-lived plant species. Seedlings of shade-tolerant trees, such as American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*), become established and overstory trees eventually penetrate the canopy. With time, a different association of species comes to dominate the site. A forest stand typically proceeds through five general structural or growth phases (Patton 1992): seedling (0 to 9 years), sapling (10 to 19 years), pole (20 to 59 years), mature (60+), and old growth.

During the seedling stage, a stand provides insects, seeds, and herbaceous food and cover for wildlife. As succession continues, woody shrubs, seedlings, and saplings provide wildlife with woody browse and cover, as well as berries and seeds. As the saplings grow, they develop into dense stands of small trees that provide too much shade to support the shrubs associated with early-successional forests. These young, pole-sized forests are less productive for wildlife, since they lack the woody browse of early-successional habitat and lack many of the features associated with mature forests, such as acorns and tree cavities. In time, the forest matures and species such as flying squirrels (*Glaucomys volans*), pileated woodpeckers (*Dryocopus pileatus*), and salamanders thrive because of large trees that produce acorns, decaying trees with cavities, deep leaf litter, and downed logs.

As the composition and structure of the plant communities change via succession, so do the animal species that depend on these communities (DeGraaf 1991). For example, succession of mammal species in Eastern forests is predictable as habitat progresses from early successional to closed-canopy forest (Beckwith 1954, Golley *et al*. 1965). Mice (*Peromyscus* spp.) and meadow voles (*Microtus pennsylvanicus*) often first colonize abandoned fields. Cottontail rabbits (*Sylvilagus floridanus*) begin to occupy the site as a woody understory develops (Beckwith 1954), and eventually squirrels become residents as trees dominate the area (Wilson and Ruff 1999). This simplification of the habitat association of mammals indicates that forests with a variety of seral stages support a diverse mammal community.

In early or mid-successional forested habitats, bird species such as common yellowthroats (*Geothlypis trichas*) and yellow-breasted chats (*Icteria virens*) typically occur. As plant succession proceeds further, these species are replaced with other species that are characteristic of mature forests such as scarlet tanagers (*Piranga olivacea*) and black-and-white warblers (*Mniotilta varia*). As forest stands mature and old-growth conditions develop, certain species of wildlife benefit. This maturation creates unfavorable conditions for other species (Figure 3.2). For this reason, it is imperative for natural resource managers to ensure suitable habitat exists for a diversity of forest species by providing an assortment of forest stands of differing ages.

Figure 3.2 The succession of forest communities and examples of wildlife likely to inhabit each seral stage.



Historical Context

The use of fire and the clearing of land for agriculture by Native Americans were common practices in the 1400's. As a result, a large area of Eastern forests was in early successional habitats. Native Americans used fire for various purposes, including concentrating prey in convenient areas, encouraging fruit and berry production, keeping woods open along corridors of travel, and fire-proofing villages (Hamel and Buckner 1998, Van Lear and Harlow 2000, NCSSF 2005). Native Americans undoubtedly used fire frequently and pervasively to create the open habitats that were found by early European settlers (Engstrom 2000). These periodic understory fires were an important ecological factor in the historical development and maintenance of oak forests (Abrams 1992, Abrams 2003, Abrams 2005).

At the time of European settlement, the landscape of southern Indiana was predominantly forested, with significant areas of prairie and disturbed and open forest (Potzger *et al*. 1956, Parker and Ruffner 2004). The extent of anthropogenic disturbances in eastern forests changed considerably following European settlement. Disturbances included widespread

deforestation and slash fires used by European settlers to clear the land for agriculture between 1750 and 1940 (Pimm and Askins 1995), catastrophic fire followed by fire suppression, and the introduction of exotic insects and diseases (Abrams 2003). All of these disturbances led to rapid and unparalleled changes in forest composition and structure, including a virtual cessation of oak regeneration and recruitment (Abrams 2003).

As farms were abandoned during the early 1900's, the amount of forest in the East gradually increased (Pimm and Askins 1995). At the time, most of the forest had been cut, with only small woodlots remaining, and all of the forest had been subjected to fire and grazing by livestock (DenUyl 1947, DenUyl and Day 1939). After the Federal government acquired the land, beginning in the 1930's, it planted many ridgetops, severely eroded from past land use, to nonnative pines to prevent further soil loss. Open habitats were widespread before human settlement, and many wildlife species that had been dependent on these habitats flourished during the period of farm abandonment (Hunter *et al.* 2001, Lorimer 2001). However, numerous factors have led to the decline of these species including such practices as intensification of farming; declines in the numbers of pastures, hay meadows, and abandoned fields; and the suppression of natural disturbances such as fire, beaver (*Castor canadensis*) activity, and floods that generate natural grassland and shrublands (Askins 1998, Hunter *et al.* 2001).

After the start of the twentieth century, local and regional bans on fires removed this type of disturbance from the landscape. The elimination of fire resulted in a shift in species composition, structural complexity, and landscape pattern across much of the region (Weaver and Ashby 1971, Parker and Weaver 1989, Fralish *et al.* 1991, Ecological Society of America Executive Committee 1995, Adams and Rieske-Kinney 1999). Eastern hardwood forests, including those of the Hoosier, are relatively young and even-aged with less species diversity, vertical structure, natural canopy gaps, large woody debris, and other structural features than pre-European settlement forests. The average patch size is smaller and there are fewer forests. Fire-intolerant species such as sugar maple and American beech became established at the expense of fire-adapted oak and hickory species, especially after fire control measures were adopted (Schlesinger 1976, Lorimer 1985, Engstrom 2000). The influence of Native Americans, and even more so the subsequent wave of European expansion across the Midwest, left indelible changes on the landscape of the Forest, changes reflected in the extirpated, and in some cases extinct, flora and fauna of the region. The region once supported the bison (*Bison bison*), and the passenger pigeon (*Ectopistes migratorius*), and there were also populations of the beaver, which are now present in but a fraction of their historic numbers. Each of these species influenced the composition and character of the landscape.

Early travel accounts describe the effects that bison had on the landscape. In 1765, Croghan wrote of the Big Bone Lick area in Kentucky, "In our way we passed through a fine timbered clear wood; we came into a large road which Buffaloes have beaten, spacious enough for two wagons to go abreast" (quoted in McCord 1970). John Heckewelder wrote in 1792 while traveling through Indiana, "we reached the socalled Buffalo Salt Lick where it is said 500 buffaloes may sometimes be seen at one time especially in the months of June, July, and August. The salt spot, several acres in size, is so much trodden down and grupped up, that not a blade of grass can grow and the entire woods are for miles around quite bare" (quoted in McCord 1970).

The passenger pigeon also influenced the character of the landscape. These birds formed immense flocks before their extinction, and Audubon (1831) once noted an autumn flock of this species in the Kentucky barrens located near Henderson, which continued its passage for three days. In Tennessee, a winter pigeon roost found in the woodlands and barrens was four to six

miles in circumference (Faux 1819). Nesting and wintering roosts could cover several miles and often caused tree damage or tree death (Featherstonhaugh 1844). The impacts from these roosts provided local disturbance and resulted in stands of forest that remained open. Caleb Lownes described this disturbance in 1815 while traveling through Indiana, writing "the number of or rather the quantity of Pigeons were beyond all credibility–a place, called emphatically, the Pigeon Roost, where these birds retire from the severity of the Northern Winters, cannot be described –nor obtain belief, were it described—at least fifty acres of woods in one area totally stripped of their limbs—many of the trees of a foot diameter actually broken down to the ground by the number and weight of the Pigeons—the destruction of timber is inconceivable" (quoted in McCord 1970).

Although the influence of the bison and pigeon may have been only local (Ellsworth and McComb 2003), the beaver may have pervasively influenced the distribution of wooded wetlands across the landscape. There were millions of beavers in North America and their dams and ponds also numbered in the millions. Beaver activity has a long-lasting impact on the environment, and beaver dams and beaver browsing affect soil fertility, water chemistry, plant succession, and rate of forest growth (Wilde *et al.* 1950). The result of this activity was a uniform buildup of organic material in valleys, a checkerboard of meadows throughout woodlands, and a great deal of edge habitat. Wetlands under the control of beavers covered over 200 million acres of land in the 48 contiguous states (Dahl 1990). The wetlands created by beavers provided habitat and food sources for numerous species.

Although the beaver, considered a keystone species, was widespread before European settlement, the species was exterminated or vastly reduced over much of their U.S. range by 1900 due to overtrapping (Arthur 1931, Cook 1943, Dalke 1947) and extermination in the course of agricultural development. Furthermore, farmers removed dams and dens to facilitate row crop production (Prince 1997). It is unknown when the beaver became extinct in Indiana, but for a long period it was not a part of the fauna of the state (Mumford and Whitaker 1982). Before European settlement, fires, floods, windstorms, and animals such as the beaver created extensive openings.

Recent developments in conservation biology emphasize that species loss and ecosystem change (such as decline in forest health, buildup of fuels, forest regeneration failures, and decline in habitat suitability) have been observed in areas where "natural" disturbance regimes and habitats have been substantially altered (Jensen and Bourgeron 1994). Disturbances reset succession and result in a mosaic of successional patches of different ages across the landscape (Ecological Society of America Executive Committee 1995). The restoration of natural landscapes requires the re-introduction or simulation of these disturbances. Researchers at the University of Tennessee recently concluded a five-year monitoring project to determine how declining songbird species are responding to vegetation management efforts enacted to bolster their populations. Preliminary results suggest that the use of selective timber harvests to mimic natural disturbance has led to an increase in songbird populations and diversity (Thatcher 2005).

Perhaps the loss or reduction of what once were the most substantial members of the regional plant community was even more pronounced than the loss of animal species. Mature specimens of the American chestnut (*Castanea dentata*) and the American elm (*Ulmus americana*) are now virtually absent from the landscape. The numbers of mature cottonwoods (*Populus deltoides*), associated with rich alluvial bottomland soils, have been reduced as well (Leatherberry 2003). While pathogens have claimed the chestnut and elm (Burns and Honkala 1990, Farrar 1995), the cottonwood has, to some degree, been displaced by the planting of

crops on alluvial soils. It is striking to note that these species were among the largest and fastest growing trees formerly dominating the landscape.

Early Successional Habitat

Early successional habitat (0 – 9 years old) is also discussed under Plant Communities. Early successional habitat is created through natural and manmade disturbances such as clearing of land, fire, timber harvest, tornados, and wind throw. There are two very distinct types of early successional habitat--"young forest habitat" and "early successional shrubland habitat." Early successional shrubland habitat occurs where plants colonize treeless areas created by river action or abandonment of cleared land. These areas are colonized by pioneer species of vines, shrubs, and trees and are important for species that favor dense thickets, such as prairie warbler (*Dendroica discolor*) and yellow-breasted chat. In contrast, events such as windstorms, logging, and insect outbreaks may result in young forest habitat dominated by short sprouts and seedlings of forest trees, along with some surviving shrubs and herbs from the original forest understory. Species such as the blue-winged (*Vermivora pinus*) and yellow warblers (*Dendroica petechia*) are common in these stands. Because tree saplings and sprouts grow up quickly, their crowns quickly form a closed canopy that shades out many plants; therefore, young forest habitats tend to be more transitory than early successional shrub habitats. Although both of these habitats are dominated by low, woody vegetation, there is a great difference in vegetation structure (Thompson and DeGraaf 2001).

Numerous reports indicate that the number of species that use early successional habitats are declining (Oliver and Larson 1996, Thompson and Dessecker 1997), including blue-winged warbler (*Vermivora pinus*), bobcat (*Lynx rufus*), Eastern cottontail (*Sylvilagus floridanus*), northern bobwhite (*Colinus virginianus*), and prairie warbler (*Dendroica discolor*). McAuley and Clugston (1998) attribute population declines of American woodcock (*Philohela minor*) to habitat loss and maturation of the nation's forests. The abundance and distribution of young forest habitat directly affects the foraging and nesting opportunities of these and other species. At particular times of the year, mature forest species may also depend on early successional habitats for either cover or food. Several studies have revealed that, after the breeding season, fledglings and adult songbirds usually associated with mature forest use forest openings (Pagen *et al.* 2000, Hunter *et al.* 2001). The distribution of young forests and other open habitats may be at the low range of historic conditions and may be below that needed to sustain desired population levels of some wildlife species, including many Neotropical migrants (Askins 2001, Thompson and DeGraff 2001).

The Hoosier creates and maintains permanent forest openings to provide a small amount of early successional shrubland habitat, whereas young forest habitat is created by disturbances such as timber harvest. Openings and shrubland habitats are non-forested areas dominated by forbs, grasses, shrubs, or tree seedlings. When acquired, these areas may have contained a few scattered trees, but generally they consisted of cropland, home sites, or pasture. Many of these areas would likely revert to forestland if left to natural processes. Some are natural openings with relatively little or no tree growth because of natural site characteristics.

Openings with a history of human disturbance, especially more recent use, are composed of more exotic or nonnative plants, while natural openings have more native plants. Tall fescue, an exotic cool-season grass, often dominates sites with a history of human disturbance. This species is an aggressive, sod-forming grass that creates a thick, matted condition that severely limits the movement and foraging ability of ground-nesting and ground-feeding wildlife (IDNR

2002). Tall fescue also produces compounds that adversely affect the growth or germination of surrounding plants, limiting the establishment of other plants that are more beneficial to wildlife. The result is a solid stand of fescue that reduces the ability of wildlife to select a diverse and nutritious diet, and the matting nature of tall fescue leaves little cover for wildlife concealment against avian predators. Wherever possible, the eradication of tall fescue greatly improves the opportunity to provide diverse grasslands capable of supporting more robust and healthier wildlife populations. Herbicides are often the best choice for fescue eradication because they can be adapted to any site (IDNR 2002).

Native plant communities, including prairie species, dominate some of the natural openings and semi-openings found on the Forest. Openings with native plants are more likely to harbor sun-loving plant communities than are more disturbed sites with exotic flora; however, uncommon native plants may occur in old-field openings that include some exotic species.

Openings provide grassland cover, in association with shrubs, and provide important nesting and brooding habitat for species such as blue-winged warblers (*Vermivora pinus*), field sparrows (*Spezella pusilla*), wild turkeys (*Meleagris gallopavo*), and quail. Open habitats dominated by herbaceous vegetation support greater insect abundance than the forest floor beneath a closed canopy. These herbaceous openings can provide an abundant source of insects (bugging areas) in the spring and early summer for gamebirds (Thompson and Dessecker 1997). For more information on the importance of openings and early successional habitats to wildlife, please refer to the following: *Review of New Information for Consideration of the Hoosier National Forest - Forest Openings Maintenance - Breeding Bird Surveys and Species Viability Evaluation* (Basile 2005); *Review of Environmental Assessment- Forest Openings Maintenance* (McCreedy 2005); *Early Successional Forest Management Proposal* (McCreedy and Basile 2004), and *Recommendations for Continued Implementation of the 1999 Environmental Assessment – Forest Openings Maintenance* (McCreedy and Basile 2005).

Mid-Successional Habitats

Mid-successional habitat can be defined as forests 10 to 59 years old. However, age is only one factor in determining whether mid-seral conditions are functioning in an ecosystem. The structure of the forest is also important and mid-successional forest habitat includes both sapling and pole phases. This seral stage is a temporal and intermediate stage in the process of succession, and wildlife diversity in these timber stands is often much lower than other successional habitats.

Sapling stands occur between 10 and 19 years after harvest. At this age, tree saplings with a closed canopy dominate. By age 20, the number of tree stems is reduced and averages between 1,375 to 2,500 stems per acre, and larger trees on high quality sites reach 7 inches diameter at breast height (DBH) (Gingrich 1971). As stands continue to age, tree species richness tends to decline. Several bird species that typically occur in regenerating stands do not breed in sapling stands or they persist at lower densities. A few species such as black-and-white and worm-eating warblers (*Helmitheros vermivora*) seem to prefer the high stem densities and closed canopies that this age class provides (Thompson *et al*. 1995). Raccoon (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*), and Eastern cottontails often use this habitat stage.

Ninety percent of trees die due to competition as a stand reaches 20 to 60 years. The canopy in this growth phase remains closed, and there is little understory development. Canopy

nesters such as red-eyed vireos (*Vireo olivaceus*), scarlet tanagers, and wood thrushes (*Hylocichla mustelina*), or ground nesters such as ovenbirds (*Seiurus aurocapillus*) and black-and-white warblers are common species. However, breeding bird densities in mid-successional sapling and pole sized stands are much lower than densities in regenerating or mature stands (Thompson *et al.* 1992).

On the Hoosier, there are both pine stands and hardwood stands currently in this mid-seral stage. Nonnative pines were planted from the 1940's until the early 1980's in old fields to help control erosion. These pine stands represent 16 percent of the total forest acres. Of the four main pine types planted on the Forest, white pine (*Pinus strobus)* and shortleaf pine (*Pinus echinata*) represent the greatest number of acres. As pine trees grew from eroded fields and became pole and sawtimber size stands, the forest floor also changed. Due to close spacing of pines, in places the forest floor is virtually devoid of understory plant species. As these pine stands continue to age, openings in the crown form and hardwood seedlings and forbs begin to emerge. The mortality rate in the pines is dependent on the species. Shortleaf pines are shorter lived than other pine species, and white pines live the longest. Once the pine stands convert to native hardwoods, the stands would follow natural succession.

Recent studies focusing on habitat use by juvenile migratory birds between the time of fledging, the time that they leave the nest, and the beginning of migration have documented post-fledging use of early and mid-successional habitats by some forest-interior species (Rappole and Ballard 1987, Pagen *et al*. 2000, Marshall *et al*. 2003). In particular, species typically associated with mature forest, such as the worm-eating warbler, red-eyed vireo, black-and-white warbler, wood thrush, and ovenbird were among the most commonly captured (adults, juveniles, and family groups) in clearcuts (Marshall *et al*. 2003). Radio-telemetry studies with wood thrush have revealed that the young of this species travel long distances from forested nest sites to a variety of early successional, riparian, and mid successional habitats after they fledge from the nest (Anders *et al*. 1998, Vega Rivera *et al*. 1999, Lang *et al*. 2002). These studies provide evidence that some forest interior species may depend on early and mid successional habitats during the post fledgling period.

Late Successional Habitats

As hardwood stands move from early to late seral stages (60+ years), they exhibit constant change in age, composition, and diversity. Shade-intolerant species such as yellow poplar (*Liriodendron tulipifera*) and black cherry (*Prunus serotina*) become established as succession continues; these continue to grow to the mature phase (Aber 1990, Gilliam *et al*. 1995). Over time, the structural phases of these species are replaced with species intermediate in shade tolerance such as white oak (*Quercus alba*) and northern red oak (*Quercus rubra*). Late seral or sub-climax refers to the stage in plant succession immediately preceding the climax community and is characterized by oak-hickory stands. Lastly, mature shade-tolerant species, such as sugar maple and American beech dominate the stand as it approaches the climax community. Even in this climax community, there continue to be cyclic successional changes on a local scale. The lifespan of overstory plants is finite, and their disappearance from the canopy may open the site to new species.

Late successional forests exhibit a number of characteristics important to wildlife populations. Over time, mature forest types are dominated by long-lived species and well-developed structural diversity. The landscape pattern is one of more or less continuous forest cover, with little edge habitat, and human use in these stands tends to be low-impact forms of recreation

such as hiking. Typical wildlife species that are found in these stands reflect more mature forest conditions and low disturbance levels. Some edge and early successional species such as ruffed grouse *(Bonasa umbellus*), Eastern chipmunk (*Tamias striatus*), and red fox (*Vulpes vulpes*) may be present, but at much lower densities than in other habitat types. Late successional forest stands benefit species such as interior songbirds, cavity nesters, salamanders, amphibians, and small mammals that depend on large snags and downed woody material (Rose *et al.* 2001), but do not provide quality habitat for wildlife that use shrub and young forest habitat. Many species, including forest-interior birds, which depend on these mature stands of trees, have been declining over the last 50 years (Robbins *et al*. 1989, Robbins *et al*. 1992).

Almost all of the stands on the Forest are second-growth stands versus the old-growth forest in which many of these species evolved (Noss 1991). Due to the evolution of forest-interior birds in old-growth forests, it is important to compare the structure of the second-growth forest on the Hoosier to Midwestern old-growth forests. In a review of the remaining old-growth forests of the Central Hardwood Region, Parker (1989) defined old-growth forests as forests with overstory canopy trees older than 150 years with diameters of more than about 32 inches. During the past 80 to 100 years, there has been little to no understory disturbance (human-caused) in these forests. Understories are composed of late-seral shade tolerant trees and a large number of snags and downed logs. Old-growth forests have multi-layered canopies and an all-aged structure (Whitney 1987). Noss (1991) characterized old-growth forests by the fine-grained patchiness caused by small disturbance such as tree fall gaps. The forests are horizontally heterogeneous and characterized by groups of canopy trees interspersed with canopy gaps and their associated vegetation.

In contrast, second-growth forests, such as forests that become established following field abandonment, are less heterogeneous than old-growth forests (Clebsch and Busing 1989, Whitney 1987). The most significant differences between second-growth stands and old-growth forests are the size of trees and snags and the differences in canopy gap sizes and spacing. Indiana bats *(Myotis sodalis*) tend to forage in forests characterized by 30 to 60 percent crown closure (Romme *et al.* 1995). Selective cutting may increase habitat heterogeneity in second-growth forest through the creation of canopy gaps, and may support higher abundances of forest-interior species. Annand and Thompson (1997) found that selectively cut stands contained high abundances of gap-dependent species and high numbers of late-successional forest species. A study in Illinois corroborates these findings. In that study, the first selective cutting cycle in stands that had been unmanaged for 50 years did not result in decreased abundances of forest interior species (Robinson and Robinson 1999). In addition, species that may depend on gaps such as the cerulean warbler (*Dendroica cerulea*) may benefit from this type of cutting.

The Hoosier recognizes old-growth forests as a valuable natural resource, worthy of protection, restoration, and management. Old growth forests provide a variety of values including biological diversity, wildlife habitat, water quality, aquatic habitat, soil productivity, aesthetics, recreation, and cultural values. In addition, old growth forests have been greatly reduced in the Midwest, and their persistence contributes greatly to the region's diversity (Nigh *et al.* 1991). As mentioned before, old-growth forest encompasses the later stages of stand development and differs from earlier stages in a variety of characteristics which may include tree size, accumulation of large wood material, number of canopy layers, species composition, and ecosystem function (Nigh *et al.* 1991). The specific structural attributes characterizing old growth and the age at which old growth develops vary according to forest type, climate, site conditions, and disturbance regime.

Currently, less than 1.2 percent of the Forest exceeds 100 years of age, reflecting the relatively recent history of reforestation on the Hoosier (Parker and Ruffner 2004). In the following cumulative effects section, this document presents expectations concerning the amount of old-growth forest statewide

In the Eastern United States, most birds associated with early successional habitats have been declining since at least the 1950's, with most eastern states recognizing some of these species on their state protected species lists (Hunter *et al*. 2001, Askins 2000). The North American Breeding Bird Survey (BBS) is a standardized roadside survey conducted across North America to provide continental, regional, and route-specific assessments of bird populations (Sauer *et al*. 2004). Started in 1966, the primary objective of the BBS has been the estimation of population change for songbirds. BBS trends should be interpreted with caution because of possible biases; however, the data has many potential uses. BBS trends were calculated using the route regression method (Geisler and Sauer 1990) for three species groups (Table 3.4a).

Table 3.4a.

SIGNIFICANT NEGATIVE TREND ESTIMATES FOR THREE SPECIES GROUPS OF BREEDING BIRDS FOR THE STATE OF INDIANA

Species Group	1966-1979	1980-2004
Grassland breeding	-75%	-75%
Early-successional breeding	-45%	-35%
Woodland breeding	0%	-19%

This data shows grassland and early successional breeding birds have been experiencing much greater declines than woodland breeding birds. *The State of the Birds* released in mid-October 2004 by the National Audubon Society corroborates this data. This report shows statistically significant declines in 70 percent of grassland bird species, 36 percent of shrubland bird species, and 25 percent of forest bird species.

In the last several years, numerous investigators have devised methods of assessing vulnerability for bird species across the continent (Rich *et al*. 2004), physiographic areas (Ford *et al*. 2002), the Midwest (Thompson *et al*. 1993), and the state of Indiana (Rosenburg 2004). These approaches set forth a coordinated approach to land bird conservation that should be considered in every level of planning. Each of these documents presents the declines of species that depend on early successional habitats. Of the 187 bird species that breed in the Midwest, 51 percent use shrub-sapling or young forest habitats to some degree during the breeding season (Thompson and Dessecker 1997).

Importance of Oak-Hickory Forests to Animal Species

Due to natural succession and limited management, sugar maple and American beech are increasing in stand density and basal area at the expense of the oak-hickory overstory throughout the Hoosier. During the last century, there has been almost no white oak recruitment into the overstory in Eastern forests and during the last 50 years there has been almost no recruitment of other major upland oak species (Abrams 2003, Signell *et al.* 2005). A shift in forest composition from oak-hickory to forests dominated by maple and beech species has implications for many wildlife and insect species (Adams and Rieske 2001, Abrams 2003). This shift could result in a reduction of species richness and abundance within forest bird communities (Rodewald and Abrams 2002) and may negatively influence certain species. Mast

can broadly be defined as the various nuts and fruits produced by woody plants. Hard mast species are those that produce acorns, walnuts, hickory nuts, and so forth. The hard mast of oaks and hickories is a very important source of fall and winter food for many wildlife species (Vangilder 1997). Numerous studies (Kirkpatrick 1990, Kurzejeski 1990, Wentworth *et al*. 1990) have shown the importance of this food source to game animals such as deer, squirrels, and wild turkeys. In fact, in several of these species, researchers have linked productivity and body condition to the size of the annual acorn crop. In Eastern forests, blue jay (*Cyanocitta cristata*), red-bellied woodpecker (*Melanerpes carolinus*), red-headed woodpecker (*Melanerpes erythrocephlus*), tufted titmouse (*Baeolophus bicolor*), and small mammals rely heavily on acorns for fall and winter diets (Smith 1986, Grubb and Pravosudov 1994). For many species, such as eastern chipmunks and tree squirrels, hard mast is gathered and stored. For these species, hard mast is an important food source for even longer periods than for those species that do not store mast. Declines in reproductive success or reduced numbers of small mammals due to a reduction in oak and hickory mast can also impact raptors such as the red-shouldered hawk.

In addition, differences in foliage and bark structure may affect arthropod (spiders and related species) availability for insectivorous birds. The short-petioled leaves and furrowed bark of oak trees compared to maples may provide better foraging opportunities for these birds (Holmes and Schultz 1988, Rollfinke and Yahner 1991). Furthermore, Rodewald and Abrams (2002) found the total abundance of birds was greater in oak-dominated stands than maple-dominated stands in winter, spring, and fall.

Conversion of Nonnative Pine Stands to Native Hardwood Stands

By the end of the 19th century, much of the area that is now the Hoosier was recovering from widespread timber harvest, unrestrained grazing and forest burning, and poor agricultural practices (Fralish 1997). In an effort to control erosion and aid soil rehabilitation, nonnative pines were planted from the 1940's until the early 1980's. As these pines matured, the forest floor became virtually devoid of plant species in various places due to the close spacing of pines limiting sunlight to the forest floor. Many studies provide substantial evidence that pine plantations provide less suitable habitat and less biodiversity than native forest for birds, insects, herpetofauna, and a range of mammals including bats (Gysel 1966, Benzie 1977, Bender *et al.* 1997, Tibbels and Kurta 2003, Parris and Lindenmayer 2004). Scarcity of animal diversity is partly due to pine stands often having only limited understory cover as well as low species diversity of plants. These pine-hardwood stands are presently a mixture of planted pine species (primarily white and shortleaf) and various species of native hardwoods. Mortality rate in pine stands is dependent on the species. Shortleaf pines are shorter lived than other pine species, and white pines live the longest. Restoration of the native hardwood community on these rehabilitated sites would benefit a wide array of wildlife species, increase forest patch size, and connect fragments of native communities, thus reducing fragmentation and edge effects.

Currently, pine stands represent 16 percent of the total forested acres on the Hoosier. The planting of these nonnative species has created new breeding habitat for a few Neotropical migrants and other bird species in south-central Indiana. The pine warbler (*Dendroica pinus*), a nonnative, is likely the species that would be affected the most by the loss of pines on the Forest, but other warbler species including the black-throated green warbler (*Dendroica virens*) and Blackburnian warbler (*Dendroica fusca*) could also be affected. The Blackburnian warbler commonly breeds in tall mature coniferous or mixed woodlands, especially of hemlock, spruce, and fir. This species was found as a probable breeder in only one Indiana atlas block in

extreme northeastern Indiana, and no Blackburnian warblers were reported on Breeding Bird Surveys during the atlas period (Bruner 1998). However, a birder recorded a male Blackburnian warbler in 2003 and 2004 near the fire tower on Tower Ridge Road in Monroe County (Whitehead 2004, pers. comm.)

The black-throated green warbler breeds in a wide variety of coniferous and mixed forest habitats and, in parts of its range, in purely deciduous forests. A multi-storied layering of foliage, often best developed in fairly open forests or around edges or openings in denser forests, is a common characteristic of all breeding habitats. Spruce, hemlock, fir, and several species of pines, including white pine, are important trees in various parts of its breeding range. Singing males were consistently found in pine stands at Brown County State Park in the early 1980's (Whitehead 1998a), and researchers from Indiana University discovered additional small, isolated breeding populations in pine stands in the northern portion of the Hoosier (Whitehead 2004, pers. comm.). As part of the Hoosier's monitoring program, breeding bird surveys have been conducted across the Forest by a variety of universities since the early 1990's. During most years, black-throated green warblers were detected at a few survey points.

The pine warbler has one of the most extensive breeding ranges among warblers, but rarely nests in any habitat but pines (Chapman 1968), including native pine stands, pine plantations, and mixed woods with scattered pines. Throughout its range, pines are the key component of the breeding habitat. In northern states, the species preferentially uses dense mature pine or mixed pine and hardwood forests (Dunn and Garrett 1997). Shortleaf, red, and white pines are all frequently used. The pine warbler is not a long distance migrant, wintering in the southeastern United States and northeastern Mexico (Vanner 2002). Considered a rare migrant and summer resident in Indiana by Butler (1898), pine warblers migrate north to their breeding grounds during early spring, often arriving in Indiana in late March and early April. They migrate south relatively late in summer, and can often be found in middle latitudes during late August (Dunn and Garrett 1997). Pine plantings in southern Indiana have resulted in increased numbers of the species (Mumford and Keller 1984). Throughout Indiana, pine warblers have been detected in few bird atlas blocks, except in the south-central region (Whitehead 1998b).

Importance of Barrens Habitat

Barrens are natural fire-dependent communities (Engstrom 2000) characterized by a tree canopy cover of 20 to 60 percent, usually of post oak (*Quercus stellata*), and a ground cover dominated by prairie grasses, especially Indian grass (*Sorghastrum nutans*), little bluestem (*Andropogon scoparius*), and big bluestem (*A. gerardii*). Barrens have thin soils over limestone or occasionally sandstone bedrock. These communities occur at scattered sites on the Forest--on a few sites in the Brown County Hills and the Crawford Escarpment and on several sites in the Crawford Uplands. These sites have species characteristic of both prairie and open timber. Fire use by Native Americans played an essential role in slowing succession and maintaining these communities with few or no shrubs or trees (Engstrom 2000).

Barrens are generally small and are considered globally imperiled (G2) by the Nature Conservancy (Faber-Langendoen 2001). In the Eastern Region, barrens communities provide habitat for at least 60 Regional Forester Sensitive Species (RFSS), including 45 plant and 15 animal species. Currently, 12 barrens insects are considered RFSS on the Hoosier. Appropriate management of this habitat is necessary to provide for viable populations of all barrens species. Lack of active management leading to habitat degradation in the form of woody vegetation encroaching into the open portions of these ecosystems is the greatest threat

to these communities. With the advance of woody species, barrens sites become more mesic, and their biological diversity decreases (Ladd 1991). The maintenance and restoration of these natural areas is a fundamental strategy for maintaining diversity as these areas serve as refuges for unique and often endemic plant and animal communities (Simons *et al.* 1999). Prescribed burning is often the most efficient management in barrens communities. With the exclusion of periodic disturbance, succession to a forest-like condition may occur rapidly. Small mammals, nesting birds, and hundreds of insect species require the structure found in barrens as maintained by fire including an open canopy, scattered shrubs, and a patchwork of dense and sparse herbaceous vegetation.

One of the greatest needs in the barrens communities on the Hoosier is additional surveys for rare species, particularly insects. During an ongoing survey of barrens insects on the Forest, several insect species were discovered that are in need of protection and management, as well as several species new to Indiana. While conducting surveys at three study sites, including Boone Creek Barrens, Cloverlick Barrens, and Harding Flats Barrens, Bess (2004) found that these barrens communities contained very diverse faunas of remnant-dependent insect species, rivaling the combined faunas of all other barrens remnants he had surveyed in the region. This study recorded roughly 1,200 insect species, thus emphasizing the importance of this habitat type.

Management Indicator Species

The National Forest Management Act directs the Forest Service to select and track species that are of special interest or indicative of management trends. Forests select Management Indicator Species (MIS) because they are likely to provide information on the effects of management activities. Forest Biologists reviewed the 31 species identified as MIS in the 1991 Forest Plan amendment using the following criteria:

- diversity of habitats found on the Hoosier;
- current forest issues;
- feasibility and cost associated with monitoring populations across the forest;
- the ability to assess the effects of management activities listed in the alternatives on the selected species;
- the effects of additional species that use similar habitats; and
- recommendations of the Species Viability Evaluation Panels.

Creel surveys are exit surveys, usually conducted at boat ramps, detailing the catch and release by anglers leaving an area. The lack of creel and other surveys on the Forest eliminated the selection of fish species as MIS, and the lack of surveys covering the three terrestrial species (raccoon, bobcat, and gray squirrel) limited their selection. Established breeding bird survey routes and data collected over the last 10 years allowed for the selection of bird species as MIS. After this selection, the Cornell Lab of Ornithology's "Birds in Forested Landscapes Program" was checked for inclusion of the identified species.

The Hoosier selected five species as MIS to cover a range of habitats, as well as a range of response to the issues presented in the Forest Plan: Acadian flycatcher (*Empidomax virescens*), American woodcock, Louisiana waterthrush (*Seiurus motacilla*), wood thrush, and yellow-breasted chat. Yellow-breasted chat and American woodcock are MIS of early successional hardwood habitats. The remaining species are associated with mature forests of varying tract sizes ranging from wood thrush on small tracts, to Louisiana waterthrush and Acadian flycatchers, which require much larger tracts of forest interior habitat. These species

represent the effects on forest interior and forest fragmentation. Response to fire would vary among the species. Table 3.5 shows the MIS selected and the associated habitat conditions or life history traits for each. This new list of MIS better responds to the issues facing the Hoosier today.

Table 3.5
MANAGEMENT INDICATOR SPECIES AND ASSOCIATED HABITAT CONDITIONS

Species	Habitat Conditions Associated with Species
Acadian flycatcher	• Inhabits large tracts of mature, mesic, forests with shrubby understory. • Nests are usually placed on a fork of a horizontal branch well away from the main trunk. Height ranges from 6 to 30 feet.
American woodcock	• Habitatrequirements vary with activity, time of day, and season. The birds prefer early successional habitats created by periodic disturbance of the forest. Therefore, young forests and abandoned farmland mixed with forested land are ideal habitat. • Woodcock use forest openings, clearcuts, fields, roads, pastures, and abandoned farmland as display areas for courtship. • Nests and broods are found in young to mixed-age forests, but young, open, second-growth stands are preferred. Nests are located on the ground. • During summer, young hardwoods and mixed forest with shrubs provide daytime cover for feeding.
Louisiana waterthrush	• Mature deciduous or mixed forests with moderate to sparse undergrowth, near rapid flowing streams. • Nests are located on the ground along streambanks, hidden in the underbrush or among the roots of fallen trees.
wood thrush	• Inhabits the interior and edges of deciduous and mixed forests, generally in cool, moist sites. • Requires moderate to dense understory and shrub density with a lot of shade. • Nests are located on the lower limbs of a tree or shrub, usually 10 to 13 feet above ground, hidden among leaves in a shady area.
yellow-breasted chat	• Early successional habitat requires moderate to dense understory. • Nests are located on lower limbs of trees or shrubs, hidden among leaves in a shady area.

"Alternatives and the Effects of Management" (a few pages further in the document) displays the effects on MIS that would result from implementation of the alternatives.

Species Viability Evaluation and Regional Forester Sensitive Species

The National Forest Management Act (36 CFR 219.19) incorporates the following direction on biodiversity when developing or revising a Land and Resource Management Plan:

> "Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired nonnative vertebrate species in the planning area. For planning purposes, a viable population shall be regarded as one which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is

well distributed in the planning area. In order to insure that viable populations will be maintained, habitat must be provided to support at least a minimum number of reproductive individuals and that habitat must be well distributed so that those individuals can interact with others in the planning area."

Activities proposed in alternatives must meet these minimum standards for viability of native and desired nonnative birds, mammals, fish, amphibians, reptiles, and plants. Additional direction (USDA Regulation 9500-4) extends this mandate to include vascular plants. The Hoosier used the Species Viability Evaluation during the Plan revision to address the viability of plants and animals in the planning area. The Committee of Scientists (1999) recognized that it was impossible to monitor the status and assess the viability of all species, and identified the need to focus on a small subset of species. A matrix was generated for each group of species (terrestrial, aquatic, and plant) incorporating all of the habitat types found on the Hoosier. This matrix was used as a screen in combination with the criteria to select species for viability assessment. The criteria that was used is as follows: species listed as Eastern Region RFSS; species listed as Federally threatened, endangered, or proposed; species representative of each of the habitat types located on the Forest; the availability of literature on a species; and species occurrence within the last 25 years. This screen resulted in a list of preliminary species to be carried forward in the species viability evaluations (SVE) process (for a detailed review of this process, see Appendix H).

The SVE Panels selected 20 SVE species to be used in conjunction with GIS-based modeling to evaluate the effects of each management alternative. These SVE species included two mammal species, eight bird species, two reptile and amphibian species, two aquatic species, and six plant species, representing each of the habitats found on the Forest. This process included not only a coarse-filter, ecosystem-level assessment, but also a fine-filter, species–level assessment to responsibly assess risk for all species that occur on the Forest (Noon *et al*. 2003). After reconvening in 2003, the SVE Panels replaced the gray treefrog (*Hyla chrysoscelis*) with the spotted salamander (*Ambystoma maculatum*) to ensure that the SVE Process covered the group of amphibians using upland ponds and waterholes. Table 3.6 displays species considered during the species viability evaluation.

Table 3.6

SPECIES EXAMINED IN SPECIES VIABILITY EVALUATION PROCESS

Mammals	**Plants**	**Bird**	**Reptiles & Amphibians**	**Aquatic Species**
Indiana bat	Carolina thistle	American woodcock	spotted salamander	Indiana crayfish
river otter	climbing milkweed	cerulean warbler	timber rattlesnake[1]	northern cavefish
	Illinois wood-sorrel	Henslow's sparrow		
	French's shootingstar	northern bobwhite		
	prairie parsley	ruffed grouse		
	yellowish gentian	wood thrush		
		worm-eating warbler		
		yellow-breasted chat		

[1]This species was dropped in May of 2004 due to the unavailability of geospatial data needed to complete a habitat suitability index model for this species.

Ensuring that a species will persist indefinitely is not possible because species and their environments are dynamic. Furthermore, there is no single fixed population above which a species is viable and below which it will become extinct (Boyce 1992) or, in the case of the Hoosier, extirpated. Consequently, viability may be better ensured by the maintenance of principal habitats. Risk to maintenance of viability over the next 150 years was assessed for each SVE species. For other species on the forest, including Regional Forester sensitive species and Federally threatened, endangered, and proposed species, viability is ensured in relation to each of the species' principal habitat relationships by alternative. The Hoosier has organized animal and plant species by the 10 principal habitat types found on the Hoosier:

- Barrens: Typically upland dry sites with exposed limestone and open canopy
- Cliffs: Sandstone or limestone cliffs and outcrops
- Dry Forest: Upland dry forest
- Karst: Caves and sinks
- Mesic Forest: Lowland or bottomland moist soil forest
- Openlands: Grasslands, old-field, early successional habitats
- Ponds: Ponds, waterholes, lakes
- Rivers: Rivers, streams
- Wetlands: Shallow water wetlands, vernal wetlands, wet prairie
- Wide-ranging: Species that may use multiple habitat types

The Hoosier contracted with North Central Research Station and Pangaea Information Technologies, Inc. to create GIS-based habitat suitability models for each of the SVE species. GIS-based habitat suitability index (HSI) models can be used to guide decisions in habitat conservation initiatives and provide a unique tool for natural resource managers to evaluate wildlife-habitat relationships, especially at a landscape level. HSI models provide a numerical index of habitat quality (ranging from 0 to 1) based on measured features such as overstory canopy cover, average tree height, and so forth (Schamberger *et al*. 1982). To compare alternative land management scenarios over time, GIS-based HSI models can be used to evaluate landscapes simulated by spatially explicit forest landscape models, such as LANDIS. These HSI models use digital maps of ecological land types and age and species groups of dominant overstory trees, which are available from a variety of sources such as forest inventories, interpreted aerial photos, and classified satellite imagery.

Since NFMA regulations require the provision of habitat for species viability in the planning area, the focus of this evaluation is the habitat provided on NFS lands. Surrounding private lands may contribute to, or hinder, the maintenance of species viability on NFS. However, these lands are not relied on to meet regulation requirements. For this reason, HSI models assess the habitat abundance and quality of the NFS lands only. Habitat Suitability Index models assessed habitat distribution and connectivity by considering the condition of intermixed ownerships and conditions, which may affect the interactions of certain species among suitable habitat patches on the Hoosier.

Table 3.7 defines the species considered by their habitat.

Table 3.7

SPECIES BY HABITAT TYPE

Species	Wet-lands	Ponds	Rivers	Dry Forest	Mesic Forest	Bar-rens	Cliffs	Karst	Open-lands	Wide Ranging
American Woodcock				X	X				X	
Cerulean warbler					X					
Henslow's sparrow									X	
Indiana bat										X
Indiana crayfish			X							
Northern cavefish								X		
Northern bobwhite				X		X			X	
Northern river otter	X		X							
ruffed grouse				X	X				X	
spotted salamander		X		X	X					
wood thrush					X					
Worm-eating warbler				X	X				X	
Yellow-breasted chat						X			X	
Carolina thistle				X						
Climbing milkweed						X				
French's shootingstar							X			
Illinois wood-sorrel					X					
Prairie parsley				X		X				
Yellow gentian						X				

On the Hoosier, high levels of risk to species viability are associated with certain principal habitats that are currently not represented well on the forest. Because viability regulations focus on the role of habitat management in providing for species viability, successional stage is a key factor used to drive the SVE process. The highest risks to species viability are associated with:

- Barrens: critical to maintaining species viability due to their natural rarity on the landscape, their decline during European settlement due to fire exclusion, and the large number of rare species, both plant and animal, associated with them.
- Openlands - Grasslands: critical to maintaining species viability due to their rarity on the landscape and the ephemeral nature of this habitat type.
- Openlands - Shrublands: critical to maintaining species viability due to their rarity on the landscape and the ephemeral nature of this habitat type.

- Openlands – Young Forests: critical to maintaining species viability due to their rarity on the landscape and the ephemeral nature of this habitat type.
- Wetlands: critical to maintaining species viability due to their natural rarity on the landscape, their decline during European settlement due to beaver control and drainage for agriculture, and the large number of species that use this habitat type during some portion of their life cycle.

Due to the rarity of the openlands habitats (grasslands, shrublands, and young forests), the Hoosier selected several open land species. These habitats were of key interest because of the high risk to species viability and the role of management to reduce this risk by improving abundance and distribution of these habitat types.

The 19 SVE species were selected to represent all the species on the Forest including RFSS. As before mentioned, RFSS viability is ensured in relation to each of the 10 principal habitat types found on the Forest (Table 3.7). Persistence of these habitat types should ensure the viability of these species on the Hoosier. The biological evaluation, conducted as a part of all national forest management decisions, includes specific consideration of effects to RFSS. For a detailed account of the effects of the each of the proposed alternatives on RFSS, see the Programmatic Biological Evaluation of Regional Forester Sensitive Species, Hoosier National Forest Land and Resource Management Plan Revision (2005). Although the RFSS list will be revised on a somewhat regular basis, the selected species will likely still be organized by the 10 principal habitats. The Eastern Region maintains the Regional Forester sensitive species list, which is located on the internet at: http://www.fs.fed.us/r9/wildlife/tes/tes_lists.htm.

Habitat Fragmentation

Habitat fragmentation is the disruption of extensive habitats into small, isolated patches and the overall loss of total habitat area (Harris 1984). Fragmentation is often thought of primarily in terms of songbirds, but many other species are also affected. Wilcox and Murphy (1985) described habitat fragmentation as the most serious threat to biological diversity and as a primary cause of accelerated rates of extinctions of plants and animals worldwide. The effects of forest fragmentation are especially strong on species that have historically been dependent on large areas of contiguous forest (Finch 1991, NCSSF 2005). Such area-sensitive species, including many migratory songbirds, show greater declines in numbers and range distribution than would be expected from the proportion of habitat loss (Robbins *et al*. 1989). Fragmentation not only results in a reduction of the amount of forest, but it also isolates the remaining forested tracts from one another because of intervening land use, such as agricultural or urban uses (Harris and Silva-Lopez 1992). Furthermore, loss of forest area may reduce the availability of nesting sites (Burke and Nol 1998), causing a crowding of nests in the remaining habitat fragments. An increase in nest density has been shown to reduce nesting success for some species (Keyser *et. al* 1998).

Fragmentation by conversion of forested lands to other land uses has a high degree of impact on biodiversity by changing existing habitat for long periods of time (or permanently), and the remaining habitat is left in smaller, more isolated patches (Openlands Team 1995). Although clearing of woodlands and urban development are permanent changes that contribute to habitat fragmentation, timber harvesting results in temporary reductions in habitat quality and quantity for some species. Fragmentation of forest age classes, which leaves a forest matrix intact but with several different age classes can have both beneficial and adverse effects depending on the species.

Adverse effects of edges created by timber harvest in forested landscapes have not been well documented. Although the mechanism by which fragmentation affects populations in Indiana is unknown, the response of these species to habitat fragmentation may be related to other factors associated with fragment size. These factors include brood parasitism by the brown-headed cowbird (*Molothrus ater*) and high rates of nest predation by generalist predators, such as blue jays and raccoons (Faaborg *et al.* 1995). Predators are more common in fragmented habitats containing large amounts of edge than in the interior of larger forest tracts (Keyser *et al.* 1998).

The brown-headed cowbird has expanded its range eastward and increased sharply in abundance in the last few decades (Bystrak and Robbins 1977, Mayfield 1965). Fragmentation of Eastern forests created small patches of forest surrounded by open habitat that cowbirds require for feeding and nest searching (Brittingham and Temple 1983). Robbins *et al.* (1992) listed nest parasitism by cowbirds as a chief constraint on the breeding habitat for many Neotropical migrants. Data indicate that cowbirds are dependent on agricultural and developed habitats that are critical for feeding, and this species abundance may be regulated by the availability of suitable feeding habitat (Thompson and Dijak 2000). This dependence on suitable feeding habitat in forested landscapes has important conservation implications for cowbird hosts. In Indiana, where an array of agricultural lands surround forest patches of all sizes, most breeding habitats suitable for interior forest species also support breeding cowbirds. Brittingham and Temple (1993) found increased cowbird parasitism around gaps as small as half an acre in fragmented forests of central Wisconsin.

Fragmentation and increased edge negatively affect some species, but other species benefit from these conditions. Songbirds such as gray catbirds (*Dumetella carolinensis*) and common yellowthroats are numerous in brushy and edge habitats resulting from clearcut stands and transmission line corridors (Yahner 1997, Piergallini 1998). White-tailed deer, red fox, and coyote (*Canis latrans*) also favor increased edge and forest fragmentation (Yahner 1995, McGuinness 1997).

Landscapes dominated by agriculture, such as in the Midwest, may contribute to such low levels of reproductive success that many species of Neotropical migrants are unable to support viable populations (Ford *et al.* 2001). The persistence of Neotropical migrant populations in these Midwestern landscapes suggests source-sink dynamics (Robinson *et al.* 1995, Brawn and Robinson 1996), in which productive source habitats provide immigrants for sink habitats (Pulliam 1988, Pulliam and Danielson 1991). Brawn and Robinson (1996) suggested that the entire agricultural portion of the Midwestern U. S. might act as a regional “sink” requiring Neotropical migrant populations in this region to be maintained by constant immigration. Specifically, they reported that the reproductive success of many migrant species is so low in the forests of Illinois that much of the state may be a population sink requiring colonists from contiguous forests in surrounding Midwestern states, such as Missouri and Indiana, which may provide source habitat.

Weins and Rotenbery (1981) define source habitat as an excess production of young beyond the carrying capacity of the habitat, promoting dispersal. As little as 10 percent of a metapopulation, a set of local populations connected by migrating individuals, may be found in some source habitats. Yet this source population may be responsible for maintaining the remaining 90 percent of the population in sink habitats (Pulliam 1988).

Exotic Invasive Animal Species

The invasion of exotic species and their ability to alter population, community, and ecosystem structure and function is an important issue in natural resources. The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 defines exotic species as, “The condition of a species being moved beyond its natural range or natural zone of potential dispersal, including all domesticated and feral species and hybrids….” People in the United States have often introduced exotic species with little consideration of the long-term negative consequences that these species may eventually have on native biotic communities. Although some introductions have had nominal impacts on native populations and habitats, several have caused devastating damage to natural ecosystems. The majority of exotic terrestrial vertebrates found on the Hoosier originated in Africa, Asia, or Europe. Only one species, the house finch (*Carpodacus mexicanus*), is native to North America. Four species were intentionally introduced to the eastern United States including the European starling (*sturnus vulgaris*), house finch (*Carpodacus mexicanus*), house sparrow (*Passer domesticus*), and rock dove (*Columba livia*). People intentionally introduced three species--cats and dogs (*Felis domestica* and *Canis familiaris*) and hogs (*Sus scrofa*)--with subsequent escapes resulting in established feral populations. Two species, cattle egret (*Bubulcus ibis*) and Eurasian collared-dove (*Streptopelia decaocto*), disperse naturally into the area. All of the terrestrial exotic species found on the Hoosier are well adapted to, and flourish in association with, human habitation.

The outright loss of native species is one of the major effects that invasive exotic species have on biodiversity (Nott *et al.* 1995). Globally, invasive exotic species have caused the extinction of at least 109 vertebrate species (Cox 1993). This is a significant percentage of the overall identified causes of vertebrate extinctions. Based on information of the U.S. Fish and Wildlife Service (1994), exotic species contribute to a significant portion of listings of threatened and endangered species in the United States. Exotic species have contributed to the decline of approximately 35 percent of listed species. Exotic species also have other serious effects on ecosystems including general decline in abundance of native species, change in ecosystem structure and function, and the rearrangement of prey-predator relationships.

The level of human-induced disturbance is one of the most important features that make a community susceptible to invasion by exotic species (Hobbs 1989). Generally, human disruptions of natural communities, through soil alterations, removal of vegetative cover, or suppression of natural disturbance regimes, seem to promote community invasion by exotic species, whereas intact communities may be more difficult to invade. Many nonindigenous bird species, including European starlings and house sparrows, flourish in disturbed areas such as cities, farms, and suburbs.

In the United States, the problem of biological invasion began with European colonization over 500 years ago. Colonists introduced species for aesthetic, economic, and recreational reasons. Livestock and nonindigenous food crops essential to survival were the earliest introductions. Many species such as cats and dogs were introduced as domestic animals, but have since established feral populations causing significant ecological problems. While much attention has been focused on the effects of invasive plants and insects, in many instances introduced aquatic and terrestrial vertebrates have had as great or even greater impacts on natural systems.

Exotic species may compete with native species for many things including food and nesting sites. For example, European starlings aggressively compete with other cavity nesters including

buffleheads (*Bucephala albeola*), eastern bluebirds (*Sialia sialis*), great crested flycatchers (*Myiarchus crinitus*), purple martins (*Progne subis*), tree swallows (*Tachycineta bicolor*), and woodpeckers (Cabe 1993). Exotic terrestrial species may also degrade habitat quality for native wildlife and introduce diseases, pathogens, or parasites that can spread to native wildlife.

Further information regarding the exotic terrestrial species that inhabit the Hoosier, see *The Hoosier-Shawnee Ecological Assessment* (Thompson, ed. 2004)

Alternatives and the Effects of Management on Animal Communities

Over 500 wildlife species inhabit the Forest during some part of their life cycle. The "Maintain and Restore Watershed Health" section considers aquatic species. Since it is not feasible to cover the effects of the proposed alternatives on every wildlife species known to occur on the Hoosier, the Forest has used a variety of approaches to provide for ecological conditions that contribute to the long-term abundance and distribution of species. This section presents predictions under alternative ways of managing animal communities on the Hoosier. The consequences, or effects, discussed in this section provide a basis for understanding the implications of and differences among alternatives. This section focuses on species groups or examples of species potentially affected by proposed actions. An analysis of SVE species and MIS is also included in this section.

All Alternatives

The abundance and distribution of wildlife species on the Forest depends greatly on the amount, distribution, and quality of habitat. Wildlife habitat is comprised of vegetation types and features such as dead trees, downed logs, and water bodies. Configuration, size, and habitat characteristics of management areas and riparian corridors influence the degree to which management activities would affect wildlife. Large (1,000+ acres) contiguous tracts where natural succession determines forest conditions (as in Management Areas 5.1, 6.2, 6.4, and 9.3) would gradually decline in habitat diversity as sugar maple and American beech come to dominate most stands. Species that have lower reproductive success near forest edges and in edge-dominated forest fragments due to predation and brood parasitism would benefit from this opportunity. On the other hand, wildlife that use young forest, open land, or shrub land habitat would gravitate toward the perimeter of such blocks.

Across the Hoosier, natural processes of forest succession would gradually increase the amount of habitat associated with middle-aged and older forests without openings. Wildlife that use these habitats, such as area-sensitive species or forest interior species would eventually benefit from more acreage with suitable habitat conditions. An increase in acreage would support a larger population and provide greater potential to produce excess individuals for dispersal to remote or less productive areas. Long, linear, often-interrupted strips (MA 2.4 and streamsides) provide corridors or partial corridors along streams between habitat blocks. Although many of the vegetative conditions that would develop in these areas are identical to those that would appear in Charles C. Deam Wilderness, the narrow shape and spotty ownership pattern result in different effects.

Management Area 2.4 and riparian corridors enhance riparian area values and attributes associated with water quality. These areas function as wildlife travel corridors for many species. Bats are likely to use these corridors for travel, feeding, and obtaining water.

When the management objective is preservation, animal communities gradually change as habitat changes with the succession of forest vegetation. Over a period of 150 to 200 years, succession would favor species normally associated with mature forest habitats. Den trees and snags would increase over time because of natural decline and death of trees. An increase in den trees and snags would benefit cavity-nesting birds (Evans and Conner 1979) and mammals, including pileated woodpecker, raccoon, and Eastern gray squirrel (*Sciurus carolinensis*).

Initially, horizontal diversity in these areas would decrease as the forest matured, with a resulting decrease in habitat for species associated with early successional vegetation. White-tailed deer, prairie warbler, yellow-breasted chat, and ruffed grouse populations would decline over time from present levels, as natural succession of the brush-stage vegetation on the area eventually converts to canopied forest stands. The few forest interior species associated with closed-canopy forest such as ovenbird and wood thrush would benefit (Crawford *et al*. 1981), but species requiring a variety of habitats during the course of their yearly cycle would decline. As blocks of forest attained old growth characteristics, tree death and natural disturbance would create openings resulting in an increase in diversity.

Less accessible Management Areas 5.1 and 6.2 would provide a degree of escape cover for game animals hunted in adjacent forest areas that are more accessible by roads.

As highlighted in this section, many nonnative exotic species, such as feral cats, hogs, and starlings, have become established in the area, largely due to human alteration of the landscape. This suggests that land management practices may at least limit the impacts of exotic wildlife. By managing habitats specifically for native wildlife, native species may be better able to cope with the many threats presented by exotics. Ecological communities have characteristics that promote invasion by exotic species. The level of human-induced disturbance is one of the most important features that make a community susceptible to invasion by exotic species (Hobbs 1989). Generally, human disruptions of natural communities through soil alterations, removal of vegetative cover, or suppression of natural disturbance regimes seem to promote the invasion of a community by exotic species, whereas intact communities may be more difficult to invade.

Alternatives 1, 3, 4, and 5

Within landscapes, disturbance is considered important in maintaining diversity of species and community structure and function (Attiwil 1994). In addition, protection from disturbance would likely hasten the transition of species and result in a loss of biological diversity across the Forest.

Even-aged Management Techniques

The Forest has considered the effects of even-aged management on wildlife from two perspectives: (1) effects on the immediate area and (2) effects from a landscape perspective over time.

Clearcutting and shelterwood harvest and subsequent regeneration result in changes in animal populations and communities. Although such treatments temporarily remove habitat for wildlife requiring mature forest, they can create and enhance habitat for species that use early successional plant communities in the forested area. Each newly regenerated stand reverts, in time, to mature woodland after passing through various stages of succession. Wildlife diversity also changes through time on these sites as plant succession progresses.

The volume of mast production would essentially remain unchanged in forested areas under even-aged management. Without even-aged management, the variety and amount of mast would tend to change due to natural selection processes associated with regeneration in the central hardwood forest. Without even-aged management, mast trees such as black gum (*Nyssa sylvatica*), beech, and maple would occur more frequently. This shift in forest composition has implications for many wildlife species that depend on oak and hickory trees, which would occur less frequently than then they do today. An even-aged forest, would maintain the availability of acorns and hickory nuts, which are important foods for many species. It would also maintain niches associated specifically with oak or hickory trees.

Soft mast is the fleshy fruits of trees, shrubs, vines, and herbaceous plants, and is another important food source for many wildlife species. White-tailed deer, many songbirds, numerous small and medium-sized mammals, and some reptiles forage extensively on this food source (Perry *et al.* 1999). Reductions in the amount of forest canopy typically increase soft mast production, and even-aged harvest can result in abundant soft mast. One study found that soft mast production was greater in harvested stands than in unharvested stands 3 to 5 years after treatment. Even-aged treatments resulted in significantly more soft mast than unharvested stands, single-tree selection cuts, and group selection cuts (Perry *et al*. 1999).

Although even-aged management changes plant and animal diversity on a given site for many years following regeneration harvest, effects on wildlife diversity across a forested area depend on existing conditions and the amount, frequency, location, size, and configuration of periodic harvests. The age class distribution and vegetative diversity of a forest area could remain relatively stable if the acreage reaching maturity is approximately equal to the acreage that is regenerating.

Even-aged management with a 120-year rotation would prevent some forest patches from ever obtaining the characteristics of old growth forest in which many forest-interior birds evolved. These characteristics include overstory canopy trees older than 150 years with diameters ranging from 32 to 64 inches, understories composed of late-seral, shade-tolerant trees, and large numbers of snags and downed logs. Canopies in old growth forests are multi-layered with groups of canopy trees interspersed with canopy gaps and their associated vegetation (Parker 1989). Species unfavorably affected by changing mature stands of large trees to young seedling and sapling stands include cerulean warbler, black and white warbler, pileated woodpecker, blue-gray gnatcatcher (*Polioptila caerulea*), and scarlet tanager. In addition, nest predation can be higher in recently cut stands. For example, one study in Illinois found that rates of predation on the nests of Kentucky warblers were significantly lower in older forest than in even-aged clearcuts (Morse and Robinson 1999).

Species richness and abundance of salamanders may be temporarily reduced following even-aged management activities. One study found that captures of salamanders from plots located in forest stands older than 50 years were five times higher than those on recent clearcuts (Petranka *et al*. 1993). Land managers can mitigate the effects on these and other species by controlling size, shape, and location when harvesting activities are permitted. Species favored by an increase in acres in seedling and sapling stage stands include bobcat, ruffed grouse, ovenbird, and American woodcock.

Given the proper combination of successional stages or acceptable habitats, most animal species found on the Forest can maintain viable breeding populations. Many animal species key in on certain kinds of habitat. Different sets of wildlife species occur in association with different successional stages of forest stands. Treatment of a stand by clearcutting changes the

structure of the stand and can result in rapid changes in species assemblages inhabiting the stand. In particular, birds respond to changes in forest stand age and structure over time, with an almost complete species turnover following clearcutting (Probst *et al*. 1992).

Bird species that feed in the tree canopy such as warblers and vireos, as well as bark foragers such as nuthatches, woodpeckers, and brown creepers (*Certhia americana*), are typical of mature forest stands. Aerial pursuers like swallows, as well as ground foragers such as sparrows and house wrens (*Troglodytes aedon*), dominate newly harvested stands.

As the stand regenerates, a dense shrub layer develops and more understory foliage feeders visit the stand, including many warbler species. These changes are positive or negative depending on the species considered. While species requiring large quantities of snags and large cavity trees may lose quality habitat following clearcutting, many other bird species that depend on shrub-sapling habitat would benefit. Furthermore, Thompson *et al*. (1993) identified many bird species requiring shrub-sapling habitat as having high conservation concern based on the organization Partners in Flight's criteria such as global abundance and distribution, population trends, and breeding ground threats.

Even-aged management maintains a mosaic pattern of mature forest, young forest, and regenerating stands in a patchwork arrangement. The interspersion of these habitat types can result in fragmentation of mature forest stands, increased edge effects, changes in vegetation and structural diversity, and changes in forage quality and quantity, all of which effect wildlife habitat and populations. Clearing of woodlands for farmland or urban development are permanent changes that contribute to habitat fragmentation, but timber harvest can also result in temporary reductions in habitat quality and quantity for some species. Adverse effects of edges created by timber harvest in landscapes that are predominately forested have not been well documented. Although the mechanism by which fragmentation affects populations in Indiana is unknown, the response of these species to habitat fragmentation may be related to other factors associated with fragment size. These factors include brood parasitism by the brown-headed cowbird and high rates of nest predation by generalist predators, such as blue jays and raccoons (Faaborg *et al*. 1995). Predators are more common in fragmented habitats containing large amounts of edge than in the interior of larger forest tracts (Alverson *et al.* 1988, Yahner and Scott 1988).

Although fragmentation and increased edge have negative effects on many species, other species benefit from these conditions (Yahner and Scott 1988). Songbirds such as catbirds and common yellowthroats are numerous in brushy and edge habitats resulting from clearcut stands and transmission line corridors (Yahner 1997, Piergallini 1998). Increased edge and forest fragmentation have also favored white-tailed deer (Alverson *et al*. 1988), red fox, and coyote (Yahner 1995). The American woodcock uses lowland shrub and dense early successional forests for both feeding and nesting. Although ruffed grouse uses mature forest stands for feeding on buds and catkins, the species also uses dense young growth for cover and for habitat for raising broods.

White-tailed deer, as an edge and early successional species, browse extensively in regenerating stands. Deer have been termed a keystone species because they greatly influence the abundance and distribution of other plant and animal species by directly competing for limited resources and by altering habitat features that determine the distributions of other species (Kraft *et al*. 2004, Rooney and Waller 2003). Deer browsing can reduce biodiversity by limiting the regeneration of tree species including oak, hickory, and maple, and by eliminating populations of herbaceous plants. Both the density of deer and the forage

available within the landscape influence the impact of deer on forest ecosystems (Horsley *et al.* 2003). Extensive overbrowsing by deer can impact oak regeneration by preventing oaks from establishing or entering the sapling size class (Carson *et al*. 2005). Although the Forest can manage habitats such as regenerating forest stands and openings, it cannot manage the white-tailed deer. The State of Indiana has the authority to manage the herd, and does so by setting goals, seasons, and the harvest level.

There is potential for mortality during even-aged management treatments due to tree felling and equipment use, mainly among small, relatively immobile animals such as amphibians, nestling birds, or mammalian young. Adults of many species would simply vacate an area during the time of disturbance; however, direct mortality could occur if the adults abandoned the nests or young during harvest operations.

Uneven-aged Management Techniques

Uneven-aged management techniques reduce the number of trees per acre, resulting in a more open stand structure below the forest canopy. Over time, increased sunlight encourages vigorous growth of tree seedlings, shrub species, and herbaceous plants. Stands managed by uneven-aged techniques grow back to a closed canopy, and there is often a greater structural variation than before harvest. Although the vegetative changes are more subtle than those under even-aged regeneration harvest, they tend to occur on a given site at more frequent intervals (every 20 to 30 years rather than 80 to 120 years). Since this type of harvest removes fewer trees per acre, there are generally fewer effects than with even-aged management.

The uneven-aged management system produces a variety of effects on animal species and community diversity. Species richness, abundance, and distribution depend largely on the amount, variety, and distribution of plant communities and associated characteristics collectively referred to as habitat. The degree of effects on species diversity are a direct result of the quality, amount, and mixtures of habitat produced and perpetuated over time.

One of the main structural effects of uneven-aged management is the creation of gaps in the canopy. The creation of gaps increases the amount of sunlight reaching the forest floor, resulting in a substantial response by herbaceous plants, tree seedlings, and shrub species. This response creates a distinct change in the stand structure, producing more diversity in terms of vertical layering and understory species.

Effects of uneven-aged management on animal species depend on whether harvest is by single-tree selection or group selection. Stand structure and plant communities resulting from single-tree selection differ from those of group selection.

Single-tree selection perpetuates an all-aged forest with a predominately closed but uneven canopy and a relatively homogeneous distribution and variety of wildlife habitats. Periodic removal of selected trees maintains a high level of vertical diversity in canopy structure. This favors those species that use food and cover of forest stands that are vertically diverse—for example, eastern wood peewee (*Contopus virens*), summer tanager (*Piranga rubra*), and great crested flycatcher (*Myiarchus crinitus*). Because this method of harvest allows only limited light to reach the forest floor in any particular spot, understory vegetation is relatively sparse, and habitat for wildlife species requiring dense understory vegetation or ground cover is limited.

Due to periodic single-tree selection harvests and associated damage to residual, standing dead trees and living trees with cavities, the numbers of shade-intolerant to moderately

intolerant plant species (oaks and hickories) and numbers of large-diameter, dead standing trees would tend to decline in the area harvested. These changes may eventually cause a decline from present population levels in some wildlife species, such as bark gleaners and species using cavities and downed logs like the pileated woodpecker, raccoon, and many salamanders. Because these components are important to a variety of wildlife species (Fan *et al.* 2005), existing standards and guidelines require retention of some of these trees. In single-tree selection harvests, although some snags would be lost, they would be removed only if they posed a danger in the sale operation or were accidentally damaged. In addition to leaving snags when marking stands, the Hoosier would maintain a number of den trees to provide for necessary nesting cavities.

Effects on many wildlife species also depend on the numbers of different sized snags and downed logs perpetuated. Opportunities for providing habitat elements of this kind are reduced under single-tree selection.

In the group selection system, managers periodically make openings up to 3 acres, producing habitat for animals that have small home ranges (less than 3 acres), prefer early successional vegetation, or are adapted to forests with openings and "edges," such as common yellowthroat, indigo bunting (*Passerina cyanea*), and field sparrow. In addition, some evidence suggests that forest interior Neotropical and short-distance migrants may shift their habitat preferences during fall to include forest gaps (Kilgo and Miller 1999).

Older trees would be perpetuated in groups surrounding recent openings, providing habitats for a variety of species adapted to different seral stages, including mature trees. Depending on the amount, size, and frequency of harvests, stands under group selection may structurally resemble areas under even-aged management on a smaller scale with a mosaic of well-dispersed, even-aged groups and a variety of plant communities associated with different successional stages. However, because group openings are smaller than clearcut or shelterwood openings and have relatively more shaded borders, less shade-intolerant vegetation would be perpetuated. The decline in shade-intolerant plant species due to group selection may cause declines of some wildlife species populations, such as the Eastern gray squirrel. Furthermore, stands are entered more frequently under uneven-aged treatments.

Group selection produces forage volumes and quality similar to those produced by even-aged management in the sunlit portion of each group, and forage volumes and quality similar to single-tree selection in the shaded area of each group.

On a Forest-wide basis, species richness should not change due to uneven-aged management practices. However, the abundance and distribution of some species would change. Species such as the eastern bluebird, yellow-breasted chat, prairie warbler, and ruffed grouse, which require forest openings or sapling and pole stands larger than three acres in size, may be even less abundant than they are today. Species, such as pileated woodpecker and Eastern gray squirrel, that require stands with several large-diameter trees (more than 20-inch DBH) or a continuous high canopy, would be more widely dispersed in an uneven-aged forest and may also occur in lower numbers than today.

Uneven-aged management is ideally suited to maintaining corridors for wildlife travel and streamside protection, and to create habitat for species that are gap-dependent. Corridors managed for these purposes must have a fairly continuous forest canopy. Forest structure is more important than tree species composition, and benefits provided by the corridor would offset losses of shade-intolerant species (Healy *et al.* 1989).

When forested landscapes are disturbed by human activities, populations of certain songbird species tend to decline. However, some evidence indicates that small, internal openings created in forested landscapes may have few negative effects on bird populations as long as the total number of openings remains relatively small (Hejl *et al*. 1995, Thompson *et al*. 1995,1996). Uneven-aged management, both single-tree and group selection, creates small openings or gaps in the forest canopy. Annand and Thompson (1997) found few effects on bird species characteristic of forest interior habitat in Missouri, but they did report that edge-preferring species may be attracted to openings when gaps are large enough. The introduction of edge into the interior of a forest may increase predator and brood parasitic species, which could greatly reduce the breeding success of songbirds (Brittingham and Temple 1983). In a study of the effects of logging on the breeding success of the Acadian flycatcher in Yellowwood State Forest, Winslow and Whitehead (unpublished data) did not find a statistically significant difference between nest parasitism at selectively logged sites compared with control sites. Furthermore, nest parasitism did not increase at logged sites following timber harvests. In a study of landscape patterns of land cover and the nesting success of Neotropical migrants in south-central Indiana, Doran *et al.* (unpublished data) found that nest parasitism was not significantly correlated with forest cover. Percent cover in this study ranged from 68 percent to 90 percent.

Likewise, a study in a mature, deciduous forest in southern Illinois (Robinson and Robinson 1999) found that selective logging appeared to add little to the existing effects of forest fragmentation. Only two species of forest birds were significantly more numerous in uncut forests, whereas several species populations were dramatically larger in recently cut forests including hooded warbler (*Wilsonia citrina*), indigo bunting, white-eyed vireo (*Vireo griseus*), and Carolina wren (*Thryothorus ludovicianus*). Contrastingly, brown-headed cowbirds showed no consistent differences between uncut and cut stands (Robinson and Robinson 1999).

Timber Stand Improvements

All intermediate treatments increase light availability throughout the canopy and on the forest floor, which increases the abundance and nutritional value of herbaceous vegetation. These changes improve habitat quality for some plant and animal communities that benefit from more open conditions or from increased herbaceous ground vegetation. Grapevine control as practiced on the Forest slightly reduces food and cover provided by grapevines. However, the Hoosier typically leaves in place grapevines that do not threaten dominant overstory trees or species composition in a given stand (approximately 80 percent). Stand improvement activities generally leave grapevine arbors and areas where there are heavy concentrations of grapevines. These grapevine arbors generally are less than 1 acre in size.

All intermediate treatments with the exception of pruning can be used to favor a desired diversity of species, including major mast producers. They may also foster a greater complement of native species. These treatments also provide the opportunity to develop or retain den trees, standing snags, and down logs.

Comparison of Alternatives

Due to the amount of the Forest not considered suitable for timber harvest and the small amount of proposed harvest, the majority of the Forest will move into a late successional stage. Under all alternatives, the amount of mature hardwood (80 + years) is expected to surpass the amount currently found on the Hoosier (Table 3.8). Alternative 2 emphasizes mature forest interior species, and under this alternative almost all wildlife habitat would move over time to a late successional stage. Limited vegetation management could occur with this alternative, but

only if needed to benefit or maintain Federally threatened and endangered species' habitat. This alternative would classify zero percent of the Forest as suitable for timber harvest, and no wildlife openings would be maintained, leading to a reduction of early successional habitats and upland openings. Fragmentation and edge effects could be reduced and forest patch size should increase under alternative 2. This alternative would benefit wildlife species requiring high forest canopy and little disturbance. However, it would negatively affect wildlife species requiring early or mid successional habitats. In some cases, habitat for these species would likely disappear, resulting in a loss of the species on the forest (see SVE Analysis for additional information) and a decrease in overall biological diversity. Over time, the majority of stands on the Hoosier could obtain old-growth characteristics such as larger average tree size leading to large snags and cavity trees providing den and nest sites, large trees with loose flaking bark providing roost sites for bats, and large downed woody material providing habitat for salamanders and small burrowing mammals.

Table 3.8

PERCENT OF MATURE HARDWOOD (80+ YEARS OLD)
At 50 and 150 Years in the Future

Existing	Alt. 1		Alt. 2		Alt. 3		Alt. 4		Alt. 5	
	50 Years	150 Years	50 Years	150 Years	50 Years	150 Years	50 Years	150 Years	50 Years	150 Years
48	63	81	65	86	62	80	56	65	63	81

Under Alternatives 1, 3, 4, and 5, timber harvest would be one of the primary disturbance factors affecting forest communities. Harvest results in a diversity of habitats by affecting vegetation composition, structure, and pattern across the Forest. Alternatives 1 and 5 include a lower timber harvest level than Alternatives 3 and 4, both in terms of acreage considered suitable for timber production and in terms of the maximum level of timber produced from the suitable land base under Forest Plan constraints. Timber harvest would help create and maintain wildlife habitat. Harvest methods would vary under Alternatives 1 and 5, but uneven-aged management would predominate in these alternatives. Approximately 77 percent of the harvest would be uneven-aged prescriptions, with 23 percent being even-aged.

Table 3.9 displays clearcut and shelterwood acres per decade. The effects of even-aged management on wildlife populations and habitat in Alternatives 1 and 5 would be intermediate between Alternatives 3 and 4. However, the clearcut size would be larger under Alternative 5 than Alternative 1. The effects of Alternatives 1 and 5 on wildlife from group selection are greater than those of any other alternatives. The effects from single-tree selection are, however, less than with Alternative 3 or 4. These effects are positive or negative, depending on the species and their requirements.

Alternative 3 includes an intermediate timber harvest level in terms of the maximum level of timber produced from the suitable land base under Forest Plan constraints (average annual ASQ– 6.2 million board feet per year). However, the acreage considered suitable for timber production is the same as Alternative 4. Harvest methods would also vary under Alternative 3: approximately 45 percent of the harvest would be uneven-aged prescriptions and 55 percent would be even-aged.

Even-aged management with Alternative 3 would have a greater effect on wildlife populations and habitat than Alternative 1 or Alternative 5 and less of an effect than Alternative 4. Conversely, the acreage of group selection is much smaller than with Alternative 1 or Alternative 5, and slightly greater than Alternative 4. The effects of single-tree selection are intermediate between Alternatives 1 or 5 and Alternative 3.

Alternative 4 proposes the greatest amount of timber harvest among all the alternatives. The annual mix of activities and volumes is expected to vary, but the allowable sale quantity of 95 million board feet per decade would not be exceeded. Approximately 35 percent of the harvest would be uneven-aged prescriptions, with 65 percent being even-aged.

The effects of even-aged management on wildlife habitat and populations would be greater with Alternative 4 than with any other alternative, as would the effects of single-tree selection. Since Alternative 4 would harvest the most timber, it would have the greatest overall effect on wildlife populations and habitat. The effects are positive or negative, depending on the species and their requirements.

Table 3.9

ACRES OF VEGETATIVE TREATMENT FOR THE FIRST 10 YEARS

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Total Clearcut	2,020	0	1,600	6,020	2,020
Hardwood Clearcut	1,020	0	110	3,050	1,020
Pine Clearcut	1,000	0	1,490	2,970	1,000
Hardwood Shelterwood	760	0	1,950	2,990	760
Pine Shelterwood	80	0	2,120	610	80
Single Tree Selection	1,110	0	3,820	5,160	1,110
Group Selection[1]	2,850	0	240	0	2,850
Total Harvest Acres	6,820	0	9,730	14,780	6,820
Prescribed Fire	20,000	0	50,000	100,000	20,000
Openings Maintained	5,000	0	4,170	5,000	5,000

[1] For group selections, the acreage affected by management activities would be three times the area shown. Figures in the table are proposed acres treated.

Alternatives 4, 3, 5, and 1, respectively, would likely increase the biodiversity of both plant and animal species by providing a mixture of vegetation cover types and ages and more edge than Alternative 2. Some species that use interior forest blocks may not benefit from these effects, but the majority of the Forest would remain unharvested. Currently, less than 1.2 percent of the Forest exceeds 100 years of age, reflecting the relatively recent history of reforestation on the Hoosier (Parker and Ruffner 2004). Under current management practices, the Forest expects old-growth forests (greater than 150 years in age) to increase dramatically in extent. Old-growth forests on Indiana public lands are expected to increase from 895 acres to 136,450 acres over the next 50 years (Parker 1989, Spetich *et al.* 1997). The majority of these acres are on the Hoosier. Conversely, forestland less than 10 years of age comprises less than one percent of the forested landscape reflecting the lack of disturbance across the Forest (Parker and Ruffner 2004).

Old-growth forests, and the degradation and fragmentation of second-growth forests, remain conservation concerns. An equally legitimate issue is the decline of early successional habitats, habitats dominated by grasses, shrubs, or young trees. Of those ecosystems in eastern North America that have declined by greater than 98 percent, 55 percent of these are grassland, savanna, or barrens communities and another 24 percent are shrubland habitats (Noss *et al.* 1995, Thompson and DeGraaf 2001). The SVE analysis revealed that these habitats were not well represented on the Forest and that the viability of species that use these habitats may be at risk. Long-term maintenance of diversity requires a management strategy that considers species characteristics and arrangements of vegetation on the landscape important to retaining landscape level biodiversity and sustainable ecosystems. Management activities will ideally maintain high-quality examples of presettlement ecosystems in approximate proportion to their former abundance in the region (Noss 1983).

Alternatives 3, 4, and 5 allow for the creation of MA 3.3 which allows for larger clearcuts, which would benefit species that require larger openings (for example, ruffed grouse). Alternatives 3, 4, and 5 would direct a portion of proposed even-aged harvest into the MA 3.3 located in the Tell City Ranger District. Directing even-aged management to one management area would meet two conservation objectives: first, to provide an area managed to benefit early successional forest species; and, second, to similarly benefit late successional forest interior species where this harvest might otherwise occur by minimizing edge effects and fragmentation across the Forest. Furthermore, by directing harvest to MA 3.3, these habitats would be enhanced by approximately 1,600 acres of windthrow resulting from severe storms in the summer of 2004 within this management area.

Use of a 100 year rotation would sustain approximately 10 percent of the management area in a 0 to 9 year-old age class. This harvest level is well within the proposed acres of even-aged management that is available within the range of alternatives. This would be enhanced, at least initially, by the proximity of early successional habitats resulting from blowdown. Key considerations are:

- Retain the ability to manage hardwoods and pines throughout the Forest, by either even- or uneven-aged methods.
- Enhance habitat suitability by placement of management units in proximity to existing blowdown.
- Reduce, if not eliminate, the risk of loss of viability for early successional forest species in three alternatives.

Although ruffed grouse, American woodcock, and yellow-breasted chat were selected as SVE species, this directed approach to management would ensure habitat for other early successional forest species such as these currently noted on the Audubon watchlist: the golden-winged warbler (*Vermivora chrysoptera*), Bell's vireo (*Vireo bellii*) and the blue-winged warbler (*Vermivora pinus*). This approach would also benefit forest interior birds, which is a continuing conservation issue.

Thompson and Dessecker (1997) stated, "Grouping harvest activities in one portion of the landscape maximizes habitat quality for early successional wildlife in that portion of the landscape while providing a large block of late-successional forest for other wildlife."

Prescribed Fire

Fire regimes have been a major force shaping landscape patterns and influencing productivity for thousands of years (Abrams 2005). Recently, fire-dominated oak-hickory communities have

undergone a shift in composition due to fire suppression on NFS lands. In Eastern deciduous forests, hardwood species with vigorous sprouting ability, especially oaks, tend to dominate after a fire. However, without fire, sugar maple and American beech tend to dominate such sites.

Although the effects are negligible in most instances, fire occasionally injures and kills wildlife directly by burning and suffocation (Bulan and Barrett 1971, Harrison and Murad 1972, Buech *et al*. 1977). Effects of fire on living organisms depend largely on the season, intensity, and severity of the fire. Burning during the nesting season would have increased effects on populations of birds and mammals (Erwin and Stasiak 1979). Uncontrolled wildfire (high fire severity) would have more lasting effects than low-intensity prescribed fire (low fire severity). Understory fires, like those used in prescribed burning on the Hoosier, would alter habitat structure less than stand-replacement fires.

Habitat changes caused by fire influence animal populations more profoundly than fire itself. Fires can enhance food resources that are available to wildlife by creating openings in otherwise dense overstory vegetation. Periodic understory burns can cause many plants to resprout, and these new sprouts, whether woody or herbaceous, are more palatable and higher in protein and nutritive content than the older tissues that they replaced (Van Lear and Harlow 2000). Soft mast production can be increased significantly through prescribed burning, providing an important food source for numerous small and medium-sized mammals, many songbirds, and some reptiles (Perry *et al*. 1999). These changes could contribute to substantial increases in herbivore populations due to higher birth weights, higher survival of adults, and increased recruitment into post-fire populations (Riggs *et al*. 1996). Potential increases, however, would be limited by an animal's ability to thrive in the altered structure of the post-fire environment.

The effect that fire has on invertebrates can be transitory or longer lasting (Lyon *et al*. 1978). Generally, there would be a decrease in invertebrates during a fire because the flames or lethal soil temperatures would kill the organisms or their eggs, or the fire would destroy their shelter and food supply. Increases in herbaceous vegetation following fires may support increased insect abundance. Some populations of invertebrates would increase after a fire because trees that were damaged or killed by fire would provide a more suitable habitat for those invertebrates that survived, or because the habitat would be maintained in a preferred successional stage, such as barrens communities.

The response of amphibians and reptiles to prescribed burning is an important issue in current wildlife research. Because amphibians and reptiles seem to be able to avoid direct heat by either moving away from fire or by burrowing into the soil, the direct effects of fire seem to be minimal (Mushinsky 1985). However, scientists less clearly understand the indirect effects of fire on these species. Kilpatrick *et al*. (2004) found no significant treatment effects on abundance in five major taxa (frogs and toads, salamanders, turtles, lizards, and snakes) between burned and control areas. Ford *et al*. (1999) found few discernable differences for most species of herpetofauna and small mammals between burned and control areas, supporting the assertion that prescribed fires had little overall impact on these species. A study conducted in California (Vreeland and Tietje 2000) observed no change in relative abundance of amphibians, reptiles, small mammals, or breeding birds in response to prescribed fire.

Burning or suffocation during burn operations can kill small mammals directly (Debano *et al*. 1998). However, most small mammals escape fire by using underground tunnels, pathways under moist forest litter, stump and root holes, and spaces under rock and large dead wood (Ford *et al*. 1999). Indirect effects such as the temporary loss of shelter and food, exposure of

surface runways or burrow openings, and increased predation can reduce the number and diversity of small mammals for 1 to 3 years following a fire (Ream 1981). One study (cited in Debano *et al*. 1998) revealed that many small mammals may increase in burned areas compared to unburned sites within 2 years of a fire.

Opening up the dense overstory with prescribed fire can provide additional space for deer movements and an increase in abundance and quality of browse species. Although reproductive success may be reduced in the first postfire year for ground and low-shrub-nesting birds, habitats for many nongame bird populations are improved by fire (Dickson 2000, Artman *et al*. 2001).

Structural diversity is an important element in wildlife habitat quality. Because fire rarely burns evenly across the landscape, postfire clumps of vegetation, burned logs, and open spaces usually result. Prescribed fire would be likely to result in an increase in food and cover for game and nongame wildlife species (Lyon *et al*. 1978, Ganey *et al*. 1996, Riggs *et al*. 1996). Fire could also create snags, which are important to numerous species of birds, mammals, reptiles, amphibians, and invertebrates. Because large omnivores, such as coyotes, have large home ranges, their populations would change little in response to fire.

Prior to modern agriculture, fire suppression, and urbanization, fire regimes with characteristic severity, size, and return interval shaped flora and fauna patterns in this region (Heinselman 1981, Frost 1998, Gill 1998). Because fire has influenced composition, structure, and landscape patterns of animal habitat for centuries, it is reasonable to assume that animals have coexisted and adapted to periodic disturbances by fire. For these reasons, animal populations should benefit from the use of prescribed fire on the Hoosier. Alternatives 1, 3, 4, and 5 all include prescribed fire. Alternative 4 would use the most prescribed fire and therefore would have the greatest effects on wildlife habitat and wildlife species, followed by Alternative 3. At the lower end of the spectrum are Alternatives 1 and 5. Because Alternative 2 includes very limited prescribed fire, it would allow a buildup of fuels that could lead to a large wildfire. If that should occur, direct effects on animal communities such as mortality could increase. In addition, a large wildfire could increase the opportunities for food and cover for many wildlife species, after regrowth occurs. The lack of prescribed burning in Alternative 2 would also lead to a decrease in barrens habitat and a reduction in oak-hickory regeneration.

Oak-Hickory Regeneration

In addition to including the most timber harvesting among all alternatives, Alternative 4 would also include the greatest amount of oak-hickory management and would result in the largest amount of oak and hickory across the Forest. Table 3.10 displays the change over time by alternative in the acreage of the oak-hickory type. Through the combined use of harvesting and burning, the Forest can maintain the oak-hickory component. If fire were removed from the prescription, all alternatives would likely result in a decrease in the oak-hickory component. However, recent studies have revealed that the application of fire alone, without at least partial harvesting, does not improve oak regeneration consistently. High tree densities, such as those found on the Hoosier, will retard the development of oak understories and subsequent recruitment, even if periodic burning occurs (Hutchinson *et al.* 2005, Signell *et al.* 2005).

Although extensive overbrowsing by deer can impact oak regeneration by preventing oak establishment, some evidence suggests that herbivory does not impact seedling vigor following a prescribed burn. A study examining herbivore pressure on white oak seedlings in once-burned, twice-burned, and unburned plots found no significant difference in arthropod and mammalian herbivory levels on seedlings (Adams and Rieske 2001). The findings from this

study indicate that herbivory, at least in the short term, does not impact oak seedling vigor, while single- and multiple-year fires increase oak seedling growth.

Alternative 4, which has the greatest amount of even-aged management, would result in the greatest amount of oak and hickory over time, followed by Alternative 3 and then by Alternatives 1 and 5. Even-aged management is often the best oak regeneration method (Jacobs and Selig 2005). By maintaining the oak-hickory component on the Hoosier, hard mast of these tree species would still be available for wildlife species, including game animals that depend on this important seasonal food. These species include deer, squirrels, and wild turkeys, as well as nongame species such as the tufted titmouse, blue jay, red-bellied woodpecker, and numerous small mammals that rely heavily on acorns for fall and winter diets (Smith 1986, Grubb and Pravosudov 1994).

In a review of three remnant old-growth woodlots in Ohio (Hicks and Holt 1999), the authors noted that the dynamics of these remnant stands provide clues to the potential fate of many present-day stands that, like most old-growth remnants, developed from disturbances such as fire. In all three stands, oaks and other mesophyitic hardwood species are being replaced by beech and maple. Furthermore, there is little or no oak regeneration in these stands. As noted by the authors, these stands give a good indication of what forests in the central hardwoods region will resemble with fire exclusion and limited cutting. Under Alternative 2, lack of harvesting and prescribed fire would result in the greatest change in the oak-hickory component as the forest continues to age and shift to more shade-tolerant species. Without management, this conversion to more shade-tolerant species would continue over time as the stands continued to age. Hard mast would become less available for species that depend on this food source.

Table 3.10

CHANGE IN ACRES OF OAK-HICKORY OVER TIME

Existing	Alt. 1		Alt. 2		Alt. 3		Alt. 4		Alt. 5	
	50 Years	150 Years	50 Years	150 Years	50 Years	150 Years	50 Years	150 Years	50 Years	150 Years
130,890	134,920	87,610	130,890	63,570	144,800	104,600	149,880	135,340	134,920	87,610

After harvests, Alternatives 1, 3, 4, and 5 would use prescribed burning to assist in the maintenance of stands in the oak-hickory type. Under Alternative 2, late seral oak-hickory stands would transition to climax beech-maple stands over time. Under uneven-aged management, which Alternatives 1 and 5 emphasize, stands would transition to beech-maple stands. Conversely, the Hoosier could manage stand vegetation to maintain some of the seral oak-hickory type, which is valuable to an array of plant and animal species. Alternatives 3 and 4 would apply even-aged management on selected lands suitable for timber harvesting and increase the amount of prescribed burning substantially from the other alternatives. This increase in management would result in an increase in oak regeneration (see Table 3.10).

Conversion of Nonnative Pine Stands to Native Hardwoods

Hardwood species would gradually replace the current pine overstory as these species age and senesce even without management. However, management activities such as timber harvest and prescribed fire would hasten the conversion of this type to native hardwoods (Table 3.10a). Alternatives 3 and 4 would remove the greatest amount of pine, especially in the first 30 years.

These alternatives would remove entire stands of pine and not just portions of stands, thus reducing the likelihood of pine seedlings becoming established in newly regenerated stands. Prescribed burning would follow most pine harvesting immediately, with an additional burn occurring within a few years to aid in oak-hickory regeneration. Alternative 4 would convert pine plantations to hardwood stands more quickly than the other alternatives, followed by Alternatives 3, 1, 5, and 2, respectively. Although Alternatives 3 and 4 would result in a greater reduction of pine during the first three decades, by year one hundred many of the pines across the forest would have died naturally. The loss of pine through natural mortality or through vegetation management would result in a loss of breeding habitat for the pine warbler, black-throated green warbler, and Blackburnian warbler.

The North American Breeding Bird Survey (BBS) is a useful tool in analyzing population trends for many bird species. The BBS, started in 1966, is a large-scale roadside survey covering the continental United States and southern Canada, and BBS has recently initiated survey routes in Alaska and northern Mexico. The primary objective of the BBS has been the estimation of population change for songbirds. One should interpret BBS trends with caution because of possible biases. However, the data has many potential uses, and investigators have used the data to address a variety of research and management objectives. BBS trends were calculated for the period of 1996-2003 by the route regression method (Geisler and Sauer 1990) for the U.S. Fish and Wildlife Service Region 3, which includes Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. For this period, the Blackburnian and black-throated green warblers have exhibited relatively stable population trends, and the pine warbler has experienced a significantly positive population trend (Sauer *et al*. 2004). Table 3.10a displays acres of pine that are expected to remain.

Table 3.10a

APPROXIMATE ACRES OF PINE PRESENT ON THE HOOSIER

Time	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
50 Years	20,400	21,800	14,700	14,800	20,400
100 Years	10,600	13,400	7,600	8,500	10,600
150 Years	3,600	5,500	2,300	2,400	3,600

Barrens Communities

The primary factor threatening the long-term survival of barrens-associated insects is fire suppression. Fire suppression over the last 250 years has reduced formerly extensive barrens communities to small, isolated remnants that are separated from one another by extensive tracts of closed-canopy forest, fescue fields, or urban areas. Although using prescribed fire in individual barrens communities is a good start, this practice does very little to limit isolation. Species like the mottled duskywing are rarely found in the non-barren environments that separate these communities. Thus, these highly isolated barrens are islands surrounded by tracts of hostile environments that limit population emigration or immigration. Landscape-scale prescribed fires have been recommended as the most ecologically sound method to treat barrens areas (Stritch 1990). This type of burn would create a mosaic of conditions across an area including some areas that remain unburned, some lightly burned, and other areas with more intense burns.

The succession of open barrens habitat to closed-canopy forest has greatly reduced the diversity of plant species and rendered the habitat unusable by many insects (Olson *et al*. 2002). Restoring and maintaining barrens also requires the mechanical removal of Eastern

redcedar, as burning alone may not remove all of this species. An aggressive invader to barrens habitat, Eastern redcedar has allelopathic effects that may prevent the establishment of desirable plants in an area (Quarterman 1973). Redcedar does not resprout, and prescribed fire can control it, unless individual trees are too large. Harvesting redcedar can lead to an increase in herbaceous growth by removing allelopathic effects and by allowing light to reach the ground (Olson et al. 2002).

Vegetation management, including prescribed fire and timber removal, maintain barrens communities and allow opportunity for their restoration. Alternative 4 would provide the greatest acreage of barrens habitat (Table 3.10b). Over time, the effects of the various alternatives on the barrens community would continue to be realized, dependent on the amount of vegetation management. The numbers in Table 3.10b present a conservative estimate of the acres affected. Alternative 3 would likely increase the acreage of barrens followed by Alternatives 1 and 5. During the first decade, Alternative 2 would result in a slight decrease in the acres of barrens due to the inability to manage this habitat. Throughout time, hardwoods and pine trees would continue to invade barrens communities, resulting in a more closed canopy that could be detrimental to the species that use this habitat. Withdrawing fire from the ecosystem would result in a reduction of the acreage of barrens by approximately five percent per decade. For this reason, Alternative 2 would likely decrease the quality of barrens habitat, and could result in a reduction of viability for plant and animal species, especially over time.

Table 3.10b

ACRES OF BARRENS AFTER THE NEXT 10 YEARS

Habitat	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Barrens	1,430	1,360	1,600	1,700	1,430

Forest Openings

The acreage of forest openings maintained across the forest was used as an indicator of response to display how the alternatives responded to Issue Two: Ecosystem Sustainability. This reflects a component of how the alternatives maintain early successional habitat.

Forest openings increase the production potential for animal species that require early successional habitats for some portion of their life. The Hoosier designs treatments to provide missing habitat components or to increase the variety and quality of existing habitat. Forest openings contain plant communities quite different from surrounding stands of timber and include shrubs, herbs, and grasses. This mix of plants enhances vegetative diversity by perpetuating specialized early successional stages in some portions of the Forest.

Openings provide grassland cover in association with shrubland that provides components necessary to support populations of some animals, such as blue-winged warblers (*Vermivora pinus),* field sparrows (*Spizella pusilla*), yellow-breasted chat (*Icteria virens*), and wild turkey (*Meleagris gallopavo*). Openings also provide important bugging areas in the spring and early summer for gamebird species such as turkey and quail. Bugging areas are relatively unobstructed by leaf litter allowing young birds a place to find, capture, and consume insects. Because this habitat component is important for the survival of young birds, these species would benefit from the construction and maintenance of forest openings. Furthermore, species that depend on or frequently use open or semi-open habitats, such as bobcat, prairie warbler, or yellow-breasted chat, would also benefit.

Several species may be absent from smaller opening patches and are more likely to be found in larger areas, or have increased densities with increasing opening size (Solheim *et al.* 1987). This is especially true in highly fragmented landscapes that lack adequate connectivity. At the low end of the scale, yellow-breasted chats occur in openings of 5 acres or more (SVE Panel 2002), whereas ruffed grouse benefit from openings of 20 to 40 acres (Thompson and Dessecker 1997). Because some species such as the hooded warbler are found primarily in habitat patches smaller than 1 acre, forest wildlife in general will likely benefit more from a range of opening sizes.

To enhance the likelihood of maintaining the viability of species that use openings, the Forest will:

- emphasize larger areas as opposed to numerous smaller areas where a mosaic of successional stages may be maintained,
- select new openings based on the proximity to other openings to maximize the benefit to area dependent species associated with these habitats,
- drop from management openings that no longer possess the characteristics of early successional habitat, have limited access, or where management as early successional habitat conflicts with other natural resource values,
- manage with the intent of maintaining a native habitat component that mimics the historical composition that once occurred within uplands of the Highland Rim and Shawnee Hills ecological units, and
- emphasize the removal of non-native species from areas designated as openings.

Wildlife species that prefer other habitats would not directly benefit (cerulean warbler (*Dendroica cerulea*), for example) and may be adversely affected in areas so treated. Retention of den trees would improve habitat for such species as squirrels, raccoons, and cavity-nesting birds. Retention of additional snags would be beneficial to species such as bats, birds of prey, and pileated woodpeckers (*Dryocopus pileatus*). Findings from a study of managed openings on the Shawnee National Forest suggest that continued maintenance of openings would benefit a variety of wildlife, help maintain distinctive remnant plant communities, and not necessarily impact forest-interior species (Overcash *et al.* 1989).

Managing vegetation could disrupt normal wildlife use patterns and create conditions that establish new use patterns. Management activities in openings could also influence reproductive success in localized areas if they were to occur during nesting or brood-rearing seasons. Timing of activities could avoid these peak periods and reduce these effects. Wildlife having territorial boundaries that incorporate all or part of an opening could adjust to immediate changes in habitat composition.

The effects of planting, seeding, liming, and fertilizing are more subtle and might not be realized for a year or more. Improved site productivity and restoration of native plant communities resulting from these activities would improve habitat quality for many plant and animal species found on the Forest.

The alternatives propose different acreages of openings across the Forest. On the low end of the scale, Alternative 2 would maintain no openings, followed by Alternatives 1, 4, and 5, which would provide approximately 5,000 acres of openings. Alternative 3 would provide slightly fewer acres of openings than these three Alternatives, resulting in approximately 4,070 acres of openings. Depending on the species considered, the effects associated with openings would be

either positive or negative. Under all alternatives, the percentage of the Forest maintained in forest openings is very small (see Table 3.11).

Table 3.11

PERCENTAGE OF SUITABLE MANAGEMENT AREAS MAINTAINED AS OPENINGS

Existing	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
3	3	0	2.5	3	3

Numerous studies have reported that several species that use early successional habitat are declining (Oliver and Larson 1996, Thompson and Dessecker 1997). Specifically, researchers such as McAuley and Clugston (1989) have attributed the population decline of the American woodcock to habitat loss as forests mature (1998). New studies suggest the abundance and distribution of early successional forest habitat directly affects the foraging and nesting opportunities of species generally associated with mature forest (Pagen *et al*. 2000, Hunter *et al*. 2001), as forest openings are used by fledglings and adult songbirds following the breeding season. For wildlife species that depend on this habitat type, Alternatives 1, 4, and 5 would provide the greatest amount of forest openings, followed by Alternative 3 . As the forest ages, Alternative 2 would result in a drastic loss of this habitat on the Hoosier; conversely, species that depend on large contiguous blocks of forest would benefit from the reduction in openings and the associated effects such as fragmentation and edge effects. This document previously described edge effects for even-aged management; similar edge effects are associated with permanent forest openings.

Road Construction and Reconstruction

Roads affect wildlife directly by reducing habitat and by increasing the risk of death by vehicles (Maxell and Hokit 1999, Hannay 2001). This is especially true for species such as amphibians and reptiles that have annual life cycles requiring migration between different habitat types (Jensen 1998, Maxell and Hokit 1999). One direct effect of road construction, reconstruction, and reuse on forest vegetation is the introduction of grasses and legumes to protect disturbed soils along the road. Erosion control grasses and legumes are usually native species, but sometimes nonnative short-lived plants (annuals) are used.

Besides the direct effects, construction or reconstruction of a road can have an indirect effect on vegetation along the road. Construction or reconstruction of roads opens the tree canopy along the road. This increase in light can stimulate understory development for a limited distance into the adjacent forest. If the forest canopy were interrupted by clearing for road corridors, the clearing operations could also remove ground cover for wildlife. Following roadwork, the disturbed areas on either side of a road may support different vegetation from that which was present before road construction (Hannay 2001, Hannay 2000). Wildlife that prefers continuous forests with closed canopies would not benefit. However, the habitat edge created by roads would benefit many wildlife species, such as the indigo bunting, white-eyed vireo, song sparrow (*Melospiza melodia*), and several species of forest bats.

Some birds may be drawn to roadways because of the availability of digestive grit for use in gizzards, standing water puddles, a supply of carrion, and abundant nest and perch sites (Postelli 2000). Raptors may be drawn to roadways because they are used as dispersal corridors by rodents. One study of the effects of roads on small mammals (Adams and Geis 1983) found that the density and diversity of small mammals were greater in interstate right-of-way habitats than in adjacent habitats. While these habitats may provide many needs for some

species, they may also result in an increase in animal-vechicle collisions, from large mammals to amphibians (Gaines *et al*. 2003). Furthermore, roads can fragment forested habitat and may increase predation rates on songbirds by increasing the ratio of edge to interior habitats (Hamann *et al*. 1999).

Canopy effects of road-clearing widths (except for two-lane, hard-surfaced or other high-speed roads), however, would last only until canopy foliage closes over the road. It is possible to construct or reconstruct some roads through mature hardwood forest sites without opening the crown. In pine and young hardwood stands, corridors created by roads would remain open (no canopy over the road) longer (10+ years) than corridors created in mature hardwood forests, where the canopy typically closes in 2 to 10 years. Road corridors would have positive effects on some wildlife by providing diversity of plant communities, habitat transition zones, and travel corridors. Construction would displace deer and wild turkey, and those species might tend to avoid road corridors if the corridors were heavily used. Displaced cavity-nesting species might not return if snags and cavity trees were removed (a common safety practice in construction and maintenance of roads).

Road construction and reconstruction vary by alternative, and there are various types of roads. See Table 3.12*,* for a display of roads that might be constructed or reconstructed during the first 10 years. The bulk of road construction and reconstruction would be temporary roads.

Table 3.12

FOREST SERVICE LOCAL ROAD DEVELOPMENT

For the Next 10 Years

Description of Road	**Alt. 1**	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**
Miles of All-weather, open road construction/ reconstruction					
On rights-of-way across private land[1]:	3	2	3	5	3
On NFS land:					
Roads	2	1	2	3	2
Total number of parking lots	20	5	40	20	20
Miles of Dry-weather, “closed” road construction/ reconstruction/ reuse[2]					
On rights-of-way across private land[1]:	1	1	2	5	1
On NFS land:	145	5	144	199	145

[1] Forest Service roads constructed on existing or yet-to-be-acquired rights-of-way across private land. Some of the road mileage shown represents reconstruction of existing county roads across private land.
[2] Approximately 15 percent of total roads to be new construction (figure estimated from German Ridge Restoration Project proposal).

Road management can be an important tool in managing wildlife populations. Roads opened during the hunting season can have positive or negative effects on wildlife. Allowing access to hunters can prevent damage to wildlife habitat from overpopulation of species such as white-tailed deer. Roads would also facilitate the creation, maintenance, and dispersion of permanent wildlife habitat developments. The Hoosier wold close nearly all new roads to public motor vehicle use after the end of resource management projects requiring access. Closure to vehicular access would minimize all but short-term disturbances to wildlife. Furthermore, revegetation of closed roadbeds would provide habitat for some species of wildlife for a short time following the closure.

Open roads provide easy public access, which in combination with motorized use of roads, can be disruptive to wildlife species requiring solitude and can increase poaching. Human activity can negatively affect wildlife during breeding and nesting seasons, when they are rearing their young or during adverse weather in winter. Wild turkey, ruffed grouse, raptors, and waterfowl may abandon their nests, and turkeys can be displaced from brood habitat.

The miles of road development vary by alternative (see Table 3.12). The indirect and direct effects mentioned above would vary in their influence on wildlife depending on the species. Alternative 2 would construct the fewest miles of road. This could result in a slight reduction of edge effects and forest fragmentation. However, besides having a decreased level of road construction and reconstruction, Alternative 2 would also result in no maintenance of wildlife openings, waterholes, and wetlands. All of these types of management contribute to the biodiversity of the forest, and these activities would help ensure viability of the species that occur on the Forest. Of all the alternatives, Alternative 4 would create the greatest number of roads and the most miles of road due to the increase in timber harvest operations. This alternative would exhibit the greatest effects associated with road construction and reconstruction. Alternatives 1 and 5 have more miles of road than either Alternative 2 or 3 due to the number of roads necessary to carry out single-tree techniques. Alternatives 1, 3, 4, and 5 would likely benefit species associated with edge habitat, and could have a negative effect on species that historically have been dependent on large areas of contiguous forest.

Off-highway Vehicle (OHV) Use

Off-highway vehicle use is one of the fastest growing forms of outdoor recreation. Although OHV's represent one way to experience the outdoors and national forest lands, use of these vehicles has the potential to cause undesirable impacts. Studies of OHV effects show that negative impacts are more likely to occur with species that are small or rooted or that live in fragile ecosystems. Studies of effects of OHV use on larger mammals are not conclusive (Schubert 2000).

A study by Barrett (1976) on the Eldorado National Forest showed that a moving vehicle has no detectable effect on deer, but deer seem especially wary of a vehicle that suddenly stops. A report in 1989 indicates no apparent effects on the density, home range size and characteristics, or activity level of black-tailed deer, but deer temporarily retreated in the face of heavy OHVactivity. Wisdom *et al.* (2004) determined that OHV activity appeared to have a substantial effect on elk behavior, but mule deer showed little response.

Conversely, other studies indicate adverse effects from OHV use, and Sheridan (1979) has shown that OHV's have especially adverse effects on terrestrial vertebrate populations. Exposure to the noise of OHV's can result in modifications of feeding and mating patterns of wildlife and increased physiological stress in individual animals (Dorrance *et al.* 1975, Larkin 1995, Schubert 2000). Numerous studies cited by Havlick (2002) indicate that wildlife, including birds, reptiles, and large ungulates respond to disturbance with accelerated heart rate and metabolic functions, and suffer from increased levels of stress. Many big game species, such as white-tailed deer, may be displaced from the preferred habitats because of avoiding OHV routes (Hamann *et al.* 1999, Schubert and Smith 2000). Batcheler (1968) found that deer displaced to lower quality habitats often experienced reduced reproductive rates and lower fat deposition.

Studies of birds also indicate mixed results. OHV use during sensitive breeding or nesting times can lead to nest abandonment, decreased parental care, shortened feeding times, and increased stress (Colorado DNR 1998, Holsman 2004). However, Kutilek *et al.* (1991) found

few discernable negative effects on birds in the riparian woodlands of a state vehicular recreation area in California. These researchers surmised that potentially negative effects were reduced by thick vegetation that buffered noise and dust and kept vehicles on established trails.

Impacts of OHV's can result in an outright loss of habitat for some wildlife species or modification of habitat that reduces the value of available food, cover, or other key components (Holsman 2004). Another serious indirect impact on wildlife is the spread of nonnative invasive species (NNIS) in wildlife habitat, which can result from OHV use. Competition from these invasives may reduce the quality and quantity of summer forage for ungulates, resulting in poor reproductive performance over the lifetime of an animal. Lacey *et al.* (1997) found that the undesirable spotted knapweed could hitchhike thousands of seeds on the undercarriage of ATVs for distances of up to 10 miles. OHV's have been shown to reduce diversity of vegetation in sensitive plant communities such as wetlands (Waller *et al*. 1999), facilitate the spread of exotic and noxious weeds, and contribute to habitat fragmentation and edge effects through development of trail systems (Holsman 2004).

Newly constructed roads and off-highway vehicle (OHV) routes increase route densities, divide habitat into small pieces, and impede the dispersal of wildlife species. Effects from habitat fragmentation are well recognized with respect to Neotropical migrants. Roads and OHV trails add to forest fragmentation by dissecting large patches into small pieces, and by converting forest interior habitat into edge habitat (Askins 1994, Askins *et al*. 1987, Reed *et al*. 1996, Hamann *et al.* 1999). However, the habitat edge created by OHV routes would benefit many wildlife species.

Alternative 3 is the only alternative that proposes the development of an all-terrain vehicle (ATV) trail system on the Forest. Therefore, the effects of legal OHV use discussed in this section apply only to this alternative.

Species Viability Evaluation (SVE) Analysis – Animals

The acreage of available habitat across the forest was used as an indicator of response to display how the alternatives responded to Issue Two: Ecosystem Sustainability. This displays how the alternatives maintain suitable habitat for the 19 species considered in the Species Viability Evaluation.

Analysts used Habitat Suitability Index (HSI) models to describe the future habitat conditions for each SVE species under each of the proposed alternatives. These models provide a comparison of future conditions to current conditions on the Hoosier instead of providing a simple determination of what does or does not constitute a "viable" population. Simple thresholds for viability do not exist, especially when assessments are done on a broad array of taxa. Therefore, the Hoosier has determined continued viability for a species based on the amount of suitable habitat on the Forest. Providing general forest type or structure conditions does not necessarily supply adequate habitat for every species. If the Forest can continue to maintain major habitat associations and rare communities, adequate habitat should be available to maintain the viability of species. The 19 selected species use the following 10 principal habitats found on the forest: barrens, cliffs, dry forest, karst, mesic forest, openlands, ponds, rivers, wetlands, and wide-ranging. For other species on the Forest, including Regional Forester sensitive species and Federally threatened, endangered, and proposed species, viability is ensured in relation to these same 10 principal habitat types.

Based on functional relationships between wildlife and habitat variables, HSI models provide an index of habitat quality ranging from 0 (not habitat) to 1 (habitat of maximum suitability). Models

were developed using published empirical data and expert opinion (see SVE Appendix) for 19 species. Projected future conditions that result in similar amounts of habitat or increases in suitable habitat from current conditions should result in stable or increasing populations. Large decreases in suitable habitat are considered unfavorable for individual species, and would likely result in a decrease in viability. When models result in large decreases in suitable habitat, viability for species that use that habitat type is considered a very high risk.

Every analysis has some limitations; therefore, several cautions must be applied to the interpretation of these results. These cautions fall in five broad areas:

- limitations of geospatial data;
- lack of integration of standards and guidelines into models;
- broad geographic and time scale of the analysis;
- lack of site specificity in the prescriptions of the alternatives; and
- gaps in knowledge.

All HSI models were rerun for each SVE species between the publication of the DEIS and the FEIS. The data in this section reflects the latest outputs from all models. Between draft and final, all models underwent an extensive quality control review. As a result, some changes occurred in these models to correct typographical errors in programming statements for individual suitability indices, to include more accurate GIS data than was originally available, or to incorporate the latest scientific findings so that model performance better matched the most current scientific knowledge of habitat use by a particular species. These changes generally resulted in slightly higher amounts of suitable habitat, but the ranking of alternatives remained similar (Thompson 2005, pers. comm.).

Cerulean Warbler Habitat Requirements– Mesic Forest Habitat Species
The cerulean warbler is a canopy-foraging insectivore that is usually found in large tracts of deciduous broadleaf hardwood forests with open understories (Hamel 2000a). Habitats may be wet bottomland, mesic slope, or upland (Hamel 2000a), ranging in elevation from about 100 to 3,300 feet (Hamel 2000b), though the species is believed to prefer floodplain sites or other mesic conditions (Lynch 1981, Garber *et al*. 1983, Kahl *et al*. 1985, Robbins *et al*. 1992). The cerulean warbler is considered to be sensitive to patch size, avoiding smaller areas, but the threshold size is not known (Hamel 2000a). Our cerulean warbler habitat model contained three suitability indices: species preference for broadleaf forest, deciduous forest age by ecological land type, and forest area requirement.

Table 3.13

ACRES OF CERULEAN WARBLER HABITAT BY SUITABILITY CLASS

Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑) or decreases (↓) from the current condition. Highlighted classes indicate higher quality habitat.

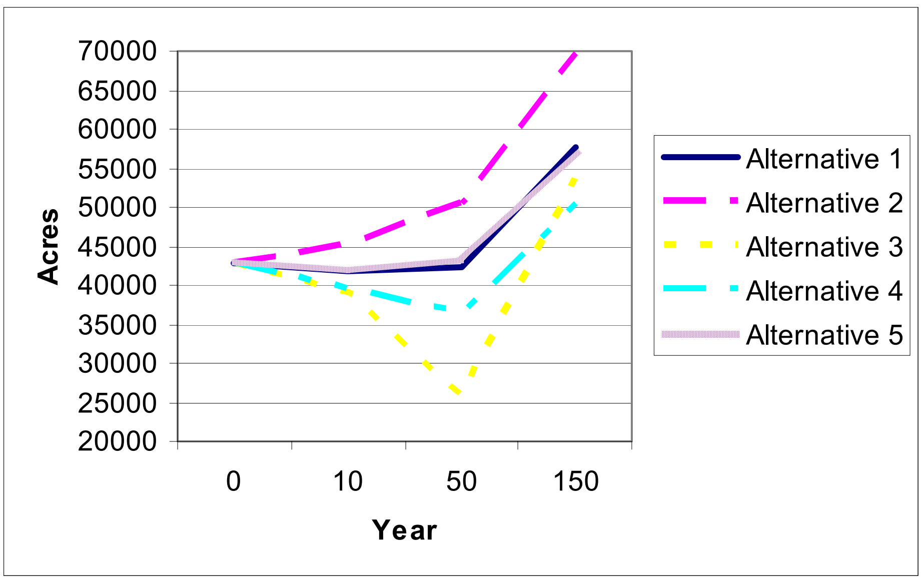
Cerulean Warbler	Class 0	Class 0.1 - 0.25	Class 0.26 - 0.50	Class 0.51 - 0.75	Class 0.76 - 1.0
Current Condition	93923	24857	29374	15418	27344
Year 10					
Alternative 1	100375 ↑	21258 ↓	27541 ↓	13083 ↓	28661 ↑
Alternative 2	95988 ↑	22718 ↓	26992 ↓	17666 ↑	27553 ↑
Alternative 3	106328 ↑	19657 ↓	25876 ↓	12672 ↓	26385 ↓
Alternative 4	107125 ↑	19585 ↓	24735 ↓	12688 ↓	26784 ↓
Alternative 5	99923 ↑	21802 ↓	27469 ↓	12977 ↓	28748 ↑
Year 50					
Alternative 1	93129 ↓	26171 ↑	29407 ↑	15700 ↑	26510 ↓
Alternative 2	87159 ↓	22622 ↓	30749 ↑	19804 ↑	30583 ↑
Alternative 3	114329 ↑	27340 ↑	23234 ↓	11921 ↓	14094 ↓
Alternative 4	91358 ↓	33633 ↑	29526 ↑	14801 ↓	21600 ↓
Alternative 5	91666 ↓	26857 ↑	29372 ↓	15825 ↑	27198 ↓
Year 150					
Alternative 1	78246 ↓	22072 ↓	32947 ↑	16845 ↑	40806 ↑
Alternative 2	67460 ↓	16070 ↓	37729 ↑	20396 ↑	49263 ↑
Alternative 3	81629 ↓	24723 ↓	30931 ↑	17422 ↑	36211 ↑
Alternative 4	85048 ↓	25581 ↑	29695 ↑	16281 ↑	34312 ↑
Alternative 5	78397 ↓	22972 ↓	32293 ↑	17002 ↑	40253 ↑

Summary of viability analysis - cerulean warbler

All alternatives provide similar amounts of suitable habitat for the cerulean warbler during the first 10 years. Because the cerulean warbler depends on large patches of late-successional deciduous forest, Alternative 2 would provide the most acres of suitable habitat over time, primarily due to the absence of timber harvesting. Alternatives 1 and 5 would provide more acres of suitable habitat in years 50 and 150 than Alternatives 3 and 4, primarily due to the lower level of timber harvest in these alternatives. There is little difference in the amounts of suitable habitat under Alternative 1 and Alternative 5 even though the latter contains MA 3.3. Over time, Alternative 3 would provide more acres of suitable habitat than Alternative 4 due to the lower levels of timber harvest. As the forest continues to age, the amount of suitable habitat for this species would increase under any alternative. This is due to the large acreage not

considered suitable for harvest under any of the alternatives. For this reason, viability for this species, and species associated with this habitat type, are a very low risk. Populations of this species should remain stable or increase under all alternatives. One limitation of this model is that it does not reflect this species' need for canopy gaps (SVE Panel 2002, Hamel 2000a, Hamel 2000b). Cerulean warblers are considered disturbance-dependent species because of their affinity for openings adjacent to the largest trees in a stand, their preference for old growth forests where tree-fall gaps have lead to suitable conditions, and their use of areas recently subjected to shelterwood cuts or severe storm damage (Hunter et al. 2001). The scientific literature for this species documents the need to quantify the size of canopy gaps used by cerulean warblers, but this data does not currently exist. This gap in our knowledge does not allow us to include this important habitat component in this model. Alternatives that propose single-tree selection or group selection would likely result in higher HSI values if this habitat affinity had been included in the model.

Figure 3.6 Amount of suitable habitat (HSI >0.50) for the cerulean warbler under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



Wood Thrush – Mesic Forest Habitat Species

Wood thrushes nest in shrubs and small trees of deciduous and mixed forests. Primary habitat features are a shrub-canopy layer, shade, moist soil, and leaf litter found in deciduous and mixed forests, bottomland hardwood forests, pine forests with deciduous understory, and wooded residential areas (Roth *et al*. 1996). Breeding populations are more likely to be found in larger tracts, but they also use small (2.5 acres or smaller) fragments (Roth *et al*. 1996). The HSI model for this species contains four suitability indices: species preference for broadleaf forest, deciduous forest age by ELT, forest area requirement, and interspersion of post-fledging habitat and breeding habitat.

Table 3.14

ACRES OF WOOD THRUSH HABITAT BY SUITABILITY CLASS

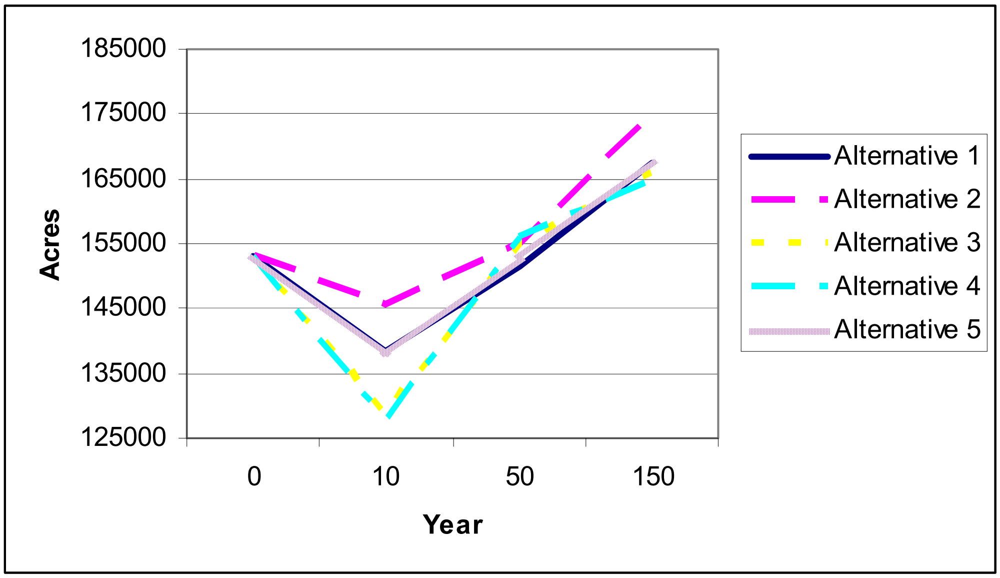
Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑) or decreases (↓) from the current condition. Highlighted classes indicate higher quality habitat.

Wood thrush	**Class 0**		**Class 0.1 - 0.25**		**Class 0.26 - 0.50**		**Class 0.51 - 0.75**		**Class 0.76 - 1.0**	
Current Condition	10029		23510		4366		41149		111863	
Year 10										
Alternative 1	26742	↑	20973	↓	4875	↑	42863	↑	95464	↓
Alternative 2	17505	↑	23148	↓	4827	↑	45267	↑	100170	↓
Alternative 3	40411	↑	17031	↓	4540	↑	41027	↓	87908	↓
Alternative 4	42449	↑	16022	↓	4574	↑	40551	↓	87322	↓
Alternative 5	27844	↑	20756	↓	4681	↑	42594	↑	95042	↓
Year 50										
Alternative 1	19006	↑	15229	↓	5337	↑	45884	↑	105461	↓
Alternative 2	9336	↓	20959	↓	5650	↑	49230	↑	105743	↓
Alternative 3	24853	↑	6391	↓	4605	↑	44722	↑	110345	↓
Alternative 4	25390	↑	5174	↓	4255	↓	43910	↑	112189	↓
Alternative 5	18798	↑	13745	↓	5475	↑	46301	↑	106598	↓
Year 150										
Alternative 1	16588	↑	868	↓	5970	↑	48102	↑	119389	↑
Alternative 2	7354	↓	1435	↓	6908	↑	56811	↑	118410	↑
Alternative 3	19306	↑	572	↓	5115	↑	49395	↑	116529	↑
Alternative 4	21124	↑	376	↓	4712	↑	46047	↑	118658	↑
Alternative 5	16528	↑	849	↓	5763	↑	48067	↑	119711	↑

Wood thrushes primarily require fairly young to mid-successional forest and reappear in older sapling to mature deciduous or mixed forest (Kahl *et al.* 1985). Therefore, the species depends on large forest patches containing both young (10 to 30 years old) and mature (at least 80+ years old) trees. Because breeding populations are more often found in larger tracts, Alternative 2 would result in the most acres of suitable habitat due to the absence of disturbance from timber harvest and prescribed fire leading to large blocks of mature forest. Under this alternative, small amounts of young forest would still occur across the landscape due to natural disturbance providing habitat for juveniles. Alternatives 1, 3, 4 and 5 would have similar amounts of suitable habitat over time despite differences in timber harvest and prescribed burning levels due to this species' bi-modal forest age requirements. The amount of suitable habitat available for this species would surpass current conditions by year 150 for all

alternatives, so all alternatives should maintain viability. Because breeding populations of wood thrush are more likely to be found in larger tracts (Roth *et al.* 1996), reducing the amount of harvest across the Forest by directing even-aged management into MA 3.3 results in high levels of suitable habitat under Alternatives 3, 4, and 5. Because Alternative 5 proposes the least amount of harvest of these three alternatives, this alternative would result in the greatest amount of suitable habitat for this species. The amount of suitable habitat available for this species would surpass current conditions by year 150 under all alternatives, so all alternatives are likely to maintain viability.

Figure 3.7 Amount of suitable habitat (HSI >0.50) for the wood thrush under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



Worm-eating Warbler– Dry Forest/Mesic Forest Habitat Species
The worm-eating warbler is a ground-nesting forest songbird with breeding habitat described as large tracts of mature deciduous and mixed deciduous-coniferous forest with moderate to steep slopes and smaller patches of dense understory shrubs (Hanners and Patton 1998). Minimum area requirements within the breeding range of this species range from 370 acres (Robbins *et al*. 1989) to 840 acres (Hayden *et al*. 1985). Worm-eating warblers declined incrementally in response to repeated prescribed burning and did not recover within one year after burning (Artman *et al.* 2001). SVE Panel experts agreed, however, that most studies of the impacts of fire on this species have been short-term studies. Four suitability indices are included in the HSI model for this species: species preference for broadleaf forest, deciduous forest age by ELT, forest area requirement, and sensitivity to fire.

Table 3.15

ACRES OF WORM-EATING WARBLER HABITAT BY SUITABILITY CLASS

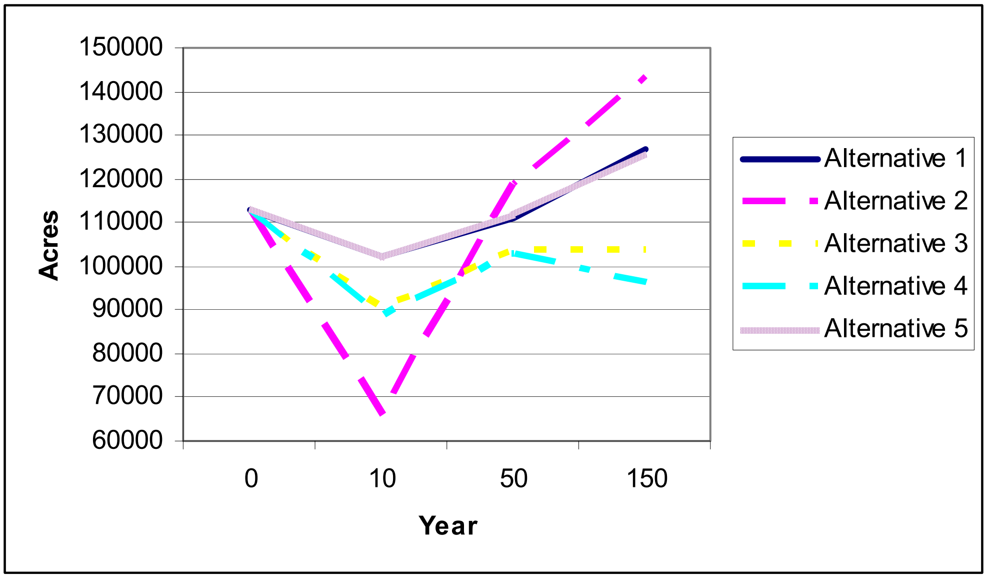
Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑) or decreases (↓) from the current condition. Highlighted classes indicate higher quality habitat.

Worm-eating warbler	Class 0	Class 0.1 - 0.25	Class 0.26 - 0.50	Class 0.51 - 0.75	Class 0.76 - 1.0
Current Condition	35967	16999	25059	25962	86930
Year 10					
Alternative 1	37259 ↑	16816 ↓	34594 ↑	21017 ↓	81232 ↓
Alternative 2	89068 ↑	13634 ↓	22386 ↓	16586 ↓	49243 ↓
Alternative 3	31985 ↓	23434 ↑	45557 ↑	17734 ↓	72206 ↓
Alternative 4	31623 ↓	21715 ↑	49007 ↑	18016 ↓	70555 ↓
Alternative 5	38215 ↑	16528 ↓	34651 ↑	20646 ↓	80878 ↓
Year 50					
Alternative 1	28678 ↓	17514 ↑	33718 ↑	28823 ↑	82185 ↓
Alternative 2	31108 ↓	14109 ↓	26787 ↑	28172 ↑	90741 ↑
Alternative 3	19005 ↓	23212 ↑	44982 ↑	29206 ↑	74512 ↓
Alternative 4	18763 ↓	22523 ↑	46907 ↑	29406 ↑	73317 ↓
Alternative 5	28216 ↓	16405 ↓	34674 ↑	29143 ↑	82478 ↓
Year 150					
Alternative 1	12275 ↓	15030 ↓	36961 ↑	23059 ↓	103592 ↑
Alternative 2	9680 ↓	9891 ↓	27861 ↑	22968 ↓	120517 ↑
Alternative 3	12144 ↓	22239 ↑	52752 ↑	22194 ↓	81587 ↓
Alternative 4	12011 ↓	24072 ↑	58870 ↑	22084 ↓	73881 ↓
Alternative 5	13273 ↓	15346 ↓	36946 ↑	26435 ↑	98917 ↑

Because this species depends on moist, forested slopes within a large patch of forest and is somewhat fire intolerant, the greatest amount of suitable habitat would be available under Alternative 2 in all years due to the absence of disturbance from timber harvest and prescribed fire. Likewise, Alternatives 1 and 5 would result in more suitable habitat than Alternatives 3 and 4 due to lower levels of timber harvest. Alternative 4 would result in even less suitable habitat than Alternative 3 due to the increased amount of timber harvest that would occur under Alternative 4. However, as the forest continued to age, the amount of suitable habitat for this species would increase over time for all alternatives. This is due to the large acreage not considered suitable for harvest under any alternative and the small amount of proposed timber

harvest. Because all alternatives would result in more acres of suitable habitat than is currently available, all alternatives should maintain or increase viability.

Figure 3.8 Amount of suitable habitat (HSI >0.50) for the worm-eating warbler under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



<u>Henslow's Sparrow (*Ammodramus henslowii*)–Openlands/Grassland Habitat Species</u>
The Henslow's sparrow is a ground-nesting grassland associated bird. Primary breeding habitat may be described as grasslands, including hayfields, pastures, wet meadows, dry saltmarshes, and old grassy fields (Smith 1992). Within-habitat characteristics include tall, dense grass, a well-developed litter layer, standing dead vegetation, and sparse or no woody vegetation (Herkert 1994b). An area-sensitive species, Henslow's sparrow is more likely to exist and have higher densities in larger grassland areas (Herkert 1994a, Bollinger 1995, Swengel 1996, Winter and Faaborg 1999). Herkert (1994a) determined that in Illinois an area of at least 135 acres was required to detect the species 50 percent of the time. Further, Henslow's sparrows in Illinois were rarely encountered on grassland fragments smaller than 250 acres (Herkert 1994b). The Henslow's sparrow habitat model contained three suitability indices: species requirement for grasslands, grassland area requirement, and sensitivity to forest and urban edges.

Table 3.16

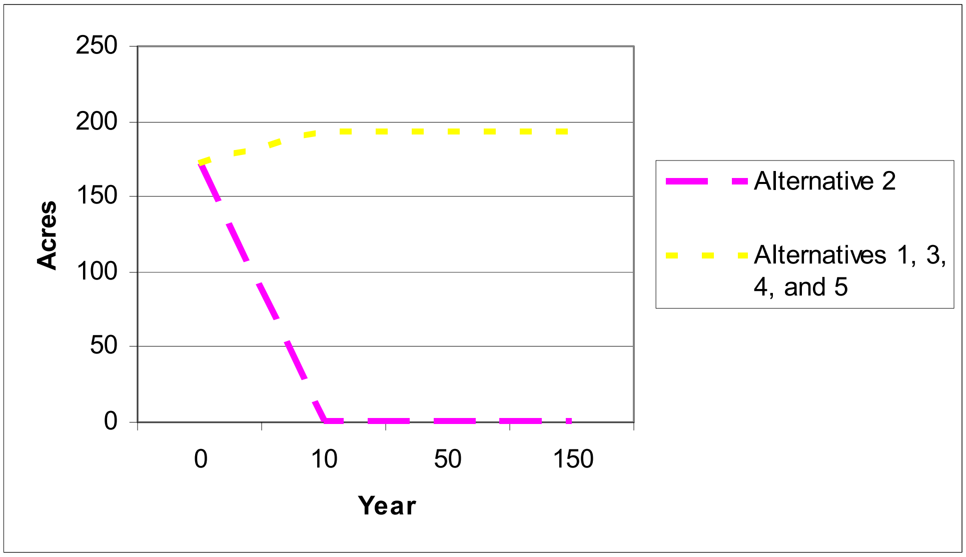
ACRES OF HENSLOW'S SPARROW HABITAT BY SUITABILITY CLASS

Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑), decreases (↓), or remains stable (←→) from the current condition. Highlighted classes indicate higher quality habitat.

Henslow's Sparrow	Class 0	Class 0.1 - 0.25	Class 0.26 - 0.50	Class 0.51 - 0.75	Class 0.76 - 1.0
Current Condition	189954	688	103	109	63
Year 10					
Alternative 1	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑
Alternative 2	190914 ↑	3 ↓	0 ↓	0 ↓	0 ↓
Alternative 3	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑
Alternative 4	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑
Alternative 5	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑
Year 50					
Alternative 1	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑
Alternative 2	190917 ↑	0 ↓	0 ↓	0 ↓	0 ↓
Alternative 3	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑
Alternative 4	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑
Alternative 5	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑
Year 150					
Alternative 1	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑
Alternative 2	190917 ↑	0 ↓	0 ↓	0 ↓	0 ↓
Alternative 3	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑
Alternative 4	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑
Alternative 5	189810 ↓	745 ↑	169 ↑	109 ←→	84 ↑

This species requires large patches of grassland, which limits its distribution on the Forest. Alternatives 1, 3, 4, and 5 would provide the same amount of suitable habitat over time, because the acreage in grassland habitat does not change across the Forest. Conversely, Alternative 2 would not provide suitable habitat due to the succession of grasslands to forestlands across the Forest without active management. This loss of habitat would result in a decrease of viability for Henslow's sparrow on the Forest, and therefore, viability is a high risk under Alternative 2. Alternatives 1, 3, 4, and 5 result in an increase in suitable habitat for this species, and viability is considered a low risk under these four alternatives.

Figure 3.9   Amount of suitable habitat (HSI >0.50) for Henslow's sparrow under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



Yellow-breasted Chat–Openlands/Shrubland Habitat Species
The yellow-breasted chat is a disturbance-dependent shrubland bird. Chats may be found in low, dense vegetation without a closed tree canopy, including shrubby habitatalong stream, swamp, and pond margins; forest edges, regenerating burned-over forest, and logged areas; and fencerows and upland thickets of abandoned farmland (Eckerle and Thompson 2001). This species is rarely detected in patches smaller than one acre (Robinson and Robinson 1999), and 2002 SVE Panel species experts agreed that the species is not seen in Indiana in patches smaller than 5 acres. The HSI model for this species contains three suitability indices: requirement of early successional forest habitat for nesting, early successional forest area requirement, and sensitivity to forest and urban edges.

Table 3.17

ACRES OF YELLOW-BREASTED CHAT HABITAT BY SUITABILITY CLASS

Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑) or decreases (↓) from the current condition. Highlighted classes indicate higher quality habitat.

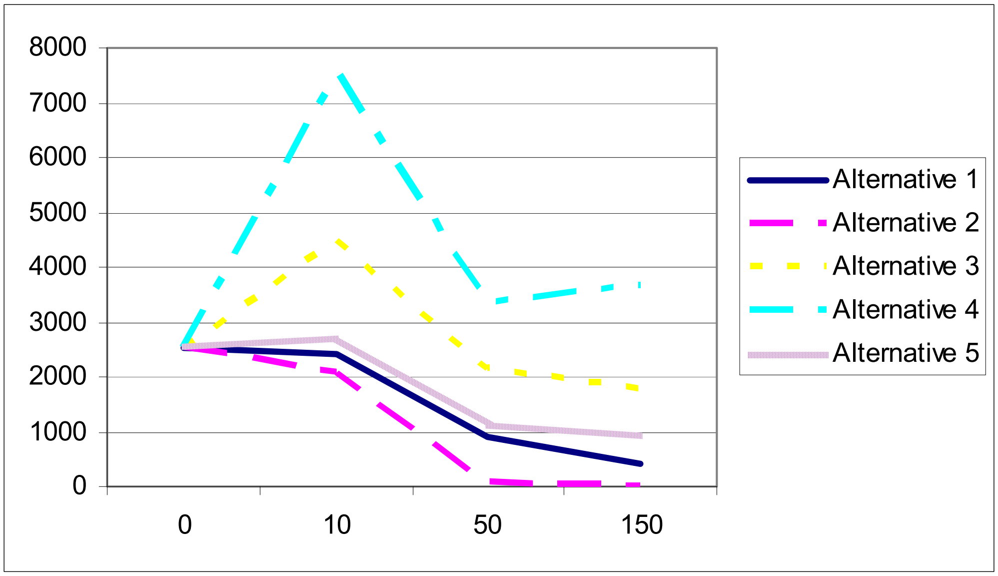
Yellow-breasted Chat	Class 0	Class 0.1 - 0.25	Class 0.26 - 0.50	Class 0.51 - 0.75	Class 0.76 - 1.0
Current Condition	186559	758	1086	2093	422
Year 10					
Alternative 1	185669 ↓	656 ↓	2162 ↑	724 ↓	1706 ↑
Alternative 2	186216 ↓	813 ↑	1829 ↑	652 ↓	1407 ↑
Alternative 3	181708 ↓	712 ↓	1810 ↑	724 ↓	5964 ↑
Alternative 4	181181 ↓	391 ↓	1798 ↑	674 ↓	6873 ↑
Alternative 5	185549 ↓	690 ↓	1987 ↑	711 ↓	1982 ↑
Year 50					
Alternative 1	189368 ↑	262 ↓	377 ↓	616 ↓	294 ↓
Alternative 2	190719 ↑	32 ↓	103 ↓	53 ↓	10 ↓
Alternative 3	187755 ↑	364 ↓	656 ↓	994 ↓	1147 ↑
Alternative 4	186230 ↓	397 ↓	950 ↓	1640 ↓	1701 ↑
Alternative 5	189320 ↑	217 ↓	289 ↓	636 ↓	456 ↑
Year 150					
Alternative 1	190011 ↑	257 ↓	239 ↓	272 ↓	138 ↓
Alternative 2	190916 ↑	0 ↓	0 ↓	0 ↓	0 ↓
Alternative 3	188223 ↑	388 ↓	534 ↓	939 ↓	833 ↑
Alternative 4	185935 ↓	448 ↓	873 ↓	1927 ↓	1734 ↑
Alternative 5	189474 ↑	202 ↓	352 ↓	536 ↓	353 ↓

The dependence of this species on larger patches of early-successional habitat would necessitate management for this type of habitat. Alternative 2, which does not propose any type of management, would have the least amount of suitable habitat due to the absence of disturbance from timber harvest and prescribed fire. By year 150, Alternative 2 would result in no suitable habitat for this species and would pose a high risk to viability. SVE Panel members (2002) agreed that clearcuts and shelterwood cuts that create openings of five acres or more would lead to the development of suitable habitat. Though 5 acre openings are the minimal size for this species,12 acres or greater would provide the best habitat (Rittenhouse et al. 2004). According to The Nature Conservancy (1998), clearcuts are likely the best way to create new habitat for this species. Logging that uses either single-tree selection or group selection would

not create openings large enough to attract chats. Alternatives 1, 5, 3, and 4 would result in progressively more acres of suitable habitat than Alternative 2 due to increases in timber harvest. However, only Alternatives 3 and 4 would result in acres of suitable habitat similar to the current condition. Alternative 1 would provide fewer acres of suitable habitat than Alternative 5 due to the inclusion of MA 3.3 (which allows clearcuts up to 40 acres). Alternative 1 will maintain acres of suitable habitat similar to the current condition through year 10, but there would be a large reduction in suitable habitat by year 150 posing a high risk to viability. It is important to note that Alternatives 3, 4, and 5 result in an increase in highly suitable habitat (0.76 – 1.0) through the first several decades. A loss of habitat due to the continual advancement of forest succession and the lack of active forest management on the Hoosier has resulted in a decrease in young forested habitat (0 – 9 years of age). Long-term viability of this species is dependent on active management designed to provide appropriate habitat across the landscape.

The yellow-breasted chat is rarely detected in Indiana in shrubland patches smaller than 5 acres (SVE Panels 2002). An increase in the size of even-aged treatments in MA 2.8 as proposed under Alternative 5 should result in an increase of habitat for this species. With an increase in suitable habitat, the risk to viability for this species should decrease. The increase in clearcut size was not included in the outputs for the HSI and suitable habitat should be higher than the data reflects. Alternative 4 would result in the greatest amount of suitable habitat for this species due to the increase in harvest levels, followed by Alternatives 3 and 5.

Figure 3.10 Amount of suitable habitat (HSI >0.50) for Yellow-breasted Chat under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



Ruffed Grouse–Dry Forest/Mesic Forest/Openlands Habitat Species
The ruffed grouse is a forest gamebird that is most abundant in early-successional forests dominated by aspens and poplars. Although commonly identified as an "edge" species, ruffed grouse association with habitat edges largely reflects their use of various interspersed forest habitats at different times of the year. Edge habitats are generally marginal in quality and used where higher-quality habitat is lacking (Dessecker and McAuley 2001). Although home range size may vary throughout the species range (Woolf *et al*.1984, Thompson and Fritzell 1989, McDonald *et al*. 1998), the researchers recommended release locations in Indiana of 1,000 acres of relatively contiguous forest with a interspersion of 20 to 25 percent mature timber, very little pole timber, 50 to 70 percent saplings at 15,200 to 25,300 stems per acre, and 10 percent field openings, surrounded by 1,235 to 2,000 acres of primarily forested cover types (Backs 1984). Leaves, buds, and the fruits of deciduous-forest plants constitute most of the ruffed grouse's diet (Rusch *et al*. 2000). In Missouri, hard mast (consisting primarily of white oak, red oak, chinquapin oak (*Quercus muehlenbergii*), and black oak (*Quercus velutina*) acorns) was the second most prevalent food group, comprising 15.3 percent of crop contents and was present in approximately 30 percent of all crops (Thompson and Fritzell 1986). Five suitability indices are included in the HSI model for this species: winter food provided by hard mast, species requirement for early successional forest habitat, early successional forest area requirement, home range composition, and forest area requirement.

Table 3.18

ACRES OF RUFFED GROUSE HABITAT BY SUITABILITY CLASS

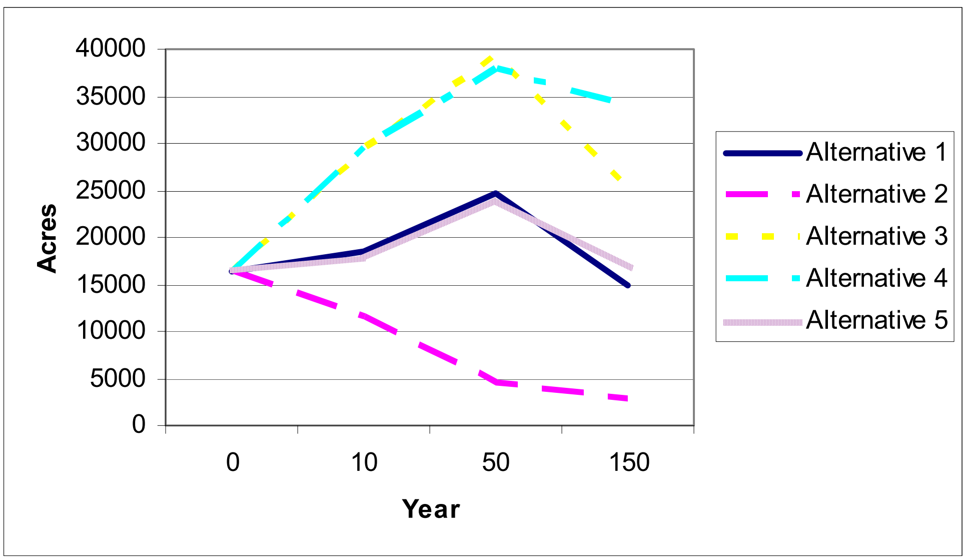
Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑) or decreases (↓) from the current condition. Highlighted classes indicate higher quality habitat.

Ruffed Grouse	Class 0	Class 0.1 - 0.25	Class 0.26 - 0.50	Class 0.51 - 0.75	Class 0.76 - 1.0
Current Condition	116890	52929	4634	9328	7136
Year 10					
Alternative 1	116169 ↓	48736 ↓	7492 ↑	10350 ↑	8170 ↑
Alternative 2	117828 ↑	57391 ↑	4226 ↓	6798 ↓	4674 ↓
Alternative 3	109705 ↓	43610 ↓	8324 ↑	12173 ↑	17105 ↑
Alternative 4	107914 ↓	44652 ↓	8708 ↑	12321 ↑	17323 ↑
Alternative 5	116149 ↓	49739 ↓	7349 ↑	9690 ↑	7990 ↑
Year 50					
Alternative 1	109548 ↓	48275 ↓	8439 ↑	11175 ↑	13479 ↑
Alternative 2	123284 ↑	61585 ↑	1611 ↓	1874 ↓	2563 ↓
Alternative 3	92557 ↓	47277 ↓	11632 ↑	17390 ↑	22062 ↑
Alternative 4	93120 ↓	47931 ↓	11937 ↑	17884 ↑	20047 ↑
Alternative 5	110145 ↓	48704 ↓	8276 ↑	10883 ↑	12910 ↑
Year 150					
Alternative 1	100883 ↓	68355 ↑	6714 ↑	8015 ↓	6950 ↓
Alternative 2	126349 ↑	60493 ↑	1317 ↓	1224 ↓	1533 ↓
Alternative 3	69456 ↓	85524 ↑	10661 ↑	14072 ↑	11203 ↑
Alternative 4	59018 ↓	87885 ↑	10178 ↑	16895 ↑	16941 ↑
Alternative 5	101779 ↓	66028 ↑	6464 ↑	8965 ↓	7680 ↑

Ruffed grouse are early successional forest specialists, more so than any other species endemic to the Central Hardwoods Region. This species depends on oak mast production and early-successional forest in a forested landscape. The aging and succession of forests limit ruffed grouse populations at local and regional scales (Rusch *et al*. 2000). At the end of the first 10 years, Alternative 2 would have the least amount of suitable habitat due to the lack of timber harvest across the forest. After year 10, Alternative 2 would continue to have the least amount of suitable habitat due to the absence of early-successional forest and oak-hickory regeneration created from disturbance (such as prescribed fire or harvest). Alternative 2 would result in a large reduction in the availability of suitable habitat and viability for this species (as well as other early successional species) would be a high risk under this alternative.

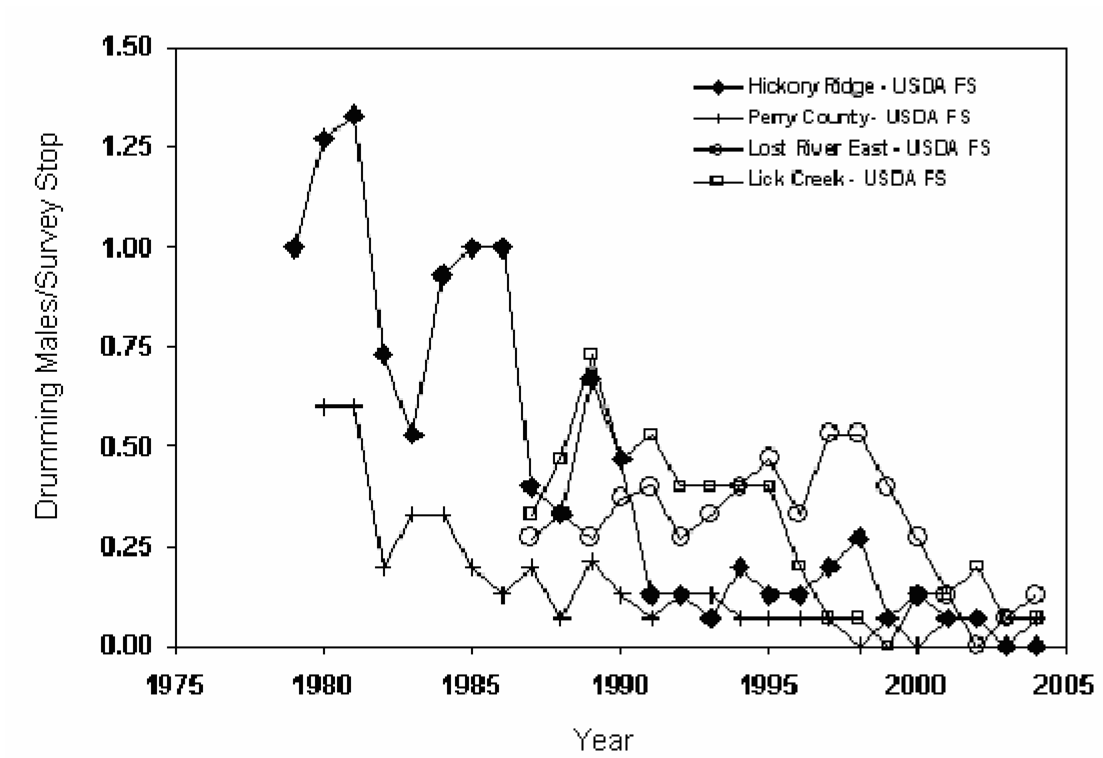
Alternative 1 would have fewer acres of suitable habitat than Alternatives 3 and 4 because it would include less timber harvesting and prescribed fire than these two alternatives. With the creation of MA 3.3, timber harvest would be implemented in such a way as to maximize the habitat quality for the ruffed grouse by ensuring that appropriate habitat types occur in proximity to one another. This species is nonmigratory, and viability is dependent, at least in part, on dispersal capabilities. Furthermore, Thompson and Dessecker (1997) recommend the creation of habitat patches of regenerating hardwoods of 10 acres or larger. Specifically, they suggest harvest units of 20 to 40 acres may be most beneficial for the ruffed grouse. Alternative 5 includes MA 3.3 which allows for a larger harvest size (up to 40 acres) and would provide more habitat than Alternative 1. An increase in the size of even-aged treatments in MA 2.8 as proposed under alternative 5 would result in more suitable habitat for this species than is shown in the data set. The most suitable habitat is created under Alternative 4 followed by Alternative 3. These alternatives provide more early successional forest and oak-hickory regeneration than the other alternatives. Only Alternatives 3, 4, and 5 result in levels comparable to or higher than the current condition. Therefore, viability for this species is only a low risk under these three alternatives.

Figure 3.11 Amount of suitable habitat (HSI >0.50) for Ruffed Grouse under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



In Indiana, the core of the ruffed grouse range is the south-central portion of the state. According to data from roadside drumming routes, after a population high in 1979, a downward trend in grouse populations began in Indiana (Backs 2004). Although there have been some periodic fluctuations in the grouse breeding population density along these routes, there continues to be a general downward trend as more of the forests in Indiana mature (Figure 3.12). Prospects for population recovery remain poor for this species given the continued loss of early successional habitats. Data from four survey routes located on the Hoosier confirm this trend. If the Hoosier did not use active vegetation management, the small ephemeral pieces of grouse breeding habitat extant on the Forest would be expected to disappear within the next 5 years due to the continual advancement of forest succession (Backs 2004). The result could be the loss of this native species on the Forest.

Figure 3.12 Grouse population trends on the Forest



<u>Northern Bobwhite–Dry Forest/Mesic Forest/Openlands Habitat Species</u>
In the Midwest and Northeast, bobwhites (*Colinus virginianus*) are associated principally with heterogeneous, patchy landscapes composed of moderate amounts of row crops and grasslands along with abundant woody edge (Roseberry and Sudkamp 1998). Bobwhites eat seeds of agricultural crops and weeds. They also rely heavily on seeds from forest, agricultural, and rangeland vegetation, especially understory plants and plants along field margins (Brennan 1999). Johnsgard (1973) described optimum habitat as consisting of 30 to 40 percent grassland, 40 to 60 percent cropland, 5 to 20 percent brushy cover, and 5 to 40 percent woodland cover (Johnsgard 1973). Our northern bobwhite habitat model contained four suitability indices: requirement for grasslands for nesting, cover, and food; use of agricultural crops as food; use of woody edge cover; and interspersion of grassland, cropland, and woody edge.

Table 3.19

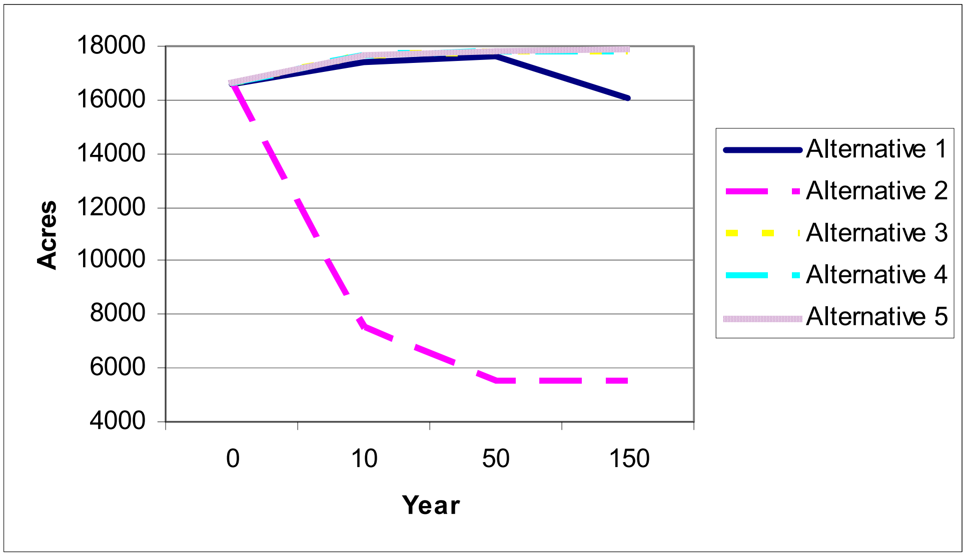
ACRES OF NORTHERN BOBWHITE HABITAT BY SUITABILITY CLASS

Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑) or decreases (↓) from the current condition. Highlighted classes indicate higher quality habitat.

Northern Bobwhite	Class 0	Class 0.1 - 0.25	Class 0.26 - 0.50	Class 0.51 - 0.75	Class 0.76 - 1.0
Current Condition	3789	163961	6582	16440	145
Year 10					
Alternative 1	3693 ↓	162806 ↓	7030 ↑	17211 ↑	177 ↑
Alternative 2	3897 ↑	171314 ↑	8220 ↑	7474 ↓	12 ↓
Alternative 3	3897 ↑	162548 ↓	6827 ↑	17472 ↑	173 ↑
Alternative 4	3897 ↑	162543 ↓	6827 ↑	17478 ↑	173 ↑
Alternative 5	3689 ↓	162550 ↓	7027 ↑	17473 ↑	177 ↑
Year 50					
Alternative 1	3687 ↓	162470 ↓	7165 ↑	17423 ↑	172 ↑
Alternative 2	3897 ↑	179533 ↑	2034 ↓	5452 ↓	2 ↓
Alternative 3	3897 ↑	162400 ↓	6851 ↑	17598 ↑	172 ↑
Alternative 4	3897 ↑	162388 ↓	6856 ↑	17605 ↑	172 ↑
Alternative 5	3689 ↓	162386 ↓	7053 ↑	17615 ↑	173 ↑
Year 150					
Alternative 1	22072 ↑	146202 ↓	6570 ↓	15923 ↓	151 ↑
Alternative 2	3897 ↑	179479 ↑	2059 ↓	5480 ↓	2 ↓
Alternative 3	3897 ↑	162369 ↓	6858 ↑	17625 ↑	169 ↑
Alternative 4	3897 ↑	162379 ↓	6854 ↑	17617 ↑	172 ↑
Alternative 5	3690 ↓	162346 ↓	7061 ↑	17648 ↑	173 ↑

The northern bobwhite depends on the interspersion of grasslands, croplands, and forest cover. For this reason, Alternative 2 would have the least amount of suitable habitat due to the conversion of grasslands to forestlands without vegetation management. This decrease in suitable habitat from the current condition makes the viability for this species a high risk under Alternative 2. Alternative 1 would also result in less suitable habitat than the current condition making viability a high risk under this alternative. Alternatives 3, 4, and 5 would provide similar amounts of suitable habitat over time because the acreage of grassland does not change substantially under these three alternatives, and croplands do not change on private lands in the HSI model. These three alternatives would result in similar amounts of suitable habitat over time, and each should result in stable or increased viability. Analysis of habitat for this species depicts the importance of land use on private lands. Without croplands, all alternatives would greatly reduce the amount of suitable habitat for the northern bobwhite, especially Alternative 2.

Figure 3.13 Amount of suitable habitat (HSI >0.50) for Northern Bobwhite under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



American Woodcock–Dry Forest/Mesic Forest/Openlands Habitat Species

The American woodcock is a migratory game species confined to North America. Keppie and Whiting (1994) described ideal habitat as young forest and abandoned farmland mixed with forest. Nests and young broods inhabit young to mid-age forests interspersed with openings; older broods are found where tree basal area is greater with a sparser mature tree composition (Keppie and Whiting 1994). Most available openings, including abandoned agricultural fields, forest gaps and harvests, meadows, pastures, orchards, bogs, and other natural clearings become display areas (Keppie and Whiting 1994). These singing grounds are usually some distance from diurnal cover used by the same individual; several studies indicate a median distance of up to 1,300 feet with a maximum of about 1.5 miles (Hudgins *et al*. 1985). The HSI model for this species contains four suitability indices: species preference for broadleaf forest, use of clearcuts for nesting, foraging, and cover; habitat used for displays; and proximity of nesting, foraging, and display habitat.

Table 3.20

ACRES OF AMERICAN WOODCOCK HABITAT BY SUITABILITY CLASS

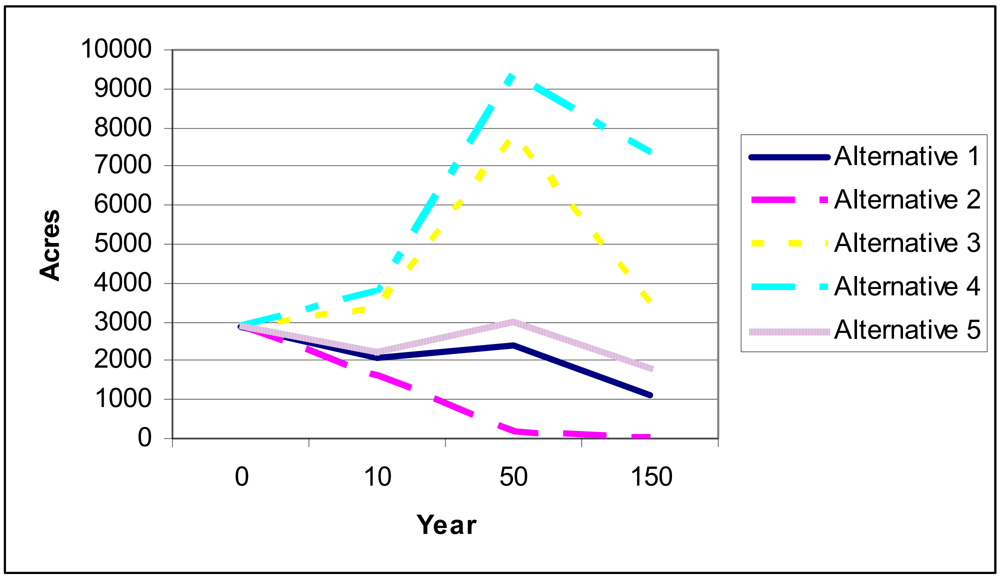
Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑) or decreases (↓) from the current condition. Highlighted classes indicate higher quality habitat.

American Woodcock	Class 0		Class 0.1 - 0.25		Class 0.26 - 0.50		Class 0.51 - 0.75		Class 0.76 - 1.0	
Current Condition	162722		10366		14943		2863		23	
Year 10										
Alternative 1	153292	↓	16997	↑	18541	↑	2039	↓	49	↑
Alternative 2	162275	↓	14729	↑	12317	↓	1522	↓	74	↑
Alternative 3	141713	↓	15793	↑	30080	↑	3267	↑	64	↑
Alternative 4	139569	↓	15882	↑	31663	↑	3682	↑	120	↑
Alternative 5	152607	↓	17088	↑	19060	↑	2115	↓	47	↑
Year 50										
Alternative 1	139238	↓	26430	↑	22858	↑	2376	↓	15	↓
Alternative 2	168889	↑	18858	↑	3027	↓	143	↓	0	↓
Alternative 3	125445	↓	24203	↑	33432	↑	7656	↑	181	↑
Alternative 4	117312	↓	27428	↑	36817	↑	9096	↑	263	↑
Alternative 5	138410	↓	26192	↑	23317	↑	2957	↑	41	↓
Year 150										
Alternative 1	153822	↓	21655	↑	14328	↓	1109	↓	3	↓
Alternative 2	181396	↑	7926	↓	1572	↓	23	↓	0	↓
Alternative 3	147225	↓	21474	↑	18711	↑	3420	↑	88	↑
Alternative 4	137905	↓	22099	↑	23551	↑	7058	↑	305	↑
Alternative 5	150623	↓	22910	↑	15629	↑	1730	↓	26	↑

The American woodcock depends on the interspersion of young forest and openlands. With the creation of MA 3.3, timber harvest would be implemented in such a way as to maximize the habitat quality for the woodcock by ensuring that appropriate habitat types occur in proximity to one another resulting in an increased amount of suitable habitat under Alternatives 3, 4, and 5. The risk to viability for this species would be reduced under all three of these alternatives by directing a portion of even-aged management into MA 3.3. Alternatives 1 and 5 would have similar amounts of suitable habitat in year 10. However, Alternative 5 will provide more suitable habitat than Alternative 1 throughout time. With timber harvest and prescribed burning, Alternatives 1, 3, 4, and 5 would provide more acres of suitable habitat in all years than Alternative 2. Alternative 2 would result in a reduction in suitable habitat that continues to drop through year 150. By year 50, Alternative 2 would provide virtually no suitable habitat for the woodcock.

Alternatives 3 and 4 would result in the creation of more early-successional habitat than other alternatives due to their higher proposed levels of timber harvest and prescribed burning. Alternatives 3 and 4 would result in an increase in suitable habitat from the current condition, making species viability a low risk under these Alternatives. Alternative 5 results in a slight reduction in suitable habitat, however, even-aged management treatments have been increased to a maximum size of 10 acres in MA 2.8. In addition, Visual Quality Objectives have been adjusted to allow vegetation management along some riparian zones to provide habitat for wildlife species dependent on early successional mesic areas. These changes will result in an increase in suitable habitat for these species, and a subsequent low risk to species viability.

Figure 3.14 Amount of Suitable Habitat (HSI >0.50) for the American Woodcock Derived from a GIS-based HSI Model at Year 0, 10, 50, and 150.

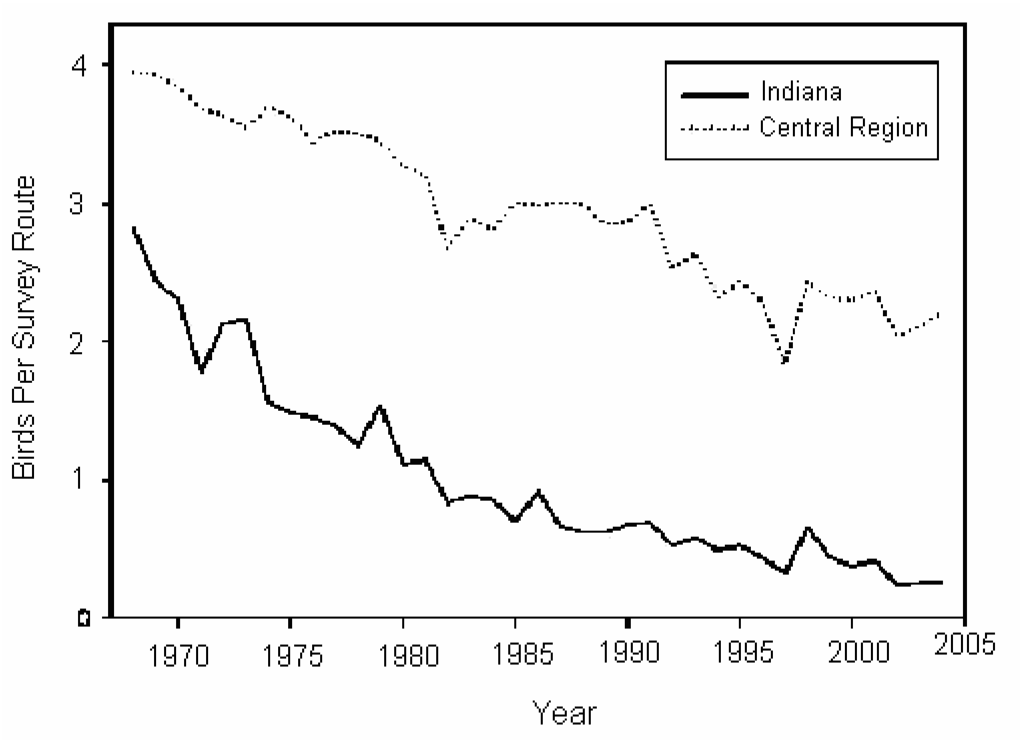


Because viability is a high risk for this species, further analysis of population trends was warranted. Each year, the USDI Fish and Wildlife Service conducts a survey throughout the known breeding range of the American woodcock to monitor changes in population abundance. This is conducted during the breeding season and has been shown to be a reliable index to population abundance (Duke 1966). Indiana is a member of the central management region and has participated in the Federal singing-ground survey annually since 1968. American woodcock populations have been declining over the last 30 years (Figure 3.15). Woodcock require early successional habitats, particularly in areas with moist soils. Because woodcock feed by probing their beak into the ground to find grubs and earthworms, moist soil is essential. The reduction in timber harvest on public and private lands has resulted in a large decrease in suitable habitat available to the woodcock.

The American woodcock has been ranked as a highest (global) priority species in need of conservation action by Partners in Flight - North American Bird Conservation Initiative (2004). The USFWS has named the woodcock as one of a handful of national focus species (Williamson 2005). Habitats used by woodcock also support other high priority species in need of conservation action. The largest public-private coalition ever created has been assembled by the Wildlife Management Institute to address the loss of habitats for woodcock and other high

priority species. Major partners include the USFWS, U.S. Geological Survey, state fish and wildlife agencies, and private forest landowners. This initiative will focus on projects that create areas on state and Federal lands that exemplify best management practices (BMPs) for American woodcock and projects that monitor woodcock populations and habitat use before, during, and after implementation of BMPs. The initiative emphasizes the need to focus attention to this suite of species and integrate early successional habitat management into lands that we conserve and restore on the Forest.

Figure 3.15 American Woodcock population trends in Indiana and the Central Management Region



<u>Indiana Bat–Wide-ranging Habitat Species</u>
The Indiana bat is a Federally endangered, migratory species that uses caves and abandoned mines in winter and forested habitat in the summer. Female Indiana bats form maternity colonies (100 individuals or less) under exfoliating bark during the summer months (Whitaker and Hamilton 1998). Indiana bats' maternity range has been changed dramatically from pre-settlement conditions as forests have been fragmented in the upper Midwest: Fire has been suppressed, and prairies have been supplanted with agricultural systems, primarily row crop and pasture and hayland (USDI Fish and Wildlife Service 1999). Humphrey *et al*. (1977) determined that dead trees are preferred roost sites and that trees standing in sunny openings are preferable because crevices under the bark are warmer. In Missouri, Callahan (1993) noted that more bats used "open snags," "interior snags," or "interior live trees." Callahan *et al*. (1997) found all primary roosts in open snags (that is, exposed to solar radiation).

Viability of Indiana bat is a part of Issue Two: Ecosystem Sustainability. Indicators of response for ecosystem sustainability appropriate to Indiana bat are:

- Acres of Available Habitat (see Table 3.21)

- Species Composition (see Figures 3.21a, b, c, and d)
- Age Class Distribution (see Table 3.37)

Indiana bats leave the roost approximately 25 minutes after sundown to feed on flies, moths, and caddisflies, which they capture in the mouth or with a wing or the tail membrane (Kurta 1995). Preferred foraging habitat consists of a dense floodplain forest (Kurta 1995) or even upland forest at an edge (SVE Panels 2002) where they frequently forage over or near water (Jones *et al*. 1985, Gardner *et al*. 1996). In Indiana, however, Brack (1983) observed bats foraging in riparian areas, upland forests, over a pond, a pasture, and an old field. Most foraging occurred along habitat edges. Four suitability indices are included in the HSI model for this species: available roost trees, solar radiation and foraging habitat, proximity of roost trees to water sources, and interspersion of open areas, forest gaps, and roost trees.

Table 3.21

ACRES OF INDIANA BAT HABITAT BY SUITABILITY CLASS

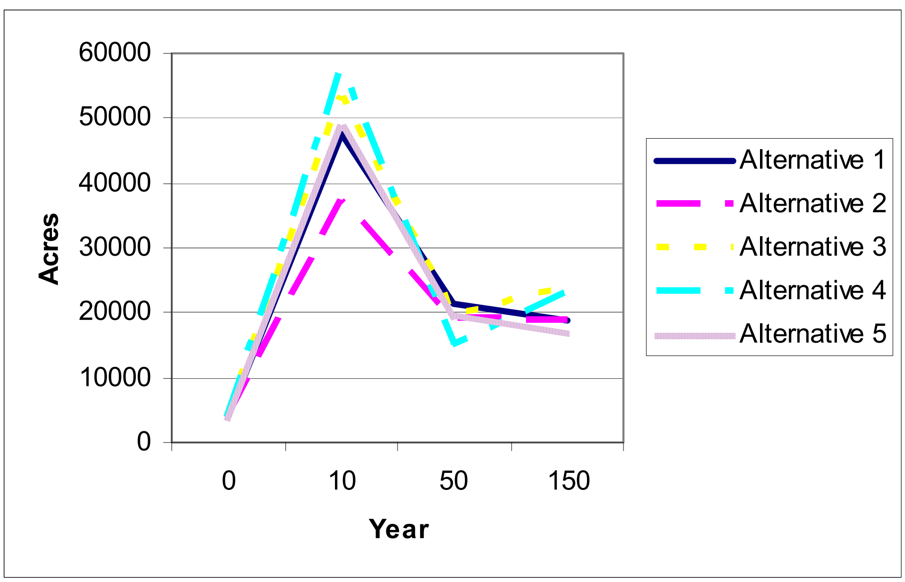
Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑), decreases (↓), or remains stable (←→) from the current condition. Highlighted classes indicate higher quality habitat.

Indiana Bat	Class 0	Class 0.1 - 0.25	Class 0.26 - 0.50	Class 0.51 - 0.75	Class 0.76 - 1.0
Current Condition	3897	75230	108094	97	3599
Year 10					
Alternative 1	3897 ←→	62874 ↓	76685 ↓	787 ↑	46675 ↑
Alternative 2	3897 ←→	60937 ↓	88827 ↓	723 ↑	36534 ↑
Alternative 3	3897 ←→	65455 ↓	68135 ↓	932 ↑	52499 ↑
Alternative 4	3897 ←→	65115 ↓	64368 ↓	989 ↑	56547 ↑
Alternative 5	3897 ←→	63097 ↓	75674 ↓	850 ↑	47400 ↑
Year 50					
Alternative 1	3897 ←→	73830 ↓	91938 ↓	692 ↑	20561 ↑
Alternative 2	3897 ←→	42436 ↓	125495 ↑	371 ↑	18718 ↑
Alternative 3	3897 ←→	96555 ↑	71051 ↓	438 ↑	18977 ↑
Alternative 4	3897 ←→	108897 ↑	63099 ↓	147 ↑	14877 ↑
Alternative 5	3897 ←→	73830 ↓	91938 ↓	692 ↑	20561 ↑
Year 150					
Alternative 1	3897 ←→	55574 ↓	112474 ↑	250 ↑	18723 ↑
Alternative 2	3897 ←→	13868 ↓	154336 ↑	192 ↑	18624 ↑
Alternative 3	3897 ←→	63520 ↓	99444 ↓	527 ↑	23529 ↑
Alternative 4	3897 ←→	76365 ↑	87782 ↓	389 ↑	22484 ↑
Alternative 5	3897 ←→	61617 ↓	108680 ↑	257 ↑	16466 ↑

This species depends on mature timber with canopy gaps in proximity to water. Alternatives 3 and 4 would result in the most acres of suitable habitat throughout time because of the increased number of gaps created by higher levels of timber harvest. Alternative 1 would result in slightly more suitable habitat than Alternative 5. Alternative 5 concentrates a portion of even-aged harvest in MA 3.3 with an increased harvest size (up to 40 acres) resulting in less foraging habitat than Alternative 1. In Alternative 2, natural disturbance would provide some gaps to create suitable habitat. All alternatives would result in an increased amount of suitable habitat for the Indiana bat than is currently found on the Forest, and should provide continued viability for this species. Increases in the acres of highly suitable maternal roosting habitat for the Indiana bat, under all alternatives, results primarily from the aging of the forest. At present, the Forest is comparatively young, especially in respect to a species that uniquely depends on senescent trees for maternal habitat.

It is important to note that a spike in suitable habitat occurs in year 10 under all alternatives, primarily as an artifact of the stocking procedure for the LANDIS model. In the first decade, LANDIS goes thru the landscape and establishes understory trees (age class 0) to create a complete data set.

Figure 3.16 Amount of suitable habitat (HSI >0.50) for the Indiana bat under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



<u>Spotted Salamander - Wetlands/Dry Forest/Mesic Forest Habitat Species</u>
The preferred habitat of the spotted salamander is found in mature deciduous forest cover. The species often inhabits coniferous forest and mixed conifer/deciduous forest (Minton 1972, Petranka 1998), but locally pine forests do not foster a healthy herbaceous understory (Ewert *et al*. 1992). Petranka *et al*. (1994) found the highest densities of spotted salamanders in hardwood stands older than 120 years. With a breeding season ranging from 4 to 29 days, adult spotted salamanders spend about 92 to 99 percent of the year in the forested uplands surrounding a breeding area (Semlitsch 1998). On the Hoosier, breeding sites most commonly consist of small manmade water bodies or ephemeral pools, in which the salamander larvae eat

mainly small aquatic invertebrates (DeGraaf and Rudis 1983). Petranka *et al*. (1998) noted that fish-free habitat in small ponds was essential.

Semlitsch (1998) summarized published terrestrial migration distances from studies conducted in five Eastern states at breeding sites for six species. By aggregating data, he computed a mean migration distance of about 1,350 feet and suggested that a zone about 540 feet wide surrounding a breeding pond would encompass 95 percent of the salamander's core habitat. Pooling Semlitsch's data for the spotted salamander only (from six studies) and including the unpublished dissertation work of Williams (1973) at Indiana University, the migration distances are found to range from 0 to about 820 feet, with a mean of about 390 feet. Our spotted salamander habitat model contained four suitability indices: distance of non-breeding habitat from ponds, likelihood of the presence of fish in ponds (two methods used), preference of broadleaf forest, and forest age.

Table 3.22

ACRES OF SPOTTED SALAMANDER HABITAT BY SUITABILITY CLASS

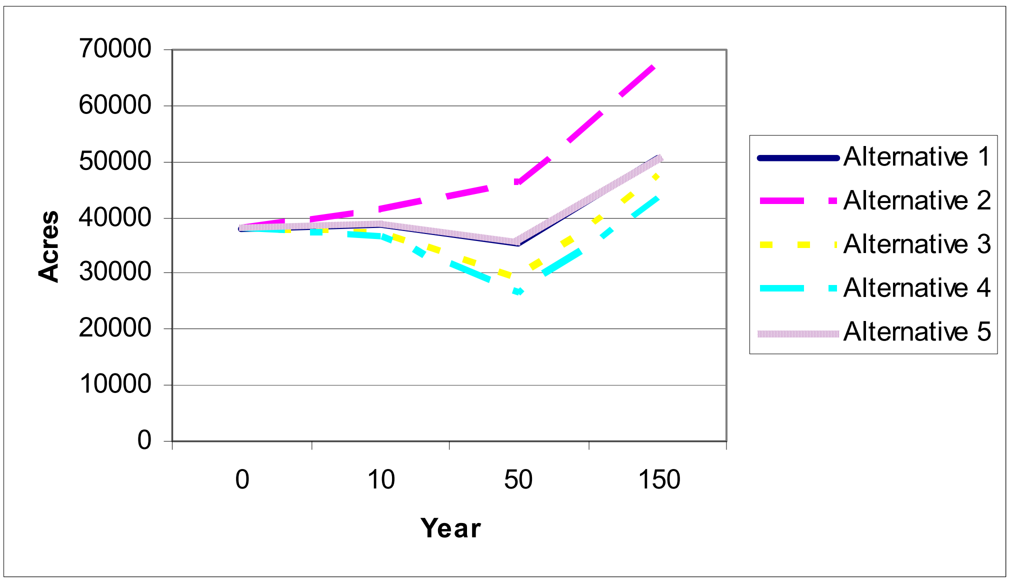
Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑), decreases (↓), or remains stable (←→) from the current condition. Highlighted classes indicate higher quality habitat. Highlighted classes indicate higher quality habitat.

Spotted Salamander	Class 0	Class 0.1 - 0.25	Class 0.26 - 0.50	Class 0.51 - 0.75	Class 0.76 - 1.0
Current Condition	4141	106950	45095	33884	4013
Year 10					
Alternative 1	4141 ←→	110030 ↑	41077 ↓	33517 ↓	5318 ↑
Alternative 2	4141 ←→	105197 ↓	43481 ↓	35539 ↑	5726 ↑
Alternative 3	4141 ←→	114423 ↑	38382 ↓	31980 ↓	5157 ↑
Alternative 4	4141 ←→	115106 ↑	38244 ↓	31566 ↓	5026 ↑
Alternative 5	4141 ←→	110117 ↑	41020 ↓	33545 ↓	5259 ↑
Year 50					
Alternative 1	4141 ←→	119366 ↑	35078 ↓	25811 ↓	9686 ↑
Alternative 2	4141 ←→	103559 ↓	40364 ↓	33123 ↓	12895 ↑
Alternative 3	4141 ←→	127845 ↑	32990 ↓	20951 ↓	8156 ↑
Alternative 4	4141 ←→	130535 ↑	32788 ↓	18964 ↓	7655 ↑
Alternative 5	4141 ←→	119888 ↑	34829 ↓	25505 ↓	9720 ↑
Year 150					
Alternative 1	4141 ←→	96597 ↓	96598 ↑	37564 ↑	12903 ↑
Alternative 2	4141 ←→	78385 ↓	44192 ↓	45948 ↑	21416 ↑
Alternative 3	4141 ←→	100549 ↓	41774 ↓	35604 ↑	12015 ↑
Alternative 4	4141 ←→	106004 ↓	40450 ↓	32693 ↓	10794 ↑
Alternative 5	4141 ←→	96357 ↓	42979 ↓	37480 ↑	13126 ↑

In year 10, all alternatives would result in similar acreages of suitable habitat. Alternatives 3 and 4 have slightly smaller amounts of suitable habitat than other alternatives due to increased harvest levels. Through time, Alternative 2 would have a much higher amount of suitable habitat than all other alternatives due to the lack of disturbance from harvest and fire. Under this alternative, as the forest matured, the habitat around small breeding ponds would age and improve in structure. However, this model did not account for the loss of breeding ponds due to a lack of management. Alternative 2 does not allow for the maintenance of ponds or waterholes. This would likely reduce the breeding habitat considerably from the acres predicted above.

Alternatives 1 and 5, which propose less harvest than Alternatives 3 and 4, would result in the next highest amount of suitable habitat. Although this model did not include the creation of new water bodies, Alternatives 1, 3, 4, and 5 allow for this type of activity. Therefore, these four alternatives would likely result in greater acreages than are predicted above. By year 150, all alternatives would result in an increase in suitable habitat above the current condition on the Forest. Therefore, any of the alternatives should maintain or increase viability for this species. Because the spotted salamander depends on mature deciduous forest cover and reaches highest densities in stands older than 120 years (Petranka *et al*. 1994), directing management into MA 3.3 would increase the amount of suitable habitat for this species across the Forest under Alternatives 3, 4, and 5.

Figure 3.17 Amount of suitable habitat (HSI >0.50) for the Spotted Salamander under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



Aquatic Habitats – SVE Species

Events associated with timber harvests can affect riparian habitat in a number of ways such as fluid leaks or spills, negative impacts on water quality, or direct physical impacts due to stream fording. However, the most common and significant effects of unmitigated timber harvest on riparian habitat is increased levels of sediments deposited in streams. The sediment originating from the construction and use of logging roads and skid trails generally exceeds that from all other forestry activities (Eschner and Larmoyeux 1963, Binkley and Brown 1993). Benthic invertebrates, by definition, inhabit the stream bottom. Therefore, any modification of the streambed by deposited sediment would most likely have an effect on the benthic invertebrate community.

In general, as deposited sediment increases, the production of invertebrates decreases. The greatest invertebrate production comes from a wide variety of large, hard substrates, such as gravel and cobble, as well as the interstitial spaces between these substrates which are used for cover and access to oxygen (Waters 1995). Fine sediments can cover these substrates, and

the interstitial spaces within the substrate become filled, resulting in a loss of habitat quantity or habitat quality. A small increase in sediment may result in decreases in the population size of aquatic invertebrates; however, the community structure may not change (Lenat *et al*. 1979). Yet, as deposited sediment increases, changes in the diversity and density of communities could occur (Lenat *et al.* 1979).

These changes in community generally involve a shift in dominance from mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), and caddisflies (*Trichoptera*) to species that burrow such as aquatic worms (*oligochaetes*), crusteaceans (*amphipods*), and slugs and snails (*gastropods*) (Lenat *et al*. 1979, Matter and Ney 1981). Sediment can lead to decreased invertebrate production, which in turn can affect fish production, as burrowing insect species are much less available to fish.

Zweig and Rabeni (2001) stated that the stream substrate condition is the most important factor determining benthic invertebrate distribution and abundance at the local or reach level. In a study of several Missouri streams, they found species decline with increasing deposited sediments in every stream, and they reported major declines in density (up to 50 percent reductions) at low deposition levels. Tebo (1955) found a significantly lower standing crop of bottom organisms at stations affected by sediment from a logging site compared to a site on the stream just upstream from the logging site. He found that the difference persisted for five months until a large flood event flushed most of the sediments from the segment. Newbold *et al*. (1980) reported that logging in California significantly reduced macroinvertebrate diversity in streams. They found that protected buffer strips greater than 100 feet wide along streams eliminated most of the negative impacts.

Research has shown that where timber harvesting employs BMPs properly (IDNR 1998a), significantly less erosion and sedimentation occur (Swift 1986, Lynch *et al.* 1985, Kochenderfer and Helvey 1987, Kochenderfer and Hornbeck 1999), especially when protective buffer strips are established along perennial and intermittent streams. In a comprehensive summary of North American studies, Binkley and Brown (1993) noted that the retention of forested buffer strips along streams prevent unacceptable increases in sediment concentration and stream temperatures. Vegetation along perennial and intermittent streams (Forest Plan Direction, Chapter 3) should preclude the effects of increased sedimentation.

The potential for increased erosion during timber harvest can be reduced even more if harvest operations are conducted when the ground is frozen or dry. The risk of erosion can also be reduced by limiting harvest operations to gentle and moderate slopes, requiring tracked or low ground pressure equipment, or using cable logging systems to reduce the effects of logs being transported over the ground. Leaving woody debris on site following timber harvest operations is another practice that could reduce erosion potential. Woody debris acts as a physical barrier to soil movement and protects soil from splash erosion (Pritchett and Fisher 1987, Sharpe 2003). Appropriate layout and design of the logging system and skid trails is imperative to reducing the erosion potential. Transporting logs over poorly located skid roads or in fine-textured soils increases the erosion potential. The impacts of erosion and sediment production can be reduced through careful layout and construction, caution in wet weather, and road closure (Hornbeck and Federer 1975, Kochenderfer and Aubertin 1975, Patric 1996, Stone *et al.* 1978).

Although sediment is a natural part of aquatic systems, problems arise when the sediment load of the stream exceeds the ability of the ecosystem to process that sediment. Fish species have

varying tolerances to sediment and pollution, and increases in sediment load may result in a shift to more tolerant species within a fish community (Sweeten and McCreedy 2002).

Application of Forest Plan direction and BMPs are expected to result in minimal increases to sediment and erosion. Refer to Maintain and Restore Watershed Health section.

Northern River Otter (*Lontra canadensis*)--Wetlands/Rivers Habitat Species
River otters live in almost every aquatic habitat available. This species does very well in rivers, lakes, ponds, swamps, marshes, bayous, and small streams (Brown 1997). Suitable habitat must provide enough food, because food influences otter habitat use considerably (Melquist and Dronkert 1987). Otters are most common in watersheds that contain clean, fairly deep water and healthy fish populations. Inland populations of otters prey mainly on lake and river fishes, birds (especially waterfowl), small mammals, crayfish, and amphibians (Gilbert and Nancekivell 1982, Reid *et al*. 1994, Lizotte and Kennedy 1997).

Home range is typically linear, with the species using 20 to 30 miles for a pair of males and less for females with young (NatureServe 2001b). They may hunt over as much as 50 to 60 miles of stream during the course of one year. Johnson and Berkley (1999) describe river otters in Indiana selecting den or resting sites based on the availability of suitable shelters that offer protection and seclusion. When inactive, otters occupy hollow logs, space under roots, abandoned beaver lodges, dense thickets near water, or burrows of other animals (Waller *et al.* 1999). Otters also use such sites for rearing young. Their aquatic life patterns tie river otters almost exclusively to permanent water. Two classes of HSI sub-indices are included in the river otter model: basin-level and stream segment-level.

Table 3.23

MILES OF NORTHERN RIVER OTTER HABITAT BY SUITABILITY CLASS

Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑), decreases (↓), or remains stable (←→) from the current condition. Highlighted classes indicate higher quality habitat. Highlighted classes indicate higher quality habitat.

Northern River Otter	Class 0	Class 0.1 - 0.25	Class 0.26 - 0.50	Class 0.51 - 0.75	Class 0.76 - 1.0
Current Condition	87	396	34	72	75
Year 10					
Alternative 1	87 ←→	403 ↑	41 ↑	83 ↑	50 ↓
Alternative 2	87 ←→	389 ↓	49 ↑	64 ↓	74 ↓
Alternative 3	87 ←→	413 ↑	41 ↑	92 ↑	31 ↓
Alternative 4	87 ←→	411 ↑	44 ↑	92 ↑	30 ↓
Alternative 5	87 ←→	401 ↑	45 ↑	76 ↑	54 ↓
Year 50					
Alternative 1	87 ←→	390 ↓	47 ↑	70 ↓	70 ↓
Alternative 2	87 ←→	387 ↓	40 ↑	65 ↓	84 ↑
Alternative 3	87 ←→	392 ↓	47 ↑	73 ↑	64 ↓
Alternative 4	87 ←→	391 ↓	53 ↑	67 ↓	65 ↓
Alternative 5	87 ←→	390 ↓	44 ↑	69 ↓	74 ↓
Year 150					
Alternative 1	87 ←→	389 ↓	46 ↑	73 ↑	68 ↓
Alternative 2	87 ←→	387 ↓	41 ↑	65 ↓	83 ↑
Alternative 3	87 ←→	396 ←→	44 ↑	70 ↓	66 ↓
Alternative 4	87 ←→	397 ↑	48 ↑	74 ↑	57 ↓
Alternative 5	87 ←→	390 ↓	46 ↑	69 ↓	71 ↓

This model represents the potential habitat for the river otter. This model predicts potential impacts without the use of BMPs or guidance to illustrate the importance of these practices, as well as potential differences among the alternatives. Because this HSI model did not simulate BMPs and Forest Plan direction, variation among alternatives is a measure of riparian cover and sedimentation levels resulting from timber harvest activities, connectivity to wetlands and ponds, and adequacy of the food base. The reduction of vegetation along shorelines significantly reduces the suitability of otter habitat in this model. Riparian cover and structure in the form of trees, snags, stumps, and so forth are critical otter habitat, as otters tend to avoid shorelines without large trees and other vegetation (Melquist and Dronkert 1987). Because the Hoosier would implement BMPs (IDNR 1998a) and Forest Plan direction, no measurable difference is

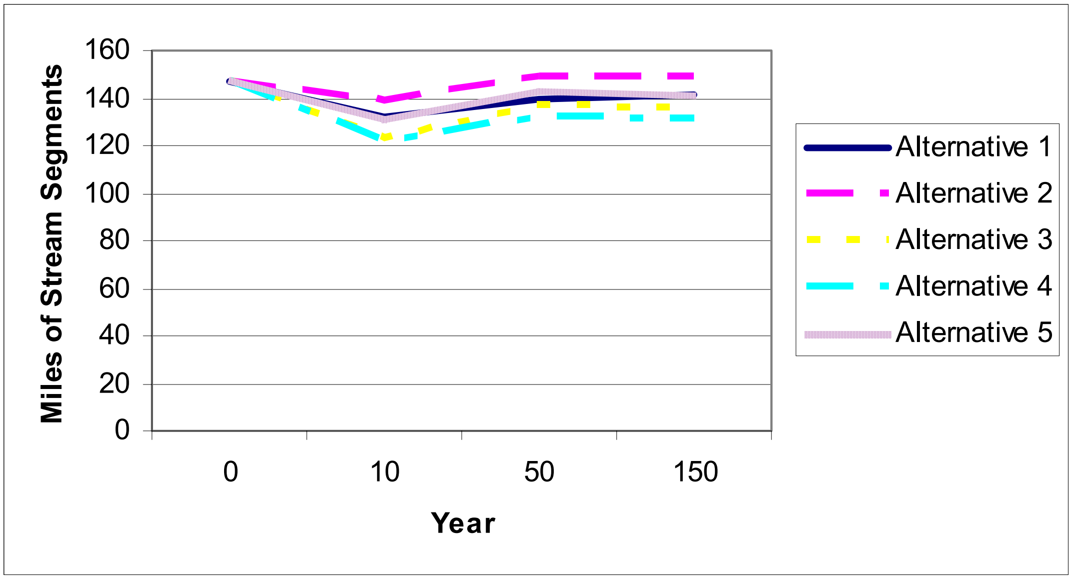
expected among the alternatives, and the amount of suitable habitat under Alternatives 1, 3, 4, and 5 is actually higher than shown in this data set.

The SVE panels (2002, 2004) ranked an adequate food base as the most important feature influencing river otter habitat use. The majority of the river otter's diet in Indiana is composed of fish. Benthic invertebrates make up the majority of food for many stream fish, and a reduction in the levels of stream invertebrates due to increased sedimentation could lead to a decrease in available food for otters.

The amount of suitable habitat for this species declines in year 10 for all alternatives, primarily because of the stocking procedure for the LANDIS model. For the remaining years, this model estimates that Alternative 2 would have the greatest amount of suitable habitat for the river otter due to a lack of timber harvest. Under this alternative, riparian cover along streams would continue to age with little disturbance. Alternatives 1 and 5, which would allow less acres of shelterwood and clearcut treatments than Alternatives 3 and 4, would result in the next highest amounts of suitable habitat. However, BMPs (IDNR 1998a) and Forest Plan direction, which are required on the Hoosier, are designed to mitigate or prevent adverse impacts due to sediment movement, water temperature shifts, changes in streamflow, and habitat alternation. Therefore, all four alternatives should result in little impact to potential river otter habitat and would maintain viability.

The Indiana Department of Natural Resources, Division of Fish and Wildlife released 303 river otters in six different watersheds--three in northern Indiana and three in southern Indiana. Scott Johnson, Indiana Nongame Mammal Biologist, predicts that the river otters will become established in all Indiana watersheds in the next 50 years (2004, pers. comm.). The HSI model for the river otter is a measure of riparian cover and sedimentation levels resulting from harvest. Both of these indices can affect habitat suitability for the otter. Directing a portion of even-aged management into Management Area 3.3 will likely result in more suitable habitat under Alternatives 3, 4, and 5 by minimizing the amount of harvest in other watersheds across the forest. Management Area 3.3 falls in three counties - Dubois, Crawford, and Perry.

Figure 3.18 Amount of suitable habitat (HSI >0.50) for the Northern River Otter under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



Indiana Crayfish (*Orconectes indianensis*)-Rivers Habitat Species
Indiana crayfish are not commonly associated with soft-bottomed, turbid streams and rivers. They also avoid fast currents, standing water, and deep water (Page 1985; Page and Motessi 1995). In the Hoosier, the Indiana crayfish is found in the tributaries of the Patoka River and Patoka Lake, as well as in the headwater streams of the Anderson River.

Page and Motessi (1995) noted an absence of Indiana crayfish from streams lacking riparian trees, exhibiting high turbidity, or exhibiting extensive siltation. They hypothesized that any land use practice that increased the turbidity and siltation of streams (such as removal of riparian vegetation, or runoff from construction, agriculture, or forestry) would adversely alter suitable Indiana crayfish habitat. The HSI model for this species contains three suitability indices: perennial nature of the stream segment, presence of riparian cover, and degree of siltation.

Table 3.24

MILES OF INDIANA CRAYFISH HABITAT BY SUITABILITY CLASS

Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑), decreases (↓), or remains stable (←→) from the current condition. Highlighted classes indicate higher quality habitat. Highlighted classes indicate higher quality habitat. Values represent the length (miles) of all 1st – 4th order stream segments at a scale of 1:24,000 for streams and basins that are identified in the literature as being occupied by the Indiana crayfish and that spatially intersect NFS land. These stream segments represent potential Indiana crayfish habitat.

Indiana Crayfish	Class 0	Class 0.1 - 0.25	Class 0.26 - 0.50	Class 0.51 - 0.75	Class 0.76 - 1.0
Current Condition	63	0.5	2	34	68
Year 10					
Alternative 1	66 ↑	2 ↑	11 ↑	58 ↑	30 ↓
Alternative 2	63 ←→	0.5 ←→	3 ↑	56 ↑	46 ↓
Alternative 3	67 ↑	11 ↑	33 ↑	44 ↑	12 ↓
Alternative 4	66 ↑	8 ↑	30 ↑	53 ↑	12 ↓
Alternative 5	66 ↑	2 ↑	8 ↑	60 ↑	32 ↓
Year 50					
Alternative 1	66 ↑	0.5 ↑	2 ↓	36 ↑	63 ↓
Alternative 2	63 ←→	0 ↓	0.1 ↓	11 ↓	94 ↑
Alternative 3	66 ↑	2 ↑	6 ↑	42 ↑	53 ↓
Alternative 4	66 ↑	1 ↑	4 ↑	44 ↑	53 ↓
Alternative 5	66 ↑	1 ↑	3 ↑	38 ↑	60 ↓
Year 150					
Alternative 1	66 ↑	0.5 ←→	2 ↑	38 ↑	61 ↓
Alternative 2	63 ←→	0 ↓	0 ↓	7 ↓	98 ↑
Alternative 3	67 ↑	1 ↑	4 ↑	54 ↑	43 ↓
Alternative 4	66 ↑	2 ↑	8 ↑	46 ↑	45 ↓
Alternative 5	66 ↑	1 ↑	3 ↑	37 ↑	61 ↓

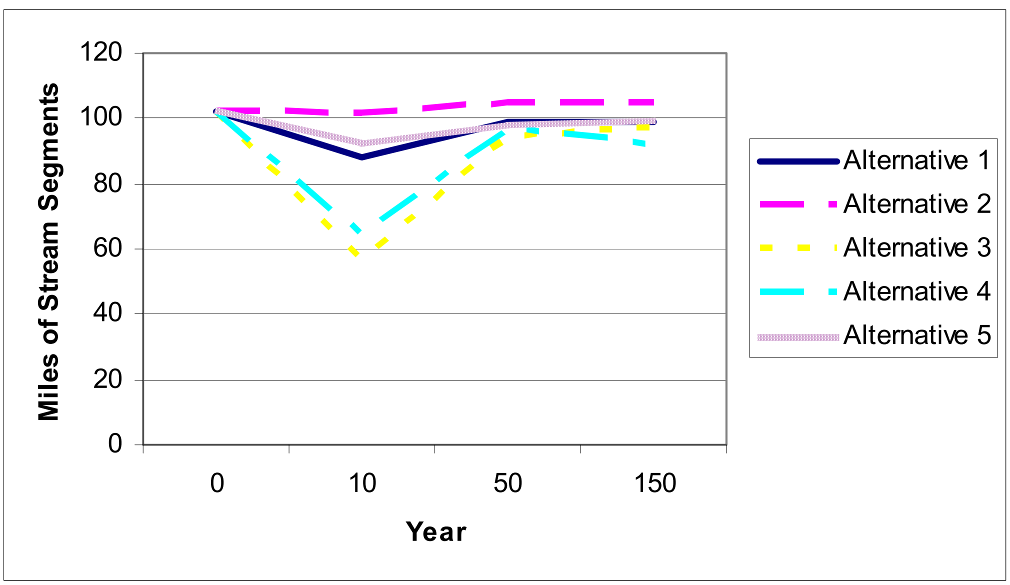
The most common and significant potential impact of timber management practices on Indiana crayfish habitat is the effect of increased levels of deposited sediments in the stream. Benthic invertebrates by definition inhabit the stream bottom; hence, modification of the streambed by deposited sediment could have major effects on this aquatic community. Furthermore, interstitial habitat (availability of silt, gravel, and pebbles) is important for crayfish (SVE Panels 2002).

Another major impact on the Indiana crayfish is the alteration of riparian vegetation. Page and Mottessi (1995) reported that Indiana crayfish did not occupy what would be considered otherwise suitable habitat when the stream segment was denuded of riparian trees. This finding was consistent with the information gathered at the SVE Panels (2004). Vegetation would remain along all perennial and intermittent streams and would filter sediment that might otherwise reach streams.

Variation among alternatives is a measure of riparian cover and sedimentation levels resulting from timber harvest activities without the use of BMPs. Because this model includes all 1st to 4th order stream segments on the Hoosier within the range of the crayfish, the relative effects of the alternatives can be compared. The amount of suitable habitat for this species declines in year 10 for all alternatives, primarily because of the stocking procedure for the LANDIS model. Because Alternative 2 does not allow timber harvest, riparian cover along streams would continue to age and there would be little disturbance. This alternative would result in the most suitable habitat for the Indiana crayfish, followed by Alternatives 1 and 5. Alternative 3 would provide more suitable habitat than Alternative 4.

Because this HSI model did not simulate BMPs and Forest Plan direction, streamside land use and tree age were considered in the evaluation of Indiana crayfish habitat suitability to estimate potential effects. As a result, the amount of suitable habitat under alternatives 1, 3, 4, and 5 is actually higher than shown in this data set. BMPs and Forest Plan direction would provide additional protection during timber harvest which would result in more suitable habitat for this species. Because the Hoosier would implement BMPs (IDNR 1998a) and Forest Plan direction, no measurable difference is expected among the alternatives. This model predicts potential impacts without the use of BMPs or guidance to illustrate potential differences among the alternatives and the importance of these practices.

Figure 3.19 Amount of suitable habitat (HSI >0.50) for the Indiana Crayfish under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



Northern Cavefish (*Amblyopsis spelaea*)-Karst Habitat Species

Northern cavefish are obligate cave dwellers and are restricted to the underground environment. Poulson (1963) reports that northern cavefish is most often found in caves with uniform silt-sand substrate. He hypothesized that larger individuals may prefer rocky, flowing stream habitat and speculated that this may be due to dietary preferences.

Sedimentation of aquatic habitat in caves is a major concern with respect to northern cavefish habitat and populations (Pearson and Boston 1995). These researchers specifically mention logging roads and clearcuts as examples of human activities that are likely to have adverse effects on the northern cavefish. Sediment from logging roads and major skid trails could be transported into cave streams via sinkholes, blind valleys, sinking stream channels, and karst windows just as they could be delivered to surface streams via surface drainage. Silting in and reducing the depth of important deep water pools could also damage cavefish habitat (Keith 1988). However, the Hoosier expects implementation of BMPs (IDNR 1998a) and Forest Plan direction to minimize impacts to these resources.

The potential areas of impact for this species were determined by identifying the hydrologic recharge areas that intersect the Forest boundary within the predicted range of the northern cavefish (outermost confirmed sightings buffered 5 miles). Using the Forest's 10-meter digital elevation model, a "sinks" layer was developed and edited to remove anomalous features, such as those created where a creek flowed under an elevated road. The Forest delineated the watersheds of those sinks. The cavefish HSI model was run over 7,715 acres of habitat that met all of the criteria, referred to as the areas of impact. Our northern cavefish habitat model contained two suitability indices: harvest intensity and propensity for erosion to occur in the areas of impact.

Table 3.25

ACRES OF NORTHERN CAVEFISH HABITAT BY SUITABILITY CLASS

Values were derived from a GIS-based HSI Model at Year 0, 10, 50, and 150. HSI models provide a numerical index of habitat quality ranging from 0 (Unsuitable) to 1 (Highly Suitable). Arrows denote whether the amount of habitat increases (↑), decreases (↓), or remains stable (←→) from the current condition. Highlighted classes indicate higher quality habitat. Highlighted classes indicate higher quality habitat.

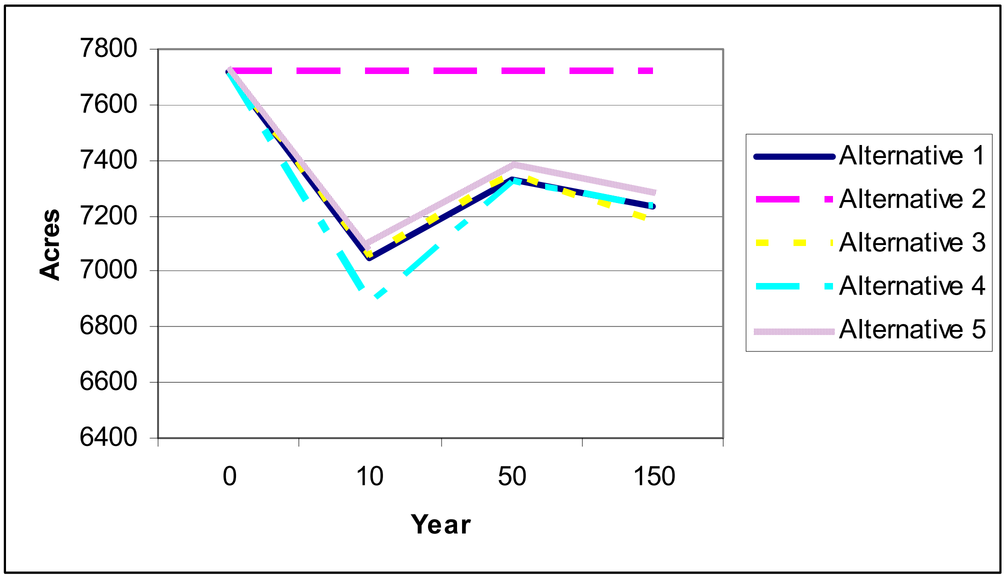
Northern Cavefish	Class 0	Class 0.1 - 0.25	Class 0.26 - 0.50	Class 0.51 - 0.75	Class 0.76 - 1.0
Current Condition	0	0	0	0	7715
Year 10					
Alternative 1	255 ↑	102 ↑	313 ↑	0 ←→	7045 ↓
Alternative 2	0 ←→	0 ←→	0 ←→	0 ←→	7715 ←→
Alternative 3	255 ↑	329 ↑	73 ↑	0 ←→	7058 ↓
Alternative 4	255 ↑	258 ↑	318 ↑	17 ↑	6867 ↓
Alternative 5	255 ↑	85 ↑	286 ↑	0 ←→	7089 ↓
Year 50					
Alternative 1	255 ↑	48 ↑	78 ↑	19 ↑	7314 ↓
Alternative 2	0 ←→	0 ←→	0 ←→	0 ←→	7715 ←→
Alternative 3	255 ↑	70 ↑	43 ↑	5 ↑	7342 ↓
Alternative 4	255 ↑	107 ↑	32 ↑	15 ↑	7306 ↓
Alternative 5	255 ↑	34 ↑	46 ↑	34 ↑	7346 ↓
Year 150					
Alternative	255 ↑	77 ↑	148 ↑	36 ↑	7199 ↓
Alternative 2	0 ←→	0 ←→	0 ←→	0 ←→	7715 ←→
Alternative 3	255 ↑	182 ↑	99 ↑	0 ←→	7179 ↓
Alternative 4	255 ↑	108 ↑	117 ↑	5 ↑	7230 ↓
Alternative 5	255 ↑	37 ↑	143 ↑	84 ↑	7196 ↓

Within the areas of impact, Alternative 2, which proposes no timber harvest, would maintain a stable amount of suitable cavefish habitat through time. Alternatives 1, 3, 4, and 5 would have very similar amounts of suitable habitat through time, and the quantities would not vary greatly from the current condition (4 to 10 percent reduction). Differences in suitable acres under Alternatives 1, 3, 4, and 5 are attributed to differences in the amount of potential sediment from harvest regimes and topography of logged areas, as higher rates of erosion could be related to increases in slope length and slope steepness. Of these alternatives, Alternative 5 provides the most suitable habitat throughout time. Forest Plan direction (Chapter 3) would provide additional protection along riparian corridors, resulting in additional protection of habitat for this species. As a result, suitable habitat would likely be higher for all alternatives that propose

harvest than shown here, and no measurable difference is expected among the alternatives. All alternatives should maintain viability for the northern cavefish.

The creation of MA 3.3 directs a portion of even-aged management away from the areas of impact for this species, thus reducing the potential effects of timber harvests on sediment export in Alternative 5 below those in Alternative 1. The northeast portion of Management Area 3.3 is over 10 miles from the Lost River Watershed, where the northern cavefish is known to occur. Directing even-aged management away from this watershed and into Management Area 3.3 results in very similar amounts of suitable habitat for the cavefish between Alternatives 1, 3, 4, and 5 even though Alternatives 3 and 4 propose more timber harvest.

Figure 3.20 Amount of suitable habitat (HSI >0.50) for the Northern Cavefish under each alternative. Values were derived from a GIS-based Habitat Suitability Index (HSI) Model at Year 0, 10, 50, and 150.



SVE Species Analysis – Plants

Geospatial data specific to the habitat needs of plants is not available. For this reason, the approach used to develop HSI models for plant species differs from the approach used for animal species. Biologists developed values to assess the magnitude of effect of management activities that vary by alternative on new habitat creation or destruction for each plant species, leading to an overall HSI value. Management activities that were evaluated included the following activities that could be measured (number of acres): prescribed fire, clearcuts, shelterwood cuts, group selection harvests, single-tree selection, and openings. Habitat values range between 0 (not habitat) and 1 (habitat of maximum suitability). The numbers between 0 and 1 were determined empirically by the following method. Carolina thistle benefits from prescribed burning, so Alternative 4 which burns the most acres is assigned the highest value (1). Alternative 2, which burns the least amount, receives a value of 0, since burning is beneficial. Alternatives 1, 3, and 5 fall between Alternatives 2 and 4, and receive a value that is based on the number of acres burned.

The SVE Panels (2004) also noted additional management activities that could affect these SVE plant species. For the following activities it was not possible to assign a measurement, except

subjectively, so they were not included in the HSI value. The following activities (Table 3.27) can impact the potential habitat represented by these SVE species, and their impacts to individual species are discussed in the subsequent sections.

Table 3.27

OTHER ACTIVITES THAT COULD AFFECT PLANT SPECIES

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Seasonal Trail Closures		X	X		
ATV Trail System			X		
Herbicide Use (other than administrative sites)	X		X	X	X
New Construction – Developed Recreation	X		X	X	X
Increased Hardened Sites – Dispersed Recreation			X		

Carolina Thistle-Dry Forest Habitat SVE Species

This species shows a preference for dry, rocky soil in sites such as natural barrens, and prefers acidic to strongly acidic soils in Shawnee Hills (SVE Panel 2002). Carolina thistle occurs in open forests with an overstory that includes white oak, post oak, and blackjack oak (*Quercus marilandica*). Thistles need direct sunlight to germinate, and vegetation changes would reduce population viability if the canopy closes and a shrub layer develops. Loss of this openness would lead to reduced plant vigor and lower reproductive rates (Campbell *et al*. 1991). The use of prescribed burning at appropriate sites can reduce these threats by opening the understory.

This species seems to follow artificial gaps and may be located on trail systems that are infrequently used, as well as some user-developed trails where leaf litter has been moved away and the mineral soil exposed (SVE Panel 2002). If populations occur in a heavily forested area, the species may benefit from harvest. The SVE Panels (2004) recommended the use of single-tree and group selection for forest management as clearcuts would not achieve the desired community. Table 3.28 shows the HSI value assigned for various activities considered in the analysis.

Table 3.28

HSI VALUE FOR CAROLINA THISTLE HABITAT CREATION OR DESTRUCTION
(see Appendix H for model parameters)

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Prescribed Fire	0.20	0	0.50	1.00	0.20
Clearcut	0.66	1.00	0.73	0	0.66
Shelterwood	0.77	1.00	0	0.12	0.77
Group Selection	1.00	0	0.09	0	1.00
Single Tree	0.21	0	0.74	1.00	0.21
Openings	0	1.00	0.17	0	0
Total Value	2.84	3	2.23	2.12	2.84
HSI Value (All impacts treated equally)	0.47	0.50	0.37	0.35	0.47

SVE Panel (2004) comments:

- Prescribed burning is essential to open up the mid-canopy.
- This species may not be affected by frequent burning; however, a fire interval of 3 to 5 years might be the most beneficial.
- Scattered openings are important, and this may be achieved by single-tree selection.
- Small group cuts adjacent to a population may be beneficial; however, clearcuts are not going to achieve the community needed.
- Although nonnative invasive species (NNIS) are a threat to the community, herbicides could be detrimental to specific plants ([be] careful with application).
- This species likes artificial openings, but surface soil disturbance from activities such as OHV horse, or foot travel is not desirable.

Alternative 2 has the highest HSI value because there would be no even-aged management or openings under this alternative. Alternative 2 has a reduced overall habitat suitability due to the exclusion of prescribed burning and the lack of gap creation in the canopy. Alternatives 1 and 5 have the second highest HSI value because these alternatives would include several activities that could benefit the Carolina thistle, including prescribed fire, group selection, and single-tree selection. Alternative 5 has the same HSI value and harvest treatments as those of Alternative 1, but also includes the proposed creation of MA 3.3, which would emphasize a mix of early and late successional vegetative stages using even-aged harvests up to 40 acres in size. Even though implementing this action would concentrate some harvest activities within Management Area 3.3, there are no known Carolina thistle populations in this MA. In fact, there is only one known occurrence of any RFSS plants in MA 3.3. Alternatives 3 and 4 also include the proposal to create MA 3.3.

Alternative 3 proposes nearly the same amount of clearcutting as Alternatives 1 and 5, but it is projected to implement more shelterwood harvesting. Alternative 4 proposes more clearcuts and shelterwood cuts than any of the other alternatives. However, Alternatives 3 and 4 propose more prescribed burning, which would benefit this species.

The HSI value for Alternative 2 is only slightly higher than that of Alternatives 1and 5. This occurs because Alternative 2 does not permit clearcuts and other disturbance activities detrimental to Carolina thistle, yet it restricts the use of active management that could aid in maintaining the optimal canopy closure of 60 to 80 percent, and the use of prescribed burning that could help provide optimal habitat quality by removing understory vegetation. The SVE Panels (2004) stated that the species responds favorably to prescribed fire, and also commented that vegetation changes resulting in canopy closure and the shrub layer development would reduce population viability. Considering this information, Alternatives 1 and 5 would be expected to do the best at maintaining species viability for Carolina thistle and other RFSS plants inhabiting similar ecological conditions.

The SVE Panels (2002) suggested that the species does better with less used trail systems. Alternatives 2 and 3 both propose seasonal trail closures that would decrease use and minimize affects to habitat during periods of inclement weather. Alternative 3 is the only alternative that proposes the development of an ATV trail system. Implementation of an ATV trail system would likely decrease habitat quality in the limited area where a system might be developed.

Besides removing areas that may provide potential habitat, construction of new recreational developments and hardened dispersed recreation sites would likely decrease habitat quality

because of increased use and possible soil compaction. Alternative 3 proposes increasing the number of hardened dispersed sites. Alternatives 1, 3, 4, and 5 may construct new developed recreational sites. Alternative 2 does not allow either activity.

Selective and careful application of herbicides could occur away from known populations. Alternative 2 does not allow application of herbicides outside of administrative or recreational areas, thus removing the possibility of the application of herbicides inadvertently affecting the species or any unknown populations.

Considering the adequate numbers of populations present on the Hoosier and for the reasons described above, we anticipate that implementation of any alternative would maintain population viability of Carolina thistle. However, Alternatives 1 and 5 would be expected to best maintain species viability for Carolina thistle and other RFSS plants inhabiting similar ecological conditions. Continuing the implementation of projects that perpetuate open woods and remove or reduce the shrub layer and understory vegetation is essential for species viability. With all site-specific projects, biologists would evaluate the effects on all individual known populations of RFSS plants to provide protection and maintain species viability for those plants. Site-specific analyses would likewise occur for all RFSS plants on the Hoosier within all habitat communities and the SVE plant species.

The Hoosier contains 12 of the 14 known populations of Carolina thistle in Indiana, so maintaining these conditions is important for the viability of that species and other RFSS plants requiring an open understory beneath a relatively open canopy in dry forest habitat.

<u>Prairie Parsley-Dry Forest/Barrens Habitat SVE Species</u>
Similar concerns about the capacity to conduct active management to maintain species viability are more critical for other RFSS plants represented by the SVE species prairie parsley. This species requires more open canopy conditions. Generally, the species it represents occur in fewer populations on the Hoosier and can occur in barrens, as well as in small openings in dry forests.

This species appears to prefer well-drained, loamy sites in full sun (USDA NRCS 2001b). Prairie parsley occurs in sandstone and siltstone barrens and glades in southern Indiana. The species is also found on barrens remnants, in dry woods with prairie association; and at the top of bluffs on dry, rocky upland slopes (SVE Panel 2002).

Occurring in only a single site on the Hoosier, prairie parsley is at risk of extirpation. This opportunistic species benefits from prescribed fires, overstory thinning, and girdling (SVE Panel 2004) or thinning from below (6-inch DBH trees). Fire suppression may lead to habitat decline for this species (Olson 1999). Although the species likes artificial openings, soil-disturbing activities would be detrimental to the habitat of this species (SVE Panels 2004).

Table 3.29

HSI VALUE FOR PRAIRIE PARSLEY HABITAT CREATION OR DESTRUCTION
(see Appendix H for model parameters)

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Prescribed Fire	0.20	0	0.50	1.00	0.20
Clearcut	0.66	1.00	0.73	0	0.66
Shelterwood	0.23	0	1.00	0.88	0.23
Group Selection	1.00	0	0.09	0	1.00
Single Tree	0.21	0	0.74	1.00	0.21
Openings	1	0	0.83	1	1
Total Value	3.3	1	3.89	3.88	3.3
HSI Value (All impacts treated equally)	0.55	0.17	0.65	0.65	0.55

SVE Panel (2004) comments:

- This plant occurs in extremely dry situations.
- Clearcuts would be detrimental without prescribed fire to delay succession.
- Alternative 2, which proposes no management, is detrimental to this species.
- NNIS are a threat to the community, but herbicides could be detrimental to specific plants ([be] careful with application).
- This species likes artificial openings, but surface soil disturbance from activities such as ATV, horse, or foot travel is not desirable.

The SVE Panels (2004) agreed that a lack of vegetation management would be detrimental to this species, especially the exclusion of fire. The species often occurs in openings, and quickly regenerating clearcuts would be detrimental to this species due to its need for full sun. Southern Indiana populations occur in dry, open woodlands, so managing for full sun by clearcutting is a concern. Shelterwood cuts could be beneficial, as long as succession was controlled, because these cuts would allow more light to reach the soil. For these reasons, Alternative 4 and 3 would likely benefit this species the most, followed closely by Alternatives 1 and 5. Alternative 2 has a much lower HSI Value, and viability is a concern under this alternative.

Although increased developed and dispersed recreation would create openings, the plant does not do well with soil compaction or soil displacement (SVE 2004). The creation of these openings would likely impact the soil and result in negative impacts on prairie parsley habitat. A reduction in habitat quality is anticipated because of increased use and possible soil compaction associated with these activities. Concerns exist regarding use of herbicides in the immediate vicinity of this species.

Of the six SVE plant species, the prairie parsley has the greatest concern for maintaining long-term species viability because of a single occurrence on the Forest. However, the population has been self-sustaining for many years (Dolan 2002). Alternatives 1, 3, 4, and 5 each have similar HSI values and would maintain suitable habitat conditions for the species. Alternatives 3, 4, and 5 would create MA 3.3, where an increased portion of the future harvest activities would be concentrated. The proposal for MA 3.3 would not affect the single occurrence of this species that exists outside of this area, and may reduce the overall effect on potential habitat for

prairie parsley by directing harvest away from areas where suitable habitat is probable (close to the known occurrence). Many of the other RFSS plants found within both dry forests and barrens communities on the Hoosier have single population occurrences on the Forest or they exist in a few isolated populations. Therefore, these species are at risk for extirpation on the Forest regardless of the alternative selected for implementation. This is especially true for those populations with low numbers of individual plants. Nevertheless, none of the botanists at the SVE Panels (2002, 2004) expressed any concerns about continued viability of prairie parsley or the RFSS plants that occur in similar habitat, especially if the Hoosier implemented management recommendations suggested by the panels. Because of its lack of active management, the SVE Panels (2004) did express concerns about Alternative 2 being detrimental to the species.

The prairie parsley first appeared on the Hoosier after a prescribed fire in 1991. The best examples of barrens on the Hoosier are where active management has occurred, primarily with the use of prescribed fire. The greatest threat to these sites is lack of, or interruption of, active management (Olson *et al*. 2002). The SVE Panels (2002) recommended increased inventories for this species and monitoring, especially after conducting prescribed burning.

All of these dry forest or barrens RFSS plants with only one population on the Hoosier occur within MA 8.2, Special Areas. The primary management goal of these special areas is the protection and maintenance of unique features, including actions that may benefit or maintain habitat for RFSS plants. Projects conducted at the site-specific level would analyze the effects on these individual rare plant populations to ensure their protection and viability. Monitoring of dry forest or barrens RFSS plants with single occurrences on the Hoosier is essential to assess their continued viability and determine the need to conduct projects that would maintain or enhance their habitat.

Based on the findings during the SVE Panels and Olson's (2002) conservation assessment for barrens and glades, the lack of management, and especially the exclusion of fire, barrens habitat quality would diminish and possibly affect species viability of prairie parsley or other RFSS plants inhabiting dry forests or barrens. Botanists believe that other populations of these species may still exist across the Forest (Hedge *et al.* 2002), especially if their habitat is maintained or improved.

<u>Yellow Gentian-Barrens Habitat SVE Species</u>
Yellow gentian occurs in moist prairies and open woods, usually associated with dry upland forest species - post oak and blackjack oak. One also finds this species in barrens, upland areas, and limestone glades (SVE Panel 2002). Most populations occur in open sites, as the species tolerates shade only to a limited degree (SVE Panel 2002).

Yellow gentian has so few known sites in Indiana that loss of occupied habitat through natural or human-caused destruction carries a high risk of extirpation. Canopy closure due to natural succession would make the habitat less favorable for yellow gentian. Barrens sites require active management to suppress woody succession. Recommendations from the SVE Panels (2002) included overstory thinning and girdling with prescribed burns to keep sites open. Table 3.30 shows HSI values for yellow gentian habitat that would occur under various activities.

Table 3.30

HSI VALUE FOR YELLOW GENTIAN HABITAT CREATION OR DESTRUCTION
(see Appendix H for model parameters)

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Prescribed Fire	0.20	0	0.50	1.00	0.20
Clearcut	0.34	0	0.27	1.00	0.34
Shelterwood	0.23	0	1.00	0.88	0.23
Group Selection	1.00	0	0.09	0	1.00
Single Tree	0.21	0	0.74	1.00	0.21
Openings	1	0	0.83	1	1
Total Value	2.98	0	3.43	4.88	2.98
HSI Value (All impacts treated equally)	0.50	0.00	0.57	0.81	0.50

SVE Panel (2004) Comments:

- This species needs high levels of light (0 percent canopy cover ideal, 0 to 20 percent very good).
- This species benefits from prescribed fire, but mowing has a negative effect on the species.
- Timber should be removed from areas where this species occurs.
- Assigning a harvest regime to benefit this species and community is difficult, but the habitat needs to be kept open.
- The need for open conditions makes Alternative 2 a bad choice.
- NNIS should be controlled, but this species is very inconspicuous. Herbicide application should be extremely cautious.

Yellow gentian needs high levels of light, even more than previous species discussed in this section. The SVE panels (2004) concluded that habitat quality drops off sharply with greater than 20 percent canopy closure. Due to the species' requirement of a very open canopy, any harvest regime could benefit yellow gentian. Alternatives that maintain forest openings would also benefit this species. Alternatives with prescribed fire would create more suitable habitat by opening the understory. For these reasons, Alternative 4 has the highest HSI value followed by Alternative 3 and then 1 and 5. Alternative 2 does not propose active management necessary to maintain barrens habitat and its zero HSI value reflects this requirement. Alternatives 1 and 5 have equal HSI values and vegetative treatments, but Alternative 5 contains the proposal creating MA 3.3. Known yellow gentian populations and barrens habitat for other RFSS plants do not occur within MA 3.3, so harvest activities would not directly affect these plants or their habitat. Because this action concentrates a portion of the even-aged harvests within this area, it could result in reduced amounts of vegetative treatment using this technique near barrens habitat and a lost opportunity to improve habitat conditions in those locations.

Activities that affect soil negatively could have negative effects on yellow gentian or its habitat. Those concerns mentioned previously in the prairie parsley section regarding species viability by the implementation of Alternative 2 because of its inability to apply active management are especially applicable to yellow gentian and other associated RFSS barrens species. Accordingly, the HSI values reflect the need to conduct vegetation management, including burning, and any of the other alternatives would do better at maintaining species viability for

barrens species than Alternative 2 would. The SVE panels (2002) recommended carrying forward this species because it is a good indicator of high quality barrens habitat.

Forest Plan direction for RFSS species recognizes barrens with specifications to maintain or enhance these areas. This guidance includes the prohibition of planting NNIS or other exotic plant species within or near barrens and glades. Each alternative includes this direction and these actions would contribute to maintaining species viability of yellow gentian and other sensitive barrens plants.

<u>Climbing Milkweed-Barrens Habitat SVE Species</u>
Climbing milkweed inhabits rocky woods, thickets, and limestone glades. The species seems to grow best in open woods and glades, tending to grow on shrubs in these areas. Canopy closure negatively affects climbing milkweed (Johnson 1999). Shaded plants tend to be small and non-reproductive.

Experimental opening of the canopy by Johnson (1999) in two sites with non-reproducing plants resulted in increases in leaf and flower production. Management in the Shawnee National Forest, including prescribed burning and partial canopy opening via removal and girdling, has been "successful in creating and maintaining suitable habitat for healthy populations" of climbing milkweed (Johnson 1999).

Table 3.31

HSI VALUE FOR CLIMBING MILKWEED HABITAT CREATION OR DESTRUCTION
(see Appendix H for model parameters)

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Prescribed Fire	0.20	0	0.50	1.00	0.20
Clearcut	0.34	0	0.27	1.00	0.34
Shelterwood	0.23	0	1.00	0.88	0.23
Group Selection	1.00	0	0.09	0	1.00
Single Tree	0.21	0	0.74	1.00	0.21
Openings	1	0	0.83	1	1
Total Value	2.98	0	3.43	4.88	2.98
HSI Value (All impacts treated equally)	0.50	0.00	0.57	0.81	0.50

SVE Panel (2004) Comments:

- The requirements of this species are similar to yellow gentian, but this plant could tolerate more shading (much larger leaves).
- The presence of small trees is important.
- Zero percent canopy cover is not necessarily appropriate (30 to 50 percent ideal).
- Climbing milkweed has airborne seeds and might tolerate clearcuts.
- A cut that opens the canopy might be good (clearcut, for example), but not necessarily the best option.
- This species grows in thin soils; however, it might not be impacted by horse and ATV trails as much as other plant SVE species.
- Fire is beneficial to this species.
- Alternative 2 is not appropriate.

All proposed harvest regimes could benefit climbing milkweed due to the species' requirement of an open canopy. Alternatives that maintain forest openings and propose prescribed burning would also benefit this species. For these reasons, Alternative 4 would provide the highest amount of suitable habitat among the alternatives, followed by Alternative 3, then 1 and 5, and finally 2.

Because climbing milkweed grows in thin soils, the SVE Panels (2004) suggested that ATV and horse trails could negatively affect the plant community. However, this species does not seem to be as sensitive to human disturbance as the other species discussed here. Activities could displace some habitat, but because the species is tolerant to human effects, implementation of developed and dispersed recreation sites would create openings and thus be beneficial.

This species grows in habitat similar to yellow gentian, but it prefers forest edges in barrens and can tolerate some shading. The plant is a vine that needs small shrubs or trees for climbing (SVE Panel 2004). Alternatives 3, 4, and 5 include MA 3.3, which increases the size of clearcuts up to 40 acres. This increased size could decrease the amount of edge habitat within this management area. None of the known occurrences for climbing milkweed or barrens habitat exist within MA 3.3. The SVE Panels (2002, 2004) considered forest edges a necessary requirement for milkweed, but did not identify it as a specific need for any other RFSS plant. All alternatives would likely maintain species viability because of its ability to tolerate disturbance, and the species is less likely than other barrens species to decline from woody encroachment. For this reason, the concerns over the lack of management in Alternative 2 are likewise not as critical, but that alternative would probably still be detrimental for the species. As the HSI values indicate (Table 3.31), selection of an alternative that allows for management that is more active would be more beneficial for species viability of these plants or other RFSS barren species with similar habitat characteristics and tolerance for disturbance.

<u>Illinois Wood-sorrel-Mesic Forest Habitat SVE Species</u>

Found on thin soil and on moss mats over rocks, Illinois wood-sorrel is restricted to limestone and other calcareous substrate. Habitat for this species is typically dry in the summer and wet in the spring (SVE Panels 2002).

Destruction of the specialized limestone habitat is a direct threat to Illinois wood-sorrel, which is restricted to this substrate. Any road construction, development, extensive logging, or other land-clearing activity would kill plants. If these activities occurred near populations, they might decrease a plant's viability through reduced shade and soil moisture if overstory trees were lost. ATV use or user-developed trails would also cause a decline in habitat quality.

Maintenance of small canopy gaps is beneficial to this species, but it is important to ensure that trees fall away from sites, rather than directly on them. Heavy soil disturbance should also be avoided: Tubers are not very deep and are therefore vulnerable to the loss of topsoil. Prescribed burns may not be beneficial for this species (SVE Panels 2002).

Table 3.32

HSI VALUE FOR ILLINOIS WOOD-SORREL HABITAT CREATION OR DESTRUCTION
(see Appendix H for model parameters)

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Prescribed Fire	0.80	1.00	0.50	0	0.80
Clearcut	0.66	1.00	0.73	0	0.66
Shelterwood	0.77	1.00	0	0.12	0.77
Group Selection	0	1.00	0.91	1.00	0
Single Tree	0.79	1.00	0.26	0	0.79
Openings	0	1	0.17	0	0
Total Value	3.02	6	2.57	1.12	3.02
HSI Value (All impacts treated equally)	0.50	1.00	0.43	0.19	0.50

SVE Panel (2004) comments:

- This species needs high humidity and complete shade (80 to 100 percent canopy cover).
- No management would work for the species, and some management might not hurt.
- NNIS are a threat.
- Any drying of the habitat could be a threat, and clearcuts could have a strong negative affect.
- Prescribed burning could have a negative impact.
- Stands where this species occurs do not have to be old growth, but they need to be mature.
- There is a definite understory component present in the habitat of this species.
- Trails can cause disturbance to plants if too open.

Alternative 2 has the highest HSI value (Table 3.32) because there would be no timber harvest or prescribed fire with this alternative; reduced shade and soil moisture are therefore unlikely. Although Alternatives 1 and 5 propose more clearcutting than Alternative 3 and much less clearcutting than Alternative 4, the acreage that would be treated by shelterwood harvests is drastically less in Alternatives 1 and 5 than Alternatives 3 and 4. These activities could negatively affect Illinois wood-sorrel. Since Alternatives 1 and 5 would harvest fewer acres using these two types of harvest, it would provide more suitable conditions for this species. Alternatives 3 and 4 also propose more burning than Alternatives 1 and 5, which could reduce soil moisture and affect plants.

Habitat Suitability Indices represent potential effects on habitat rather than direct effects to the plants. The HSI values are useful in comparing alternatives and the indirect effects to these species relating to changes in suitable habitat. Alternatives 1, 2, and 5 have higher HSI values for the reasons described above, providing more protection from possible damaging activities, but Alternatives 3 and 4 would also maintain species viability to a lesser degree.

Alternative 3 is the only alternative that proposes the development of an ATV trail system. The SVE Panels (2002 and 2004) suggested that this type of recreational activity could be

detrimental to the habitat of Illinois wood-sorrel. Other recommendations related to trail management included: re-route existing trails away from known populations, avoid building new trails near those areas, and prevent creation of excessive openings or heavy disturbance (SVE Panels 2002, 2004).

Although wood-sorrel habitat is often prone to invasion by aggressive NNIS (SVE Panels 2004), the SVE Panels (2002) recommended that implementers of control projects pull weeds instead of using herbicides in areas near known populations. Illinois wood-sorrel is another inconspicuous plant with a very similar looking common species, big yellow wood-sorrel (*Oxalis grandis*), often inhabiting the same mesic forest habitat. Selective and careful application of herbicides in other locales away from sensitive plant populations could improve habitat quality of mesic forest species degraded by nonnative plant infestations.

Forest-wide RFSS guidance would provide some additional protection to the Illinois wood-sorrel and other sensitive plants inhabiting mesic forests. This includes considering the presence of sensitive species and potential effects when evaluating the need for harvest within 50 feet of a perennial or intermittent stream.

The Illinois wood-sorrel has one of the most occurrences of any SVE species. Of the SVE plant species, more potential or suitable habitat exists across the Forest for Illinois wood-sorrel. The mesic forest community contains the greatest number of associated RFSS plants and more species' populations than any other plant habitat group. Based on the relative abundance of known populations and the widespread areas of suitable habitat, the Illinois wood-sorrel and associated RFSS mesic forest plants would have the greatest potential for effects resulting from management activities conducted across the Forest. Continued protection of known populations and surveys conducted within new site-specific project areas in suitable habitat is essential for maintaining species viability.

French's Shootingstar-Cliffs Habitat SVE Species

French's shootingstar is a pioneer species growing on exposed sand on or under sandstone cliff overhangs and ledges, and the species is almost always associated with a drip line. Plants also require shading and erosion protection provided by upland forest trees on the cliff and ledge tops (Voigt and Swayne 1955). The species prefers north and east-facing exposures (NatureServe 2001c). It also requires older trees that are a short distance away from the bluffs and along the edges (SVE Panel 2002).

Loss of the surrounding buffer of upland forest, through logging or other activity, would result in habitat degradation for French's shootingstar. The plants require cool, moist, shaded habitat that large, mature upland mesic forest trees provide. Loss of these trees would result in the death of the plants. In addition, trees help stabilize soil to prevent erosion.

Destruction of suitable habitat through logging, development, road building, or other human disturbance would result in the loss of these highly localized populations. Activities such as rock climbing, horseback riding, and ATV use may directly kill plants or degrade habitat. In some cases, entire populations along drip lines have been completely eliminated by horse trails (SVE Panel 2002).

Table 3.33

HSI VALUE FOR FRENCH'S SHOOTINGSTAR HABITAT CREATION OR DESTRUCTION
(see Appendix H for model parameters)

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Prescribed Fire	0.80	1.00	0.50	0	0.80
Clearcut	0.66	1.00	0.73	0	0.66
Shelterwood	0.77	1.00	0	0.12	0.77
Group Selection	0	1.00	0.91	1.00	0
Single Tree	0.79	1.00	0.26	0	0.79
Openings	0	1	0.17	0	0
Total Value	3.02	6	2.57	1.12	3.02
HSI Value (All impacts treated equally)	0.50	1.00	0.43	0.19	0.50

SVE Panel (2004) comments:

- This species needs a moist, shaded habitat with a high amount of canopy cover (60 to 100 percent).
- Single-tree selection would not affect the community.
- Vehicles, people, horses, and OHV use are very damaging.
- Other than NNIS prevention or removal, there is no need for vegetation management.
- This species is sensitive to herbicides.

Although clearcuts and shelterwood cuts would result in a canopy that is too open, uneven-aged harvests should not impact the plant community (SVE Panels 2004). Prescribed burning is considered detrimental for the French's shootingstar due to the species' need for high moisture.

Alternative 2 has the highest HSI value (Table 3.33) because there is no proposed timber harvest or prescribed burning under this alternative. The increased prescribed burning, clearcutting, and shelterwood harvesting proposed in Alternatives 4, 3, 1, and 5, respectively, would result in lower habitat suitability for these alternatives.

Alternative 2 also proposes more trail closures that would reduce impacts to the resource, and there would be no net increase in mountain bike or horse trails. The SVE Panels (2002, 2004) expressed similar concerns about French's shootingstar regarding trail management, dispersed and developed recreation activities, and herbicide use as mentioned above for Illinois wood-sorrel. Both of these plants occur in specialized habitat, especially French's shootingstar, which requires significant shading and is vulnerable to human-caused disturbances. The more trail use around plant populations, particularly by horses, the greater the negative effects would be on this species. An increase in hardened dispersed recreation sites would also lead to decreased habitat quality.

Forest Plan direction for RFSS species prohibits vegetation management within a distance of 100 feet from the top and base of large cliffs or overhangs except for the salvage of dead and dying trees or sanitation harvest. Trees harvested outside but near this zone would require directional felling away from the cliff area. Each alternative includes this guidance, and these

actions would contribute to maintaining species viability of French's shooting star and other RFSS cliffs community plant species.

Because of this required guidance for cliffs and the evaluation of project effects in site-specific projects on individual known French's shootingstar populations, expectations are that any of the proposed alternatives would maintain species viability. The disparity among the alternatives reflects its vulnerability to potential habitat alteration and disturbance from management or recreational activities. The SVE Panels (2002) stressed the need to monitor these populations, including qualitative research of NNIS infestation that may threaten some of the populations. Hill (2002) raises the issue of possible habitat fragmentation affecting local populations because of activities resulting in barriers to dispersal, but with proper habitat management, the populations should persist.

Summary of Effects from the SVE Analysis for Plants and Animals

The habitats that were associated with the highest risk to species viability are habitats where management can reduce this risk by improving abundance and distribution of the habitat type. Such habitats are of key interest on the Forest. The highest risks to species viability on the Hoosier are associated with the following habitat types: barrens, openlands – grasslands, shrublands, and young forest, and wetlands. To meet our obligation to ensure species viability as part of the Forest Plan revision process, to achieve the goal of maintaining and restoring suitable ecosystems, and to incorporate substantive comments from the public, the preferred alternative was adjusted. This adjustment included two aspects that will affect the amount of suitable habitat for species associated these habitats. The first adjustment is an increase in even-aged treatments within hardwood stands in MA 2.8. This increase in size will result in an increase of suitable habitat for area-sensitive species such as the yellow-breasted chat. An additional change to the selected alternative was the adjustment of Visual Quality Objectives to allow vegetation management along some riparian zones to provide habitat for wildlife species dependent on early successional mesic areas such as the American woodcock. Both of these changes will result in an increase in suitable habitat for species associated with early successional habitats and will decrease the risk to viability for these species.

Alternative 2 would result in a reduction of acreage of each of these four high-risk habitats. Without the use of prescribed fire, plant growth and invasion would reduce the acreage of barrens. Site-specific characteristics would likely ensure that this habitat is still present on the landscape, but at a greatly reduced level. Although species requiring mature, unfragmented forests would likely thrive under Alternative 2, the exclusion of vegetation management would also result in a decreased acreage of early successional habitats. As projected by the HSI models for SVE species, species viability for late successional species would be at a low risk under all Alternatives.

With regard to providing optimal protection and management for these high-risk habitat types, Alternatives 1, 3, 4, and 5 would provide different acreages of habitat. They would accomplish this primarily through the combination of restoration of naturally rare or limited habitats such as wetlands and barrens and through management activities designed to create early successional habitats. Standards and guidelines in all alternatives would specifically protect cliffs, caves, springs, and riparian corridors. Alternatives 1, 3, 4, and 5 would improve habitat abundance and distribution, primarily through the restoration of habitats such as wetlands, openings in the forest canopy, fire-enhanced systems, oak-hickory stands, and early successional forests. The actions of these alternatives would likely increase the habitat locally available for species favored by early successional forest habitat, such as American woodcock, ruffed grouse, yellow-breasted chat, blue-winged warbler, wild turkey, bobcat, and prairie warbler. Under these four

alternatives, the Hoosier would leave over 46 percent of the landbase to undergo natural processes of forest succession without harvest. Although the amount of mature forest would be less than with Alternative 2, these alternatives would still provide more acres of mature forest than are currently found on the Forest.

Table 3.26

DETERMINATION OF VIABILITY RISK FOR EACH SVE SPECIES AT YEAR 150

Species	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
ANIMALS					
Cerulean warbler	LOW	LOW	LOW	LOW	LOW
Wood thrush	LOW	LOW	LOW	LOW	LOW
Worm-eating warbler	LOW	LOW	LOW	LOW	LOW
Henslow's sparrow	LOW	HIGH	LOW	LOW	LOW
Yellow-breasted chat	HIGH	HIGH	LOW	LOW	MEDIUM
Ruffed grouse	HIGH	HIGH	LOW	LOW	LOW
Northern bobwhite	MEDIUM	HIGH	LOW	LOW	LOW
American woodcock	HIGH	HIGH	LOW	LOW	LOW
Indiana bat	LOW	LOW	LOW	LOW	LOW
Spotted salamander	LOW	LOW	LOW	LOW	LOW
Northern river otter	LOW	LOW	LOW	LOW	LOW
Indiana crayfish	LOW	LOW	LOW	LOW	LOW
Northern cavefish	LOW	LOW	LOW	LOW	LOW
PLANTS					
Carolina thistle	LOW	LOW	LOW	LOW	LOW
Prairie parsley	LOW	HIGH	LOW	LOW	LOW
Yellow gentian	LOW	HIGH	LOW	LOW	LOW
Climbing milkweed	LOW	HIGH	LOW	LOW	LOW
Illinois wood-sorrel	LOW	LOW	LOW	MEDIUM	LOW
French's shootingstar	LOW	LOW	LOW	MEDIUM	LOW

Management Indicator Species (MIS)

The Hoosier selected the five species as MIS to meet the objective of maintaining ecological conditions that contribute to the long-term abundance and distribution of species. The selected species vary in their response to management activities. The preceding section discussed three of the MIS in detail (yellow-breasted chat, American woodcock, and wood thrush). The following sections discuss the effects of the proposed alternatives on the other two MIS (Acadian flycatcher and Louisiana waterthrush).

<u>Acadian Flycatcher</u>

This species is common throughout much of the eastern U.S. with overall stable populations at present, although observers have noted steep declines in Florida and the southern Appalachians. One most often finds Acadian flycatchers in deciduous forests near streams, in bottomland hardwoods, and cypress swamps. Key habitat requirements for this species include large tracts of mature, closed-canopy forest with relatively open understories. These birds usually place nests on a fork of a horizontal branch well away from the main trunk, and often over water, a ravine, or other clearing.

Generally regarded as a forest interior species, the Acadian flycatcher requires a contiguous forest block much larger than the breeding territory size of the species (Ambuel and Temple 1983). Robbins (1979, 1980) estimated the minimum forest area needed to sustain a viable breeding population at 80 to125 acres. Likewise, Anderson and Robbins (1981) found the largest percentage of Acadian flycatchers in woods of 95 to 300 acres. Blake and Karr (1984) reported breeding birds in woods as small as 60 acres in Illinois.

Habitat degradation and fragmentation (and therefore indirectly, cowbird parasitism and nest predation) are the primary threats to this species. Throughout the bird's breeding range, the conversion of natural forest to pine plantations and agricultural fields, as well as residential development, strip mining, and road construction, continue to contribute to habitat loss and fragmentation. Whitehead (1992) found lower rates of brood parasitism (about 8 percent of nests parasitized by cowbirds overall) and nest predation in south-central Indiana than found by Robinson (1992) in central Illinois. The Indiana study included interior forest sites (greater than 3.5 miles from fields where cowbirds feed), exterior forest edge sites (forests adjacent to agricultural fields), and forest sites adjacent to young clearcuts. Whitehead (1992) found nest parasitism was higher in forests adjacent to clearcuts (about 18 percent) than in either the exterior (about 4 percent) or the interior (0 percent) sites. Generally, forest management practices that produce large mature forests with closed canopies and high tree density would be favorable for Acadian flycatchers (Bushman and Therres 1988). Yet several studies suggest that the species would tolerate light selection cutting (Lent and Capen 1995, Annand and Thompson 1997, Robinson and Robinson 1999).

In southern Illinois, nesting success was evaluated for the Acadian flycatcher by comparing levels of nest predation and brood parasitism experienced in compartments recently selectively cut, older selectively cut compartments, and compartments that had remained uncut for at least 40 years (Robinson and Robinson 2001). Nests were parasitized nearly twice as often in recently cut stands as in the other stands; however, daily mortality rates for the species were higher in uncut stands than in cut stands. The nature of Acadian flycatcher nests, placed at the tips of long, horizontal tree limbs stretching over a gap in the understory, may make the nests more conspicuous to cowbirds in recently harvested stands where logging has reduced the total volume of foliage in the mid-story.

Alternative 2 would likely have the most limited effects on this species due to the very limited vegetation management proposed in this alternative. This alternative would contribute to larger blocks of contiguous forests, with less edge. Alternatives 5, 1, 3, and 4 would likely have more negative impacts on this species (see the Even-aged and Uneven-aged Management Techniques discussion for more information) with the effects increasing in respective order. However, all four of these alternatives consider timber harvest unsuitable on over 50 percent of the total forest landbase. These blocks of forest considered unsuitable would continue to mature with little human disturbance, providing habitat for the Acadian flycatcher.

Louisiana Waterthrush

Cornell Lab of Ornithology considers this species of high conservation importance due to its relatively small breeding range, low overall density, and dependence on clear forest streams both on its breeding and tropical wintering grounds. Populations of this warbler appear to be stable, and the species' breeding range is expanding northward in northeastern states (Andrle and Carroll 1988, Laughlin and Kibbe 1985), likely in response to reforestation (Andrle and Carroll 1988).

The species is a common resident of headwater riparian woodlands, rocky streams, swamps and scrub, thickets, and ravines near streams in much of the East and Midwest. Precise habitat requirements, especially the characteristics of forest patches surrounding their streamside territories, are poorly known. However, essential habitat includes large tracts of mature, deciduous and mixed deciduous forest (greater than 60 acres) located along ravines with rapidly flowing water in areas with moderate to sparse undergrowth (Prosser and Brooks 1998). Mature, deciduous swamp forest with standing pools of water characterizes secondary habitat (McCraken 1991). Wetlands and headwater streams with high water quality and well-developed pool and riffle complexes are important to this species (Prosser and Brooks 1998).

The Hoosier should protect wooded streambanks and ravines for this species and maintain areas of thick cover well away from the stream during the post-fledging stage (Natureserve 2004). Preferred nest sites are found in the underbrush, among the roots of fallen trees, in crevices or raised sites in tree roots, or in rock walls near water (Harrison 1978, Bushman and Therres 1988). The species is often absent in highly fragmented landscapes and where sediments from agricultural and urban landscapes have negatively affected water quality and stream substrates.

Loss and degradation of headwater riparian habitat, due to agriculture, logging, acid pollution (acid mine drainage or acid deposition, especially in the central Appalachians), and urbanization are among the main threats to this species. Additional threats are forest fragmentation and other activities that cause reductions in forest canopy cover or negatively affect aquatic insect communities.

Louisiana waterthrush, the only obligate avian species of this ecosystem, is an ideal calibrator for an index of headwater ecosystems (Brooks *et al*. 1998).

Alternative 2 would likely have the fewest effects on this species due to the very limited vegetation management proposed in this alternative. This alternative would contribute to larger blocks of contiguous forests, with less edge and a thicker understory due to the exclusion of fire. Alternatives 5, 1, 3, and 4, in order of increasing effects, would likely have more negative effects on this species (see the Even-aged and Uneven-aged Management Techniques discussion). However, all alternatives include determinations that timber harvesting is unsuitable on more than 50 percent of the total landbase of the Forest. These blocks of forest would continue to mature with little human disturbance and continue to provide habitat for the Louisiana waterthrush. Forest Plan direction, as well as BMPs (IDNR 1998a) would provide further protection of the breeding habitat used by this species.

Cumulative Effects of All Alternatives

Historical factors affecting wildlife habitat within the planning area include the use of fire and the clearing of land for agriculture by Native Americans common in the 1400's. Native Americans used fire frequently and pervasively to create the open habitats that were found by early European settlers (Engstrom 2000). These fires were an essential ecological factor in the historical development and maintenance of oak forests (Abrams 1992, Abrams 2003, Abrams 2005).

European settlers deforested large areas and used slash fires as they cleared the land for agriculture between 1750 and 1940 (Pimm and Askins 1995). At the time of European settlement, essentially the entire planning area was forested, but significant areas of prairie and disturbed and open forest (Potzger *et al*. 1956, Parker and Ruffner 2004) also existed. By the late nineteenth century, most of the forest had been cut, with only small woodlots remaining,

and all of the forest had been subjected to fire and grazing by livestock (DenUyl 1947, DenUyl and Day 1939). After farms were abandoned during the late 1800's, the amount of forest in the Midwest gradually increased (Pimm and Askins 1995). Following acquisition by the Federal government, many ridgetops, severely eroded from past land use, were planted to pine beginning in the 1930's to prevent further soil loss. All of these disturbances led to rapid and unparalleled changes in forest composition and structure, including a virtual cessation of oak regeneration and recruitment (Abrams 2003).

Local bans on fires and regional laws forbidding this activity came into effect after the start of the twentieth century, thus removing this type of disturbance from the landscape. The suppression of fire resulted in a significant shift in species composition, structural complexity, and landscape pattern across much of the region (Weaver and Ashby 1971, Parker 1989, Fralish *et al*. 1991). Eastern hardwood forests, including those of the Hoosier, are relatively young and even-aged with less species diversity, vertical structure, natural canopy gaps, large woody debris, and other structural features than pre-European settlement forests. The average patch size is smaller and there are fewer large blocks of interior mature forest than were present in the pre-European settlement forests (USDA 2000d). Fire-intolerant species such as sugar maple and American beech became established at the expense of fire-adapted oak and hickory species during the period when fire control measures were enacted across the region (Schlesinger 1976, Lorimer 1985). Fire control measures removed an important ecological factor, fire, from the landscape resulting in a reduction of oak-hickory regeneration.

Within the planning area, the Forest Service has attempted to consolidate ownership, especially by exchanging isolated parcels with willing owners during the last several decades. The majority of these new aquistions have been revegetated, and mostly reforested. An evaluation of land use change between the 1930's and 1990's reveals that closed canopy forests have increased by 24 percent (Table 3.0) on the Hoosier. This has resulted in a decrease in coarse level fragmentation within the planning area.

Open habitats were widespread before human settlement, and many wildlife species that had been dependent on these habitats flourished during the period of farm abandonment (Hunter *et al*. 2001, Lorimer 2001). However, the intensification of farming and declining numbers of pastures, hay meadows, and abandoned fields, as well as the suppression of natural disturbances, such as fire, beaver activity, and floods that generate natural grasslands and shrublands, have caused significant declines of these species (Askins 1998, Hunter *et al*. 2001

The draining of wetland habitat for agricultural, rural, and urban development has had an impact on the planning area. Analysis of hydric soils in Indiana by the Indiana Department of Natural Resources yielded an estimation of approximately 5.6 million acres of wetlands in the state 200 years ago. Compared to the existing wetlands today (813,000 acres), approximately 85 percent of wetlands in the State have been lost (IDNR 1996a).

Other past events and processes that have affected, and in many cases probably continue to affect, wildlife species within the planning area include:

- past timber harvest, almost none recently (has likely displaced individual animals on a temporary basis),
- the urbanization of some locales near the Forest (has resulted in the loss or fragmentation of forested lands),
- agricultural use and development of riparian areas (have reduced the acres of habitat available for wildlife, fragmented foraging areas, disrupted travel corridors, and decreased water quality),

- impoundments and navigation projects (these projects alter the morphology of the natural river, change the flow, oxygen levels, and substrates),
- the construction of roads and highways (has brought people into more contact with wildlife and wildlife habitat),
- changes in human lifestyles (have sometimes resulted in increased disturbance),
- the Hoosier's forest openings program (has provided early successional habitat),
- wind events and sometimes subsequent salvage operations (have had a variety of effects, including creating additional early successional forest habitat),
- forest succession with little disturbance (has resulted in a shift to climax species),
- species shifts with the loss of species like American chestnut (changes in habitat structure and decreased mast for many species of wildlife),
- introduction of nonnative species like the European starling and house sparrow (increased competition and displacement of native species),
- the arrival of new species like the pine warbler and the brown-headed cowbird in particular as a result of habitat alterations (reduction in reproductive success of many bird species), and
- the increased presence of domestic and feral cats and dogs (the deaths of many individuals of a variety of wildlife species).

Where roads have been closed, the effects on animal species associated with open public roads have been eliminated. Closed roads help reduce human disturbance and increase habitat quality for species that prefer less disturbance. Obliteration of roads altered habitat and contributed to overall habitat diversity until natural processes dominated the site (2 to 10 years). The vegetative cover on these closed roads provided herbaceous forage and browse for deer, grouse, and wild turkey. In addition, these areas provide habitat for some birds, reptiles, and amphibians.

Several types of land management are being used on non-federal lands in southern Indiana pertinent to the cumulative effects discussion. According to Bratkovich *et al.* (2004), non-federal forest landowners in Indiana include State, county, and municipal (6 percent), forest industry companies (9 percent), and family forest (76 percent). Although the type of harvest used on privately owned forested lands varies, the most common practice is diameter-limit harvests that remove all trees of value over 12 inches dbh.

Trends from the 2002 USDA Forest Service National Woodland Owner Survey (NCSSF 2005), suggest that over the next two years the number of family forests will increase substantially, while the total amount of forest acreage will remain the same. This turnover of forest ownership is leading to the increased conversion of forests at the urban-rural interface to other uses and the increased fragmentation of remaining forests. Conversion of these forests to other land uses is likely to increase both the density of white-tailed deer in the state and their impacts on the composition and structure of forest vegetation (Horsley *et al.* 2003).

While most private forests are harvested every 10 to 20 years (Unversaw 2002), private forests provide very little early successional habitat for wildlife species. NFMA regulations require the provision of habitat for species viability within the planning area. Although private lands may contribute to, or hinder, the maintenance of species viability on NFS, the Hoosier can not rely on these lands to meet policy requirements for species viability. However, it is important to review the type of habitat available on private lands to analyze cumulative effects.

An estimated 744,000 acres of private forests occur in the nine counties that encompass the Hoosier. Forest Inventory and Analysis (FIA) data (Miles 2004) include information on the size class, species type, and age of species on private lands. Of the private forests that are located in the nine counties encompassing the Hoosier, a little over one percent is in the seedling growth stage, and an additional two percent of these private forests is in the sapling stage.

Conversely, agricultural lands are still abundant in Indiana, resulting in pasture and cropland near the Hoosier and on private lands within the Forest. The forested landscape of southern Indiana may serve as a population source of Neotropical migrants for portions of the lower Midwest. The status of these populations may be compromised by extensive intrusion of agricultural and rural development within the heavily forested landscape due to increased edge-effects from these land uses (Ford *et al.* 2001). Furthermore, the future distribution and abundance of many wildlife species associated with aquatic habitats may be affected by contaminants from both point and non-point sources from agricultural lands. In addition to agricultural inputs to watersheds, the urban areas of Bedford, Indianapolis, Muncie, and Anderson contribute municipal as well as industrial wastes.

Ongoing agricultural activities, timber harvest, and rural development on private lands may contribute sediment to the 20 fifth-level watersheds that contain portions of the Hoosier. Improvement of wastewater treatment, both municipal and industrial, may reduce contaminants associated with industry and sewage treatment. State and local efforts to improve implementation of conservation measures associated with rural development, agriculture, or timber production may result in reduction of those contaminants, including sediment, associated with these activities in the basin. Failure to implement effective conservation measures, or failure to reduce point source municipal or industrial wastes, may result in loss of habitat quality for numerous wildlife species. We addressed potential future activities within the planning area for each of the alternatives for the next 10 to 15 years, so we will not describe them again here. Potential future activities for lands outside the Hoosier are difficult to predict due to the large geographic area, diverse ownerships, and array of land uses. However, the Hoosier suggests a number of predictions based on recent and current trends:

- private forest would likely continue to be managed for a variety of purposes including timber production,
- some private agricultural lands would be converted to other uses such as pine plantations, vacation or hunting properties, or allowed to naturally convert to brush and forestland due to lack of agricultural use,
- recreational use would likely continue to increase, including the increased use of OHVs, and
- additional lands would be acquired or exchanged by the Forest.

Perhaps the greatest benefit of land adjustments for wildlife is the ability to acquire tracts that contain habitats in short supply on the Forest. Wetlands, cave and karst areas, riparian zones, cliffs and rock shelters, openlands, barrens, and glades all are special habitats of value to wildlife. Land adjustments also provide an opportunity to protect or enhance habitats of endangered, threatened, and sensitive species that may be located partially on or adjacent to NFS lands.

Biological diversity, on a regional scale, can be maintained or improved by adding to the Forest landbase. In some cases, plant and animal diversity would increase as areas with little or no vegetation revert to forest. In other areas, habitat diversity may decline.

Some blocks of contiguous forest are managed by the State or other Federal agencies offering areas of compatible management adjacent to the Forest or even linking units of the Forest, including Yellowwood State Forest, Brown County State Park, and Naval Support Activity Crane. It is likely that areas managed by State Parks and Federal agencies would continue to be managed in ways similar to previous and current management. However, the Indiana Department of Natural Resources recently issued its Strategic Plan for 2005 through 2007. This plan states that efforts over the next two years will be directed towards management of forest resources for increased timber production and enhanced wildlife habitat. If implemented, this could result in an increased timber harvest from an estimated 3.4 million board feet per year to approximately 10 to 17 million board feet per year on State lands. This will increase the amount of early successional habitats available on these lands, as well as provide wood products and revenue to the state of Indiana and its citizens. It is important to note that NFMA regulations require the provision of habitat for species viability within the planning area. Although State lands may contribute to, or hinder, the maintenance of species viability on NFS, the Hoosier can not rely on these lands to meet our legal requirements. However, it is important to review the type of habitat available on State lands to analyze cumulative effects. The effects of this proposal will be better known once the State's proposal is implemented on the ground. These effects will be considered and evaluated in site-specific analyses conducted at the project level by the Forest.

The cumulative effects of the actions of Alternatives 3, 4, and 5 in combination with the existing condition of the species and habitats, past events and actions, and reasonably foreseeable future actions would be a forest that would continue to provide quality habitat for a large number of species, but that could not provide optimum habitat everywhere for every species. For example, these alternatives, in combination with less pine being planted now on private lands, would over time decrease the total amount of pine warbler habitat. These alternatives may also decrease habitat for some interior forest species below today's level.

Alternatives 1 and 2, on the other hand, would fail to maintain habitat for many species including the following SVE species: yellow-breasted chat, ruffed grouse, and American woodcock and would lead to a decrease in biodiversity.

Plant Communities

The following sections provide a pitcture of the affected environment related to plant communities.

Fire History

Historically, fire played a critical role in shaping the ecosystems on the Hoosier. Lightning-caused fires and burning by Native Americans shaped the plant communities and the animal species associated with them. Fire suppression in the twentieth century has allowed fire-sensitive, shade-tolerant species to invade these historic fire-adapted systems. This has altered habitat conditions, altered landscape patterns and species diversity, increased fuels, and decreased forest health.

The historic role of fire in the development and maintenance of oak forests has been well established across much of the eastern deciduous biome (Parker and Ruffner 2004). Fire is widely accepted as a natural component of the ecosystem (Parker and Ruffner 2004).

Fire history studies on the Hoosier indicate a mean fire return interval of about 8.4 years. Fire intervals ranged from one to 129 years. Studies indicate the fire return intervals during the Native American period (about 1650-1820) were longer (averaging about 23 years) than those of the Euro-American settlement period (averaging about 5.3 years) (Olson 1996, Guyette and Dey 2000, Guyette *et al.* 2003, Parker and Ruffner 2004)).

Long-term maintenance of oak in southern Indiana was probably driven by recurring fire. When there was a mean fire return interval of about 8.4 years, a combination of drought and recurring fire maintained the barrens communities of southern Indiana (Guyette *et al.* 2003).

Archeologists believe Woodland Indian cultures practiced a form of agriculture in which forests were cleared and burned to create open areas. By the time of European contact, the landscape resembled a mosaic pattern of croplands near settlements, abandoned clearings with early successional species, and open forest stands dominated by fire-adapted species such as oak, hickory, and walnut (Parker and Ruffner 2004).

The sequence of fire and drought and the abrupt changes in fire frequency at the study site suggest that a strong relationship exists between fire frequency and human population density, settlement, and migration (Guyette *et al*. 2003). Reports during the early 1900's noted that farmers annually burned forests to increase regeneration of grasses and forbs, as well as to reduce the understory to facilitate hunting and travel. The forest could not be burned every year due to a lack of sufficient fuel; however, these early accounts record that some portions of the forests were affected by fires each year, but the woods were not completely burned (Robertson and Heikens 1994).

Fire has played an important role in the development and maintenance of the oak-hickory forests of the area, and it continued to do so through the early part of the twentieth century. After the Forest Service and other agencies enacted wildfire controls, the effects of periodic fire in maintaining forests were removed from the ecosystem. Authors in Illinois have suggested that during this time there was a growing shift in species composition when fire-intolerant species such as sugar maple began to replace fire-adapted oak and hickory species (Parker and Ruffner 2004).

Plant Community Types

Upland forest timber type dominates the Forest (see Figure 3.1). The Shawnee Hills Section (subsections 222De and 222Ff) consists of an oak-hickory mix on the upper slopes, including black oak, chestnut oak (*Q. prinus*), pignut hickory (*Carya glabra*), post oak, scarlet oak (*Q. coccinea*), shagbark hickory (*C. ovata*), and white oak. Characteristic shrub and ground cover plants include black huckleberry (*Gaylussacia baccata*), dittany (*Cunila origanoides*), flowering dogwood (*Cornus florida*), greenbrier (*Smilax spp.*), hillside blueberry (*Vaccinium pallidum*), and panic grass (*Panicum spp.*).

Characteristic trees of lower slopes and coves include American beech, black walnut (*Juglans nigra*), red oak, sugar maple, white ash (*Fraxinus americana*), and yellow poplar. Shrub and ground cover plants on these sites include bladdernut (*Staphylea trifolia*), broad-leaved waterleaf (*Hydrophyllum canadense*), Gray's sedge (*Carex grayii*), nodding fescue (*Festuca subverticillata*), pawpaw (*Asimina triloba*), sharp-lobed hepatica (*Hepatica acutiloba*), and spicebush (*Lindera benzoin*).

The Mitchell Karst Plain subsection (222Ek), in the Highland Rim Section, has several forest communities present of which pignut hickory, shagbark hickory, sugar maple, white ash, and white oak and are typical. Shrubs and ground cover plants in this area include black snakeroot (*Cimicifuga racemosa*), enchanter's nightshade (*Circaea lutetiana*), maple-leaved viburnum (*Viburnum aceriflolium*), redbud (*Cercis canadensis*), silvery spleenwort (*Athyrium thelypterioides*), and wild geranium (*Geranium maculatum*).

The Brown County Hills subsection (222Em) is rather uniform in composition with uplands dominated by oak-hickory, especially chestnut oak, and ravines with American beech, red oak, sugar maple, and white ash. Typically, upper slopes have almost pure stands of chestnut oak, a thick growth of greenbrier, low-growing shrubs, and large whorled pogonia orchids (*Isotria verticillata*) in a carpet of sedges (*Carex spp.*).

Statewide and nationally, the area of oak-hickory type is declining. Forest scientists and researchers believe there are several reasons. Mature oak-hickory stands where no cutting has taken place are evolving into maple-beech and cherry-ash-poplar stands (mixed hardwood types). This is occurring due to the exclusion of fire and grazing in the stands. Historically, fire and grazing kept shade-tolerant species from dominating the stands and out-competing the oak-hickory stand component. Excluding fire allows shade-tolerant species, such as maple and beech, to fill the holes when an oak drops out of the stand.

Table 3.34 shows the current vegetative diversity by component and age class (Combined data system using GIS to derive acres 2002).

Table 3.34

EXISTING VEGETATIVE DIVERSITY
(NFS Lands)

Vegetative Component	Percent	
	Total	Component
Open and Shrub Land	3.6	
-- Mowed Openings		1.7
-- Barrens		0.7
-- Redcedar		1.2
Hardwoods	77.7	
-- 0-9 Years		0.5
-- 10-39 Years		11.6
-- 40-59 Years		4.4
-- 60-79 Years		13.1
-- 80+ Years		48.1
Conifers	16.3	
-- 0-9 Years		<0.1
-- 10-39 Years		6.9
-- 40-59 Years		7.9
-- 60+Years		1.4
Aquatic	1.1	
-- Lakes/Ponds		0.5
-- Rivers/Streams		0.5
-- Marsh/Wetlands		<0.1
Other Non-Forest - includes rocky areas, roads, and other nonproductive areas	1.3	

The desired condition on the Hoosier is greater vegetative diversity. Greater diversity provides a wider range of wildlife habitat and food sources for all life, from insects to large mammals. Vegetative diversity also minimizes the risk of severe insect and disease attacks on the forest.

Most of the timber stands on the Hoosier are even-aged and consist of one or two layers in the canopy. There is little vertical diversity or layering of crown heights within the stands. Thus, ecological niches for wildlife sensitive to vertical diversity within a stand or sensitive to horizontal variety may be absent in parts of the Forest. Multi-storied stands provide more vertical diversity for wildlife species desiring these attributes.

Desired conditions include an even (sustainable) distribution of age classes in both tree and shrub species. Increasing the acreage of the 0 to 9 year age class and decreasing the acreage of the 80+ age class would provide a more even distribution of age classes in the hardwood type. This would increase plant and animal diversityin the forest. Providing areas for potential old growth would provide habitats for those species requiring areas of unbroken canopy.

Succession is the relatively sequential process of change in community composition over time. Succession explains patterns of distribution and abundance of plant and animal species.

Early Successional Habitats

See successional habitat discussions under Animal Communities.

The landscape of pre-settlement southern Indiana was predominately forested (Lindsey and Schmelz 1965, Potzger *et al.* 1956, Zhalnin 2005), with significant areas of prairie and disturbed and open forest (Olson *et al.* 2002, Eagelman 1981). According to historical accounts, Native American activities heavily influenced the region (Temple 1966, Kimmerer and Lake 2001). Use of fire and the clearing of land for agriculture by Native Americans were common in the 1400's, and began to decrease by the late 1500's and early 1600's as European diseases reduced Native American populations (Denevan 1992, Williams 2000). This reduced the overall impact on vegetation across the landscape by Native Americans, allowing some recovery of forested conditions by the 1700's, when Europeans became more active in the region (Olson 1996). Native Americans continued to use fire and agriculture, but by then there was only a reduced population of Native Americans. The research of Guyette and Dey (2003) indicates that fires may have burned the barrens of southern Indiana about every 23 years from 1650 to 1820.

A wave of forest clearing swept across the East and Midwest of the United States between 1750 and 1940 (Pimm and Askins 1995) as European settlers began clearing the land for agriculture. These early settlers cleared forest for agricultural patches, grazed livestock in forested areas, and cut fuelwood and logs for building. To increase regeneration of grasses and forbs, as well as to reduce the understory to ease hunting and travel, farmers annually burned forests (Miller 1920). By the late nineteenth century, most of the forest had been cut, with only small woodlots remaining, and all of the forest had been subjected to fire and grazing by livestock (DenUyl 1947, DenUyl and Day 1939). Aerial photographs from 1939 show many open forest canopies that, due to fire and grazing, have no second layer of trees.

After the start of the twentieth century, fire disturbances were largely controlled or removed from the forest as local bans on fires and regional laws forbidding this activity came into effect. The policy of many Federal agencies, including the Forest Service, was to suppress all fires. As a result, a significant shift in species composition occurred across much of the region (Weaver and Ashby 1971, Parker 1989, Fralish *et al*. 1991). Fire-intolerant species such as sugar maple and American beech became established at the expense of fire-adapted oak and hickory species during the period when fire control measures were enacted across the region (Schlesinger 1976, Lorimer 1985). For a time, periodic fire no longer maintained healthy oak-hickory ecosystems.

Since the late 1800's, the amount of forest in the East and Midwest has progressively increased, primarily because of farms being abandoned (Pimm and Askins 1995). Open habitats were widespread before human settlement, and many species that had been dependent on these habitats flourished during the period of farm abandonment (Hunter *et al*. 2001, Lorimer 2001). However, the intensification of farming and declining numbers of abandoned fields, hay meadows, and pastures, as well as the suppression of natural disturbances such as beaver activity, fire, and floods that generate natural grasslands and shrublands, have caused significant declines of these species (Askins 1998, Hunter *et al*. 2001).

Forest Openings

Over the past planning period, the Hoosier has maintained permanent forest openings for the purpose of establishing and maintaining early seral wildlife habitat and vegetation. The Forest designs management activities in openings to create, enhance, or maintain plant communities to benefit native plant and animal communities, especially Regional Forester sensitive species, and contributes to recreational opportunities, including visual quality. Important considerations in prescribing management activities include biological objectives for management areas, existing plant communities (including the presence of sensitive plants), habitat conditions on adjoining lands in the area, potential natural communities, and site characteristics. Openings and shrub land habitats are non-forested areas dominated by forbs, grasses, shrubs, or tree seedlings. They may contain a few scattered trees. Before these areas became national forest, they generally consisted of cropland, home sites, or pasture, and they would revert to forest if left to natural processes. Some are natural openings with relatively little or no tree growth because of natural site characteristics.

Openings with a history of human disturbance, especially more recent use, are composed of more exotic or nonnative plants, while natural openings and old abandoned fields have more native plants. Native plant communities, including prairie species, dominate some of the natural openings and semi-openings. Openings with native plants are generally more likely to harbor sun-loving plants and plant communities than are more disturbed sites with exotic flora; however, sensitive native plants may occur in old-field openings that include some exotic species.

Forest openings benefit wildlife species that prefer early seral stage vegetation. The species benefited include a variety of both non-game and game animals that find food, shelter, or cover needed for successful reproduction in these early successional stages of vegetation.

To manage for a desired level of biological diversity, openings would be perpetuated, developed, and maintained in portions of the Forest. Openings provide habitat or habitat components for native plant and animal communities, including several Regional Forester sensitive species. The diversity of plant and animal communities provides additional recreational opportunities in the Forest, such as hunting, picking berries, and nature watching.

Mid Successional Habitats

See successional habitat discussions under Animal Communities.

On the Hoosier, there are both pine stands and hardwood stands currently in this mid-seral stage. Nonnative pines were planted from the 1930's until the early 1980's in old fields to help control erosion. These pine stands now represent 16 percent of the total forest acres. Of the pine species planted on the Forest, white pine and shortleaf pine represent the greatest number of acres. As pine stands grew from eroded fields to pole and sawtimber size stands, the forest floor also changed. Due to close spacing of pines, in places the forest floor is virtually devoid of plant species. As these pine stands continue to age, openings in the crown form and hardwood seedlings and forbs begin to emerge. The mortality rate in the pines is dependent on the species. Shortleaf pines are shorter lived than other pine species, while white pine lives the

longest. Once the pine stands convert to hardwoods, the stands would then follow the natural successional path.

Late Successional Habitats

See successional habitat discussions under Animal Communities. Hardwoods exhibit change in age, composition, and diversity as they progress from early to late seral stages. In general, over time many of these communities will convert to beech-maple.

Alternatives and the Effects of Management on Plant Communities

Species composition and age class distribution were used as an indicator of response to display how the alternatives responded to Issue Two: Ecosystem Sustainability. The following section displays these indicators.

All Alternatives

Vegetative cover in Management Areas 2.4, 5.1, 6.2, 6.4, 8.1, 8.2, 9.2, and portions of other management areas would gradually change to a mature, old-growth forest over the next 100 to 200 years. During this time, the forest would take on a more uneven-aged character as larger trees die from wind, insects, disease, fire, or old age and small groups of young trees become established. Except for occasional catastrophic natural occurrences, such as widespread insect and disease epidemics or wind events, the forest canopy would appear unbroken.

Over time without management, the acreage of the oak-hickory type would continue to decline, and more shade-tolerant sugar maple and beech type would succeed it. Table 3.10 shows the change over time by alternative in the representation of the oak-hickory type in the forest.

The progression toward a more closed canopy would benefit some plants, but some other plant communities require open conditions such as barrens or glades. Barrens and glades occur primarily in 6.4 and 8.2 areas, which emphasize the protection, restoration, and perpetuation of uncommon habitats and plant communities, including the use of vegetation management.

The amount of mature timber would vary by alternative, depending on the amount and type of activities. Table 3.8 displays the change over time by alternative in the amount of mature hardwood projected to be present on the Forest. Each alternative would have acreage where natural processes of forest succession (Table 3.35) could occur.

Table 3.35

MANAGEMENT FOR NATURAL PROCESSES OF FOREST SUCCESSION – NO HARVESTING PLANNED
(Numbers shown to the nearest thousand acres)

Practice	Acres				
	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
NFS land	108,000	199,000	87,000	87,000	108,000

Cumulative Effects

All alternatives would increase the acreage of mature hardwood above that presently existing. Even Alternative 4, which proposes to harvest the greatest amount of timber and provides the most early age hardwood, would result in an increased acreage of mature hardwood. Alternative 2, which proposes no harvesting, would provide the most mature hardwood but, as discussed later, would provide the least amount of early age class composition. Lack of harvesting and burning in Alternative 2 would result in the greatest change in the oak-hickory component as the forest continues to age and shift to more shade-tolerant species. Without active management, this conversion to more shade-tolerant species would continue as the stands continued to age. If fire were removed from the prescription, all alternatives would be expected to result in a decrease in the oak-hickory component. Through the combined use of harvesting and burning, the Forest can maintain the oak-hickory component.

The Forest used the SPECTRUM model to calculate harvest schedules through time by four alternatives. Alternatives 1 and 5 would produce the same results; therefore, Alternative 5 was not modeled in SPECTRUM. SPECTRUM uses a series of formulas to model activities through time and the resulting forest structure and species diversity. Appendix B provides considerable detail about the information and formulas used in the SPECTRUM modeling.

Alternatives 1, 3, 4, and 5

These four alternatives differ in the way the acreage in Management Area 2.8, 3.1, 3.3, and 3.5 is treated. The alternatives allocate the same land area differently to one or two of these management areas.

Each alternative has a different mix of even-aged and uneven-aged timber harvests. The effects to plant species described below are found in Alternatives 1, 3, and 4, in relation to the balance of harvesting systems indicated in Table 3.3*.* Alternative 5 was not run through the SPECTRUM model, but effects under this alternative should be similar to Alternative 1. Table 3.3 displays the amount of harvesting by decade by showing first decade harvest amounts and average harvest levels. In Alternatives 3 and 4, the Forest would accelerate harvesting in pine stands during the first 30 years. Providing the average amount of harvest provides a more consistent and informative picture of the amount of harvesting in each of the alternatives. There would be two different prescribed burns following most timber harvesting, separated in time by a few years. The acreage shown in the table accounts for that acreage; that is, only half of the acreage shown would be burned, but it would be burned twice.

The alternatives differ in the proportion of even-aged and uneven-aged management as shown in Table 3.36.

Table 3.36

AREAS PRESCRIBING TIMBER MANAGEMENT[1]

Practice	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Acres managed under an even-aged system	16,500	0	39,000	88,000	16,500
Acres managed under an uneven-aged system	64,500	0	73,000	24,000	64,500
Total acres	81,000	0	112,000	112,000	81,000

[1] Cutting could occur in some other management areas for reasons like salvage, recreational needs, and wildlife habitat, but harvest for managing the timber base would not be appropriate.

Even-aged Management

Of the four alternatives that use this type of management, Alternative 4 applies the most even-aged management. Alternatives 1 and 5 would use the least even-aged management (see Table 3.3*).*

Even-aged management produces a mosaic of dispersed, different-aged forest stands. Harvesting of mature stands creates new seedling-sapling stands; some middle-aged stands reach maturity, and younger-aged stands grow into older age classes. Varieties of plant communities are associated with the different stages of plant succession on different sites throughout the Forest. Across the forest landscape, the early age class (age class 0 to 9 years) is least represented on the Forest. The early age class or newly regenerated forest generally contains the highest number and greatest diversity of shrub and tree species. As stands age, the composition changes, and stands continue to age and stratify according to their physiology and habitat requirements.

Pines were planted from the 1930’s until the mid 1980’s to aid in erosion control. They are currently aging and senescing. Alternatives 3 and 4 would emphasize the removal of the pine, especially during the first 30 years. Alternatives 3 and 4 were conceptualized as harvesting up to 4,000 acres of pine per decade. However, adjacency constraints in the model limited the maximum amount of pine that could be harvested during the first 30 years to approximately 3,000 acres per decade. Alternatives 3 and 4 would emphasize pine conversion and remove as many nonnative species as feasible. Emphasizing pine conversion reduced the amount of even-aged management in the hardwood types. Table 3.3 shows not only the amount of harvest for the first 10 years but also the average for 15 decades to demonstrate the overall alternative direction.

Effects of even-aged management on vegetation need to be considered from two perspectives: (1) effects on a given site when an existing mature stand is harvested, and (2) effects on plant diversity across a forested area when periodic harvesting occurs on several sites.

Even-aged regeneration harvests, which remove all or a good portion of the trees in the stand, would change vegetation composition on the site. In the short term, vegetative structure would change from a multi-layered forest stand with canopy, herbaceous shrub, and sub-canopy

layers of vegetation to a forest opening with only a single, low layer of woody and herbaceous plants. Immediately following such a regeneration harvest, the shrub and herbaceous composition would change, and the percentage of shade-intolerant species would increase in 3 to 5 years. As the new stand of trees develops a closed canopy, these effects would decline.

Regeneration harvest would set back ecological succession to an earlier stage. Intermediate harvests would tend to accelerate processes of succession. Stand structure and plant species diversity would change on a given site as succession progresses. Tree species would differ depending on stand composition prior to harvest. Generally, for several years after harvest, the percentage of pioneer species such as black cherry (*Prunus serotina*), sassafras (*Sassafras albidum*), and yellow poplar would increase. Herbaceous vegetation would respond in a similar manner, with species requiring more open conditions and those tolerant of disturbance increasing the most following harvest activities. In time, regenerated stands would revert to mature multi-layered stands.

Soil fertility, drainage, and other environmental factors influence site productivity, determining which tree species and plant communities would eventually occupy the site.

The effects across the Forest depend on the current vegetative composition, site capabilities, the amount, frequency, location, and size of periodic harvests, and other environmental factors. The age-class distribution and vegetative diversity of a forest could remain relatively stable if the amount of forest reaching maturity is almost equal to the amount regenerated.

The large representation of oak currently on the Forest results from land use practices around the beginning of the twentieth century, all of which favored oak and hickory establishment. Under protection from such practices, natural trends have shifted toward more shade-tolerant species, except on extremely dry or wet sites. Oak-hickory stands should continue to dominate drier sites. Although further research on how to retain more oak and hickory trees is underway, current knowledge indicates that even-aged management perpetuates more of the oak and hickory type than any other silvicultural system (Seifert 2004). Without harvest, the stands would continue to shift toward less oak-hickory. The effect of even-aged management on the oak and hickory components and on associated wildlife depends up the amount and intensity of even-aged management. Fire also has an effect on the amount of oak-hickory. Prescribed fires help support and sustain the oak component (Brose 1999).

Uneven-aged Management

There are two methods of applying uneven-aged management - group selection and single-tree selection. Uneven-aged silviculture is a method that maintains a continuous forest with harvest treatments every 20 to 30 years. Stands become multiple-aged (after two treatments) and resemble a forest with a mix of tree sizes ranging from seedlings to mature timber.

Alternatives 1 and 5 would use uneven-aged management the most, and Alternative 4 would likely use it the least (see Table 3.3*).*

Effects of uneven-aged management on vegetation depend on whether harvest is by single-tree selection or group selection. Stand structure and plant communities resulting from single-tree selection differ from those of group selection.

Periodic harvest of individual, selected trees in single-tree selection perpetuates stands with trees of different ages and sizes, and maintains a predominantly closed but uneven tree canopy. Frequent entries (about every 20 to 30 years) would likely occur in most stands to remove

different sized trees and achieve a predetermined stand condition. Such harvesting leaves well-stocked stands, and such stands have a relatively high degree of shade. Shade affects the establishment, survival, and growth of both shade-intolerant and shade tolerant regeneration.

Since relatively few trees would be harvested at any one time and the forest floor is generally shaded, shade-tolerant plant species are favored under single-tree selection. By removing shade-intolerant species and species intermediate in shade tolerance, such as oaks, hickories, and yellow poplar, from a stand, the tendency is for shade-tolerant species, such as beech and maples, to replace these species. The rate of succession in an area depends on existing vegetation, intensity of harvest, method of harvest, site characteristics of the area, and post-harvest treatments.

In general, uneven-aged management accelerates the natural process of succession in terms of species composition moving toward a climax forest. The physical characteristics of a managed climax forest should not be confused with that of an old-growth stand. Unlike an old-growth stand, a managed climax stand has much less dead and down woody material and fewer standing snags.

Group selection and single-tree selection involve periodic removal of individual trees and small groups of trees (0.1 acre to 3 acres). The goal is to maintain a given number of trees per acre in each age class. Removing trees within several diameter classes can perpetuate a predetermined stand structure. Single-tree selection is effective in producing and maintaining deciduous hardwood stands with a high percentage of shade-tolerant species, such as maple and beech. The purpose of group selection is to regenerate some intolerant species. The larger the opening the more likely there will be some intolerant species.

In the group selection system, small groups are harvested rather than individual trees. Depending on amount, size, distribution, and frequency of harvests, stands under group selection may result in a mosaic of well-dispersed, even-aged groups and a variety of plant communities associated with different successional stages. Because individual group openings would be less than 3 acres in size, much of their edge would be shaded. Regeneration of shade-tolerant plant species would be favored, especially near these shaded edges.

Uneven-aged management would increase the diversity of size classes within a stand. From a Forest-wide perspective, uneven-aged management produces different community types than even-aged management produces.

Vegetative treatments affect the age class distribution of stands on the Forest. Table 3.37 displays the age class distribution at year 150 that would be expected with each of the alternatives.

Table 3.37

AGE CLASS DISTRIBUTION
Projection of 150 Years from Today (Percent)

Age Class	Existing	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
0-9	1	1	0	2	3	1
10-39	19	5	3	6	11	5
40-59	12	4	0	3	8	4
60-79	14	3	2	4	7	3
80+	48	80	91	78	64	80
Non-Forested Areas[1]	6	7	4	7	7	7

1/ Non-forested areas related to maintained forest openings, lakes, ponds, streams, and power line right-of-ways

Treatments can also affect species composition. Figures 3.21a, b, c, and d display the species over 150 years.

Figure 3.21a Dominant Species for Alternatives 1 and 5 over 150 years.

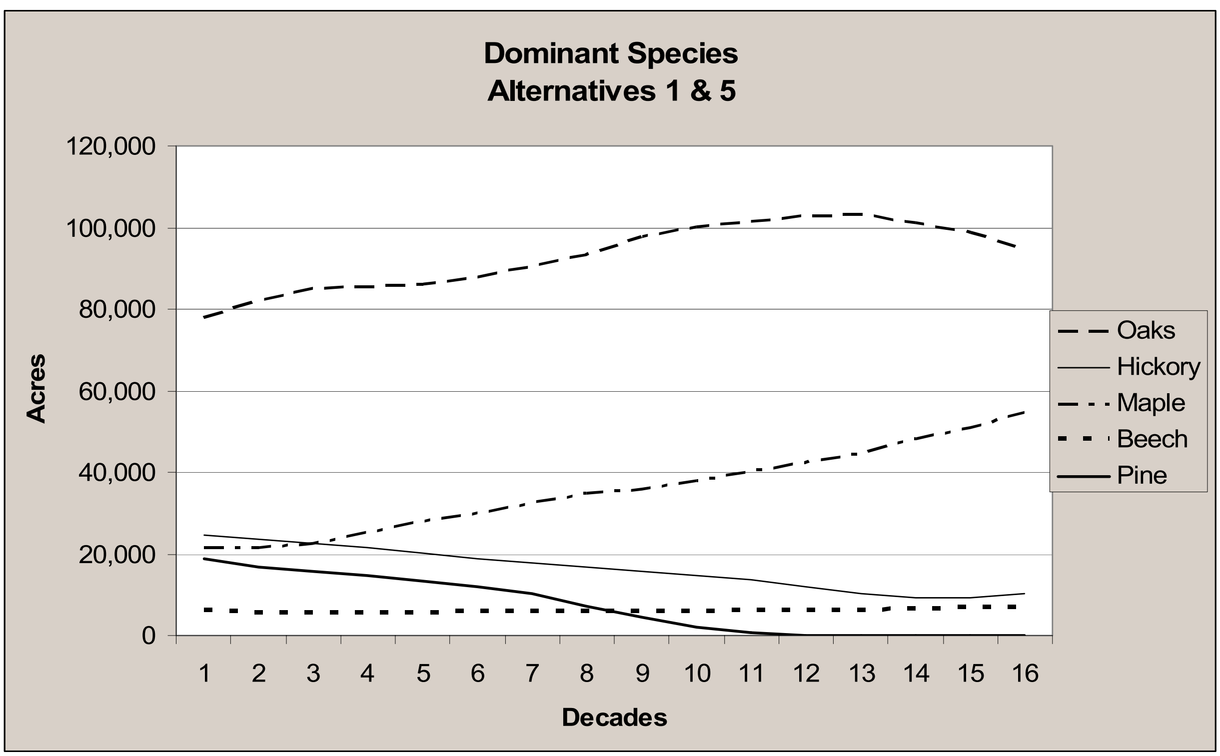


Figure 3.21b Dominant Species for Alternative 2 over 150 years.

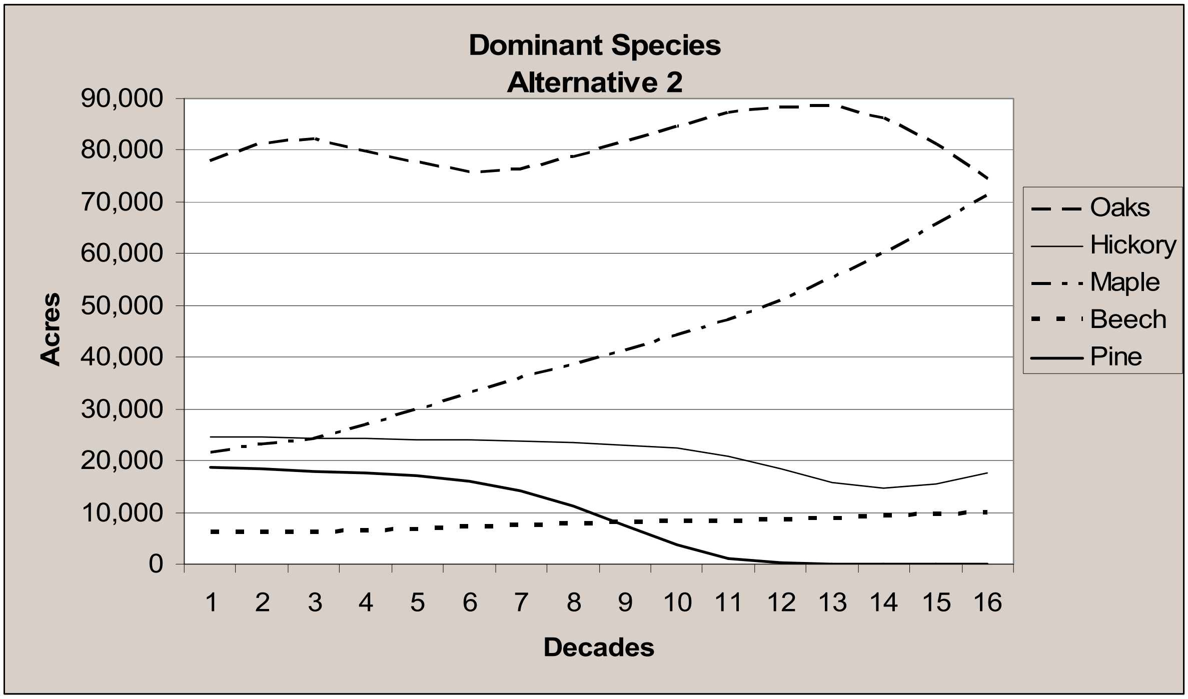


Figure 3.21c Dominant Species for Alternative 3 over 150 years.

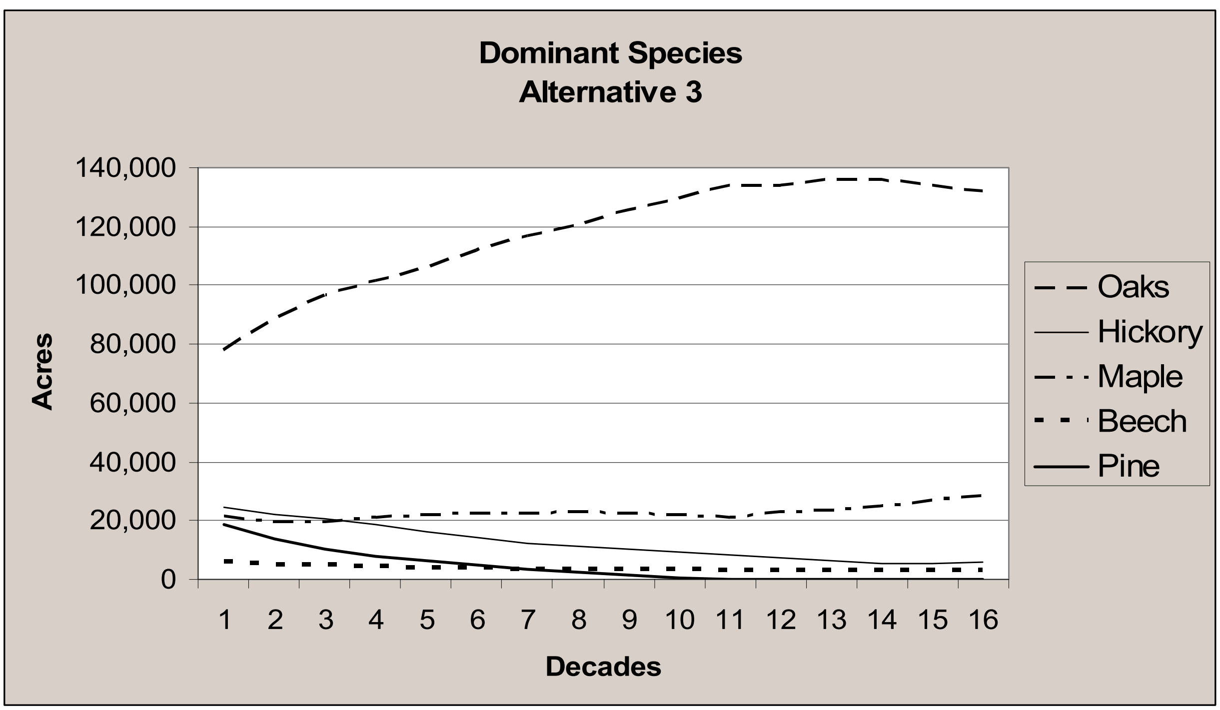
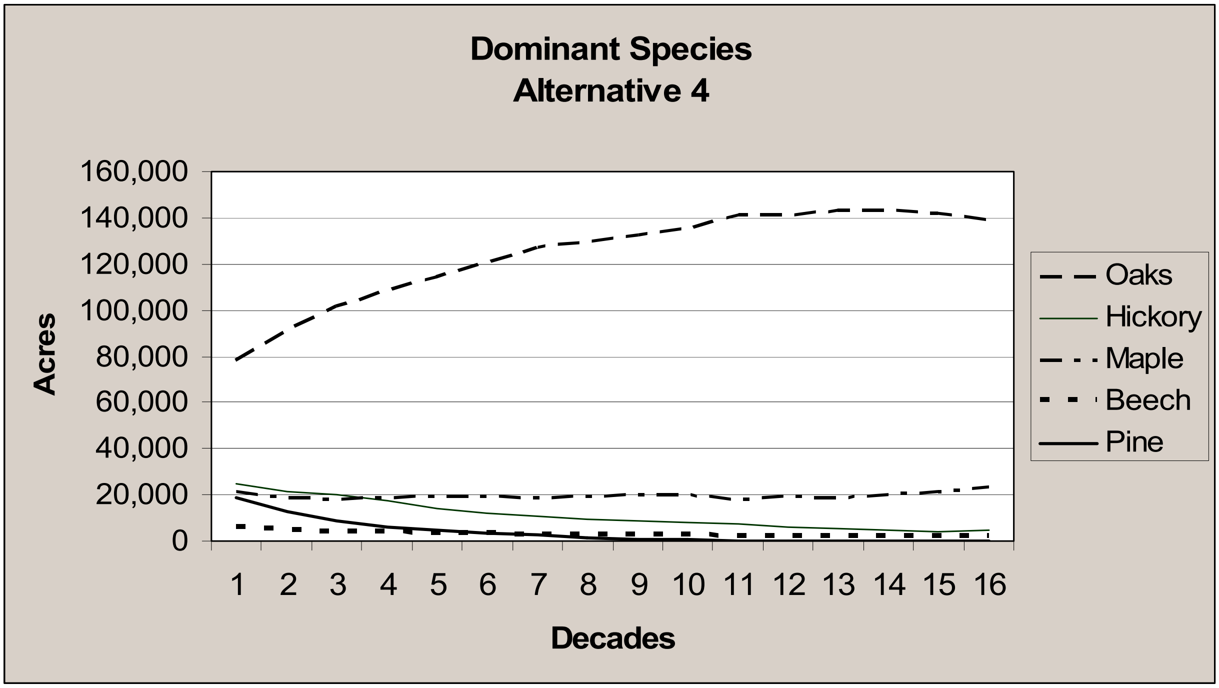


Figure 3.21d Dominant Species for Alternative 4over 150 years.



Timber Stand Improvement

Coupled with the timber harvesting activities are those activities that improve the health, vigor, and composition of forest stands. All intermediate treatments, with the exception of pruning, enable residual vegetation to grow more vigorously than if no treatment occurred. Some species, such as oak, other shade intolerant to mid-tolerant tree species, and prairie plants, may be favored if intermediate treatments and even-aged regeneration cuts are conducted.

Fire control interrupted and reduced the widespread burning and grazing of the late 1800's and early 1900's. These activities set back successional stages of vegetation and encouraged the growth of oak. Currently, oaks dominate much of the Forest, mixed with more shade-tolerant mesic hardwoods, such as sugar maple, on all but the wettest and driest sites (Parker and Weaver 1989). Intermediate silvicultural treatments can alter species composition and the genetic quality of stands whether they are natural or planted. It is desirable to eliminate poor quality and undesirable species before they can contribute to the next generation by pollen, seed, or sprouts. This influences both the economic and the biologic quality of the residual and subsequent stands.

Though the cost-benefit value of pruning and grapevine (*Vitis spp.*) control may not be practical on a large scale, in some cases these practices would appreciably affect the quality and growth of forest stands. Pruning results in clearer boles (trunks) and concentrates growth on height and diameter. The Forest may choose to use grapevine control when grapevines become so prolific that they cover the canopy and virtually smother and break down the canopy of trees. When one wind-blown or dead tree falls, the interlacing grapevines drag down other treetops and limbs with them.

The fruit of grapevines has value to wildlife. Grapevines can become a problem in forest openings and even-aged stands, as they can become so prevalent that they can pull down trees or break the tops. Cutting grapevines in stands improves stand growth and survival of newly established trees, and reduces grapevine abundance. As stands continue to age and trees fall down with the attached grapevine, vines have a more difficult time becoming established under a closed canopy. Grapevine is a mid-tolerant shade species and does not thrive in a closed-canopy situation.

Tree Planting

Planting and site preparation activities affect species composition and both vertical and species diversity. Planting prepared sites produces the greatest change in forest cover types. Planting non-forested acres adds a seedling, sapling, or brush layer, increasing species diversity. Planting occurs after site preparation, such as burning or scarifying.

Planting can be beneficial to biological diversity by adding new species, increasing the gene pool, and providing contrasting types of plant communities. In some cases, the Forest can plant to maintain particular forest types. Planting also offers an opportunity to introduce species such as butternut (*Juglans cinerea*) and American chestnut back to the landscape.

Site preparation for regeneration can prevent residual trees of more shade-tolerant species from dominating sites.

Cumulative Effects

The effects on the flora and fauna are related to the amount of management. The alternatives differ in the amount of management proposed. Alternatives 1 and 5, which have the greatest amount of uneven-aged management, would favor those species that benefit from the harvest of small groups of trees and from single tree harvesting. Species such as sugar maple and American beech would benefit from this alternative. Although Alternatives 1 and 5 propose some even-aged management, the limited acreage of even-aged management would allow some oak and hickory to be succeeded by beech and maple. Since only portions of pine stands could be harvested, there would be residual pine acreage providing pine as a seed source and seeding into the newly regenerated stands. Figure 3.22 shows the expected forest types from implementing the alternatives

Alternatives 3 and 4 would have the greatest effect on those species needing disturbance and even-aged practices. Species such as bigtooth aspen (*Populus grandidentata*), black cherry, black walnut, butternut, oaks, and yellow poplar would benefit from the use of even-aged management. Alternatives 3 and 4 would also remove the greatest amount of pine, especially in the first 30 years. Under these alternatives, the greatest amount of pine would be removed (approximately 3,000 acres per decade), resulting in the greatest amount of hardwood being restored. Alternatives 3 and 4 would also provide for the greatest amount of young hardwood stands. These alternatives would remove entire stands of pine and not just portions of stands, thus reducing the likelihood of pine seeding into newly regenerated stands. Alternatives 3 and 4 would also provide the greatest amount of timber stand improvement, which would help maintain the oak-hickory component.

Private landowners adjacent to the Forest generally treat their land with a diameter limit harvest. Private landowners generally do not harvest and convert their pine stands to native hardwood, or use prescribed burning to alter the forest floor condition. As a result, private land provides very little early successional habitat and little treatment that could perpetuate the oak-hickory component.

Alternative 2

Alternative 2 provides no disturbance from management activities and does not provide early successional habitat.

Cumulative Effects

With Alternative 2, early successional stands, which contain the greatest mix of tree species, would be limited to those resulting from natural disturbances. Species needing disturbance, such as from harvesting and burning, would not benefit, since wildfire in Indiana currently affects relatively few acres. Species needing early age class conditions to regenerate, such as black cherry, sumac (*Rhus spp.*), and yellow poplar, would not benefit. The species diversity would continue to decrease as the forest moves towards shade-tolerant species. This alternative would not convert pine stands to hardwoods.

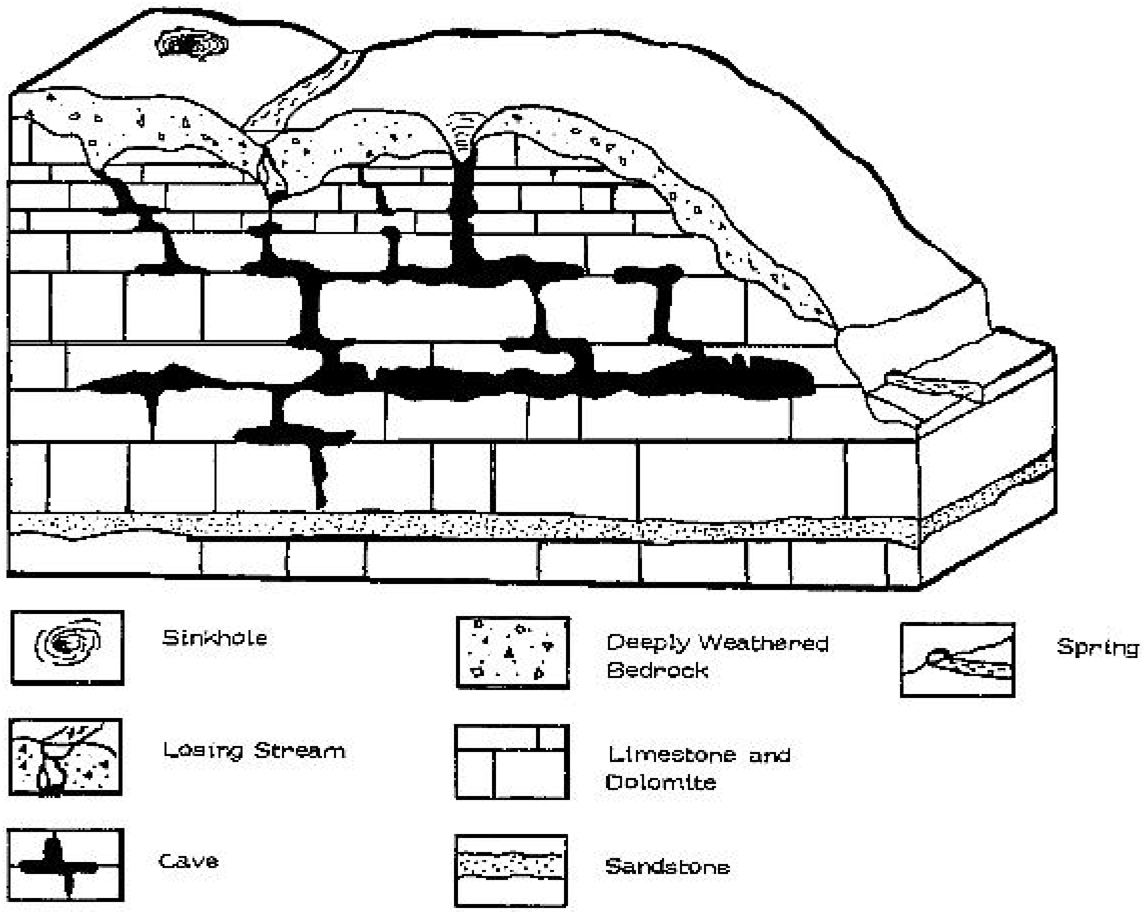
Combined with treatments on private lands, this alternative would move the forest toward a beech-maple composition and a diminished presence of oak and hickory. The forest would tend to become more homogeneous in composition and age class, as most stands would move toward an old-growth condition. This diminished diversity of structure and age class would make the stands more vulnerable to insects, disease, and other disturbance.

Cave and Karst Features

Cave and karst features are part of the affected environment. The Hoosier has special underground values that are largely hidden from view and unrecognized by most Forest visitors. The Forest is located on an area rich in caves and karst features. Karst is a term that comes from an area in Yugoslavia called the Carso Plateau where scientists first documented these features, and it typically refers to a landscape pockmarked with sinkholes, may be underlain by caves, and has many large springs that discharge into stream valleys (Figure 3.23). Karst is any terrain based upon a layer of soluble bedrock, and in Indiana karst forms on limestone and dolomite. Karst landscapes form when rainwater seeps down through a relatively thin soil cover and into fractured and soluble bedrock. Weak acids in rainwater that filter down through vegetation and soils easily erode limestone. The acid slowly dissolves the limestone and creates voids. These voids gradually enlarge as underground water moves through them. Over time, the interaction of water and stone creates blind valleys, caves, gulfs, rises, sinkholes, sinking streams, springs, swallow holes, and other karst features.

Limestone, with its high calcium carbonate content, easily dissolves in the acids produced by organic materials. About 10 percent of the earth's land surface--and 15 percent of the land area of the United States.--consists of soluble limestone (http://geography.about.com/library/weekly/aa060800a.htm).

Figure 3.23 Karst diagram – cutaway view of topography



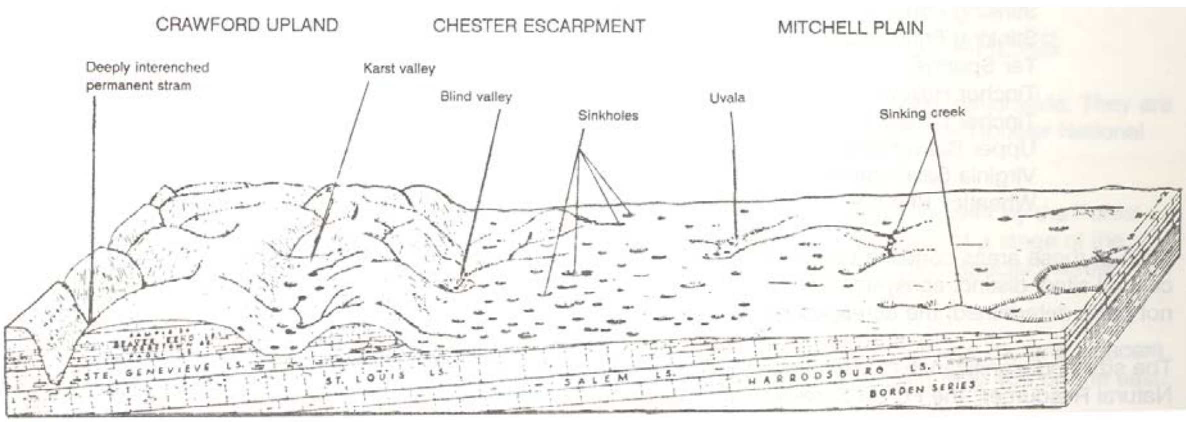
Cave environments, by their very nature, provide a unique system which is highly valuable for scientific study. Indiana has one of the best-known karst areas in the United States. Well over 100 studies have been published on karst features within the State, many of these in the area of the Forest. C.A. Malott's *The Physiography of Indiana* (1922) published the physiographic terms most commonly accepted by geologists and used here to describe karst topography. These terms differ slightly from those used in the ecological section and subsection descriptions referenced under Geographic Location. Additionally, caves provide excellent natural classrooms for environmental education of unique underground resources and the interrelationships between the surface and subsurface.

The karst region in southern Indiana is divided into two parallel areas called the Mitchell Plain (the eastern one third) and the Crawford Upland in the west (Figure 3.24). The Upland is technically less than 100 feet higher than the plain, so the division is not obvious to most; but underground the rock layers are significantly different. Layers of rock (limestone, sandstone, and shale) over 400 feet thick were built up by ancient seas that once covered this part of Indiana. The lowest and thickest layers are limestone up to 170 feet thick.

Over time, massive rock beds tilted and developed cracks and faults. Erosion has worn away the upper layers in the Mitchell Plain, exposing the geologically older limestones. Here the karst features such as sinkholes and disappearing streams are common elements of the landscape. It is here that towns such as Bedford, Bloomington, Mitchell, and Oolitic developed around the limestone quarry industry. It is also here one can find the majority of Indiana's 2,500 caves.

Figure 3.24 Typical diagram of a karst area of southern Indiana

From *Principals of Geomorphology*, William Thornbury, 1954



The Crawford Upland runs along the western edge of the Mitchell Plain. This area still has the upper strata of shale and sandstone rock over the limestone. The limestone still has caves, springs, and other karst features. The area's drainage is still subterranean, exhibiting dry-beds, rises, sinking streams, swallow holes, and other karst features. The karst features are still there, but many are hidden beneath layers of rock. The State's best caves lie at the interface between the Mitchell Plain and the Crawford Upland called the Chester Escarpment.

When compared with equivalent sites with non-karst bedrock, karst areas are more productive. Increased productivity can be credited to nutrient-rich soils with higher base saturation and well developed subsurface drainage (Aley *et al*. 1993, Baichtal 1993). Many wildlife species use the surface karst features and the stable environment and shelter provided by caves (Baichtal 1993). Caves can provide important natal den sites for river otters, and deer and small furbearers may rest near or in caves. Frogs (such as the pickerel frog, *Rana palustris*) are sometimes winter inhabitants of cave entrances. Cave environments also provide critical habitat for bats that require specific air circulation patterns, temperature profiles, humidity, and structure (Hill and Smith 1992).

Several uncommon plants and animals have at least part, if not all, of their life cycle dependent on the environment provided in caves. Cave life exists in a finite space without light. Caves provide air, food, humidity, temperature, and water in a normally steady state. Major changes to this delicate environmental balance are disastrous to many of these uncommon plants and animals. Because caves are dependent on the interaction with the surface, management above ground is important. Cave ecosystems rely on maintenance of microclimates, prevention of erosion and siltation, soil acidity, and other factors.

Cave environments provide habitat for a considerable number of invertebrate species. The description and inventory of karst fauna on the Hoosier is a distinctly recent achievement (Lewis 1994, Lewis 1998, Lewis *et al.* 2002, Lewis *et al.* 2003). Undertaken to acquire baseline inventories, this work continues to describe species new to the scientific literature and to document new distributions of previously described species. While this work represents a remarkable achievement in the description of karst species and their distribution, science still knows little of their life histories and vulnerabilities. Due to the extreme isolation and harsh conditions of the cave environment, many of the species, especially cave obligates, are rarely found. Obligate cave species represent more than one-half of the rare (G1 – G2, which are classifications based on rarity and related factors) species listed in the Nature Heritage Program, yet only 4 percent of these species have Federal protection status (Jones *et al.* 2003). To complicate matters, the Natural Heritage Program rankings are based on the number of known populations with no consideration of threats to the species.

Karst landscape contributes to productivity in aquatic environments through its carbonate buffering capacity and carbon input dissolved from limestone bedrock (Baichtal 1993). Initial research from Alaska suggests that karst systems may be 8 to 10 times more productive than those systems associated with non-karst dominated aquatic habitats. Karst-dominated aquatic systems appear to have higher growth rates for resident fish, have less variable temperatures and flow regimes, support higher biodiversity, and contain uncommon habitat that may affect species abundance, adaptations, and distribution.

Karst is vulnerable to groundwater pollution because surface waters channel rapidly into the subsurface at sinkholes and swallow holes. These waters flow underground without the benefit of filtration or exposure to sunlight, which might remove or kill some organic contaminants. To make matters worse, the use of cave conduits as natural sewer lines and sinkholes as garbage dumps in small towns and rural areas puts the local drinking water supplies at risk. Contaminants from agricultural pesticides, leaking gasoline tanks or spills, livestock feeder lots, and septic fields may be washed into the underground cavern systems. It is likely that as much as one quarter of the world's population derives its water supply from karst water (http://www.gcrio.org/geo/karst.html). Dye-tracing studies have shown that septic tank waste can travel through the thin soils that are characteristic of most karst areas into the aquifer and then to a spring in only a few hours. Scientists and concerned citizens have only recently begun to address these problems. Urban expansion in karst areas often leads to building of houses on land that cannot support them and problems with septic tanks, underground pipeline breaks, and pollution from landfills.

Alternatives and the Effects of Management on Cave and Karst Features

All Alternatives

The management of cave and karst features does not vary by alternative. The Hoosier will evaluate and manage all caves on the Hoosier under the direction of the Federal Cave Resource Protection Act of 1988 and 36 CFR 290. The Forest has developed standards and guidelines in the Forest Plan to protect these features on the Forest. When caves are present in a project area, the Hoosier develops site-specific mitigation measures relative to existing prescriptions and the proposed project. The Forest will work with members of the Indiana Karst Conservancy to develop individual specific cave management plans that are tiered to the Forest Plan.

The exclusion of caves from drilling and production activities will help protect significant cave resources, scenic and recreation values, ground water recharge areas, and wildlife habitat. The use of these lands for mining operations or mineral leasing would be incompatible with the current and continuing direction for cave management on the Forest.

Alternative 5

Any surface disturbance on or adjacent to caves could cause irreversible damage to the geological, mineralogical, cultural, paleontological, biological, research, educational, and recreational uses of the caves. Caves on the Forest contain highly significant and sensitive resources that are considered nonrenewable. Such activities could cause unacceptable resource damage to fragile cave resources and to the production of organic material on the surface. Forest Plan standards and guidelines will protect these resources on the Forest, but drilling on adjacent land located near a cave or karst feature could result in damage to the feature.

Cumulative Effects

Past events and processes that have affected and may continue to affect cave and karst systems include the activities of humans through visiting caves or more indirectly through disturbing the surface. Such activities near caves but not necessarily on NFS lands include contamination from livestock feeder lots, agricultural pesticides, leaking gasoline tanks, or spills; damage from blasting and equipment operation during mineral extraction; general degradation from human wastes and litter; increased sedimentation due to grazing and logging; and use of septic fields. Forest Plan direction is designed to prevent negative impacts to cave and karst features from Forest management activities.

Fire and Fuels

Wildfires are unplanned occurrences of fire regardless of how they start. Hoosier policy is to suppress all wildfires. In the following discussion, no quantitative estimates have been made of resource losses or impacts that would result if the Forest did not suppress wildfires.

Suppression activities include burning out and constructing firelines. Pre-suppression activities include activities designed to prevent fires or reduce their size, such as fireline construction, fuel reduction, and public education and information.

Forest fire protection is a joint effort between the Forest Service, the Indiana Department of Natural Resources, and local fire departments. Through cooperative efforts, the Forest Service may participate in suppression of fires on private lands in close proximity to NFS lands. The peak seasons for wildfire activity on the Hoosier are from February to May and from September to mid-December. During the last 10 years, the Forest has averaged 51 fires per year, with an annual average of 100 acres burned.

Wildfire has not been a major problem on the Hoosier for many years. The number one cause of fires on or near the Forest is escaped debris burning. Periodically, arson has been a problem, but it generally occurs on small sections of the Forest. High humidity and warm temperatures combine to help decompose dead organic matter. The rapid decomposition rate helps keep available fuel levels low enough that most fires are easily controlled. Low fuel levels, good access, and an established prevention program have all contributed to keeping the fire problem minor. Rainfall in the winter and summer months provide an abundance of new

grass growth, which contributes to grass and field fires in the spring and fall fire seasons. Weather patterns also provide sporadic high fire danger days during other seasons.

In addition to suppressing wildfires, the Forest Service would continue to take actions and work collaboratively with other landowners to reduce the wildfire risk to communities, municipal watersheds, and at-risk Federal lands. This would include fuels reduction projects and the promotion of healthy ecosystems within the wildland-urban interface and where otherwise needed to reduce the risk of severe wildland fire.

Alternatives and the Effects of Management

All Alternatives

Road closures and rehabilitation would reduce access to fires that occur. Longer response times should not dramatically increase fire potential, but could increase severity if a fire should occur.

Intermediate silvicultural techniques increase the amount of woody material on the ground. This site-specific effect is short term because over time decomposition would decrease the fire hazard created by additional slash. The effects of treatments such as thinning may serve to reduce the risk of catastrophic fire. The Forest could reduce fuel loading through treatment of the slash, including the use of prescribed fire. This could reduce fuel loading below natural levels and greatly reduce wildfire severity.

Storm damage or insect infestations resulting in tree mortality would also increase fuel loading. Fuel loading from such events may be extreme enough that, if a wildfire would occur in that area under high fire danger conditions, damage to resources could be severe. Suppression of wildfire in areas with high fuel loadings is not practical because of safety concerns. Salvage logging combined with use of prescribed fire would reduce fuel loads.

Pruning in pine stands, especially along roads and trails, would decrease the risk of fire reaching the crowns.

The more significant impact of wildfire suppression activities is the effect of fire itself and its role in the ecosystem. For centuries, fire has played a dominant role in determining forest vegetation. Because of its frequent and widespread occurrence, much of the forest vegetation consists of trees that are fire resistant, sprout vigorously, or have seeds able to survive fire, such as oak, sassafras, and sumac. With the inception of suppression activities early in the twentieth century, species composition of the forest began to change. Fire-sensitive and shade-tolerant species such as beech and maple replaced disturbance and fire-related species over time.

Restoration of fire regimes and natural vegetation patterns is necessary to restore, maintain, and expand barrens communities and to reduce any further loss of the oak-hickory forest type. Reintroduction of fire in these ecosystems would provide for greater stand health, richer biodiversity, and reduced fuel build up.

Cumulative Effects

Suppression of wildfires is a part of all alternatives. The acreage of prescribed fire varies as shown in Table 3.4 in Air Quality.

Alternatives 1, 3, 4, and 5

Alternatives 1 and 5 provide for the fewest acres of prescribed burning of these four alternatives, but they still allows sufficient acreage for the most needed hazardous fuels treatment projects. The lower acreage in Alternatives 1 and 5 would reduce the amount of ecosystem restoration work that the Forest could accomplish. This would contribute to a continued decline of barrens and dry forest communities, which are dependent on fire. Alternatives 3 and 4 would allow enough prescribed burning to take place to accomplish both hazardous fuels reduction and ecosystem restoration projects. The increased use of prescribed fire in barrens and dry forest communities would help restore these communities and provide for enhanced diversity of plant and animal communities across the Forest.

The ATV trails proposed in Alternative 3 may increase the risk of ignitions occurring from ATV use, but this is not expected to be significant. Management activities in all action alternatives may also increase the risk of ignitions. Proper contract administration and the use of closures, when required by extreme fire danger, would make this risk insignificant.

Alternative 2

The lack of management under this alternative would lead to increased fuel loading and reduced forest access. The risk of ignitions under this alternative would not increase. The alternative may lead to larger or more severe fires due to increased fuels and longer response time on some fires because of such conditions as closed roads.

Not being able to use prescribed fire would lead to a sharp decline in the barrens and dry forest communities. These communities are dependent on periodic fire to remove encroaching vegetation and maintain them. The absence of fire would reduce the diversity of plant and animal species across the Forest and further endanger these rare communities.

Insects and Disease

Several insects and diseases have potential to greatly alter the vegetative landscape of the Hoosier. For instance, oak-hickory and other mixed oak forests predominate on the Hoosier, and there are a number of insects and diseases of oak that have altered forests in the Midwest. In 2004, large numbers of trees of the red oak species group are declining and dying in southern Missouri and northern Arkansas from oak decline. Based on recent surveys, an estimated 100,000 acres of severe decline have occurred in the Mark Twain National Forest. Oak decline is not a single pathogen but is associated with numerous biological and physical factors. Initially, environmental, stand, and site factors induce long-term to short-term stress, and then various insects and pathogens may move in.

Two other oak pathogens having potential to alter forest composition are oak wilt, caused by the fungus *Ceratocystis fagacearum*, and sudden oak death, caused by *Phytophthora ramorum*. In addition, there are insects, such as tent caterpillars and borers, which can damage and kill oaks in large numbers (Thompson 2004).

European gypsy moth (*Lymantria dispar*) and emerald ash borer (*Agrilus planipennis)* are two insects that could devastate large areas and leave many trees dead. Butternut canker

(*Sirococcus clavigignenti-juglandacearum*) continues to reduce the population of butternut trees, and the emerald ash borer, which has killed trees in both urban areas and native forests, has been discovered in ash trees in Michigan and two locations in Indiana (Thompson, ed. 2004). The American chestnut was nearly removed from the landscape by chestnut blight (*Cryphonectria parasitica)*, and Dutch elm disease (*Ophiostoma novo-ulmi*) has largely eliminated American elm from our forests.

Integrated pest management (IPM) is a process that attempts to regulate forest pests to achieve resource management objectives. It is the planned and systematic use of detection, evaluation, and monitoring techniques, as well as all appropriate biological, chemical, genetic, mechanical, and silvicultural methods to prevent or reduce adverse effects of pest-caused damages.

Silvicultural changes can be the single most important action used to mitigate impacts of forest pests. Healthy, well-managed forest vegetation would result in high levels of productivity and resilience. Genetically improved seedlings provide an opportunity to grow forests that are more resistant to insects and diseases. With the proper mix of silvicultural treatments, there is little opportunity for pest populations to reach unacceptable limits.

Using the principles of integrated pest management to control insect and disease outbreaks helps protect the Forest and surrounding private woodlands. When outbreaks do occur, natural variations in tree species and stand ages or condition may contain them to the immediate area. When natural barriers are insufficient, the use of pesticides may be required to protect resources.

If an outbreak were to occur, the Forest could consider the use of biological controls and chemical pesticides to prevent an epidemic or reduce adverse effects of pests.

Managers would use the most economical methods that are specific in reaching their target. Options include indirect application by spraying from the air or the ground nearby and brushing or injecting undesirable vegetation.

Alternatives and the Effects of Management on Insects and Disease

All Alternatives

Controlling stand composition through reforestation determines the stand's long-term susceptibility to insect or disease damage. These effects are short term as well as long-term. Forest stands dominated by one species are more susceptible to severe damage if insect attacks or disease outbreaks occur. Mixed species stands are at less risk from insect and disease damage. The local mixture of stands of varying species composition would influence the occurrence and rate of spread of forest insects and disease.

Alternatives 1, 3, 4, and 5

Vegetation Management Activities

MA 2.4, 6.2, 6.4, and 7.1 areas would allow salvage of timber products in the event of natural catastrophes, such as insect and disease outbreaks, tornadoes, or wildfire. Salvage would be allowed in Management Areas 2.8 (Alternatives 1 and 5), 3.1 (Alternative 4), 3.5 (Alternative 3), and 3.3 (Alternatives 3, 4, and 5).

Site preparation removes suppressed and poor quality trees from a stand just before or just after harvest. If left, these trees would be more susceptible to insect and disease, as they are already under stress. The primary purpose of site preparation is to prepare the site for the regeneration of specific species. Site preparation would allow planted trees to grow vigorously, which discourages attack by insects and disease. Planting a wide variety of species also enhances the species richness and provides potential for a stand to withstand or recover from attacks by insects or diseases.

Using an even-aged management system with no intermediate treatments might increase the risk of insect and disease outbreaks over uneven-aged management due to the infrequent entry periods. The risk of an outbreak with even-aged management with intermediate treatments is similar to that of uneven-aged management. Shelterwood harvest methods involve more risk than clearcutting due to increased exposure and the possibility of damage to residual trees. Generally, the risk is short lived since residual trees would be removed once regeneration is established. Because of diseased and infected trees being removed with management, either even-aged or uneven-aged management would tend to pose a lower risk of outbreak than an area receiving no timber management.

Repeated entries with uneven-aged harvests could damage roots and stems of the residual trees. This damage would lead to a decline in productivity and higher incidence of disease and mortality than if an even-aged system were applied. Repeated entries would allow systematic removal of insect- and disease-prone trees, as well as short-lived trees, before they would lose vigor. Such harvests also could reduce insect and disease susceptibility of a forest.

Pruning opens a wound that may be attractive to a variety of insect and disease pests. To minimize this, pruning is best accomplished during the late dormant season. However, when using proper pruning cuts, pruning can be done anytime. It is best to avoid pruning when leaves are forming in the spring or falling in the fall (Schlesinger 1989). Pruning may eliminate a possible entry point for some insect or disease pests such as white pine blister rust (*Cronatium ribicola*). This disease benefits from cool, moist conditions. Removing the lower branches from near the forest floor where it is cooler and moister may remove a possible avenue of infection.

Individual tree release, pre-commercial thinning, and commercial thinning allow systematic removal of insect- and disease-prone and short-lived tree species before they lose vigor. Such treatments can also reduce the insect and disease susceptibility from levels expected if no treatment were undertaken.

Due to the infrequent entry of even-aged management with no intermediate harvests conducted, the potential for outbreaks is higher than in uneven-aged management. Overcrowding (competition) tends toward trees of uniform size and leads to stressed trees, making trees more susceptible to insects and disease. The effects of even and uneven-aged management are similar if intermediate treatments occur.

Depending on the magnitude of the treatment, changes resulting from integrated pest management treatments could be temporary or long lasting. For example, spraying plantations of yellow poplar for tulip tree scale (an insect) (*Toumeyella lriodendri*) reduces mortality of poplar trees, increases vigor of live trees, and reduces food sources for wasps, ants, and other predatory insects that feed on the insects. Spot treating plantings of oak, other hardwoods, or pines by chemical or mechanical means to reduce competition from other vegetation increases vigor of trees released. Both treatments exhibit dramatic short-term (same growing season)

responses to treatment. Effects of spraying for tulip tree scale usually last for many years. Effects of releasing plants gradually disappear in 3 to 5 years.

Without proper application, spraying chemicals could harm desirable flora and non-target invertebrates. Spraying could affect desirable and undesirable broadleaf vegetation within and possibly outside of the target area if unexpected drift occurs. Spraying chemicals might harm trees and shrubs producing food for wildlife along with plants that are threatened, endangered, or sensitive. Pre-survey analysis of the area, adherence to guidance, and careful application are necessary to avoid undesirable effects.

Methods for controlling insects, plants, and fungus affect biological diversity at the scale that control measures are applied. For example, applying control measures for lone star ticks in campgrounds interrupts a disease carrier-host relationship that affects not only the target pest (ticks) but also warm-blooded animals found in habitats associated with campgrounds (mice, opossums, raccoons, and people). The same is true for application of herbicides, fungicides, and other insecticides: Proper and careful application would confine effects to the sites where treatments are applied.

Pesticides can affect biological diversity in two ways. Chemicals reduce target pests and some non-target organisms in numbers for at least one generation of the affected species. This reduction reduces species richness. Other animals, insects, or plants, however, respond by increasing populations and expanding territories to occupy new habitat. Increases in species richness contribute to biological diversity on a local scale.

Integrated pest management principles would affect insects and disease. Those principles direct resource managers to carry out such tasks in a manner cognizant of risks associated with losses due to pests. When allowing chemical applications, all alternatives would allow and encourage avoiding conditions that could lead to significant losses.

Since pest outbreaks are difficult to predict, it is not known where, what kind, or how much of a control measure would be needed in any alternative. The Forest would consider biological control measures along with chemicals when situations suggest that type of control is needed.

Overmature vegetation is especially susceptible to insect and disease attack. As age increases, the risk of loss of wood products increases, but habitat for cavity-dwelling wildlife, which feed on insects, also increases. This effect would be proportional to the amount of old growth in each alternative. Active timber management can reduce this risk, since it could replace the older, mature, less vigorous trees with young, vigorously growing saplings and seedlings.

There are also long-term effects of vegetative composition and spatial arrangement on certain types of insects and disease. Spatially diverse vegetation conditions have lower associated risks. Large blocks of one vegetative type are more susceptible to pest damage, while the more spatially diversified types and ages would have decreased risks of loss.

The impacts of some pests would not vary by any of these four alternatives.

Increases or decreases in harvesting, reforestation, and timber stand improvement would have direct effects on the amount of dead woody material present on a site for a time following treatment. The increase in debris would increase the amount of habitat available for reproduction of insects. Since most of these insects or diseases are associated with decomposition cycles only and do not attack live plants, they are not considered pests and are

not expected to affect the production of goods and services. Untreated sites in any particular alternative would be expected to have vegetation die in an amount similar to the mortality incurred by sites having undergone treatments such as harvesting, but the effects would be spread over a longer time. The effects of treatments such as harvesting on a particular site would be concentrated in a relatively brief time.

Improved vigor of residual vegetation is a long-term effect of thinning and other decreases in stand stocking. The residual vegetation would be under less stress from competition and generally in a healthier condition. Treated stands would be less susceptible to the pest epidemics common in untreated stands.

Chemical applicators would only use materials registered by the Environmental Protection Agency (EPA) in full accordance with the Federal Insecticide, Fungicide, Rodenticide Act as amended, except as otherwise provided in orders, permits, or regulations, issued by the EPA. Unless adjacent areas are threatened, outbreaks of insects and disease generally would not be controlled in wilderness areas. Therefore, damage and mortality to trees are expected. As timber matures and loses vigor, impacts from forest pests increase and natural decay progresses. If not controlled, catastrophic outbreaks of insects or disease may reduce the quality of recreational opportunities and adversely affect habitat components for some wildlife species.

The Hoosier-Shawnee Ecological Assessment (Thompson, ed. 2004) contains more information about pests and IPM.

Cumulative Effects

The expected result of active management of forest pest conditions would be limited outbreaks of forest epidemics and a healthier and more attractive forest, but the effect would be somewhat dampened by forests under other ownership where pests might not be treated so assertively. This is not to say that some other land owners might not treat pests more aggressively than the Hoosier. Nevertheless, the large degree of adjacency to private lands might limit the effectiveness of the Forest’s insect and disease efforts.

Alternative 2

Biological controls provide forage bases or structural components usually lacking in managed forest stands. As trees get older, they tend to lose vigor. Declining vigor enables an insect or disease agent to gain a foothold in live trees. Damage caused by these attacks further reduces vigor, allowing secondary insect and disease attacks to occur resulting in death. Dead trees, either standing or lying on the ground, become an infection source for disease and a breeding area for insect pests.

Cumulative Effects

The cumulative effect of limited management under Alternative 2 combined with past agricultural uses of the area, increasing fuel load, vast acreage of forest that is not NFS land, and changes in forest composition over time could well increase potential for outbreaks of diseases or insects.

Nonnative Invasive Plant Species

Nonnative invasive plants pose a threat to forest health and biodiversity on the Forest. Invasive plants can invade and alter natural ecosystems by displacing native species, changing habitats and community structure, and damaging soil and water resources (Westbrooks 1998).

The Federal government defines an "invasive species" as a species that is nonnative (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112, 1999). People often call invasive plants weeds or exotic species. Regardless of the terminology, all of these definitions refer to invasive plants introduced into environments in which they did not evolve and where they lack natural enemies to prevent their expansion or spread to these areas (Westbrooks 1998). The Hoosier's greatest concern is for those invasive plants having the ability to invade natural habitats. In addition to Forest Service Manual and Forest Service Handbooks, other publications have presented national and Forest Service strategies or guidelines for invasive plant management (FICMNEW 1998; USDA FS 1998b; USDA FS 2001a).

The Hoosier uses an Integrated Pest Management (IPM) process or approach for control of NNIS similar to that described in the Insect and Disease section of this document. Appendix F in the Proposed Forest Plan, Pest and Nonnative Invasive Species Management, provides additional information regarding invasive plant control on the Forest. The Forest would conduct appropriate NEPA analysis and use integrated treatment methods, such as biological, chemical, manual, and mechanical, to control NNIS.

Invasive plant control actions may occur where infestations exist and focus on those species presented in Table 3.38. As ongoing NNIS surveys for invasive plants provide additional information on these infestations or locate new infestations, the Forest will adjust the list of species and treatment priorities. High priority species are those that are actively spreading and pose the greatest threat of degrading natural plant communities, especially in designated special areas on the Hoosier. Species rated medium high and medium priority are locally problematic, but they represent less threat to biodiversity where they occur.

Table 3.38 is a prioritized list of species with documented infestations on the Forest. The table does not present a complete account of all known invasive plants on the Forest, but it does contain those species known to be of concern. Undoubtedly, future inventories will discover new invasive plant infestations that become a high or medium threat, while others on this initial list will decline to a low priority because of successful control measures.

Table 3.38

NONNATIVE INVASIVE PLANTS OF CONCERN

Common Name	**Scientific Name**	**Priority**
Amur (bush) honeysuckle	*Lonicera maackii*	High
autumn olive	*Elaeagnus umbellata*	Medium/High
Chinese lespedeza	*Lespedeza cuneata*	Medium
common teasel	*Dipsacus fullonum ssp. sylvestris*	Medium
crown vetch	*Coronilla varia*	Medium/High
garlic mustard	*Alliaria petiolata*	High
ground ivy	*Glechoma hederacea*	Medium
Johnson grass	*Sorghum halepense*	Medium
Japanese honeysuckle	*Lonicera japonica*	High
Korean lespedeza (clover)	*Kummerowia stipulacea*	Medium
moneywort	*Lysimachia nummularia*	Medium
periwinkle	*Vinca minor*	Medium
potato vine	*Dioscorea oppositifolia*	High
Reed canary grass	*Phalaris arundinacea*	Medium
stilt grass	*Microstegium vimineum*	High
tall fescue	*Lolium arundinaceum*	Medium
tree of heaven	*Ailanthus altissima*	Medium/High
white sweet clover	*Melilotus alba*	High
yellow sweet clover	*Melilotus officinalis*	High

Nonnative invasive plants occur throughout the Forest. A comprehensive inventory for NNIS has not been completed, but surveys have occurred in all of the designated Special Areas and the Charles C. Deam Wilderness (Hedge and Homoya 2000, Hedge 2002). Ongoing and future invasive plant surveys will continue and will adhere to standardized Forest Service protocols for invasive plant inventories.

Nearly all NNIS plants documented on the Forest occur in openings or prefer open habitats. Many of these species exist primarily along roadsides or old fields. These plants may invade forest communities, but species intolerant of shade would decline as the forest ages through natural succession. Some of these invasive plants first become established along roadsides, but also have the ability to grow and invade the nearby forest. The species that are adapted to both open and closed-canopy conditions, as well as others having preferences for closed conditions, are the most difficult plants to control and the greatest concern on the Forest. Preventing the establishment of invasive plants in natural barrens openings is also a priority. Invasive plants have a tendency to invade natural communities along disturbance corridors, such as roads and trails. NNIS plants have spread across the Forest by a variety of methods, including unintentional movement by people (on their clothes or vehicles). Birds disperse many species, such as honeysuckle, by eating their fleshy fruit, while others spread via animals, water currents, or wind. Prior to NFS ownership, landowners planted invasive plants as ornamentals or for other reasons.

The Eastern Region (R9) of the USDA Forest Service developed a framework document identifying the goal, vision, and objectives for NNIS management (USDA FS 2003c). The

framework tiers off existing direction and the high priority management actions identified by the National Invasive Species Council (NISC 2001).

Objectives of NNIS management, based on the two documents cited above, are:

- Prevention – Develop programs and keep invasive species out before they become established.
- Early detection and rapid response – Detect new infestations quickly and stop invasive species from spreading.
- Control and management – Eliminate or control invasive species that have become a problem and limit their spread.
- Rehabilitation and restoration – Re-establish native vegetation and minimize or reverse the effects from invasive species.

Two inventories for invasive plants in selected areas of the Forest provided the primary basis for inclusion on this list (Hedge and Homoya 2000, Hedge 2002). These inventories also documented five other invasive plants as occurring on the Forest, but reported that they were a low threat to native biological diversity. In addition, Hoosier botanists and biologists have observed another 44 species, but the Forest considers these invasive plants a lower priority for treatment. A large number of these species are introduced pasture grasses or other plants typically found in old fields or homesteads. All but two of these invasive plant species with known infestations on the Hoosier originated outside of North America - in Africa, Asia, or Europe.

Decisions developed through an adaptive management approach anticipate changes in the analysis and decision-making and are appropriate for long-term invasive plant treatment decisions (USDA FS 2001b). Such adaptive management decisions allow flexibility in dealing with a changing target, such as locations and extent of invasive plant species.

Nonnative invasive plants occur across the Forest in scattered locations. Measures such as hand-pulling, mechanical methods, and prescribed burning are sometimes effective for smaller infestations, but some invasive plant populations have reached the extent where applying herbicides is the only feasible method of removing or controlling infestations. For these larger infestations, the cost of manual or mechanical methods may be prohibitive and could result in excessive soil disturbance or other resource damage. In some instances, the release of biological control insects can be effective in controlling invasive plants. The use of prescribed burning and spot treatments with a propane weed torch can be an effective treatment technique for control of some invasive plants, especially when used in conjunction with other methods.

Research shows that for some invasive plants herbicide use is the only effective method to eradicate the species, regardless of the size of the population. Application of selective herbicides can kill target plants while minimizing the effects on desirable vegetation and animal species. If herbicide application were selected, only EPA-registered herbicides would be applied and only via ground application methods. In most cases, herbicides would be applied directly to NNIS. This minimizes drift to avoid adverse effects to desirable vegetation and other organisms, including humans.

Nonnative invasive plants occur within or near all Special Areas (Management Area 8.2). One of the primary management objectives for special areas is to eliminate or control invasive species. Vegetation control may include burning, hand-pulling, and mechanical control methods. Use of herbicides would occur only after demonstration that it is a reasonable option

and is necessary to perpetuate the desired community. Regardless of the methods used, effects of the activity on all resource areas would be considered.

In the last several years, almost all NNIS plant control projects conducted on the Hoosier involved only the use of hand tools or hand pulling. In 1994, the Forest used hand tools to cut a small acreage of nonnative shortleaf pine that had encroached on a glade community, an uncommon habitat in the State. Another project involved the cutting of fruiting heads from teasel (*Dipsacus fullonum ssp. sylvestris*) within a barrens plant community. The remaining invasive plant control projects removed infestations of garlic mustard (*Alliaria petiolata*) by hand pulling in 1995 to 1998 and 2000 to 2004.

Prescribed burning reduces the biomass of invasive plants that occur within these areas, and depending on the species, burning is a useful control measure. Lastly, herbicide treatment has occurred along some public utility right-of-ways and easements where allowed by special use permits. In recent years, these treatments occurred in 10 individual easements. In addition, the Forest hand sprayed NNIS plant species and other weedy species at administrative sites and facilities.

For several years, the Hoosier has had an active rehabilitation and restoration program. In 1994, the Forest developed a native seed nursery for native plant propagation. The Forest uses seeds produced from the nursery to revegetate disturbed areas and thus give the native plants a head start on the NNIS plants. The Forest has used this native seed source along or on dams, firelines, log landings, openings, ponds, roads, timber harvest units, and trails.

Ongoing restoration involves the creation of natural levees to restore the features, functions, and hydrology of bottomland hardwood riparian ecosystems. Since 1998, the Forest has completed five of these wetland restoration projects. These projects typically occur along riparian corridors cleared to create pastures and planted to nonnative grasses, most often tall fescue. Erosion control grasses and legumes are usually native species, but sometimes short-lived plants (annuals) are used. Creating wetlands submerges and removes NNIS previously present in those areas. By restoring the natural hydrology to these bottomlands, native vegetation quickly returns from the seed source in the soil. Project proposals usually include planting native tree species that would typically occur in these bottomlands.

Alternatives and the Effects of Management on Nonnative Invasive Plant Species

All Alternatives

Nonnative invasive plant species occur across the Forest. Although each alternative proposes a different array of management areas, nearly all contain some documented and mapped infestations of NNIS. Only Management Areas 8.1 and 8.3, included in all alternatives, have no documented sightings of invasive plants.

Since NNIS plants occur throughout the Forest, any activity that disturbs the soil could potentially spread or create conditions for new infestations. Invasive plants tend to invade areas of ground disturbance, especially along log landings, roads, skid trails, and other exposed soil resulting from project activities. Although invasive plants often spread due to human caused events or activities, many invasive plants invade undisturbed areas by natural dispersal processes such as wind, animals, or water movement. Parker and Ruffner (2004) describe in

detail the changes in vegetation from prehistoric time to the present within the ecological sections encompassing the lands of the Forest. One of the primary factors that has affected community structure and maintained the diversity of species is a long history of disturbance caused by both natural and human activities. Disturbance by fire, in addition to clearing land for agriculture, is an important historical factor throughout the region. Undoubtedly, these actions contributed to the establishment and spread of NNIS just as they have influenced the current forest composition. The likelihood of invasive plants colonizing forest vegetation is relative to their ability to inhabit certain habitats or ecological land types. Other factors influencing the potential spread of invasive plants within a project area are the number and size of existing infestations and their proximity to proposed activities.

Forest Plan direction for soil and water resources would be effective in preventing the spread of invasive plants. Site-specific project mitigation would be developed and recommended following analysis.

Management goals for 6.2 and 6.4 emphasize natural-appearing forests with limited or no vegetation management activities in these areas. Among the goals for the Charles C. Deam Wilderness (MA 5.1) is preservation of natural ecosystems and allowing natural succession to occur, so vegetation manipulation is likewise limited. Vegetation management in MA 8.2 may occur to enhance or restore the purpose of the special area designation.

Restrictions on management activities would minimize the spread of invasive plants, but not completely alleviate the problem. Invasive plants would continue invading areas via disturbance corridors such as roads and trails. Some invasive plants, however, are intolerant of shade and would decline as the forest ages through natural succession.

Nonnative invasive plants may currently exist within newly acquired lands. Acquisition of land would provide the opportunity to conduct invasive plant control measures at these sites and prevent the potential invasion to nearby NFS lands. Consolidation of NFS lands would make it easier to implement and control invasive plants. Conversely, there would be a lost ability to treat infestations on lands exchanged to private ownership. All alternatives would address land acquisition activities and the issue of invasive plants in the same manner.

All alternatives evaluate the permitting of special uses on NFS lands. Among these types of projects, construction of utility corridors would have the greatest likelihood of introducing new populations of invasive plants. As with any ground-disturbing activity, the risk of NNIS invading or expanding into the project area would be proportionate to the level of ground disturbance and the proximity to existing infestations.

All alternatives authorize the use of appropriate control methods, but differ on where they permit the application of specific methods according to management areas.

All alternatives would limit prescribed burning in Management Areas 5.1 and 8.1, so burning to control NNIS plants present in those areas would not occur. All alternatives permit the use of manual hand pulling, thinning, mowing, cutting, and other similar mechanical control techniques. No prescribed burning would occur in Alternative 2.

All of the alternatives retain MA 8.2, Special Areas, which have some NNIS plants within or near them. One of the primary management objectives for special areas is to eliminate or control invasive species.

Alternatives 1, 3, 4, and 5

Vegetation Management Activities

Harvest activities could potentially spread NNIS or create conditions favorable for new infestations. However, as mentioned above, a comprehensive inventory for NNIS plants across the Hoosier is not yet complete. Therefore, comparing the amounts of harvest treatments and other vegetative manipulation activities by alternative is simply a way to show the differences in acres of disturbance that may or may not contribute to the spread of invasive plants. Refer to the discussion under vegetative management practices and the effects by alternative, which predicts the change of vegetative composition and which would have similar effects to invasive plants that may occur in those areas. A more accurate assessment of these activities in relation to invasive plants would occur at the site-specific level. When contracting activities, the Forest Service would require measures to minimize the risk of spreading NNIS.

Because most of the NNIS plants documented on the Forest typically occur in openings or prefer open habitats, these plants may invade openings created by even-aged harvesting, such as clearcuts. There is less risk of NNIS invading uneven-aged harvest areas than those harvested under even-aged systems, at least for the species that require conditions that are more open. Depending on the amount and sizes of group selection harvest implemented in a timber harvest project, these areas could approach similar susceptibility levels for NNIS invasion or expansion. The risk of NNIS plants invading or expanding following intermediate treatments such as thinning or pruning is directly proportionate to the level of ground disturbance, the amount of canopy reduction, and the proximity to existing NNIS populations. These activities benefit vegetation that requires increased sunlight, which may increase the vigor of some NNIS if they occur in these areas.

The alternatives propose various amounts of land as eligible for timber harvest. Table 3.3 displays acreage amounts by even-aged and uneven-aged systems as well as the harvest totals for the first 10 years and an average of decades 1 through 15 for each alternative. Projections from the SPECTRUM model displayed in this table show first decade treatment acres for Alternative 1 and 5 are equal, while the total for Alternative 3 is less and the total for Alternative 4 is greater. Clearcuts create the greatest amount of disturbance and have more potential to spread invasive plants. For the first 10 years, Alternatives 1 and 5 would have approximately 2,020 acres of clearcuts. Alternative 3 would have fewer acres, and Alternative 4 would clearcut approximately three times as much as Alternatives 1 and 5.

Prescribed Burning

Prescribed burning can also aid in controlling some NNIS, but other species may benefit, depending on the timing of the fires. Fireline construction clears organic material down to mineral soil, increasing the probability for invasive plants to colonize these sites. Using existing barriers and riparian corridors as natural fuel breaks can alleviate soil disturbance and minimize the spread of invasive plants. The risk of invasive plants invading or expanding following burning is proportional to the level of ground disturbance and the proximity of existing infestations.

Alternatives 1, 3, 4, and 5 would continue the use of prescribed fire. Both Alternatives 3 and 4 would allow considerably more prescribed burning than Alternative 1 or 5. Refer to Table 3.3, which displays predicted amounts of prescribed burning by decade for each alternative. Alternative 4 would implement the most prescribed burning followed by Alternatives 3, 1, and 5, respectively. Increased amounts of burning could potentially spread invasive plants, depending

on the individual species, but at the same time, it expands the opportunity to use prescribed burning as a control method where appropriate.

Openings Management

Ground-disturbing activities to remove vegetation in openings and shrublands could increase the probability of nonnative plants invading or expanding in these areas. Avoiding or minimizing the use of methods that disturb the soil in openings that have invasive plant populations would decrease the likelihood of this occurrence.

Each of these alternatives would continue the forest opening program across the Forest. Both Alternatives 3 and 4 emphasize fewer, larger openings or opening complexes. Alternatives 1 and 5 project up to 3 percent of the NFS lands would be maintained as openings. Alternative 3 would allow up to 2 percent, and Alternative 4 proposes 2.5 percent. Table 3.9 includes the acreage of prescribed burning anticipated for each alternative. Based on the small differences in the acreage of barrens in the alternatives, the potential for invasive plants to increase is about the same under any of the four alternatives.

Other Activities

Recreational use along trails could spread NNIS. Most infestations exist near roads and areas of past disturbance, so the likelihood for expansion of NNIS decreases farther into the forest interior. Trail construction and maintenance activities that disturb the soil may provide new sites for invasive plants to colonize, depending on the proximity to existing infestations. All alternatives would maintain and construct primarily multiple-use trails, but they would also provide some single-use trails. Alternative 3 proposes a seasonal closure for equestrian users in the wilderness during winter months to minimize ground disturbance and prevent further widening of trails and trampling of adjacent vegetation that contributes to spreading invasive plants. However, Alternative 3 would develop an ATV trail system that may spread NNIS.

Nonnative invasive plants occur at or near some recreational facilities. Because of the concentrated use of people at these sites, there would be a high probability for spread of some invasive species. Soil disturbance created by the expansion and development of new facilities could provide new areas for invasive plants to colonize. Implementing control measures on infestations prior to construction and selecting project sites away from invasive plant populations would reduce the risk of NNIS expansion. All four of these alternatives would develop, improve, and maintain new recreational facilities.

Roads would be the primary vectors for NNIS plant expansion. Once established, many invasive plants would thrive on roadsides because of the open conditions and their ability to tolerate continued disturbance. Many invasive plant infestations occur along or near roads. Ground disturbance associated with new road construction would provide ideal conditions for invasive plants to become established. Construction of parking areas would concentrate human use in certain areas, thereby increasing the possible expansion of NNIS. Seeding and mulching could help mitigate establishment along road shoulders. The Forest would construct parking lots and reconstruct any roads away from existing infestations, where feasible. All four of these alternatives allow for construction of roads and parking areas following site-specific analysis.

Cumulative Effects

Past events, trends, and processes show that NNIS plants occur throughout the Forest and on private and state lands across south-central Indiana. Invasive plants would continue to invade and spread across the landscape. The cumulative effect of implementing these alternatives combined with ongoing human and natural disturbances is a continuing spread of these

species. The actions and processes differ in various locations in the Forest, so the rate of spread would also differ. Site-specific mitigation would also help in controlling the problem.

Past and present disturbances, when added to reasonably foreseeable actions, have an effect on the expansion of NNIS through distribution of weed seed, ground disturbance, and the creation or perpetuation of spread vectors. The degree of effects would vary depending on the number of entrances over time, distribution of disturbance across the Forest, the proximity of infestations, and number of acres disturbed. The Hoosier manages lands that are intermixed with lands of other ownerships. Since invasive plant infestations occur at widely scattered locations on both private and NFS lands, land use decisions made by other owners may affect the spread of invasive plants as much as activities carried out by the Hoosier. Land use decisions made by other owners also could influence the effectiveness of the Hoosier's NNIS control program.

A comprehensive Forest-wide strategy for NNIS plant control management and mitigation measures recommended during individual site-specific project level analyses would ease effects of the risk of invasive plant expansion resulting from implementation of the alternatives. In addition, ongoing NNIS inventories, monitoring projects, and invasive plant species control projects would continue across the Forest.

With increased disturbance within and outside the Forest, opportunities for the spread of new invaders increase. Vehicles, equipment, wind, rain, animals, and humans have the potential to carry invasive plant seed to new and currently uninfested areas. Given the inherent susceptibility of some habitats across the Forest, spread is likely. At the same time, Forest-wide NNIS plant management and site-specific project level suppression or control activities are increasing, which may result in reduced NNIS populations.

Invasive plant control projects have involved manual hand pulling of invasive plants such as garlic mustard and very limited use of herbicides at recreational or administrative sites. Other projects to control NNIS plants have included prescribed burning and mowing. Another activity that contributes to the removal of some invasive plants is the creation of riparian wetlands. These projects, as well as expanded use of other control methods, would continue in the near future by implementing this alternative. Constraints due to budget and work force availability would limit the actual acreage treated for NNIS control.

Implementing a comprehensive Forest-wide strategy for NNIS control management and individual projects to eliminate or control invasive plants are necessary elements for preventing their spread and eventual control on the Hoosier. Nonnative invasive plant inventories and monitoring projects to assess the effectiveness of invasive control measures are other ongoing current activities. Creating partnerships with private, state, and local agencies in a collaborative effort to control invasive plants across the Forest or on adjacent ownership is a foreseeable action that is essential to combat the continued expansion of these plants. Cumulatively, all of these actions contribute to the success of the Hoosier NNIS plant control program.

Alternative 2

All Forest Activities

Alternative 2 represents a preservation philosophy for managing the Forest with no vegetative treatments or prescribed burning allowed. Alternative 2 would discontinue the forest opening program and would not permit riparian wetland restoration projects or the construction of new ponds or lakes. The alternative proposes closure of roads since access and maintenance of

openings, ponds, and wetlands does not apply. The alternative proposes to maintain existing recreation developments but does not allow for new construction. This alternative would only construct new hiking trails and separate these trails from bicycle and horse trails.

Disturbances and management activities offer avenues for the influx of invasive species. Being carried on vehicles and equipment used for management activities is a method for seeds of exotic plants to reach the interior forest areas. By restricting the use of equipment and activities related to vegetation management or recreation, implementing this alternative would slightly reduce the opportunities for new invasive species to gain access to the forest. This alternative proposes to close some seasonally (during wet winter weather) to bicycles and horses. These trail closures would minimize disturbance and reduce the likelihood of NNIS spreading to these areas. However, the lack of management tools in this alternative would limit the opportunity to control or eliminate invasive species.

Alternative 2 would allow only limited vegetation management, including limiting some techniques used to control invasive plants. The use of herbicides would be restricted to recreational areas (MA 7.1) and administrative sites. Prescribed burning would not occur. Therefore, NNIS controls would consist of hand-pulling and mechanical methods.

The alternative would not allow the continued maintenance of wildlife openings or development of new wetlands and ponds. Mowing and burning of openings can indirectly aid in controlling some invasive plants. Riparian wetland restoration projects most often occur in degraded pastures containing invasive plants, which would not occur in Alternative 2. Collectively, restrictions and limitations on vegetation management in this alternative would hinder managers' ability to control NNIS on the Hoosier.

Cumulative Effects

Effects of other alternatives would apply equally to Alternative 2. The reduction in ground-disturbing activities proposed by this alternative would also decrease the potential for spreading some invasive plants. Although the alternative restricts implementation of most ground-disturbing activities, it does allow other activities that could contribute to invasive plant expansion. Invasive plants would continue invading along existing disturbance corridors and by natural processes or disturbances. This alternative places limitations on techniques available to managers, which would adversely affect the ability to control NNIS. Another important factor influencing the cumulative effect of invasive plants increasing across the Forest would be the activities occurring on private lands inside and adjacent to the boundary of the Forest. Nonnative invasive species on private land would generally remain, just as in the other alternatives. These actions on non-NFS lands would affect the continued infestation on the Forest.

A major difference of this alternative is the restrictions placed on techniques available for control and limitations on the use of these tools in some management areas. These restrictions could severely constrain the success of a NNIS plant control program on the Forest.

Research Natural Areas and Special Areas

Pioneer Mothers Memorial Forest Research Natural Area

The Forest Service designated the 88-acre tract in Pioneer Mothers as a Research Natural Area (RNA) in 1944. Its designation preserves the area for scientific and educational purposes to

study the old growth forest that has been protected from earlier land practices that have altered nearly all the surrounding forested land.

Special Areas

The Forest designated Special Areas that contain special features as a means of protecting the character and integrity of the natural features wherever they occur. Special areas are designated in areas that contain unique or unusual cultural sites, distinct ecosystems, geologic formations, sensitive plants, or other unusual features. They nearly always involve isolated populations of plants or animals near the edge of their natural range and typically consist of small sites, such as acid seep springs, barrens, caves or karst areas, cliffs, or glades.

The Forest is not proposing any additional special areas at this time. However, the Hoosier may acquire some areas with uncommon or outstanding physical, biological, geological, or cultural characteristics, and the Forest would evaluate them for Special Area, RNA, or other designation. The Hoosier would manage any potential Special Areas as Management Area 9.2 until they were fully evaluated.

Alternatives and the Effects of Management on Research Natural Areas and Special Areas

All Alternatives

None of the alternatives propose changes to Management Areas 8.1 or 8.2. The primary management goal of these areas is the protection and maintenance of unique features. The only activities permissible are those specifically needed or fully compatible with this goal. The Forest may implement management activities such as prescribed burning and tree removal within special areas only if needed to maintain characteristics or restore the disturbed and altered sites to conditions typically present in the surrounding areas. Management Area 8.1 contributes to a nationwide network of areas set aside for scientific research. This designation prohibits most resource management activities unless they are compatible with RNA values as specified in the management plan for the area.

As part of an assessment of RNA representation for the Eastern Region and based on an ecological framework process, the authors determined that some of the Hoosier special areas were RNA equivalents (Tyrell *et al*., in press). This draft assessment evaluated both ecological units and the natural communities present on the Hoosier within established and proposed special areas. For portions of special areas to qualify as RNA equivalents, they must have protection at least equal to that of a RNA. The process involves the identification of natural communities (alliances) by community pattern and distribution. Each alliance receives vegetation quality and viability rankings on a scale from probably not viable to excellent quality, according to the best available data for the community. Every alliance receives three sub-ranks for size, condition, and landscape. To meet the requirement of a RNA equivalent, the area must have an overall ranking better than low quality (Tyrell *et al*., in press).

Since that time, the Forest has designated or incorporated all of these areas into 24 special areas. Approximately 2,267 acres in 12 different special areas would qualify as RNA equivalents based on information in the draft assessment. Because of the similar protection provided by inclusion within these designated special areas, none of the alternatives proposes any additional RNAs or candidate RNAs.

Nonnative invasive plants occur within or near all MA 8.2 areas. A primary management objective for special areas is to eliminate or control NNIS, including burning, hand-pulling, and mechanical control methods. Alternatives 1, 3, 4, and 5 allow herbicide use, but only after completion of an environmental analysis.

Recreational and other forest activities would only occur if these uses and actions were not in conflict with the area objectives.

Alternatives 1 and 5

These two alternatives retain the 24 special areas designated in the recent Forest Plan Amendment 5 (Special Areas).

Alternatives 2, 3, and 4

These alternatives designate approximately 5,700 additional acres in MA 9.2. This area is the land surrounding the Lost and Little Blue Rivers, currently designated as MA 2.4. The placement of these lands in MA 9.2 is to provide additional protection and future evaluation for their eligibility as Wild and Scenic Rivers.

Cumulative Effects (All Alternatives)

None of the alternatives propose changes to MA 8.1 and 8.2, which provide protection and maintenance of the unique features present within them. Along with the Pioneer Mothers Memorial Forest RNA and the 24 individual special areas that contain RNA equivalents are another 25 Indiana state nature preserves and 14 private nature preserves that all contribute to the preservation of natural communities in Indiana. These areas represent ecosystems across the Central States and are part of a national network of RNAs permanently protected to maintain biological diversity (Tyrell *et al.*, in press).

Besides the establishment of the Pioneer Mothers Memorial Forest RNA in 1944, the Hoosier has had a long history of managing for special areas and unusual ecosystems. Past activities designated 12 special areas and Amendment 5 established the current 24 areas.

No alternative establishes new special areas or RNAs; however, the Hoosier may designate them in the future. All of the alternatives retain Management Area 9.2, which serves as a holding category until further study and recommendations could place these areas under new management. These recent actions expand protection of unique areas on the Forest.

Maintain and Restore Watershed Health

This analysis addresses effects on soil productivity, water quality, and aquatic habitat and associated species. Effects can come from many sources, including fire (both wildfire and prescribed fire), riparian restoration activities, road construction and maintenance, stream crossings, and timber harvesting. The Forest goals for watershed health are to maintain and restore water quality and soil productivity and to improve the condition of watersheds, including those watersheds affected by past land use practices.

Numerous opportunities exist to maintain and improve watershed health through management activities.

Historical Context

Agriculture, logging practices, and development have affected Forest watersheds. Historically, there were extensive wetlands and rich riparian areas in much of Indiana. As the European descendants settled the state, they cleared and drained floodplains for farmland. Logging practices in the past have included skidding logs up stream channels and operating heavy equipment within streambeds. The placement of roads and the channelization of stream channels have changed water flow patterns. Farmers and others have drained wetlands for farmland and development. Riparian habitat structure and function have been altered as streams lost their floodplains and riparian vegetation was removed.

Watersheds

For this analysis, a watershed refers to a fifth-level hydrologic unit, which generally is hundreds to thousands of square miles in size. Hydrologic units are drainage areas defined by topographic criteria and the manner in which water flows in relation to a specific point on a river or stream.

In 2000 the Forest Service conducted an analysis of watershed integrity for Forest Plan analysis for the 20 fifth-level watersheds (Figure 3.24) that contain portions of the Forest. These 20 fifth-level watersheds range in size from approximately 9,000 acres to 132,000 acres. Table 3.39 displays the areas and percent ownership for each of the 20 fifth-level watersheds.

Figure 3.24

Fifth Level Watersheds Containing NFS Land

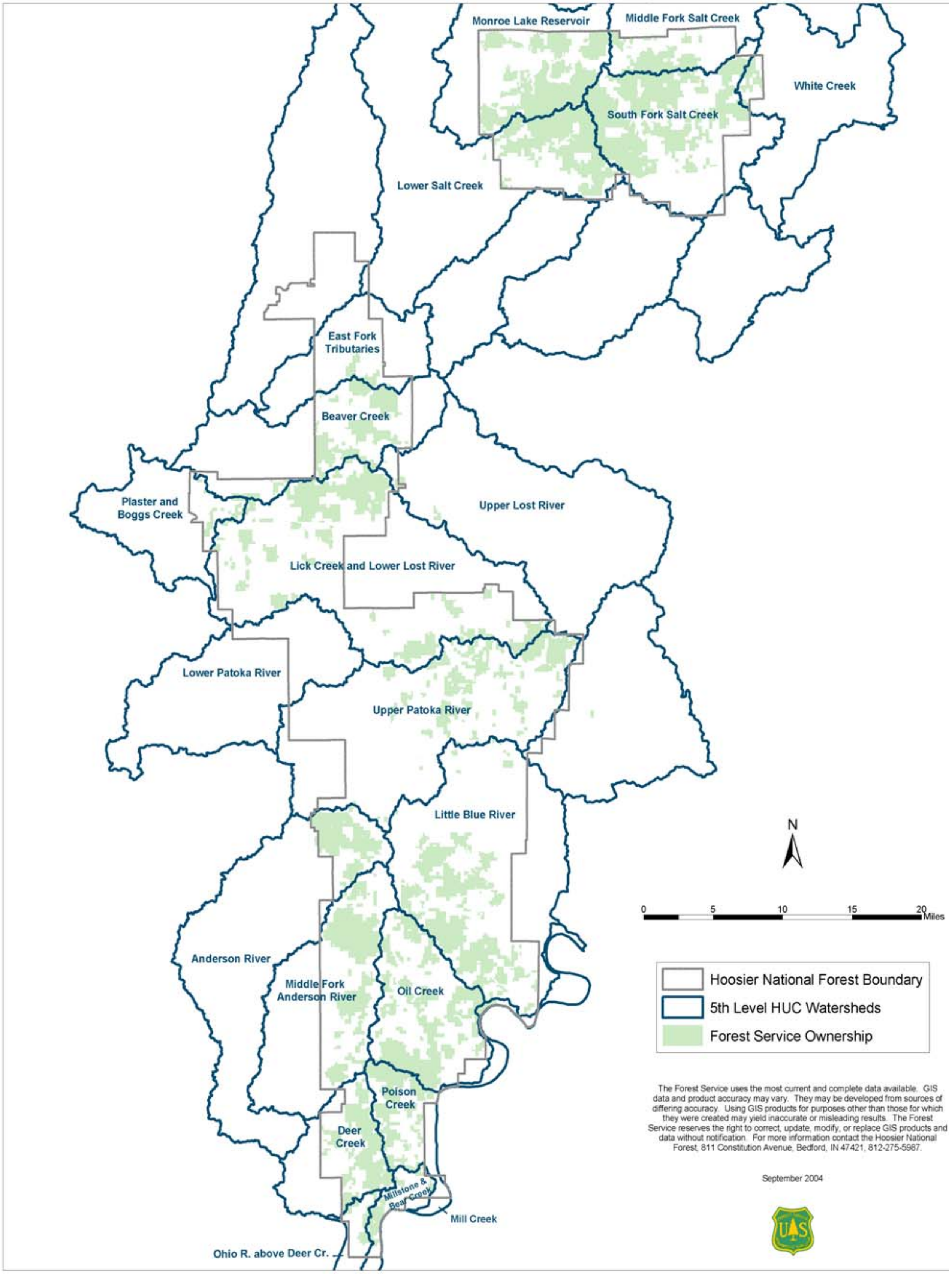


Table 3.39

FIFTH-LEVEL WATERSHEDS CONTAINING NFS LANDS

Watershed Name	Watershed Size (acres)	NFS Land as a Percent of Watershed
Lick Creek & Lower Lost River	131,642	16
Lower Salt Creek	131,318	12
Little Blue River	110,945	19
Upper Patoka River	108,112	14
Upper Lost River	104,587	1
Anderson River	98,029	8
Lower Patoka River	71,939	<1
Middle Fork Anderson River	68,032	20
South Fork Salt Creek	66,133	42
White Creek	64,134	9
Monroe Lake Reservoir	63,371	28
Beaver Creek	61,081	15
Middle Fork Salt Creek	47,175	9
Oil Creek	46,500	40
Plaster & Boggs Creeks	38,793	5
East Fork Tributaries	36,923	3
Deer Creek	32,589	29
Poison Creek	21,000	40
Millstone & Bear Creeks	9,106	14
Mill Creek & Tributaries	3,762	14

The Forest Service can most directly affect watershed health in watersheds with the highest percentage of NFS land ownership. Watersheds with low percentage of NFS lands provide opportunities for collaboration with other agencies and landowners in watershed management activities.

To better describe and understand watershed condition and sensitivity, cumulative effects, and the interaction of land use practices, the Forest Service conducted a watershed analysis on fifth-level Hydrologic Unit Codes (HUCs) within the Forest. The result of the analysis is in *An Analysis of Watershed Integrity for the Hoosier National Forest* (Ewing and Merchant 2000).

Restoration and aquatic habitat improvement activities

Wetlands and functioning riparian habitats are an important part of healthy watersheds. Restoration activities designed to improve the functions of wetland and riparian areas help to improve watershed health. Alternatives 1, 3, 4, and 5 would allow for these activities, but Alternative 2 would not.

Soil

At a landscape scale, landtype associations (LTAs) are ecological units that are delineated on ecological landtypes (ELTs); ecological landtype phases (ELTPs), bedrock type, dominant tree species, disturbance processes, landforms, and soil survey units. The LTA boundary

identification was based on physiographic boundaries such as stream channels or watershed boundaries (ridges). The Forest contains portions of 10 LTAs characterized in detail for their disturbance patterns, existing and potential vegetation, fauna, geology, historic vegetation, hydrology, soils, and other ecological attributes.

Weathered siltstone, fine-grained sandstone, shale, and limestone bedrock, as well as alluvium along streams, provide the parent materials for the soils in the Forest. Loess, wind-blown silt material, covers some of the material weathered from bedrock. The integrated effects of climate and living organisms (plants and animals) on these parent materials, as conditioned by slope and aspect through time, led to the existing soil resources of the Forest. Generally, Forest topography is moderately sloping to steep, with 12 to 60 percent slopes. Very steep slopes (greater than 60 percent) occur in most areas, but occupy less than 20 percent of the Forest. Elevation changes across the Forest can exceed 600 feet. Detailed ecological units were mapped at the landtype and landtype phase scales of the national hierarchy to provide information for project level analysis (Zhalnin 2004). The Hoosier Forest-wide soils database completed by the Natural Resources Conservation Service is used in conjunction with ecological map unit information for site-specific interpretations (USDA NRCS 2001a, IDNR 2000a).

The inherent productivity of the Forest’s soils evolved with disturbance. Droughts, erosion, fires, floods, and windstorms occurred at various spatial and temporal scales associated with climate and related plant community fluctuations. These natural disturbance regimes, along with human disturbance, have affected soil biological, chemical, and physical properties.

Past land use and management activities have had an effect on soil conditions. Some soil erosion has taken place on most of the soils that were cleared and cultivated prior to acquisition as NFS land. The amount of soil erosion depends on the intensity of the agricultural cultivation, pasturing, and grazing and the practices used at the time. There are frequent signs of erosion throughout the Forest. These almost entirely predate the Forest acquiring the land. The soil inventory process estimates the degree to which accelerated erosion has modified the soil. The Forest-wide digital soil layer displays this information.

Prior to and following acquisition as NFS land, the Forest Service and others planted some of the cultivated areas to pine or hardwood species to protect the soil and begin the soil restoration process. Other cultivated or pastured areas were allowed to revegetate through natural succession (USDA NRCS 2001a).

Historical activities, such as clearing and agricultural cultivation, intensive logging, and repeated fires, have impaired soil quality in some areas. Ground cover and organic matter have halted erosion and restored nutrient levels over the last 70 to 100 years. Vegetation on old roads and railroad beds has grown up, and areas of adversely compacted soil are not evident. In many cases, old roads are used in the existing transportation or trail system. Currently, no large areas in the Forest are identified as having land productivity permanently impaired due to historic activities.

Field monitoring of soil conditions shows several areas on the Forest where soil resource impacts from activities are beyond acceptable limits (USDA FS 2004a). When the Hoosier identifies site-specific areas as having soil resource impacts beyond acceptable limits, it corrects the adverse condition through maintenance or closure and restoration. Examples are road and stream crossings where erosion and sedimentation are occurring or trails and play areas where excessive use is causing soil degradation. Current conditions for key soil

properties affecting ecosystem health such as nutrient availability, organic matter content, and porosity are representative of the natural range of soil conditions inherent to the Forest. There are healthy populations of soil microorganisms such as bacteria and fungi in the forest litter and soil surface layers.

The Hoosier will apply Forest Plan direction for soil resource management as well as proven design features and other measures. The Forest uses current ecological unit information and soil inventory and interpretive information and monitors all treatment areas during project implementation. Resource specialists will monitor selected activity areas. The Forest will also apply improvements to design features, identified through monitoring and research studies, in future projects to maintain acceptable limits of change for measurable and observable soil properties.

Alternatives and the Effects of Management on Soils

This section presents effects of implementing Alternatives 1, 2, 3, 4 and 5 on soil resources. The consequences or effects discussed in this section provide a basis for understanding the implications and differences among alternatives.

All Alternatives

The alternatives propose various amounts of ground-disturbing activities that may change soil properties through compacting, eroding, displacing, removing nutrients, and rutting. The Forest would assess all proposed actions for site-specific effects to avoid long-term impairment of soil resources. National and Regional soil quality standards would be met.

National and Regional soil quality standards set acceptable limits of detrimental soil disturbance (USDA FS 2002a). Detrimental soil disturbance means the accepted limits of change for soil properties have been exceeded, which could result in major change in soil quality and productivity.

Effects to soil productivity and function include accelerated surface soil erosion, soil compaction, soil displacement, soil puddling, and soil rutting (USDA FS 2002a). Erosion too can affect soil productivity, since it carries away soil particles and those nutrients normally tied to the soil, such as phosphorous. Removal of topsoil affects the ability of the soil to recover productivity, since this layer has the most capacity to store nutrients readily available to nourish plants. By adhering to soil quality standards, the Forest would prevent or minimize long-term losses of soil productivity and function.

When erosion is controlled, soil productivity gradually increases.

Recreation Management Activities

Soil erosion and soil compaction occur wherever there is recreational use. Project design would include properly locating and designing trails, tread hardening, and incorporating water diversions.

No alternative would allow ATV cross-country use or areas of intensive use, or uncontrolled access to Forest system roads.

During closure or construction of trails, campgrounds, or dispersed use areas, the Forest would follow Forest Plan direction, Best Management Practices (BMPs) (IDNR 1998a), and design criteria to minimize impacts to the soil resource.

Pedestrian traffic at developed recreation sites which could result in soil compaction and vegetation loss. Trail maintenance and use result in bare mineral soil which would be subject to erosion and compaction. These impacts could be reduced by hardening of sites, barrier construction, temporary closure to allow natural regrowth, and sometimes rehabilitation, including site preparation and planting of native vegetation.

Road Management Activities

Road construction or reconstruction activities can directly affect the structure, drainage, and productivity of soil resources through earth-disturbing excavation and earth fill operations. These same road construction, reconstruction, and reuse activities can affect soil resources in a more indirect manner by exposing them to erosive effects of rainfall and runoff.

A roads analysis process identified specific roads for maintenance, reconstruction, closure, or decommissioning at project level planning (USDA FS 2001c). Project-level analysis would identify any needs for new road construction. All access activities would follow standards and guidelines, BMPs, and road design guidelines (USDA FS 2001c) to minimize soil impacts. Soil productivity would be restored over time after roads were decommissioned. Closing unsurfaced woods roads to public access would reduce the potential for soil erosion and rutting.

Bare roadbeds affect surface drainage. Normal percolation of rainfall does not occur on compacted road surfaces. Most precipitation falling on the bare roadway becomes surface runoff. This runoff typically follows the roadway for a distance before it reaches an absorbent forest floor. This movement of surface water can cause deposition of eroded material outside the roadway.

An estimated 80 to 90 percent of the roads needed for future management of the Hoosier follow the routes of old roads that evolved during nearly 100 years of occupation prior to acquisition by the Forest Service. As a result, some of these roads are poorly located and continue to erode at excessive rates. Often, relocation or reconstruction of these roads to more modern standards would significantly reduce the soil loss.

The most critical period for soil erosion is the time between initiation of earth-disturbing activities and establishment of stabilizing vegetation. Erosion that occurs during and following road construction, reconstruction, and reuse activities can usually be limited to acceptable levels by:

- properly locating and designing roads to incorporate adequate drainage and erosion control,
- completing all soil-disturbing activities in a timely manner,
- using water bars, hay bales, catch basins, or other erosion control structures,
- promptly seeding and mulching disturbed areas once earthwork is done, and
- temporarily seeding or mulching unfinished disturbed areas that must go through winter shutdown prior to completion.

Alternatives 1, 3, 4, and 5

Recreation Management Activities

The construction, reconstruction, and closure of roads, nonmotorized trails, horse trails, and campsites have potential to erode, displace, compact, and rut soil. The potential for access and recreation activities proposed in these alternatives to detrimentally affect the soil resource would be low when appropriate design features and site-specific protection measures are followed.

Alternative 3 proposes an ATV trail system. Project-level analysis for trail construction, relocation, and closure would follow Forest Plan direction and BMPs to minimize impacts to the soil resource. As stated above, impacts to soil resources can be mitigated through proper design and implementation, but the costs associated with applying these measures to ATV trails are prohibitive.

Timber Harvest Activities

Conducting timber harvests when the ground is frozen or dry greatly reduces the potential for erosion, as well as the potential for compaction or rutting. The Forest reduces the risk of erosion by limiting skid trails to slopes less than 35 percent. Tracked or low ground pressure equipment, or the use of cable logging systems, can reduce the effects of logs being transported over the ground. Timber sale layout, logging system, and skid trails will be designed to reduce the erosion potential. The impacts of erosion and sediment production can be reduced through careful layout and construction, caution in wet weather, and road closure (Reinhart *et al*. 1963, Hornbeck and Federer 1975, Kochenderfer and Aubertin 1975, Patric 1996, Stone *et al*. 1978).

Various practices during timber harvesting could reduce the erosion potential. Leaving woody debris on site following harvest operations is one such practice. The debris would protect the soil from splash erosion impacts and presents physical barriers to soil movement (Pritchett and Fisher 1987, Sharpe 2003). Harvest operations in a specific harvest unit are generally conducted in one season, and this would typically have fewer impacts on soils resources than operations that continue season after season. Proper implementation of Forest Plan direction would also limit impacts.

The increased rate of erosion may last for 1 to 3 years from project implementation and would depend on the time needed for revegetation to stabilize soil conditions. Although people tend to presume that even-aged management damages soil and water more than uneven-aged management systems, research demonstrates no such effects (Patric 1995). Cutting trees is not detrimental to soil and water resources. Removing the harvested trees is what causes the detrimental effects. Potential differences arise due to the density of skid trails, the number of landings, the length of access roads, and the mileage of roads and skid trails used. Because the access system is the major source of sediment in most forest streams, uneven-aged management (frequently cutting few trees in stands of all ages and sizes) has the potential to exacerbate damage from roads. To harvest and remove the same volume of wood, roads with uneven-aged management need to be of greater lengths and need to be used more often than would be needed with even-aged management. Although short lengths of roads are used more intensively in even-aged management, they are not used nearly so often (Patric 1995).

The potential for detrimental soil erosion and displacement from timber harvest activities is low for all proposed harvest areas across the Forest. The Hoosier would complete site-specific analysis prior to implementation of any harvest activities

The Hoosier complies with BMPs and FSH 2509.22. Harvesting equipment generally does not remove surface organic or mineral soil layers; thus soil displacement rarely occurs. Most harvest operations cut trees to a specific length (cut-to-length) before yarding them to the landing with a rubber-tired skidder. In cases where the whole tree is yarded to the landing, dragging the limbed treetops along the ground would cause some mixing of the organic and mineral soil materials, but this is not considered detrimental displacement.

Considerable research has been conducted nationally to evaluate the effects of timber management on water quality, water yield, and soil productivity.

Timber harvest activities have the potential to affect soil productivity roads, skid trails, and log landings decrease the area where vegetation would be growing. The Hoosier would revegetate these locations, either naturally or though provisions covered in Forest Plan direction. This new growth would provide surface cover to protect against soil erosion and sedimentation and allow the areas to be reused during a succeeding entry for timber removal. Regardless of the cutting method, adhering to Forest Plan direction would reduce negative impacts to soil and water.

Forest Openings

Soil compaction, rutting, and erosion are localized effects in forest openings. Tractors with brush cutting mowers have the potential to compact and rut soil. Restricting use to dry conditions reduces this potential. Mowing openings would not expose bare mineral soil, so soil erosion would not occur.

Augmenting soil productivity by adding lime, fertilizer, or organic matter would change soil chemistry as long as these additives persist in the soil. This effect is short term, as natural processes tie up or use nutrients and elements.

Planting new species on a site alters nutrient cycling and influences rates of soil development immediately. This effect would persist as long as these new plant communities dominate or remain in transition on a site. In natural forest openings, this new plant community would gradually begin to resemble original vegetation and would likely restore historic soil characteristics over time.

Controlling succession accelerates nutrient cycling for 1 to 3 years following treatment.

Pesticide Use

The forest floor is a major receptor of chemicals when pesticides are used. What happens to chemicals after entering the soil depends on the chemistry and on soil factors. High organic content, moisture, aeration, temperature, and clay content reduce chemical mobility in the soil.

At the rates that the Hoosier would apply chemicals, inherent soil properties would alleviate any adverse effects. Application would not occur when soils have moisture content above field capacity because of increased potential for runoff.

Wetland Restoration

Restoration of wetlands would occur on areas where hydric soils were already present, enhancing the natural cycling function of these soil types.

Prescribed Fire

The potential for a wildfire or prescribed fire to severely damage the soil resource is low. High-intensity fire would have potential to adversely affect soil properties and result in reduced soil

productivity and erosion. The potential is low for a large catastrophic wildfire event on the Hoosier.

Because low intensity burns would not completely incinerate surface organic material (USDA FS 2004a), the potential for increased erosion and alterations in nutrient cycling and soil properties would be minimal. In fact, the fire intensity of these prescribed burns would likely be less than a typical wildfire on the Forest, which was found to have little influence on local water quality (Moss 1995).

The Forest would implement low to moderate intensity prescribed burning only when the litter layer is moist. Forest fire intensity and duration determine the effects on the physical, chemical, and biological properties of soil. Prescribed fire on the Forest would be low intensity with no large areas of heavy fuel buildup. The fire would burn a portion of the understory vegetation and forest floor. Prescribed fires seldom remove more than 50 percent of the surface organic layers, and the soil fraction of the A horizon is generally not affected by light burns (Pritchett and Fisher 1987, p. 403). Potential for soil surface erosion is low when the organic layer remains in place. A two-foot wide line to bare mineral soil may be needed to keep fire from spreading outside of burn areas. This exposed soil would be re-seeded following implementation. Pritchett and Fisher (1987, p 403-416) list the following potential effects to the soil resource from prescribed burning:

- an increase in available phosphorous, potassium, calcium, and magnesium in the mineral soil for 1 to 5 years,
- some nitrogen loss through volatilization (minor amounts),
- temporary increase in nitrogen availability to trees,
- temporary increase in tree growth due to availability of nutrients,
- minimal increase in soil temperature during the burn due to moist, insulating humus layer,
- minimal increase in soil temperature after the burn because the canopy shades the darkened ground surface,
- initial decrease in soil microbes and bacteria followed by sharp increases as soon as the first rainfall following the burn,
- more numerous soil animals such as arthropods, and
- decreased earthworm populations due to initial post-burn adverse moisture conditions and reduced food supply.

Cumulative Effects for Alternatives 1, 3, 4, and 5

Cumulative effects on soil resources are similar in Alternatives 1, 3, 4, and 5. Some of the proposed actions would occur over acres that have previously had similar treatments. The Hoosier would use existing roads, landings, and skid trails to minimize new ground disturbance. Alternatives 1 and 5 would have the potential to affect the most acres of soil over time. However, Alternatives 1, 3, 4, and 5 are all relatively similar in the types of activities proposed and similar in effects to Alternative 2. No appreciable detrimental soil disturbance would be expected from the activities in these alternatives.

Monitoring indicates adherence to Forest Plan direction, site-specific design features, and contract provisions would eliminate or minimize potential adverse impacts from erosion, displacement, compaction, rutting, burning, or nutrient removal (USDA FS 2004a).

Alternative 2

Soil productivity would gradually increase in areas where no management practices take place.

Soil erosion and soil compaction occur wherever there is heavy recreational use. Erosion control measures include properly locating and designing trails and incorporating water breaks.

Soil erosion and soil compaction would continue to occur on existing unpaved roads and vehicle and equipment access routes under Forest Service administration. Forest Plan direction includes the Hoosier National Forest Road Design Guidelines (Forest Plan, Appendix H) (USDA FS 2001c).

Cumulative Effects

Implementing Alternative 2, when added to the effects of past, present, and reasonably foreseeable actions, would not result in adverse cumulative effects to the quality of the soil resource or total forest ecosystem carbon storage capacity.

Water Quality

The Shawnee-Hoosier Ecological Assessment identified the following as the main factors affecting water quality in this area: contaminants, discharges, nutrient pollution, and wastewater. Nutrients and contaminants accounted for more than 50 percent of the water quality problems. Siltation, habitat alteration, and pathogens accounted for 35 percent of the water quality problems (Whiles and Garvey 2004).

The percentage of soils with high erodibility was calculated for each 5th level watershed using the USDA-NRCS State Soil and Geographic Database as part of the analysis of watershed integrity for the Forest (Ewing and Merchant 2000). Ewing and Merchant (2000) present more information about watersheds and water quality. Watersheds having a higher percentage of soils rated as highly erodible have a higher potential for erosion and sedimentation.

Ewing and Merchant (2000) display watershed integrity rankings for each watershed, a sum of the adjusted rankings of overall condition and vulnerability to change (positive or negative) as the result of management activities. Condition parameters reflect natural and human factors that have the potential to affect watershed health. The condition and vulnerability parameters used to characterize overall watershed integrity can be directly or indirectly related to water quality. Watersheds were ranked from 1 (low) to 20 (high) for both overall watershed condition and watershed integrity ranking. Oil Creek watershed, which has one of the highest percentages of NFS ownership (40 percent), had the highest overall watershed condition and watershed integrity ranking (20). Lower Salt Creek and Lower Patoka River watersheds, with less than 1 percent and 12 percent NFS ownership, respectively, had two of the lowest overall watershed condition and watershed integrity rankings.

Waters designated as 303(d) are impaired waters as defined by the Environmental Protection Agency. The presence of 303(d) listed waters can be an indication of water quality within watersheds. Ewing and Merchant 2000 show the percentage of 303(d) listed waters per watershed. Non-point source pollution, such as sedimentation from forest management activities, is not identified as the cause for impairment in any of the 303(d) listed waters on or adjacent to the Forest.

Monroe Lake Reservoir and Upper Patoka Reservoir watersheds had the highest percentage of impaired waters. Both of the lakes have fish consumption advisories for mercury. Ewing and Merchant (2000) listed additional stream segments as having mercury advisories, and Lower Salt Creek watershed, Lower Patoka River watershed, and a large section of the East Fork of the White River watershed had fish consumption advisories for both mercury and PCBs.

Water quality parameters of concern in these watersheds include E. coli, total dissolved solids, dissolved oxygen, chlorides, algae, taste and odor, and impaired biotic communities.

Ewing and Merchant's (2000) watershed integrity rankings are a sum of the adjusted rankings of overall condition and vulnerability. One way to view the maintenance of watersheds and water quality is to compare these rankings with the percentage of the watershed in NFS ownership (Table 3.40).

Table 3.40

WATERSHED INTEGRITY RANKINGS AND NFS OWNERSHIP

Watershed Name	Watershed Integrity Ranking	Percent of NFS Ownership
Lower Patoka River	1 (lowest integrity)	<1
Upper Lost River	2	1
Lower Salt Creek	3	12
Upper Patoka River[1]	4	14
Monroe Lake Reservoir	4	28
White Creek	6	9
Beaver Creek	7	15
Middle Fork Anderson River	8	20
East Fork Tributaries	9	3
Plaster and Boggs Creek	10	5
Anderson River	11	8
Lick Creek and Lower Lost River	12	16
Millstone and Bear Creek	13	14
Deer Creek	14	29
Poison Creek	15	40
Mill Creek and Tributaries	16	14
Little Blue River	17	19
South Fork Salt Creek	19	42
Oil Creek	20 (highest integrity)	40

[1] Upper Patoka River and Monroe Lake Reservoir have the same watershed integrity ranking.

The higher the percentage of NFS lands in a watershed, the larger the role that the Forest can play in maintaining or improving watershed integrity.

Chapter 3 of the Forest Plan contains direction relevant to water quality, riparian habitats, and aquatic species. Resource management activities that may have an effect on water quality must follow *Logging and Forestry BMPs for Water Quality in Indiana*. Forest Plan direction may exceed Indiana BMPs, and the Hoosier's own standards shall take precedence when they more effectively protect or improve water quality. The FEIS discloses effects on water quality, riparian habitat, and fisheries habitat. The biological evaluation for the Forest Plan presents effects on specific aquatic species.

Alternatives and the Effects of Management on Water Quality

This section presents expectations or predictions under alternative ways of managing water resources on the Forest. The consequences, or effects, discussed in this section provide a basis for understanding the implications and differences among alternatives.

Conducting resource management activities without proper management direction can often result in adverse effects to the resource. All activities are expected to result in minimal effect to the resource if Forest Plan direction and Best Management practices are followed. Indicators for Issue One: Watershed Health (Chapter 1) for potential effects of the alternatives are:

- Suitable acres for management, (Table 3.36)
- Road construction and reconstruction (Table 3.12)
- Vegetation treatments (Table 3.3)

All Alternatives

Road Management Activities

Road construction exposes mineral soil. Soil particles unprotected by leaf litter and vegetation could be readily detached by rain and transported to water channels. The type of material used to surface a road would affect long-term production of sediment. Roads paved with asphalt produce little sediment. In contrast, roads surfaced with crushed, native stone often produce sediment as the running surface breaks down from vehicular use and natural erosion processes.

The use and management of roads would affect sediment production in several ways. For example, surfacing material breaks down faster when roads carry heavy truck traffic rather than passenger vehicles or light trucks. Unvegetated roads that are open year round generally produce more sediment than vegetated roads that are closed for part of the year. Roads that are used for a season, then stabilized and revegetated, produce little long-term sediment. Sediment production and its impacts can be reduced to an acceptable amount with careful layout and construction, caution in wet weather, and road closure (Reinhart *et al.* 1963).

Roads also effect surface drainage. Normal percolation of rainfall does not occur on compacted road surfaces. Most precipitation falling on a bare roadway would become surface runoff. This runoff would normally follow the roadway for a distance before it once again reaches an absorbent forest floor. Higher road densities have greater potential for effects on hydrology and water quality due to sedimentation.

Application of Forest Plan guidance and BMP's are expected to result in minimal increases in erosion and sedimentation.

Recreation Management Activities

Trails for bicycling, walking, or horseback riding may erode at rates similar to roads, especially if compacted (Leung and Marion 1996). However, the total sediment load is usually lower than the sediment load for a road because the total surface area is less than that of a road. Research shows that sediment yield from trails is much higher when trails are used by horses than when used by hikers (Cole 2000). Runoff from trails can add sediment to streams, especially at stream crossings.

Detrimental effects of concentrated recreation are likely to be seasonal. The effects of a campground on water quality depend on soil conditions, the presence of vegetation, and existing infrastructure. In concentrated camping areas, soil may become compacted and more erodible. Such increased erosion may result in increased stream turbidity and sedimentation. The proximity of campgrounds and picnic areas to water increases the chance of streambank erosion and destabilization (Ibarra 2000).

Forest Plan guidance and project design for recreation management activities would minimize impacts and decrease sedimentation.

Stream Crossings

Stream crossings may result in impacts to watersheds. Generally, the greater the number of stream crossings per watershed, the greater the effect. Table 3.41 shows the number of stream crossings per fifth-level watershed. The Hoosier has direct control of only the stream crossings of trails and NFS roads on NFS lands.

Table 3.41

NUMBER OF ROAD AND TRAIL CROSSINGS PER WATERSHED

Watershed Name	Total Stream Crossings	Stream Crossings on NFS lands
Anderson River	68	41
Beaver Creek	55	20
Deer Creek	90	48
East Fork Tributaries	6	0
Lick Creek & Lower Lost River	193	66
Little Blue River	191	65
Lower Patoka River	12	0
Lower Salt Creek	61	39
Middle Fork Anderson River	118	62
Middle Fork Salt Creek	29	7
Mill Creek & Tributaries	0	0
Millstone & Bear Creeks	28	9
Monroe Lake Reservoir	59	48
Oil Creek	93	45
Plaster & Boggs Creeks	11	2
Poison Creek	38	20
South Fork Salt Creek	162	83
Upper Lost River	2	1
Upper Patoka River	152	39
White Creek	6	3

Alternatives 1, 3, 4, and 5

Table 3.42 shows how the road mileage varies by alternative. Alternatives 1, 3, 4, and 5 would have greater potential effects on hydrology and water quality due to the larger total road

mileage. Alternative 4 has the greatest road mileage overall followed by Alternatives 1, 3, and 5, respectively.

Table 3.42

MILES OF ROAD BY TYPE

Road Type	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Existing All-weather	47	47	47	47	47
Existing Dry-Weather	436	436	436	436	436
Projected All-Weather	5	3	5	8	5
Project Dry-weather	146	6	146	204	146
Total Miles of Road at End of 10 Years (mostly closed)	654	512	654	715	654

All-weather roads are generally roads that are open for public access, at least a part of the year. Dry-weather roads are generally closed to public access.

Vegetative Management Activities

Considerable research has been conducted to evaluate the effects of timber management on water quality. Timber harvesting activities without mitigation such as road construction, skid trail construction, and log landings have potential to cause sedimentation and nutrient loss, thereby affecting water quality. The impacts to water quality from harvest activities would vary depending on the area treated, volumes harvested, method of harvest, frequency of entry, and site-specific conditions. Table 3.3 displays activities by alternative. Forest Plan guidance has been designed to result in no appreciable impacts to water resources.

Mechanical scarification for planting or the building of control lines for burning would disturb the leaf litter layer and expose mineral soil. This type of disturbance allows raindrops to detach soil particles from exposed soil causing erosion, transportation, and deposition of sediments. Avoiding steep slopes and establishing riparian corrridors along streams and drainage ways per Forest Plan direction would minimize these effects.

According to Patric (1978), neither productivity of forest soil nor water quality is substantially negatively affected during or after well-managed harvests. Researchers at the Hubbard Brook Experimental Forest, Northeastern Research Station and at Coweeta Hydrologic Laboratory, Southeastern Research Station have studied effects on nutrient concentrations, sediment, and water yield after timber harvests (Martin *et al.* 2000, Douglass and Swank 1975). The studies at the Hubbard Brook Experimental Forest were designed to compare two reference (untreated) watersheds to two harvested watersheds. One harvested watershed was stripcut, and the other harvested watershed was clearcut. The Hubbard Brook Experimental Forest compiled data on this long-term research from 1970 to 1998, and in addition, 40 years of watershed research at the Coweeta Hydrologic Laboratory analyzed effects of timber harvests on water yield, sediment yield, and nutrients (Martin *et al.* 2000, Douglass and Swank 1975).

<u>Water yield</u>

In the stripcut watershed of the Hubbard Brook Experimental Forest, for 2 to 4 years during and 5 to 7 years following the stripcuts, there were 4 to 9 percent increases in annual water yield. As trees grew back, water yield decreased 3 to 9 percent below the levels of the uncut reference watershed. In the clearcut watershed, water yield increased 23 percent the first year

following the clearcut. There were also increases of five to eight percent during year 7, 8, and 13 following the clearcut. Fourteen years of tree regeneration did not show significant decreases in water yield from the clearcut watershed (Martin *et al.* 2000).

Changes in water yield and storm peaks due to harvest may be appreciable in small headwater streams, but such changes become less measurable as streams join rivers and larger streams. Culverts within and downstream of harvest areas should be designed to accommodate increased flows for several years following a harvest operation (Martin *et al.* 2000).

According to Coweeta Hydrologic Laboratory research, cutting mixed hardwood forest in the southern Appalachians increases annual streamflow in proportion to the amount of forest removed. Additionally, streamflow tends to increase more on north-facing slopes and in areas where grass cover has replaced hardwoods (Douglass and Swank 1975).

Clearcutting may also increase streamflow from the harvest area due to surplus water that the vegetation would have used in the process of evapotranspiration. Reduced evapotranspiration increases soil water content and prolongs streamflow (Lawson and Settergren 1989). Clearcutting produces the maximum increases in streamflow, with less increase associated with selection cutting and shelterwood cuts. As vegetation regrows, streamflow recovers in relation to how fast the vegetation recovers, typically within 10 years following harvest (Swank *et al.* 1989).

<u>Sediment yield</u>
A clearcut harvest of the Hubbard Brook Experimental Forest resulted in 70 percent disturbance to the clearcut watershed, and the stripcut harvest resulted in 67 percent disturbance to the stripcut watershed. These cuts represent highly disturbed sites, much more disturbance than could be done by following Forest Plan direction. Significant increases in sediment occurred in the first 3 years and in year 12 after harvest (Martin *et al.* 2000).

Roads and skid trails are the primary sources of sediment associated with timber harvest. Sediment yields from harvesting are site and watershed specific, and effects can be minimized if Forest-wide guidance and BMPs are applied effectively (Swank *et al.* 1989). Research has shown that where timber harvesting employs timber harvesting properly (IDNR 1998a), significantly less erosion and sedimentation occur (Swiff 1986, Lynch *et al*. 1985, Kochenderfer and Helvey 1987), especially when protected buffer strips are established along perennial and intermittent streams.

<u>Nutrients</u>
Water concentrations of Ca^{2+} (calcium), K^{+} (potassium), and NO_3^{-} (nitrate) increased (and concentrations of SO_4^{2-} (sulphate) decreased) in the stripcut and clearcut watersheds of the Hubbard Brook Experimental Forest. In the stripcut watershed, elevated concentrations of calcium returned to pre-harvest levels during the fifth through tenth years from the start of harvesting. Potassium levels remained elevated over the 30-year period. Nitrate concentrations increased, then dropped below the level of the reference watershed 6 years after harvest and remained at this concentration through year 15. Sulphate concentrations decreased for 4 years after harvest and then returned to pre-harvest levels (Martin *et al*. 2000).

Calcium concentrations remained elevated in the clearcut watershed compared to the reference watershed. Potassium levels remained elevated throughout the 30 years. Nitrate levels increased to 30 times as high as in the reference watershed. By the sixth year after harvest, the nitrate level decreased to below the reference watershed level and remained there at least

through the fourteenth year after harvest. Sulphate concentrations were lower for 4 years after harvest and then returned to pre-harvest levels (Martin *et al*. 2000).

Harvesting interrupts the natural cycles of nutrients, and the greatest effects are associated with clearcutting. According to Swank *et al.* (1989), nutrient runoff to streams is usually short-term and rarely affects water quality downstream. Rapid revegetation and forest regeneration and effective application of BMP's are important in minimizing nutrient losses from watersheds (Martin *et al.* 2000).

Fire Management

The major effect of fire suppression on water quality could result from the construction of firelines, with subsequent erosion and the possibility of sediment entering streams. Water quality impacts from hand-raked firebreaks would be minimal. Quick revegetation of disturbed areas in and near riparian corridors would minimize these effects. Current direction to use riparian corridors as natural fire breaks would decrease these effects. Areas with higher fuel loads could result in more intense wildfires. More intense wildfires could burn more of the organic matter and vegetation on the forest floor, which could result in runoff and sedimentation. Prescribed burns can help prevent such intense wildfires by reducing the fuel loads.

There is a slight possibility of fuel spillage and a chance that petroleum products could be washed into streams. Careful location of refueling operations should minimize or eliminate these effects.

The effects of fire vary greatly and depend on the quality and quantity of fuels, soil properties, topography, climate, weather, fire frequency, and fire intensity. Richter and Ralston (1982) found that prescribed fire can consume less than one-third of the forest floor mass. Ash and particulates from the fire were filtered by leaf litter, soil layers, and buffer strips before they reached stream channels. At this level of consumption of the forest floor and with the filtering ability of the forest floor intact, prescribed fire showed no significant effect on the water chemistry (Richter and Ralston 1982). Low-severity burns that do not entirely consume the organic matter comprising the forest floor (like those conducted on the Hoosier) may have little or no effect on the hydrologic output of a watershed.

Sedimentation in stream channels can occur due to runoff from fire lines, and it may also occur in steep terrain and in areas where vegetation is consumed. Hot burns should be avoided through fuels management or by conducting burns at a time when sufficient fuel and soil moisture is present to prevent total consumption of surface organic matter. Functional water bars on abandoned roads, skid trails, and fire trails are also important for minimizing accelerated soil delivery to stream systems (Beschta 1990).

Developing Impoundments

Constructing an impoundment captures free-flowing water from floodplain areas within constructed levees and a dam. Such impoundments may reduce impacts of flood waters, depending on watershed size and flow patterns in stream channels. Impoundments can remove excess sediment and nutrients within watersheds by capturing sediment and nutrients during flood events. This could have an effect on water quality by reducing downstream amounts of sediment and nutrients. Design and operation of dam outlets can determine downstream flow patterns, water temperatures, and sediment loads, depending on amounts of surrounding vegetation and stream channel conditions downstream of the dam. Impoundments can obstruct natural flow and affect natural wetlands and streams if not constructed properly. Development of wetlands, small lakes, and ponds increases the riparian habitat on the Forest. Some existing

riparian values and habitat may be altered on the Forest as other riparian habitats are developed.

Openings Maintenance

Tools used in forest opening maintenance on the Hoosier include mowing, cutting, prescribed burning, pesticides, liming, fertilizing, mulching, root raking, and disking. Liming could affect the pH of the runoff water, and fertilizer could add nutrients (nitrogen or phosphorus). Herbicides could potentially have a negative effect on water quality, depending on the amount of such contaminants already in the water. If an aquatic species came in contact with a pesticide, it could negatively affect the individual. Pesticides will be selected to minimize unwanted effects on the aquatic resource.

Cumulative Effects

If the prescribed burning of small watersheds where individual burns are separated in time and space is not causing important hydrologic or water quality impacts on the site or immediately downstream, the potential for significant cumulative effects farther downstream has probably been minimized. Effects of silvicultural management, prescribed burning, openings maintenance, and impoundment construction on water quality depend on past and present activities within the watershed such as: road construction, wetland loss, timber harvest operations within stream channels, runoff from agricultural fields and residential areas, and stream channelization. No negative impacts are expected to result on NFS lands if Forest Plan direction, BMPs, and project specific measures are applied as needed. Fire and silvicultural management could improve riparian vegetation and have positive effects on water quality.

Alternative 2

Since Alternative 2 would include no prescribed burning, openings maintenance, pesticide use, or vegetation management, there would generally be less opportunity for sediment to enter a stream course, for nutrients to be leached away, or for petroleum to enter water systems. The exception would be wildfire control, which because of the increased fuel loads with this alternative and the emergency nature of suppression activities could result in more potential for sediment and petroleum to enter water systems.

This alternative would allow for a continual buildup of fuels in the forest. These fuels would have the potential of contributing to a wildfire, the type of fire that could lead to deposition of ash and sediment into waterways.

Cumulative Effects

Over time, the forest could have a higher fuel loading, which could increase the intensity of a large fire if one were to occur. Alternative 2 would not include management activities within riparian communities. Since such restoration activities would not be implemented, this alternative would forego the opportunity to improve or enhance the ability of these riparian vegetative communities to maintain water quality and function and thus aid in preventing further impacts to water quality.

Inaction on the Forest combined with inaction or development on private lands could lead to a patchwork of relatively dense forest with increasing fuel loads, areas that have been burned, areas (on private land) that have been partially harvested, and urbanized areas. Under dry conditions, this mixture could be potentially dangerous.

Aquatic Habitat

Specific aquatic habitats found in the watersheds include streams, groundwater, lakes and ponds, wetlands, and riparian areas. Geology, hydrology, land types, and soils are important factors in determining how aquatic habitats function in their watersheds (Maxwell *et al.* 1995). Effects on water resources and aquatic habitats occur at different spatial scales. Some effects occur at the watershed level; some effects occur at the habitat scale (stream reach, for example) and some at the level of a specific habitat component, such as a pool in a stream. Effects that occur at the aquatic habitat include effects from roads, vegetative management, and fire. Table 3.43 displays amounts of various aquatic habitats present on the Forest and some of the numbers used in the analysis of watershed affects. Table 3.43 includes the number of stream crossings per fifth-level watershed.

Table 3.43

AQUATIC HABITAT TYPES

Item	Units	Amount
Estimated length of streams within Forest boundary	Miles	2,150
Estimated length of streams on NFS lands	Miles	660
Estimated stream crossings within Forest boundary	Number	1,374
Estimated streamcrossings on NFS lands	Number	598
Estimated lakes and ponds within Forest boundary	Acres	16,670
Estimated lakes and ponds on NFS lands	Acres	880

Streams

Stream and river channels are dynamic and migrate within historic flood plains, eroding the bed and banks in one place while depositing sediments on the bed and building new banks in others. Streams transport and deposit large pieces of woody debris and fine organic matter, which provide physical structure and diverse aquatic habitat to the channel (IMST 1999).

Stream biodiversity and ecosystem health are highest when habitat variety is high. The components of habitat variety include a variety of substrates of various sizes (such as sand, gravel, cobble, and boulder), shapes of stream channels (morphology), and flow dynamics within those channels (Allan 1995). Large woody debris is also important to aquatic habitat as it functions as substrate for aquatic species, and inputs of decaying wood are crucial to most aspects of stream processes such as channel morphology, hydrology, and nutrient cycling (Rose *et al.* 2001). Woody debris shapes stream channels by damming them, which creates ponds that trap sediments, or by obstructing channels, which redirects waterflow creating meanders and pools (Maser and Trappe 1984).

Some streams have been channelized to promote drainage in agricultural areas. This practice often degrades in-stream habitat and channel features due to resulting sedimentation. Stream crossings and removal of wetlands or riparian forest communities can cause stream habitat fragmentation. Stream management that focuses on both water quality and in-stream habitat can maintain stream ecosystem function and aquatic species diversity. Recruitment of large woody debris and maintenance of stream temperature can help in maintaining healthy stream habitats and important riparian functions.

Lakes and Ponds

There are no natural lakes or ponds on the Forest. Forest lakes and ponds were constructed for flood control, recreation, water supplies, and wildlife habitat. Lakes and ponds impound an estimated 16,670 acres on the Forest. Waterholes account for approximately 150 acres. Almost all of them are less than 0.5 acre in size.

The aquatic habitats of the Hoosier support a large diversity of aquatic species. The State manages specific warmwater fish populations in selected Forest lakes and ponds for recreational fishing. Recreational use can affect populations, depending on accessibility and popularity of the lakes and ponds.

Aquatic plants documented in Hoosier lakes and ponds include watershield (*Brasenia schreberi*), stonewort (*Chara spp.*), American elodea (*Elodea canadensis*), quillwort (*Isoetes spp.*), water willow (*Justicia americana*), naid species (*Najas guadalupensis* and *Najas minor*), American lotus (*Nelumbo lutea*), American pondweed (*Potamogeton americanus*), curlyleaf pondweed (*Potamogeton crispus*), and cattail (*Typha latifolia*). These are mostly native species. Eurasian milfoil (*Myriophyllum spicatum*) has also been documented on the Forest.

In 2003, Forest personnel inventoried selected and non-selected waters to determine the percentage covered with aquatic vegetation. Of the 20 selected waters that were inventoried, 75 percent were 50 to 90 percent covered by aquatic vegetation. Of the 11 non-selected waters that were inventoried, 73 percent of these ponds were 70 to 90 percent covered by aquatic vegetation. Forest Plan direction notes that the desired condition for fisheries purposes is 20 to 30 percent coverage with aquatic vegetation.

Excessive or invasive aquatic vegetation could alter pond and lake ecosystems, resulting in habitat degradation, changes in water quality, and changes in aquatic species populations. Invasive aquatic plant species could establish monoculture stands and adversely affect native species. At high levels of vegetation, it would be difficult for fish predators to forage because of a lack of visibility. This could result in slower fish growth, smaller fish, and a reduced quality of a sport fishery. Fish species diversity usually does not change in a lake when the amount of aquatic vegetation changes, but the relative abundance of specific species can change.

The Hoosier would use integrated pest management to control aquatic vegetation problems on selected waters throughout the Forest. The Forest would use 20 to 40 percent aquatic vegetation cover as the target for selected waters. The Forest would apply manual control, biological control, and pesticides as appropriate to achieve this balance. The Forest would apply these methods in a manner that would maintain water quality, avoid spread of nonnative aquatic invasive species, and prevent adverse effects to sensitive species. Using this integrated pest management approach would result in improved lake and pond habitats and improved recreational opportunities.

Riparian Areas and Wetlands

Approximately 23,000 acres on the Forest either support or have the potential to support, riparian ecosystems. Extensive wetlands and rich riparian areas once existed throughout Indiana. Historical accounts tell of wide bottoms along rivers and streams where wetlands and swamps teemed with wildlife. As Europeans settled southern Indiana, they cleared and drained floodplains adjacent to rivers and streams and converted them to agricultural farmland. Bottomlands are a priority for acquisition on the Hoosier. Riparian restoration reduces floods, improves water quality, stores floodwaters, improves the aquatic ecosystem, and provides habitat for a variety of wildlife species including amphibians and migratory waterfowl, as well as

numerous wading birds. All of this contributes to watershed health. Riparian area restoration results in more diverse bottomland hardwood forests and associated shallow water wetlands.

Riparian areas are the land and water areas associated with lakes, reservoirs, estuaries, potholes, springs, bogs, fens, wet meadows, and intermittent or perennial streams (see diagram in Appendix J in Forest Plan), and they are characterized by water tables at or near the soil surface and by vegetation requiring high water tables. Riparian areas are important sources of diversity in extensive upland ecosystems. Abundant water, forage, and habitat attract more use to riparian areas than their small area would indicate. They are of prime importance to water quality, water quantity, and streambank stability and support a greater concentration of species than any other ecosystem on the landscape (Verry 2000). Two general categories of riparian areas exist on the Forest:

- land influenced by impounded water (lakes, ponds, marshes, and waterholes)
- perennial, intermittent, and some ephemeral streams

Aquatic Species

Commercial fishing occurs in the Ohio River, along the southern boundary of the Forest. In the early part of the 1900's, mussels were commercially harvested for the pearl button industry. At least eight species were harvested along the Ohio River: ebonyshell (*Fusconaia ebena*), mapleleaf (*Quadrula quadrula*), monkeyface (*Quadrula metanevra*), mucket (*Actinonaias ligamentina*), Ohio pigtoe (*Pleurobema cordatum*), pimpleback (*Quadrula pustulosa*), Wabash pigtoe (*Fusconaia flava*), and wartyback (*Quadrula nodulata*) (Williams and Schuster 1989). In 1967, the Indiana Department of Natural Resources restricted mussel harvesting to measures such as hand picking, short forks, and tongs (Cummings *et al.* 1988). Since 1991, regulations have banned collecting or taking live or dead mussel shells from public waters.

Indiana has high to moderately high fish and mussel diversity and is in the top eight states east of the Mississippi River for fish and mussel diversity (Warren and Burr 1994). The Ohio River is a major dispersal corridor for aquatic species. Several areas of the Forest support rare aquatic species.

The Shawnee-Hoosier Ecological Assessment reports documentation of 48 mussel species in the Forest (Thompson, ed. 2004). Many of these species are wide ranging, while others are restricted to specific stream types. Most mussel species depend on specific fish hosts for their reproduction, which involves transferring a parasitic larva (glochidia) to this fish host. Distribution of mussel species that depend on fish hosts depends on the presence of these host fish. Host fish serve as a means of dispersal for mussel species.

Indiana crayfish include cave-dwelling species, non-burrowing species, and burrowing species. Cave dwelling species spend their entire lives in caves. Non-burrowing crayfish spend their lives in surface waters. Burrowing crayfish spend some of their time in surface water and part of their time in burrows. They sometimes leave their burrows for the purposes of mating and during times of flooding (Simon 2001). At least 19 crayfish species exist in Indiana, with the possibility of further species pending descriptions or verifications of survey data.

Alternatives and the Effects of Management on Aquatic Habitat

All Alternatives

Excess sediment in streams may reduce fish population size, result in loss of fish species, and cause long-term damage to fish habitat (Burkhead 2001, Karr *et al*. 1985, Gammon 1990, Zweig 2001, Newcombe 1996). Excess sediment may cause direct mortality, have effects on reproductive success, and negatively affect aquatic invertebrate populations that serve as important sources of fish food. Effects of sedimentation vary, depending on the life stage of the fish species and the tolerance of the species to sediment (Waters 1995).

Sedimentation can affect reproductive success in species that require a stony substrate or interstitial spaces free of silt to breed. Sedimentation can shift the time of spawning, and eggs and larval stages of fish are often more sensitive to sediment than adults. Sedimentation can affect habitat by reducing rocky cover and interstitial spaces for winter protection and by filling in pools and reducing their depths (Waters 1995).

Sediment is a natural part of aquatic systems, but it becomes an issue when the sediment load of the stream exceeds the ability of the ecosystem to process that sediment (Kohler and Soluk 1997). Different species of fish have different tolerances to sediment and pollution, and there may be shifts to more tolerant species in a fish community, depending on the stressors introduced to the system (Sweeten and McCreedy 2002).

Stream invertebrates live at the stream bottom, so effects to the streambed would affect aquatic invertebrate habitat. Normal stream conditions have one-third or less embeddedness, which refers to the portion of the substrates on the stream bottom covered by silt or sediment. Above this amount, habitat in the streambed could be reduced and aquatic invertebrate species diversity could decline (Lenat *et al.* 1979). With small amounts of sediment, population sizes of aquatic invertebrates may decrease due to loss of interstitial habitat, but species richness may not change.

With greater amounts of sediments, where there would be a shift in substrate size and type from more cobble and gravel dominant substrates to a dominance of fine sediments, the population numbers and species present may both change. There could be an increase in populations of aquatic worms and fly larva, which are burrowers, and a decrease in mayflies, stoneflies, and caddis flies, which live on the surface of rocks. With such a shift in the aquatic insect community, less food would be available for fish that normally feed on the surfaces of rocks (Lenat *et al*. 1979).

Sedimentation can also affect amphibians. Processes that reduce the bed material to finer sizes are likely to be locally detrimental to populations of certain amphibian species. For instance, the sediment may clog the gills of some aquatic salamanders, and gill function would be reduced (Jackson *et al*. 2001).

Restoration and Aquatic Habitat Improvement Activities

The creation of new habitat and associated stocking of game fish typically would lead to greater numbers in game fish populations. Lakes and ponds provide deep-water habitat that supports warm water fish populations and shallow water environments that benefit other species (amphibians and insects). Improving habitat would increase the carrying capacity of impoundments and streams, which in turn would result in greater numbers of fish. In some

cases, water impoundments may also create breeding, foraging, and overwintering habitat for herpetofauna in areas that were previously inhospitable (Maxell and Hokit 1999).

Principal activities associated with aquatic ecosystem management include impoundment construction; improvements such as islands and underwater structures providing cover; restoration, rehabilitation or replacement of existing or historic wetlands, acquisition of riparian areas (as well as lakes, ponds, and wetlands or sites where restoration or replacement is possible), and rehabilitation or enhancement of aquatic and riparian systems. Typical stream improvement activities include streambank stabilization, construction of in-stream sediment basins, placement of cover structures, and the conversion of riparian pine to native streamside vegetation. By design, these activities favor the propagation and nurturing of plant and animal populations in, or associated with, aquatic habitats on the Forest.

Roads and Transportation System

Road construction would have the potential to affect fish and aquatic ecosystems due to increased access. This access would affect fish populations directly through increased use (fishing) and indirectly through improving fisheries habitat, carried out because of improved access. Road closures could reduce fishing pressure.

Direct effects to aquatic species resulting from roads include mortality, species avoiding certain areas near the roads, habitat fragmentation, habitat isolation, and pollution.

Recreation and Trail Management

Construction and maintenance of high-density public use sites in riparian areas alter riparian characteristics near the development. Riparian, wetland, and floodplain areas might be adversely affected if they were intensively used. Natural vegetation and natural processes are replaced by sod, pavement, gravel, or sand necessary to prevent environmental damage from increased human activity.

Construction of canoe and boat access points and associated parking lots along major streams, rivers, and lakes is allowed in all alternatives, and some facilities might be located in riparian areas and floodplains. Again, proper location, construction, and erosion control measures would mitigate damages to water or riparian values.

Pesticide Use

Applying pesticides to water affects predator and prey relationships, species diversity, and habitat (Relyea 2005). By design, these treatments modify existing conditions such as weed-choked water bodies, severely imbalanced fish populations, or an overabundance of undesirable insects. Insecticides dramatically reduce populations of target organisms and some non-target ones for one or more generations. Herbicides kill aquatic weeds. This in turn accelerates decomposition and increases biochemical oxygen demands in aquatic systems. In "closed" systems (lakes and ponds), this effect could endanger fish populations. Piscicides are chemicals intended specifically to kill fish, but other gill-breathing organisms can also be affected. Because of situations like high populations of undesirable species or health issues, managers occasionally use these chemicals to remove fish from the system temporarily. Pesticides that would be used in such environments break down relatively soon, and other organisms would repopulate the system upon detoxification. Implementation of Forest Plan guidance, EPA regulations, and label directions would result in minimal effects to non-target species.

Cumulative Effects

While a single trail crossing may be insignificant, many crossings, in combination with other resource developments, can cumulatively affect aquatic habitat, eliminating some portion of the vegetation and rendering some areas less suitable for species that would use them or make them suitable for only a reduced population.

Aquatic habitat fragmentation could result from effects of roads and stream crossings. These effects could occur at a variety of scales. Roads provide sources of sediment to streams if they are adjacent to stream channels. Roads that cross streams and enter riparian areas could influence channel shape and hydrology, which could result in a loss or degradation of aquatic habitat.

Alternatives 1, 3, 4, and 5

Vegetation Management Practices

Vegetative management practices, regardless of method, have potential to affect stream temperature, nutrient inputs, and large woody debris dynamics along the riparian corridor. Timber harvest activities also have the potential to impact streams by introducing sediment into them. The closer these activities occur to the stream, the greater the potential that sediment would enter the stream and affect aquatic habitat and associated aquatic species. The number of stream crossings a road makes also affects the amount of eroded material that reaches a stream. Limiting the number of stream crossings permitted in harvest areas can reduce these effects.

A loss of canopy could also decrease inputs such as woody debris and leaves to streams (Bilby and Wasserman 1989; Ralph *et al*. 1994), which provide important habitat and food components for aquatic life. Logging slash could obstruct channel flow, which could result in channel instability and effects on channel morphology. Fine sediments would increase in the channel as logging debris traps organic material and sediments.

Headwater streams are often a significant source of organic matter and nutrients for the rest of the watershed, and they provide significant nitrogen processing functions in the watershed (Peterson *et al*. 2001). Removing trees that shade a stream allows the sun to affect the water temperature. An increase in solar energy on the stream would stimulate the biological productivity of the stream and result in a shift in the aquatic insect community (Hetrick *et al.* 1998).

Timber harvest may affect aquatic species if sediment washes into stream channels. Recovery times would be less in high-gradient streams on steeper slopes where sediment might be flushed out of the system sooner. It may take longer in streams with lower gradients where the system cannot be flushed as quickly or where there is a continuous source of sediment, such as from road construction. Shorter recovery times from sediment inputs would allow aquatic invertebrate communities to recolonize an area quickly. Factors that facilitate rapid recolonization include the ability to fly and the presence of a nearby source population (Waters 1995).

There would be no significant potential impacts on aquatic fauna from sedimentation because the Forest will follow Forest Plan direction. Effects of vegetation management on soil and water resources are addressed throughout Chapter 3.

Fire Management

Wildfires have the potential to affect fish populations adversely. Heavy inputs of ash and debris could potentially collect in lakes and ponds and degrade habitat quality by embedding the substrate with silt.

Documented effects on aquatic habitat and aquatic species associated with wildfire include increased stream temperatures, especially in headwater streams and watersheds, an increase in large woody debris inputs for streams in burned areas, and a shift in species present in the aquatic insect community (Minshall *et al*. 1997). Water temperature is very important for healthy aquatic organisms, and temperatures that are too high would impair or kill them.

Fire can result in sedimentation, but vegetative strips along streams may filter out sediment before it reaches stream channels. Among other potential threats, sediment in stream channels can fill in the pore spaces between rocks and pebbles, which are needed for successful reproduction of a number of species.

Prescribed fire would reduce fuels that otherwise could contribute to fires of such magnitude that there could be effects on water and maybe even soils. Prescribed fire reduces the amount of excess dead and down fuels. Prescribed fires would also create opportunities for new plants to grow, plants that would deter erosion and filter out sediment. Hot burns would be avoided through fuel management or by burning at a time when there is sufficient fuel moisture and soil moisture to prevent total consumption of surface organic matter.

Riparian areas are naturally protected from the effects of prescribed burning and are further protected through appropriate prescriptions. These areas are inherently wetter than surrounding areas. Prescriptions for a prescribed fire in or near riparian areas would call for low-intensity burns that would minimize potential impacts on overstory vegetation and adjoining bodies of water.

Removing Common Variety Minerals from Streams

Removing gravel from streams could result in a loss of stream substrate, which is a necessary or important habitat component for fish, aquatic insects, and stream invertebrates. Stream invertebrates live on or in the stream bottom, and important components of their habitat include a wide variety of substrates, such as gravel, pebbles, and cobbles (Waters 1995). Some fish species prefer streambeds with gravel as habitat and for reproduction (Page 1983, Pflieger 1997). Gravel removal may negatively affect areas being used for fish habitat and reproduction. Species that prefer gravel for habitat or reproduction include:

- blackside darter (*Percina maculata*)
- bluegill (*Lepomis macrochirus*)
- central stoneroller (*Campostoma anomalum*)
- creek chub (*Semotilus atromaculatus*)
- creek chubsucker (*Erimyzon oblongus*)
- green sunfish (*Lepomis cyanellus*)
- largemouth bass (*Micropterus salmoides*)
- longear sunfish (*Lepomis megalotis*)
- redfin shiner (*Lythrurus umbratilis*)
- southern redbelly dace (*Phoxinus erythrogaster*)
- striped shiner (*Luxilus chrysocephalus*)
- white sucker (*Catostomus commersoni)*

Removing common variety minerals from streams can have negative effects to stream habitat. Effects of operations that remove creek gravel may include:

- Loss of gravel in the streambed
- Sedimentation in the stream channel or further downstream
- Changes in flow patterns in the stream channel that may result in increases in channel width and channel instability

Gravel operations that bring motorized equipment into the streambed or onto the streambanks have potential to cause sedimentation and destabilization of streambanks. The removal of creek gravel can modify channel width through direct channel disturbance, changes in streamflow, and changes in sediment processing (Rosgen 1996).

Disturbing channel features along the banks of streams and in the stream would change the patterns of erosion and sediment deposition within the channel, and the width is likely to increase. By increasing the width, the stream channel may become unstable. If heavy equipment entered the stream to remove gravel, it could result in modification of the shape of the streambed or banks and alter the composition of the streambed. This could affect how the water moves through the channel by changing directions in flow patterns and flow velocities. Changes in flow patterns could alter the spacing of riffles and pools, which might result in degradation of riffle and pool habitat needed by aquatic life.

Cumulative Effects

Removal of stream substrates could result in a loss of habitat for species that depend on gravel, pebbles, and cobbles for survival. This loss of habitat may separate individuals or populations from breeding areas or may discourage colonization of new habitats. Species may be isolated in watersheds due to poor habitat quality surrounding them. Other impacts in stream habitats due to agriculture, stream crossings, or pollution may already be affecting these species, thus resulting in long-term threats to species habitats and survival.

Removing creek gravel could modify channel width, other channel features, and flow patterns. This could result in stream channel instability. If a stream channel becomes unstable, the stream may become disconnected from its natural floodplain, which could result in the stream's inability to process its sediment effectively (Rosgen 1996). Stream instability can result in erosion problems in other parts of the stream channel downstream, or in long-term damage to channel features if the stream is not able to compensate.

Since the Hoosier would follow Forest Plan direction, there would be little risk to aquatic life from the above activities. Effects from the activities on lands of other ownership could affect some stream functions and therefore aquatic life. Attention to implementation methods and coordination and cooperation with other landowners could effectively remove the risk of such damage.

Alternative 2

Since Alternative 2 would implement almost no vegetative management or prescribed burning, the major risk to stream functions related to the above activities would come from wildfire. Wildfire in the presence of fuels that would continue to increase without vegetative management and prescribed burning could threaten local aquatic life.

This alternative would not maintain ponds and waterholes, so species dependent on some of those water bodies would gradually face displacement or habitat loss.

Cumulative Effects

The cumulative effects of not managing ponds and lakes for a long period would be a loss of habitat for many populations of species dependent on such water bodies. Assuming a continuation of the present level of maintenance of the water bodies on lands of other ownerships, the wildlife residing on some NFS ponds and lakes would migrate to those other water bodies. There would be a continuing loss of recreational fishing opportunities as these ponds and lakes became unable to support a healthy fishery.

Alternative 2 would implement almost no vegetative management, prescribed fire, or restoration activities. Wildfire may be more severe without vegetative management or prescribed fire activities to limit fuel loading. This may have localized effects on habitat quality for some species. Restoration activities such as wetland restoration, streambank stabilization, and large woody debris recruitment would not occur as part of Alternative 2.

This alternative might continue to affect aquatic species negatively because of poor aquatic habitat. Negative impacts to the habitats of aquatic species resulting from agricultural impacts, road effects, and pollution may cause further degradation. Restoration activities may be crucial to maintain suitable functioning habitat for species if current habitat conditions within watersheds continue to degrade.

Alternative 3

OHV Use

Alternative 3 would allow for an ATV trail system. If an ATV trail were provided and it included stream crossings or portions alongside streams, ATV riders could affect streams and riparian habitat by introducing sediment into streams at crossings or along streambanks. Stream crossings would require bridges or measures to harden the stream bottom. Impacts to streams at stream crossings associated with ATV trails include:

- introduction of fine sediment to streams
- denuded or altered streambanks,
- increased channel widths
- blocked fish passage

Impacts of ATVs on streams would vary, depending on driving behavior, topography, vegetation, and soil type (Cole 2000).

Aquatic Nonnative Invasive Species

Introductions of aquatic nonnative invasive species (NNIS) to the Forest have occurred through release of aquarium pets, escape of species raised through aquaculture, and release of species used as bait. Stocking programs and natural dispersal from adjacent aquatic systems have introduced nonindigenous fish species. Table 3.44 lists the aquatic NNIS species known to occur or are likely to occur on the Forest.

Table 3.44

NONNATIVE INVASIVE AQUATIC SPECIES

From Forest Service Region 9 List and State list of Aquatic Nuisance Species

Aedes albopictus - Asian tiger mosquito
Butomus umbellatus - flowering rush
Carassius auratus - goldfish
Corbicula fluminea - Asiatic clam
Ctenopharyngodon idella - grass carp
Cylindrospermopsis spp - bluegreen algae
Cyprinus carpio - Carpikoi
Dorosoma cepedianum - gizzard shad
Dreissena Polymorpha - zebra mussel
Hypophthalmichthys molitrixmolitrix - silver carp
Hypophthalmichthys nobilis - bighead carp
Lythrum salicaria - purple loosestrife
Myriophyllum spicatum - Eurasian watermilfoil
Oncorhynchus mykiss - rainbow trout
Orconecters rosticus - rusty crayfish[1]
Phalaris arundinacea - Reed canary grass
Phragmites australis - common reed
Salmo trutta - brown trout

[1] Native species that becomes invasive outside its natural range.

Just as plant and animal community have been invaded by NNIS, the same is happening in aquatic habitats. Several species occur on the Hoosier, including Asiatic clam, zebra mussel, and Eurasian watermilfoil. Rusty crayfish is a native species that becomes invasive outside its natural range.

Alternatives and the Effects of Management on Nonnative Invasive Aquatic Species

All Alternatives

The introduction of the zebra mussel and Asiatic clam has had a significant negative impact on native mussel species due to their high-density populations and rate of spread (Williams *et al.* 1993).

The invasion and proliferation of the Asiatic clam in the region is believed to have further stressed most of the remaining unionid species. Asiatic clam greatly reduces phytoplankton and zooplankton populations that are sources of food for other mussel species. Asiatic clam now occurs throughout the major streams of the region encompassing the Hoosier in moderate to low densities (Clarke *et al.* 1999).

If culverts break the continuity of the water flow, they may prevent upstream passage of some invasive species. However, some species have a greater ability to maintain position in fast currents. Culverts that maintain faster currents may allow species such as the rusty crayfish, which is able to withstand strong currents, to disperse upstream more readily or farther than other crayfish species (Vaughan 2002).

Introduction of plants like Eurasian milfoil to ponds and lakes can have effects on recreational opportunities and fisheries management. This species can outcompete native plant species and can negatively affect aquatic communities. Chemical and biological controls are available to control this plant, and prevention is important to keep this plant from spreading to other water bodies.

Alternatives 1, 3, 4, and 5

Herbicides and biological controls can be effective control measures for Eurasian milfoil. Biological control using a weevil (*Euhrychiopsis lecontei*) has proven effective in Indiana lakes containing Eurasian milfoil (Seng and White 2003). However, effects to native species from introducing this weevil are not well known. Herbicides may also have short-term impacts on water quality and other native plant species.

Alternative 2

Because it would not use herbicides or biological controls, Alternative 2 would rely completely on prevention to limit the effects of this species on native aquatic plant communities and associated habitats. There would be no means of control if this species were to invade new water bodies on the Forest. The inability to control invasie aquatic vegetation in MA 7.1 would result in loss of recreation opportunities on lakes. Swimming beaches and boat ramps in many areas would be unusable due to aquatic vegetation.

Cumulative Effects

The cumulative effects for all alternatives would include the results of whatever treatment might be applied on lands of other ownership. It is not clear to what extent the presence of culverts might hinder the spread of these invasive species. In combination with the effects of such processes as sedimentation on lands of other ownership, populations and habitat quality for some other (more desired) aquatic species could be adversely affected.

Municipal Watersheds

Lake Monroe and Patoka Lake (U.S. Army Corps of Engineer reservoirs) provide municipal water for several southern Indiana communities. As such, the public is vitally concerned with maintaining the quality of water in the watersheds of these lakes.

Approximately 28 percent of the Lake Monroe watershed is NFS land. Patoka Lake, the second largest impoundment in the State, is located along the Forest boundary. Approximately 14 percent of this lake's watershed is also in NFS ownership.

Alternatives and the Effects of Management on Municipal Watersheds

All Alternatives

Any of the alternatives would have little to no effect on these reservoirs and their watersheds. Guidance included for vegetation management and other Forest management would mitigate any potential soil movement and sedimentation to the background level. That is, the activities of any of the alternatives would not affect the water quality disproportionately compared to the percentage of the watershed in NFS ownership. Subjects such as waterflow, sedimentation,

pesticides, timber harvesting, and prescribed burning are addressed elsewhere in this document. Practices to maintain the forest would not add ash or chemicals to water above rates that are already occurring on lands of other ownership. The watersheds would retain their capacity to deliver and filter water under any of the alternatives.

Cumulative Effects

In combination with the practices (past and ongoing, as well as reasonably foreseeable future ones) on other lands, the actions permitted by the alternatives would not impair the water quality of the lakes.

Protect our Cultural Heritage

The goal is to protect and conserve heritage resources, which are both fragile and nonrenewable. The Hoosier and other public land agencies must manage these resources in a spirit of stewardship for the American public, to ensure future generations a genuine opportunity to experience and appreciate the Forest's rich and diverse heritage.

The three key components in the management of heritage resources are stewardship, public service, and context for natural resource management. The purpose is to protect significant heritage resources, to share their values with the American people, and to contribute relevant information and perspectives to natural resource management.

Government agencies and other organizations interpret many kinds of sites for the public to bring the past alive and illustrate relevance to the issues and challenges of today and the future.

Cultural and historic resources are important reminders of the ways Native Americans and early settlers coped with the world. Remnants of how civilization interacted with the environment in the past provide insight for today and the future. By protecting and interpreting these resources, we preserve our heritage, are more aware of the forces that shape our lives, and will be more sensitive to our influence on natural resources in the future.

The Forest's cultural resources provide opportunities for unique recreation experiences, enhanced interpretation, public education, development of a conservation ethic, and an appreciation of our common links with the past.

Forest lands contain evidence of past human occupation by Native Americans, European Americans, and African Americans in the form of prehistoric and historic archaeological sites. The Forest Service is involved in ongoing efforts to inventory, evaluate, protect, and enhance these sites (USDA FS 1998a, USDA FS 2000a). If significant sites are identified, the Hoosier may protect them, preserve them, nominate them to the National Register of Historic Places, interpret them for the public, or choose some combination of those actions.

Historical Perspective

The area that is now the Hoosier has been used and inhabited continuously for the past 12,000 years, first by Native Americans and later by European and African Americans. Each group of people has used the land in different ways, and each has had an influence on the land.

The earliest inhabitants traveled through the area as bands of hunters and gatherers in a time when mastodons, elk, and bear roamed the land. They established trails, temporary camps, and quarries to extract stone for their tools. They cleared or burned over some areas to improve their hunting and gathering opportunities.

As time passed, the inhabitants became more sedentary; established permanent villages; developed pottery; continued to hunt primarily white-tailed deer; developed elaborate social, economic, and governmental systems; and cultivated the now familiar crops of corn, beans, and squash. People farmed with hand tools, and selected the lands easiest and most fertile to cultivate - the river bottoms and terraces. They farmed the fields until they were no longer

productive, and then they cleared new fields. When all the fields around a village became depleted, the whole village moved to a new location.

Native American populations grew throughout their long period of occupation of the area. The increasing number of people had a great impact on the forest by harvesting its many natural resources, establishing camps and trails, burning and clearing the land, farming, and building villages.

Explorers, traders, and adventurers came into the area prior to 1800, but European American settlement did not commence until the 1810’s. Early reports about the composition of the forest at that time are incomplete, but they indicate primarily hardwoods with many large clearings in which the Native Americans had grown their crops. There are some records of Virginia pine in southern Indiana and white pine in the northern part of the State.

Early settlements were concentrated along water transportation routes, such as the Ohio River and other major rivers and streams. The Buffalo Trace was another major access route across the frontier. The Buffalo Trace was a wide path beaten down by bison migrating from the plains of Illinois near Vincennes, past the Falls of the Ohio at Jeffersonville and New Albany, and finally to the salt licks of Kentucky. They also used old Indian trails to access the interior of wooded areas.

As European Americans acquired land to settle, one of their first concerns was to clear the land of trees. The forest was an obstacle to be conquered. The settlers harvested timber to use as building material or fuel, or simply cleared fields to provide farmland for crops and pasture. Southern Indiana boasted some of the finest hardwoods in the world. In 1860, with the advent of steam-powered sawmills, extensive commercial forest clearing operations began (Lindsey 1966). During the period following the Civil War, thousands of sawmills operated in Indiana. In 1899, Indiana led the nation in lumber production. Although most of the good farmland had been cleared and settled in the early 1800’s, the remainder, the steep hills and valleys that today make up most of the Hoosier, was harvested between 1870 and 1910, with cut-over lands selling for one dollar per acre.

Times were hard, and many of the settlers gave up and moved on. The Depression sealed the fate of many of the small farmers in south central Indiana. After 100 years of wear on land never suitable for farming, the steep hills were eroding, and the nutrients were depleted from the soil. Crop prices were low, and droughts occurred several years in a row. Although many families left their unproductive lands, a few returned to raise food they could not obtain in the cities.

As many of the farmers moved out in the 1930's, generally just abandoning their farms and homes, local officials became concerned about the growing amount of tax delinquent lands on the tax rolls. In June 1934 Indiana's governor, Paul V. McNutt and the 73rd Indiana Congress asked the Forest Service to buy this land for the eventual creation of a national forest. Chapter 29 of Senate Bill 39, formally approved this action on February 6, 1935:

> “An Act to empower the United States of America to acquire lands in the State of Indiana by purchase or otherwise, for establishing, consolidating, and extending national forests, and to grant to the United States all rights necessary for proper control and administration of lands so acquired, and legalizing certain acts and proceedings connected therewith.”

The Federal government purchased the first parcels in 1935, and the land base gradually grew over the next few decades. The Forest Service's immediate goals were to rehabilitate the damaged land and control wildfires. The Civilian Conservation Corp (CCC) Program of the 1930's provided jobs for the unemployed and manpower to begin reforesting the hillsides and controlling the massive erosion problems.

Prehistoric Cultures

Prehistoric Native Americans began to settle the area that is now the Hoosier and use the local resources at the end of the Wisconsin glaciation. The region's prehistoric cultural traditions include PaleoIndian, Archaic, Woodland, and Mississippian.

The earliest known peoples to occupy this region are the PaleoIndians. They were small bands of highly mobile hunters and gatherers who established trails, temporary camps, and quarries to extract stone for their tools. The distinctive fluted Clovis and Cumberland projectile points are diagnostic of these early occupants ca. 10,000 to 8,000 B.C. (IDNR 1998b).

The Archaic people occupied the area ca. 8,000 to 700 B.C. (IDNR 1998b). They were less mobile hunters and gatherers who established seasonal camps and villages, often along river corridors. They had a more patterned life and exercised more direct control of their natural environment. They continued to hunt and gather; but they also began to cultivate native seed plants (Sieber *et al* 1989). They probably cleared or burned over some areas to improve their hunting and gathering opportunities

It was during the Woodland tradition that Native Americans developed bow and arrow technology and refined the craft of making ceramics. The construction of mounds and earthworks and the increase in elaborate mortuary activities occurred during the Woodland Tradition. These peoples engaged in a wide geographic trade network and were accomplished horticulturalists, growing corn, beans, and squash. The Woodland Tradition lasted from 700 B.C. to A.D. 1000 (IDNR 1998b).

Archaeologists call the cultural period of A.D. 1000 to A.D. 1650 the Mississippian Tradition (IDNR 1998b). It marks the peak of political complexity in the region. Settlements were large towns or villages, often fortified, that the Native Americans planned and built around a central public plaza. Large flat-topped mounds are associated with some cultures and are indicative of strong social hierarchies.

The many archaeological sites found in the region provide evidence of these early inhabitants. Site types include open air habitations, rockshelters, rock art sites, and resource procurement sites such as chert outcrops.

Archaeologists have found significant prehistoric sites on NFS land, and some have been placed on the National Register of Historic Places. Currently, three prehistoric sites on the Forest are listed on the Register, two in Perry County and one in Crawford County. In addition, four prehistoric sites have been determined eligible to the National Register of Historic Places.

Historic Cultures

When European Americans began colonizing the eastern coast of North America, they displaced Native American populations. Many groups moved west, displacing those living in our

area. As such, the first Native Americans encountered by European Americans in this area were not those groups who originally lived here. In the late seventeenth and early eighteenth centuries, the following tribes were present in what is now central and southern Indiana: the Miami, Wea, and Piankashaw (Sieber and Munson 1994). The Delaware Indians, whose homeland was much further east, settled here for a time, and the Shawnee passed through on their way west. Most of these groups left the region in the first decades of the 1800's.

People from the Upland South region of the eastern United States predominately settled the area of the Hoosier after 1820. This area stretches from western Virginia and North Carolina to northern Mississippi (Sieber and Munson 1992). English, Scotch-Irish, and German immigrants were the main settlers of the Upland South. The Upland Southerners were middle class white "plain folk" who purchased land from the Government and made their livings farming and raising livestock.

Additional settlers came from the New England states and several ethnic settlements sprang up including German American and African American. Settlers cleared the land, harvested timber, and used tree products, for example, in the tanning process. A 19^{th} century settler, Jacob Rickenbaugh started a tanning business and built a large sandstone block house. This house was also used as a post office for the nearby town of Winding Branch. The Forest Service has rehabilitated that house, located at Lake Celina, for use as a community and interpretive center. The house is listed on the National Register of Historic Places (IDNR 2002).

The Buffalo Trace Trail, a major settlement and trade access route across southern Indiana, crosses NFS land (Wilson 1919). This trail was used in westward expansion to settle the Northwest Territories. A segment is interpreted along the Springs Valley Trail as well as part of the Historic Pathways Scenic Byway.

A site of surveying importance from the settlement period is Initial Point. This was the beginning point for the land survey of the state of Indiana.

Another significant heritage resource area is the Lick Creek Settlement. Both free African American and European American pioneers settled in this area in the early 1800's. Many of the European Americans were Quakers from North Carolina. Intensive historic and archaeological research has occurred at several of these farmsteads, and many have been the focus for interpretation and volunteer efforts.

By the twentieth century, most of the lands within what is now the Hoosier contained small farms devoted to growing crops or pasture and hay, and raising livestock. By the 1930's, the Forest Service began purchasing abandoned depleted farms. The Civilian Conservation Corps (CCC) Program was created to reforest the hillsides, to prevent fires, to control massive erosion problems, and to provide for recreation. Ruins of an old CCC camp exist near Kurtz, and the CCC-built lake and recreation area at German Ridge are still in use. The Hickory Ridge Lookout Tower, built to detect wildland fires, still stands and is maintained for visitor use.

Throughout the prehistory and history of the Hoosier area, people have lived and sometimes prospered. They had an impact on the land through repeated clearing or burning, depletion of soil fertility, erosion, and extraction of natural resources. They all left evidence of their passing including foundation stones of homes and the graves of loved ones.

There are approximately 1,600 heritage resource sites recorded on the Forest. The most frequent site type is the homestead/farmstead (30 percent), followed by prehistoric rockshelters

(28 percent), and prehistoric lithic scatters/open sites (28 percent). With only 51 percent of the land surveyed, and a general site density of one site in 63 acres, archeologists estimate that an additional 1,500 to 2,000 sites are yet to be discovered and evaluated. Many will be suitable for public interpretation.

Alternatives and the Effects of Management on Our Cultural Heritage

This section presents expectations or predictions under alternative ways of managing heritage resources on the Forest. The consequences, or effects, discussed in this section provide a basis for understanding the implications and differences among alternatives.

All Alternatives

All alternatives would provide for the protection of heritage resources. Regardless of the alternative selected, one effect would be the legal requirement to inventory, evaluate, protect, and interpret heritage resources. The Hoosier will conduct inventories on all lands that could be affected by ground-disturbing projects in accordance with Section 106 of the National Historic Preservation Act. Any potentially adverse effects would be appropriately mitigated using methods such as avoidance, project redesign, and data recovery. A wide variety of interpretation would occur in all alternatives.

Any management activities that disturb the ground have the potential to affect surface and subsurface heritage resources adversely. These activities include timber harvest, tree planting, road and trail construction and reconstruction, wildlife opening construction and maintenance, facility development, prescribed fire, fireline construction, riparian restoration, placement of utilities, plowing, water inundation, and special use permit activities. Land exchange or sale also has the potential to affect heritage resources adversely by removing them from Federal protection.

Ground disturbance includes the movement, compaction, and erosion of soil. The displacement of soil could damage archaeological sites through artifact movement and loss of intact subsurface soil layers. The use of heavy equipment, horses, or ATV's could cause soil movement, compaction, and subsequent alteration of subsurface features. Prescribed fire could consume historic standing structures and other above ground features made of combustible materials. Fire could melt historic artifacts such as glass, and blacken and weaken gravestones. Erosion could result if fire is followed by heavy rains.

Inundation by water is considered an adverse effect because artifact deterioration would occur more rapidly if materials were subjected to periodic changes in saturation levels. In addition, inundated heritage resources would no longer be available for scientific study.

Another potential effect of management activity is increased site visibility. Increased visibility would provide a greater opportunity for access and vandalism.

Activities that are not considered ground-disturbing activities include but are not limited to mowing, plowing previously cultivated fields, facility painting, and use of existing roads and trails.

Natural events such as wind storms, tornados, and suppression of wildland fire would have the potential to disturb heritage resource sites. Salvage timber sales, road building, log landing and skidding, fireline construction, and other management actions taken during and after these events could also adversely affect heritage resources.

Cumulative Effects

Indiana has over 47,000 recorded heritage resource sites, and 1,600 (3 percent) of those are located on the Hoosier and are protected by Federal laws and regulations. Federal law provides a higher degree of protection from planned impacts and illegal vandalism than State laws. On private property, sites dated after 1816 are not protected. State law only protects those sites that pre-date 1816, but all human burials are protected. When Federal laws are followed, effects are considered and any adverse effects mitigated. One cumulative effect of all alternatives is that simply through Federal ownership the heritage resources on the Hoosier positively contribute to the pool of sites that are preserved, protected, and available for scholarly study.

Alternative 2

Alternative 2 would allow the least amount of on-the-ground projects. This would require the least amount of emphasis on heritage resource inventory and evaluation efforts. This change in emphasis might positively affect the protection of heritage resource sites, due to the lack of potentially disturbing projects. On the other hand, this alternative would provide the least opportunity to discover significant new sites that are in need of research, management, and protection.

Cumulative Effects

There are no additional cumulative effects, beyond those described for all alternatives. This alternative would have fewer cumulative effects on heritage resources because of the decreased level of management activities.

Alternatives 3 and 4

Alternatives 3 and 4 would allow for an increase of on-the-ground projects. An increase in activity would require a greater emphasis on heritage resource inventory and evaluation efforts. This change in emphasis might negatively affect protection and interpretation efforts. With an increase in on-the-ground activity, there would also be a greater probability that sites could be inadvertently damaged or vandalized. On the other hand, these alternatives would provide the most opportunity to discover significant new sites that are in need of research, management, and protection.

Cumulative Effects

These alternatives would result in no cumulative effects beyond those described for all alternatives.

Provide for a Visually Pleasing Landscape

The Hoosier is in the heart of scenic southern Indiana. Hills and ridges provide contrast and define valleys and streams. One finds rock formations throughout the Forest, but they are most dominant in the southern part of the Forest. The Forest provides pleasant scenery year round. In spring, dogwood and redbud are blooming; in summer trees and fields are green; fall brings a change of color, and in winter the leaves are off the trees, which opens views to the forest interior.

Interspersed private farmland and pastures provide contrast and interest in a rural landscape. Manmade features such as barns, cemeteries, churches, fences, and homes are a part of the characteristic landscape that has evolved over time.

Management practices are not visible on most of the Forest, and most areas appear to be natural, undisturbed forestland. On the remaining areas, manmade features of various types are apparent, including developed recreation areas, roads, timber removal, trailheads, trails, utility lines, and wildlife ponds.

The natural world has patterns of color, symmetry, and tones that are used to pattern activities. The Forest can soften the effects of activities and projects that might otherwise appear harsh, such as powerlines, through proper design, location, and repetition of patterns found in nature. The Forest would emphasize natural-appearing landscapes, with attention given to views from roads, trails, and use areas.

Alternatives and the Effects of Management on Visual Landscapes

With any alternative, the Forest would consider visuals and scenery management concerns in all management of the Forest. On most of the Forest, management practices would not be noticeable or attract the attention of forest users. Forest activities, such as vegetation management, trail construction, roads, and facilities, must blend in with their settings. With care, design, and timing, the Hoosier can ensure that management of the Forest results in minimal disturbance and does not disrupt the natural setting.

This section presents expectations or predictions under alternative ways of providing for a visually pleasing landscape on the Forest. The consequences, or effects, discussed in this section provide a basis for understanding the implications and differences among alternatives.

Visitors have differing levels of acceptance for alteration of the forest. In some cases, such as powerlines, these alterations are maintained indefinitely. In other cases, such as timber harvesting, alterations revert gradually to their previous condition.

There are various management strategies to achieve predefined visual quality objectives. These objectives are defined as preservation, retention, partial retention, and modification. These terms are defined in Agriculture Handbook Number 462, *National Forest Landscape Management, Volume2, Chapter 1, The Visual Management System*. All direction and information in this handbook is herby incorporated by reference.

Preservation

This VQO provides for ecological change only.

Retention

This VQO in general means man's activities are not evident to the casual forest visitor.

Partial Retention

This VQO in general means man's activities may be evident but must remain subordinate to the characteristic landscape.

Modification

This VQO means man's activity may dominate the characteristic landscape but must, at the same time, use naturally established form, line, color, and texture.

Rehabilitation and Enhancement

These are not visual objectives, but rather methods to correct a problem or enhance the visual quality regardless of the assigned visual quality objective.

- Rehabilitation might include cleaning up a dumpsite to maintain the assigned visual quality objective.
- Enhancement might include clearing an opening in the forest to view a lake or other scenic feature.

All Alternatives

Visual quality is a consideration in all land management decisions. In all alternatives, the Forest would protect some landforms and interesting visual features, such as caves, cliffs, and waterfalls.

In Management Areas 5.1, 6.2, 6.4, 8.1, 8.2, 9.2, and 9.3, the forest would appear much the same as it has historically. Exceptions are openings, which would gradually disappear in all of the previously mentioned management areas except 6.4, 8.2, and 9.2. Contrast, pattern, and variety of forest scenes, as well as opportunities for viewing surrounding landscapes, would gradually diminish in these areas.

The visual quality objective of preservation protects wilderness values from deterioration. Trails and signs would conform to the ideal of minimum service to meet users' needs while also protecting wilderness values.

An expanse of unbroken forest would develop and eventually dominate the landscape in Management Areas 5.1, 6.2, and 9.3.

Gradual development of greater numbers of large trees would occur. As the overhead canopy closes, shrubs and brush would give way to a more open leaf-covered floor. Still later, as larger trees died, small groups of young trees would replace them.

Recreation use on the Forest has visual impacts. Developed recreation facilities stand out as an obvious human-caused modification of the natural environment. Litter, trail construction and maintenance activities, trail erosion, and bicycle and horse marks may detract from the natural scene in a forest. Boat access sites, parking areas, river corridors, trail corridors, and trailheads would provide user interfaces and require visual management considerations to mitigate potential visual impacts.

Newly acquired agricultural and pasturelands would offer opportunities for management. In managing new acquisitions, the Forest would consider the character of the surrounding landscape and management area direction. The Forest may choose to retain cultural features, including old homesteads and outbuildings, for aesthetic, archaeological, or wildlife values.

Off-road parking at or near points of interest or scenic overlooks and at points in between could improve visual quality by providing access so that Forest visitors could explore on foot and further enjoy the natural beauty of the Forest.

As the countryside becomes more developed, demand for services provided by utilities increases. Existing corridors would be widened and new ones developed. This would result in a slow increase in segmentation by these corridors and an increase in the straight-line visual effects that they cause.

Effects of fire suppression activities on visual resources would be minor compared to the dramatic impacts of the fire itself. Suppression activities would consist of clearing fireline to bare mineral soil, falling trees, and piling brush and other vegetation. Suppression activities would help reduce the spread of fire to other areas, thereby reducing the overall visual impact. An intense wildfire, an infrequent occurrence in Indiana, could result in blackened areas largely devoid of plant life with the charred remains of shrubs and trees, some still standing, but many lying on the ground. The burned area would contrast sharply with adjacent unburned areas. Generally, these effects are transitory, with the burned area regaining a more natural appearance as it would quickly revegetate.

Since wildfire and the use of mechanical equipment to suppress fire have been infrequent on the Hoosier, the visual disturbance is expected to be minimal.

All alternatives would result in an increase in the average age of the forest.

Alternatives 1, 3, 4, and 5

The Hoosier would complete road construction and reconstruction to a modern standard, taking advantage of the natural beauty of the Forest. Roads could be re-routed along points of interest or scenic overlooks. Visitors driving through the Forest for pleasure could discover areas of outstanding scenic quality that they would otherwise have missed.

Road construction has the potential to affect the visual resource by altering landforms, introducing unnatural lines to the landscape, disrupting the vegetative cover, and bringing contrasting colors into view. Roads constructed into undisturbed forest change the long-term visual quality and the visual sensitivity of an area. A forest can also change from one that is natural and continuous to one with corridors through it.

Even after their use is complete and they have been revegetated, dry-weather dirt roads still have an effect on visual quality. These opportunities allow developed vegetated linear routes

through the Forest for foot travel to enjoy the scenic beauty of the Forest without having to contend with the forest underbrush.

Even if closed to public motorized vehicles, roads may attract use and can indirectly affect visual resources through the presence of more people. Conversely, closing existing roads and revegetating them may improve visual quality. Many of these roads are eroded and unsightly, so revegetation would contribute to a more natural-appearing forest environment.

Commercial timber harvest would not occur in areas with a Visual Quality Objective of preservation and in some retention areas. The remaining retention areas would be available for single-tree harvesting, which often results in increased visual penetration of the forest, the opening of vistas, new growth and colors, and a diversity of species and stages. The Hoosier would manage partial retention and modification areas to provide a natural-appearing forest, where openings would blend with the surrounding forest and private lands.

Timber harvesting and prescribed burning can maintain or change the visual appearance of the Forest through site disturbances, the opening of relatively unbroken canopies, and through long-range changes in vegetative and age-class composition. Short-term effects are blackened trunks, disruption of the vegetation, disturbed soils, loss of ground cover, and stumps.

The visual effects of timber harvesting are generally quite temporary, as the area harvested is reforested within a very few years at most. The effects of timber harvest and prescribed burning on visual resources would depend on the amount of residual slash left following treatment, the design and layout of treatment units, the location of treatment units relative to viewing areas, the logging systems used, and the total amount of treatment.

During actual harvest and burning operations, exposed soil, logging debris, and logging equipment would be apparent to Forest visitors. The Forest can mitigate visual impacts by maintaining natural stand shapes, limiting treatment area size, paying attention to spatial arrangements, and reserving some standing trees. Unit layout can also take advantage of screening vegetation and topography to mitigate some of the visual impacts or improve the visual character of an area.

Although similar, the effects of a shelterwood cut are less pronounced than those of other even-aged timber harvests. This is due to the removal of a mature stand in stages, which allows for development of a stand of young trees prior to the final removal of the mature trees, and thus viewing distances are limited.

The two recognized methods of uneven-aged silviculture (group selection and single-tree selection) also have effects on the visual appearance of a forest. Group selection with a number of small openings (1/10 acre to 3 acres) scattered throughout a forest would create visual variety and allow some views into the Forest. People walking through the forest could view a forest having undergone such treatment as a continuous uneven-aged canopy frequently broken by irregularly shaped openings. For people viewing the forest from trails and use areas, it could appear as though no harvesting were occurring (USDA FS 1987b).

Single-tree selection perpetuates a continuous but uneven canopy. Few views to the surrounding forest would exist except where topography allows and where shrubs and tree saplings are suppressed to low densities to simulate a park-like condition.

Overtopping trees would dominate flowering trees such as dogwood, redbud, and serviceberry (*Amelanchier spp*.). Shade-tolerant species with good fall color, such as sugar maple, and trees with interesting bark and branching characteristics, such as beech, would increase in most stands.

During treatment, evidence of exposed soil, slash, and equipment is apparent. Slash would persist for several years. Group selection can provide desirable vistas and views by allowing select portions of the landscape to be visible.

Thinning and other treatments in pine stands are less apparent when hardwood residual stems are left. In pine stands, the Forest would retain the hardwood component in most cases to soften the visual effects and to help hasten the conversion to native hardwoods.

Skid trails and roads often leave temporary changes to the landscape by altering landforms due to cutting into hillsides and filling on the downhill slope. Vegetation would eliminate color contrast, but the shape of the land would change. Visual impacts and disturbances would shift across the Forest over time with some stands actively growing while others were being harvested.

Mechanical site preparation for tree planting takes on an appearance of linear rows of exposed soil. The exposed soil looks like a narrow zone of rototilled soil, and it generally remains exposed for one to two months. The narrow weed-free zone is created to provide some relief from the grass and forb competition. If trees were planted in rows, the orderly appearance could be apparent to viewers.

Hand planting, on the other hand, generally results in a much more natural appearance and generally does not result in trees lined up in rows. Trees are planted more or less randomly. Planting a mixture of species is an additional way of softening the visual effects of planting.

The Hoosier may maintain some open areas for visual variety, wildlife habitat, or protection of historical landscapes.

All intermediate treatments tend to provide views into forested stands and increase growth rates on selected trees. Large-diameter trees and increased viewing distances could be a benefit to the viewing public.

Disturbed soil and slash would be evident for a short time, but residual vegetation would soften the visual effect. Silvicultural techniques often leave limbs, small trees, and treetops lying on the forest floor. These may detract from the natural setting and affect travel through the area. However, the woody debris can serve as wildlife habitat, often providing opportunities for bird watching and wildlife viewing. Treatment of slash along visually sensitive corridors would help in mitigating these effects.

Barrens, glades, and permanent openings add to visual variety through their diverse or unusual vegetation, natural-shaped edges, permanent location, small size, and wide distribution.

Forest Openings

Wildlife habitat development can add variety and interest to the landscape. Lakes, ponds, wetlands, and permanent forest openings in retention areas require special care for construction and maintenance when the Forest identifies projects. Partial retention and modification areas are more suitable for wildlife habitat improvements due to lower human concentration and less

frequent visits by people. The Forest can and will mitigate most negative visual effects of wildlife habitat development in partial retention and modification, and such development normally provides a more interesting landscape when completed. Access roads for construction and maintenance may reduce scenic quality, but the Forest can mitigate these effects in project design.

Openings offer vistas where the visitor can view a more expansive area. They provide contrast with an otherwise tree-covered landscape. The edge effect created by openings allows enough light to reach the forest floor to create a stair-step effect of attractive flowering trees and shrubs. Construction of permanent openings often leaves some trees girdled and dead to provide perches and homes for birds. Brush piles, exposed soil, and stumps would be evident for one to five years. Results of maintenance (such as brush hogging, burning, or hand cutting) would be noticeable only during the growing season in which they occur.

Pest Management

Herbicide application would cause sudden changes to the existing vegetative condition. Target plants would wilt and die. Dead vegetation provides sharp visual contrast with the adjoining untreated areas. This would be particularly noticeable if sites were treated by broadcast applications. Areas treated by spot application or by individual plant treatment would present less contrast. The greatest visual effect would be during the first year; however, dead standing trees may be evident for several years.

Herbicides might reduce the species diversity of plants, and this reduction could in turn decrease the diversity of views in affected forest settings. Over time, however, diversity would increase as more and more plant species naturally invade treated sites. Effects would tend to shift across the forest without accumulating (because of the short-term nature of the effects of the treatment).

Wetland Development and Restoration

If an impounded area extends beyond the boundary of an original wetland, vegetation there would die and create a short-term visual contrast with the surrounding area. Dams and levees to hold backwater would appear as unnatural landforms in the landscape. The development of lakes, ponds, and wetlands would create desirable views, pastoral scenes, and visual contrasts associated with water.

Prescribed Fire

The Forest uses prescribed fire to maintain permanent vistas, wildlife openings, natural openings, set back succession, and maintain forest health. Prescribed fires may leave scarred trees, so managers must be careful concerning the location and time of year to meet the assigned visual quality objective. Areas where there have been wildland fires may need to be rehabilitated to meet the assigned visual-quality objective. Besides the on-site effects of a prescribed burn being visible immediately following the burn, dead standing trees and shrubs could be evident for several years. The charring and reduction of vegetation would contrast with the adjacent unburned areas. The contrast between burned and unburned areas would be temporary, but reduction in slash would have longer lasting effects. The degree of effect would be proportional to the amount of prescribed burning accomplished in each alternative.

Recreation

The alternatives would continue to provide beautiful scenery and other types of recreation opportunities in diverse forest settings ranging from developed to primitive. More manmade structures are visible in developed recreation areas. Fishing lakes offer views of the forests

around the lake. Trails provide access to Forest scenery. Dispersed recreation areas have little to no development except gravel parking areas and signs. Visitors to the Charles C. Deam Wilderness have opportunities to view forests in their natural condition except for signs for direction and safety. General forest areas are not developed and offer recreation opportunities such as hunting, collection of forest products, and exploration.

Cumulative Effects

Management activities have gradually changed the overall appearance of the Forest. When first acquired, much of the land was eroded, cleared, and burned over, and many old farmsteads dotted the land. Forest and other landowners planted trees, and gradually the land changed from a rural farm appearance to its present forested character. The forest will continue to advance through successional stages to a climax (old growth) stage of development unless vegetative management occurs or natural disturbance processes occur. Lands classified as suitable for timber production would retain a naturally appearing character until they were harvested. Management of interior acres in the preferred alternative and all other alternatives where selection cutting is allowed would result in more acres overall disturbed visually.

Reasonably foreseeable future activities such as construction of recreation facilities, trails, and special uses collectively contribute to the developed appearance of the Forest but do not significantly vary in Alternatives 1, 3, 4, and 5. Roads are the most obvious visual factor along with the intermingled private lands in the Forest. Most of the roads are county, township, State, and private roads. These along with private developments contribute to the overall Forest appearance. Recreation facilities, roads, and trails also facilitate viewing and visiting the Forest. As more areas in and adjacent to the Forest are developed, the visual characteristic of the overall Forest appearance would change.

Alternatives 1, 3, 4, and 5 have some acreage suitable for timber harvest using one or more harvest methods such as clearcutting, group selection, shelterwood, and single-tree selection. Collectively, the total acreage harvested provides an indication of the extent of overall manipulation of the Forest visual environment. In the next 10 years, Alternative 4, followed by Alternatives 3, 1 and 5 respectively, has the largest treated acreage, with the potential to influence the visual quality of the forest.

Because the Forest manages most travel corridors for visual quality objectives of retention or partial retention, the appearance of the forest from these roads and trails would be somewhat natural. However, the view when walking through the general forest might not appear natural, depending on the intensity of manipulation of the natural scene. Vegetative manipulation of timber would leave some slash, stumps, and skid trails along with closed roads. The intensity of this activity by alternative can be estimated as a percentage of land being harvested out of the total suitable acres. Table 3.3 displays timber harvesting by alternative.

Of these four alternatives, Alternative 4 has the largest area in clearcuts followed by Alternatives 1, 5, and 3. Clearcutting is the least natural appearing of the cutting methods and the most intensive on a per acre basis.

Adjacent landowners could decide to harvest timber from their land, construct roads, create openings, do prescribed burning, or leave trash dumps, all of which have effects on the visual appearance of a landscape.

Alternative 2

This alternative would emphasize natural-appearing landscapes, with attention given to views from roads, trails, and use areas. Like the other alternatives, this alternative would create opportunities to view old growth.

With its focus on limited vegetation management and no maintenance of wildlife openings, large areas of continuous forest canopy would eliminate visual contrasts created by vegetation treatment. Some areas of trees might die off and leave those locations less visually appealing. There is also potential for a build-up of forest fuels that could lead to a wildfire.

Seasonal trail closure to horses and mountain bikes would limit access to viewing forest scenes along trails. This alternative would reduce opportunities to view wildlife dependent on early successional habitats or unusual communities of plants and wildlife. The Forest would close some roads used for access to view scenery, and there would be less chance of viewing wetlands, ponds, or lakes. Closed roads would grow over and might have to be closed if unsafe, further restricting viewing opportunities.

Cumulative Effects

The cumulative effects of this alternative would be a natural appearing forest that would become increasingly dense with trees and other vegetation. Diverse scenic views would become limited, and this situation would continue for many years, with the exception of disturbance events such as wildfires or severe storms.

Provide for Recreational Use in Harmony with Natural Communities

Issue Three asks questions related to the supply of recreational opportunities on the Hoosier. The indicators of response for this issue are:

- Access/Transportation (miles of road)
- Output, Jobs, and Income Supported by Recreation
- National Forest Visits

The Hoosier is a major provider of outdoor recreational opportunities in the State of Indiana. Indiana has only four percent of its land base available for public outdoor recreation. The Hoosier is the second largest single landholder in the State, behind the Indiana Department of Natural Resources (IDNR 2000b). Indiana residents are among the highest users nationally of outdoor amenities, but they lack adequate opportunities (Indiana Heritage Trust 2004). The Forest helps meet this need. Facilities and opportunities are provided for boating, camping, fishing, hiking, horse riding, hunting, mountain biking, nature watching, swimming, and a number of other outdoor pursuits.

There does not appear to be a typical visitor to the Forest. A recent social assessment of the Hoosier found a high degree of diversity of both communities and individuals in the nine-county area around the Forest (Welch et al. 2001). Perhaps the only significant common thread among visitors is the fact that most of them reside in nearby communities. Several studies indicate the majority of visitors to the Forest are from Indiana, with many coming from the Indianapolis area (USDA Forest Service 2004e, Brayley 2001). Observations by Forest staff also indicate requests for recreation information by people from the Evansville and Louisville areas and, in some cases, Chicago. Other information indicates that many people live in and around the Forest, and they are not willing to travel very far for recreation. For example, census data shows an average density of 88 persons per square mile in the counties where the Forest is located (U.S. Census Bureau 2000). The State Comprehensive Outdoor Recreation Plan (SCORP), a document that describes the status of outdoor recreation in Indiana, states that most people are not willing to travel more than an hour from home for their favorite recreational activity (IDNR 2000b).

The combination of high population density and an unwillingness to travel makes the Hoosier a likely recreation destination for local residents. In addition, people may be seeking the cheaper option of recreating close to home due to low income. In the counties where the Forest is located, median income per household is low at $34,500, and the percentage of children living in poverty is high at 16 percent (U.S. Census Bureau 2000). All of these factors establish the Forest as a “backyard” weekend recreational opportunity rather than a national or regional destination site.

The Forest recently participated in the Forest Service’s National Visitor Use Monitoring program and was able to obtain current recreational use data from that study (USDA Forest Service 2004e). Data indicates an estimated 645,407 national forest visits (plus or minus 15 percent) occurred on the Forest in fiscal year 2003, and 18,382 national forest visits occurred in the Charles C. Deam Wilderness in fiscal year 2003. Tables 3.45 and 3.46 summarize recreational use on the Forest.

Table 3.45

ACTIVITIES VISITORS PARTICIPATED IN WHILE USING THE FOREST

Activity	Percent Participating[1]
Relaxing	54
Viewing Wildlife	48
Viewing Natural Features	47
Hiking / Walking	36
Fishing	30
Developed Camping	20
Other Non-motorized	16
Primitive Camping	12
Hunting	12
Driving for Pleasure	12
Motorized Water Activities	11
Gathering Forest Products	11
Picnicking	9
Visiting Historic Sites	8
Nature Center Activities	6
Horseback Riding	5
Nature Study	4
Non-motorized Water	2
Backpacking	2
Bicycling	1
Other Motorized Activity	0.5
OHV Use	Less than 0.5
Resort Use	Less than 0.5

[1] This column totals more than 100 percent because visitors indicated they participated in several activities while on the Forest.

Table 3.46

FACILITIES USED BY VISITORS

Facility[1]	Percent of Visitors
Boat Launch	26
Forest Roads	26
Developed Campground	22
Developed Fishing Site	21
Forest Trails	21
Scenic Byway	11
Developed Swimming Site	10
Museum	7
Interpretive Displays	6
Picnic Area	4
Organization Camps	2
Wilderness	2
FS Fire Lookout	0.5
Information Sites	Less than 0.5

[1]The form used in the survey was provided nationally, and the questions were not developed specific to facilities found on the Hoosier.

Developed Recreation

Affected Environment

Fifteen sites on the Forest provide some degree of development beyond basic parking or access. These are developed recreation sites. Many people visit a national forest to recreate in an environment that is more natural than their home setting but that still has some amenities. These 15 sites offer such visitors a more structured recreational experience that requires buildings or services such as beaches, boat ramps, campsites, interpretive programs, picnic shelters, security patrols, and shower buildings. These facilities provide the opportunity for visitors to get away from their normal environment but in a setting where other people are likely to be close by and facilities are available to make them comfortable.

The Forest's most developed recreation areas provide lake access for water-based recreation. This fills an important niche in an area with very few lakes.

The paragraphs below describe the types of developed facilities offered on the Forest, and they are summarized in Table 3.47.

Table 3.47

EXISTING RECREATION SITES WITH AMENITIES
(Number of sites)

Recreation Site[1]	Campsites	Picnic sites	Picnic shelters	Beaches	Boat ramps	Vistas	Fee?
Blackwell Horse Camp	100		1				No
Brooks Cabin		3					No
Buzzard Roost Overlook	5					1	No
German Ridge Recreation Area and Horse Camp	20	15	1	1			Yes
Hardin Ridge Recreation Area	200	40	3	1	1	1	Yes
Hickory Ridge Horse Camp	20						No
Hickory Ridge Fire Tower						1	No
Indiana/Celina Recreation Area (Includes Rickenbaugh House)	63	5			2		Yes
Mano Point Boat Ramp		2			1		No
Ohio River Scenic Byway						1	No
Saddle Lake Recreation Area	15				1		No
Shirley Creek Horse Camp	40						No
Springs Valley Recreation Area	7	4			1		No
Tipsaw Recreation Area	41	37	3	1	1		Yes
Youngs Creek Horse Camp	50		1				No

[1]All sites function as trailheads with the exception of Mano Point and the Ohio River Scenic Byway.

Campgrounds

Campgrounds offer a range of amenities. At the low end, the Forest provides users an area where they may camp anywhere in an open field, have a vault toilet available, and possibly enjoy picnic tables. At the high end, the Forest often provides users with many additional features - electrical hookups, fire rings, flush toilets, picnic tables, shower buildings, and water hydrants. An amphitheater, bulletin boards, dump stations, gate house, interpretive program, paved roads, pay phones, picnic shelters, play fields, trash dumpsters, and security patrols are additional features that may be present. Some campgrounds also function as trailheads.

Picnic Facilities

These generally offer a picnic table, a grill, trash receptacle, possibly a picnic shelter, and a vault or flush toilet.

Beaches

Beaches generally provide a sand surface on land and in the water, marked boundaries, depth markers, life rings, flush or vault toilets, bulletin boards, a phone where possible, and some type of changing area. The Forest does not provide lifeguards.

Boat Access

A range of boat access facilities exists. At the low end, a small gravel area provides auto, canoe, and small boat access. At the high end, the Forest provides a paved ramp for any size of boat trailer along with a courtesy loading dock.

Other Facilities

Other facilities available include: Ohio River Scenic Byway, Rickenbaugh historic home, Hickory Ridge Fire Tower, and Brooks log cabin. Some facilities are accessible to persons with disabilities, and the Forest continues to upgrade facilities to meet accessibility standards. The Forest accomplishes maintenance, rehabilitation, construction, and operation through a combination of in-house labor, contracts, and concessions. Fees are charged at some sites.

Alternatives and the Effects of Management on Developed Recreation

Effects Common to All Alternatives

Under all alternatives, the Forest would continue to provide developed recreational opportunities as identified in the Affected Environment section above. Forest visitors would continue to use and enjoy the Forest for those purposes. There would be no short-term change to current conditions, regardless of the alternative selected.

Human recreational use of an area inherently causes a number of impacts, and these would likely continue. These may include litter, vandalism, soil erosion or compaction, human waste accumulation, crime, and user conflicts such as overcrowding. However, the Forest would mitigate and minimize such impacts through proper design and maintenance, education, and enforcement. Experience with managing these impacts over the last planning period indicates their effects on the environment are generally minimal. Another effect of these alternatives would be the need for the Forest to continue to manage developed recreation. Associated management activities may include, but are not limited to, building and road maintenance, educational programs, hazard tree removal, law enforcement, mowing, utility line maintenance, vegetation removal by mechanical or chemical means, and vista clearing.

Road access is a component of national forest visits to the Forest (Table 3.48). If visitors could not get to the Forest, visits would be expected to decline. The Forest estimated national forest visits based on National Visitor Use Monitoring that occurred on the Forest in 2002 and 2003 (USDA FS 2004e). The survey asked visitors questions about their recreational experiences and influences on them, such as why they came to the Forest.

Table 3.48

INDICATORS OF EFFECTS ON RECREATION

Indicator	Existing	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Miles of Road Open for Public Vehicle Travel	56	61	56	61	64	61
National forest visits	663,790	663,790	662,790	676,790	663,790	663,790

Cumulative Effects

Most categories of outdoor recreational use are experiencing unprecedented growth rates (Cordell and Overdevest 2001), and the Indiana SCORP identifies overall shortages (IDNR 2000b). The State of Indiana, in concert with other government and non-government organizations, has identified a goal of acquiring 60,000 additional acres statewide for public use by the year 2016 (Indiana Heritage Trust 2004). If successful, this action would provide outdoor recreational opportunities that would supplement those on the Forest and help reduce the expected shortage of recreational opportunities. It is unknown if this goal could be met, if it would be enough to meet demand, or if these acquisitions would occur close enough to the Hoosier to influence demand on the Forest. The Indiana State Park system plans no major expansions in the next 10 years (Pagac 2004).

Alternatives 1, 3, 4, and 5

Facilities and the level of service under these alternatives would be very similar to those presently provided. As resources allow and demand dictates, the Forest could improve, alter, or expand some sites and might add new sites. The Forest could also add additional major developed sites and group campgrounds. The effect would be the availability of more choices and a greater capacity for visitors if demand were to increase. The construction of new facilities would have the long-term effect of creating a need for more staff and budget to maintain the facilities.

Another effect of developing recreation areas would be a relatively slight reduction in the acreage of NFS land in an undeveloped state. The implications of this reduction are fewer acres for activities that require large blocks of undeveloped land, such as hunting or seeking solitude.

The Forest might remove pine trees in campgrounds to allow for safety, stand health, and regeneration of native species. This would likely be a bigger concern in those campgrounds that have a predominance of pine, such as the Celina campgrounds. The objective of regenerating stands in campgrounds is to provide an uneven-aged structure and perpetuate the forested environment. Some forest visitors may be concerned about the loss of shade, the visual effects, or the general concept of tree removal from public land. The probability of such concerns are higher in a developed recreation area simply because many more people use the area and are easily able to observe management activities that they may or may not agree with, which could result in a decline of campground use. Following Plan direction will reduce the impacts. On the positive side, pine removal would eliminate the safety hazard posed by trees that are nearing the end of their lifespan and improve the forest environment in the long term.

Cumulative Effects

These alternatives would contribute somewhat to alleviating the overall shortage of outdoor recreational opportunities in Indiana. The SCORP lists several activities that would attract more participation if facilities were available, known as the latent demand (IDNR 2000b). On this list of activities that could increase with increased availability of facilities, camping is listed as second, fishing third, picnicking fifth, swimming sixth, and boating ninth. The Forest provides opportunities for all of these activities at developed recreation areas. Demand for almost all activities is expected to increase because outdoor recreation trends indicate a high rate of growth (Cordell and Overdevest 2001).

If new recreation development occurred in addition to other management actions such as vegetative manipulation, another effect would be a cumulative reduction of undisturbed acres.

Alternative 2

Under this alternative, the Forest would construct no additional major sites. If demand increased, developed recreation sites would likely become overused and subject to crowding and increased resource impacts. With this alternative, the Hoosier would not consider undeveloped NFS land for recreation site development, and therefore the alternative would not affect activities that require large blocks of undeveloped land, such as hunting or seeking solitude.

Cumulative Effects

This alternative would not help alleviate the overall shortage of outdoor recreational opportunities that require developed sites in Indiana, nor would it contribute to meeting expected increases in demand. The SCORP documents these shortages (IDNR 2000b).

Dispersed Recreation

Affected Environment

Many people visit a national forest to recreate in an environment removed from the developed settings found in day-to-day living. The Forest offers such visitors an unstructured recreational experience that does not require buildings or services and where crowds are unlikely. This is the opportunity to “get away from it all.” This opportunity is available on 97 percent of the Forest (all NFS land except MA 7.1) in the undeveloped forestland known as the general forest area. These lands are generally any area that is not part of a developed recreation area and has few improvements or facilities. Dispersed recreation areas are grouped in three categories.

Road Corridors

Approximately 1,000 miles of secondary roads crisscross the Forest. In most cases, Forest policy allows roadside parking and camping, and many users take advantage of this opportunity, particularly during the fall hunting season. There are no facilities other than a cleared and possibly hardened area to get off the road. There are an estimated 300 such sites available on the Forest. This opportunity fills an important niche, because there are few places in Indiana where a user can simply pull over to the side of a road and camp on NFS land. Sightseers who simply want to drive through the Forest at low speeds away from traffic also use the road corridors.

Blocks of Public Land

Indiana has only 4 percent of the land base available for outdoor recreation (IDNR 2000b). Large blocks of public land are particularly desirable. The Forest consists of numerous tracts of land, ranging from just a few acres of "stand alone" tracts to several thousand acres of contiguous Forest ownership. While almost all NFS land is available for outdoor recreation, the larger blocks of NFS land provide a more desirable experience for those seeking solitude. These larger land holdings allow activities that require more space such as long distance trails, solitude, and hunting. These lands may contain caves, forested areas, old home sites, old roads, openings, ponds, and steams. Several management areas encompass the general forest area and provide different management guidance. Use and restrictions vary accordingly.

Wilderness

Wilderness, as defined by law, provides an opportunity for solitude, is undeveloped, and is affected primarily by the forces of nature rather than by humans. To promote these values, additional rules and regulations are in effect, and development is limited only to trails. For example, the law does not allow wheeled vehicles, and the managing agency must use primitive techniques for trail maintenance. This type of opportunity lends itself well to experiencing remote recreation.

The Charles C. Deam Wilderness was designated in 1982. The Wilderness covers almost 13,000 acres and is bounded on three sides by roads and on one side by a lake. In addition, a county road bisects the Wilderness. The terrain is rugged by Midwestern standards and has steep ravines, and it is heavily forested, predominantly with hardwood species but also nonnative pines. Popular recreational uses include backpacking, deer hunting, hiking, and horseback riding. A horse camp provides a major access point for horse riders, and three other trailheads provide parking. There are 32.9 miles of designated trail for horse and hiking use and 4.9 miles of hiking only trail. No other amenities are provided.

Alternatives and the Effects of Management on Dispersed Recreation

All Alternatives

Under all alternatives, the Forest would continue to provide dispersed recreational opportunities as identified in the Affected Environment section above. Forest visitors would continue to use and enjoy the Forest for those purposes. There would be no short-term change to current conditions, regardless of the alternative selected. There would also be no long or short-term change to wilderness conditions or management, regardless of the alternative selected.

Human recreational use of an area inherently causes a number of impacts, and they would likely continue. These may include human waste accumulation, litter, soil erosion or compaction, user conflicts such as overcrowding, and vandalism. However, education, enforcement, and proper design and maintenance mitigate and minimize such impacts. Experience with managing these impacts over the last planning period indicates their effects on the environment are generally minimal. Another effect of these alternatives would be the need for the Forest to continue to manage the dispersed recreation function. These management activities include, but are not limited to, educational programs, hazard tree removal, law

enforcement, maintenance of pull-offs, mowing, trash pickup, vegetation removal, and vista clearing.

Road access is a common element to recreational visits in all alternatives. If visitors could not get to the Forest, visits would be expected to decline. National forest visits are estimated from the existing National Visitor Use Monitoring that occurred on the Forest in 2002 and 2003 (USDA FS 2004e). The survey asked visitors questions about their experiences and influences on them, such as why they came to the Forest.

Closed roads and roads not usable by passenger vehicles are not included in Table 3.48, but such roads are available for foot travel. “Miles of road open for public vehicle travel” is approximately equivalent to the miles of Maintenance Level 3 and 4 roads.

Cumulative Effects

Nationwide, the trend of most categories of outdoor recreation use is upward (Cordell and Overdevest 2001), and the State has identified overall shortages (IDNR 2000b). The State of Indiana, in concert with other governmental and non-governmental organizations, has identified a goal of acquiring 60,000 additional acres statewide for public use by the year 2016 (Indiana Heritage Trust 2004). If successful, this action would provide outdoor recreational opportunities that would supplement those on the Hoosier and help reduce the expected shortage of recreational opportunities. It is not known if this goal can be met, if it would be enough to meet demand, or if these acquisitions would occur close enough to the Hoosier to influence demand on the Forest.

Alternatives 1, 3, 4, and 5

Under these alternatives, vegetative management, such as timber harvest, openings maintenance, chemical treatment, and prescribed fire, is permitted in some management areas. In those management areas where such activities would be allowed, Forest visitors would likely have mixed views depending on their recreational pursuits. For example, mushroom hunters may enjoy increased success in a prescribed burn area, but sightseers may be unhappy with blackened trees. Squirrel hunters may be unhappy with the loss of trees in a logged area, while turkey and grouse hunters may welcome the open habitat. Effects are also long and short term. Initially, those visitors seeking a natural-appearing forest would not find it in a logged area. However, after a number of years have passed, the area would again take on a natural appearance. A complete discussion of the effects of vegetative management is found in the Plant Communities section.

These alternatives allow the construction of new ponds and lakes, which would result in additional opportunities for fishing, boating, and swimming. A long-term effect of pond and lake construction would be the ongoing maintenance required to maintain the dams and any support facilities such as access roads and trails.

Cumulative Effects

These alternatives would contribute somewhat to alleviating the overall shortage of outdoor recreational opportunities in Indiana by continuing to offer dispersed recreational opportunities. Outdoor recreation trends indicate high growth of demand for almost all activities (Cordell and Overdevest 2001). The SCORP lists three water-based activities in the top 10 activities (IDNR 2000b). Fishing is ranked third, swimming fifth, and boating tenth. It also lists similar activities in the top 10 latent demand list (defined previously). Fishing ranked third, swimming sixth, and boating ninth. These alternatives could help meet the statewide demand for water-based

recreational opportunities by providing ponds and lakes in a part of Indiana where few large bodies of water exist.

Alternative 2

Under this alternative, there would be little or no vegetative management. This alternative would be beneficial for those Forest visitors who prefer a natural-appearing setting, but would not meet the needs of Forest visitors who desire activities related to manipulation of the Forest environment. For example, sightseers would welcome a forest setting that has no blackened or cut trees, but turkey hunters might complain about the loss of forest openings when trees and other vegetation gradually encroached on them.

The Forest would not construct new ponds or lakes and therefore would not provide additional facilities to meet demand for water-based activities such as swimming, boating, and fishing.

A new management area, MA 9.3, would be created which would emphasize dispersed recreation. This would benefit those visitors who prefer a natural-appearing landscape and a more primitive experience. There would be less long-term maintenance needs with this alternative, because there would be fewer facilities to maintain.

Cumulative effects

This alternative would not contribute to reducing an overall shortage of water-based activities in the State because no new ponds or lakes would be built. In addition, this alternative would not contribute to reducing an overall shortage of those dispersed recreation activities that depend on vegetative management. For example, hunting and nature viewing can benefit from vegetative management, but such benefits would not occur because there would be no vegetative management. The SCORP documents these shortages (IDNR 2000b).

Alternative 3

Alternative 3 would plan to increase the number of hardened dispersed sites and pull-offs. This action would provide more opportunity and access for visitors seeking a dispersed recreation setting. However, the addition of such sites would increase the maintenance burden and associated costs on the Forest.

Cumulative Effects

This alternative would help alleviate a statewide shortage of opportunities for undeveloped recreation such as hunting or observing nature. The SCORP documents these shortages (IDNR 2000b).

Trails

Affected Environment

The Forest currently offers approximately 249 miles of trails for use by hikers, horseback riders, and mountain bikers.

Many people visit the Hoosier for a trail experience. The 2003 visitor use study determined trail use by activity. The study did not separate the percentage of hikers and walkers who used Forest trails rather than roads, nor did it separate the percentage of bicyclists who biked on

trails rather than roads. However, that data did indicate five percent of Forest visitors ride horses, an activity generally done only on Forest trails. Based on trail permit sales and patrol logs, the Forest has estimated the following trail use (Strout 2004) (Tables 3.49 and 3.50).

Table 3.49

USER TYPES OBSERVED ON MULTIPLE USE TRAILS IN 2003

User Type	Percent of Users
Hikers	34
Horseback riders	55
Mountain bike riders	11

Table 3.50

TRAIL PERMIT SALES IN 2003

User Type	Number of Rides
Horseback riders	28,330
Mountain bike riders	5,400

In addition, the SCORP provides useful information about trail use in Indiana. That document lists hiking, jogging, and walking as the number one outdoor recreational activity in Indiana. Biking ranked ninth and horse riding ranked twentieth. The study did not differentiate between mountain biking and road biking. Walking, hiking, and jogging ranked as the number one latent demand activity. Again, latent demand is a measure of activities people would be most likely to participate in if adequate facilities were available. The ranking of latent demand for mountain biking was seventh (tied with another activity), and eleventh for horse riding (IDNR 2000b). The data collected in Indiana is consistent with national trends indicating an increase in demand for all three types of use (Cordell and Overdevest 2001).

Other studies also provide helpful information. The USDA National Agricultural Statistics Service (NASS) reports that Indiana ranks fifteenth in the United States for equine population, suggesting many people own horses and need places to ride them (USDA NASS 1999). In addition, a social assessment conducted for the Hoosier indicated 88 percent of the people interviewed for that study liked or strongly liked the Hoosier for hiking (Welch *et al.* 2001).

Current Policies

The Forest provides multiple-use trails shared by hikers, horseback riders, and mountain bike riders to optimize the number of trail miles for each user group. Because the Forest is small, there is limited space to provide separate trails for each user group and still offer adequate miles. Most large blocks of the Forest already have a trail system in place. The majority of the large trail systems are multiple use, although some hiking-only trails are available. Trails are open to year-round, all-weather use. To accommodate the multiple use and all-weather use, the Forest has armored approximately 50 percent of the multiple-use trails with crushed limestone and shaped them with heavy equipment to improve drainage. The Forest maintains a trail plan that identifies existing and proposed trails, criteria for special use trails, supplemental trail standards, and a schedule of proposed projects (USDA Forest Service 2002e).

Horseback riders and mountain bike riders are required to ride only on trails designated for that type of use or on roads open to public use. The Forest prohibits off-trail riding. Horseback riders and mountain bike riders pay a fee for trail use.

Adjacent landowners who wish to access the trail system may apply for a special use permit to do so. At the time of Plan revision the Hoosier had issued nine permits for a total of 16 miles. Three of these permit holders are to commercial horse camps, and one additional commercial horse camp accesses the Forest via a county road.

The 1985 Forest Plan, as amended, prohibited OHV use except on roads open to public transportation.

Trailheads

All trails have at least one trailhead. Five horse camps double as trailheads, and users can access trails from almost all developed recreation sites on the Forest. Although known as horse camps, any Forest visitor may use those areas for camping, picnicking, or trail access. Trailheads that are not also horse camps generally provide parking and a bulletin board. The parking is designed to accommodate the desired use at that site and therefore may not always accommodate trailers.

Table 3.51 summarizes trail opportunities on the Hoosier.

Table 3.51

TRAILS ON THE HOOSIER NATIONAL FOREST

Trail Name	**Use Type**	**Approx. Miles**
Birdseye	Multiple-use[1]	12
Brown County D	Horse/hike	2
Celina Interpretive	Hike	1
Fork Ridge	Hike	3
German Ridge	Multiple-use	24
German Ridge Lake	Hike	1
Hardin Ridge	Hike/bike	2
Hemlock Cliffs	Hike	1
Hickory Ridge	Multiple-use	47
Lick Creek	Multiple-use	7
Mogan Ridge West	Mutliple-use	12
Mogan Ridge East	Hike	7
Nebo Ridge	Multiple-use	9
Ogala	Multiple-use	6
Oriole West	Multiple-use	7
Oriole East	Multiple-use	9
Pioneer Mothers	Hike	1
Shirley Creek	Multiple-use	19
Saddle Lake	Hike	2
Springs Valley	Multiple-use	8
Tipsaw	Hike/bike	6
Twin Oaks Interpretive	Hike	1
Two Lakes Loop	Hike	16
Wilderness West	Horse/hike	31
Wilderness Sycamore	Hike	5
Youngs Creek	Multiple-use	10
Total		249

[1] Includes hiking, horseback riding, and mountain bike riding.

Off-highway Vehicles

The Hoosier does not currently permit off-highway vehicle use, except on roads open to public transportation and in accordance with local regulations. A variety of off-highway motorized vehicle uses have been discussed on the Forest for at least the past 30 years. Although the Forest Service prohibited OHV use in the Forest in the mid-1970's, it remains a contentious issue (Welch *et al*. 2001).

For this document, an OHV is a general classification including all-terrain vehicles (ATV's), off-highway motorcycles (OHM's), off-road vehicles (ORV's), and snowmobiles. Table 3.52 presents the definitions for off-highway vehicles used in this document.

Table 3.52

OFF HIGHWAY VEHICLE DEFINITIONS

Vehicle	Acronym	Definition
All-terrain vehicle	ATV	Motorized, floatation-tired vehicles with at least three but no more than six low-pressure tires, 50 inches or less in width, with an engine displacement of less than 800 cubic centimeters (cc).
Off-highway motorcycle	OHM	Motorized, off-highway vehicles traveling on two wheels. OHM's have a seat or saddle designated to be straddled by the operator and have handlebars for steering control. Motorcycles may be legal for highway use and still considered to be OHM's when used for off-highway operations on trails or across natural terrain.
Off-road vehicle	ORV	Motorized, recreational vehicles capable of cross-country travel on natural terrain, such as 4-wheel drive trucks and ATV's that have an engine displacement of more than 800 cc and/or width of more than 50 inches.
Snowmobile		A self-propelled, motorized vehicle not exceeding forty inches in width, designed to operate on ice and snow, having a ski or skis in contact with snow and driven by a track or tracks.

Many people consider riding OHV's a legitimate use of NFS land, but others are concerned by the potential resource damage (USDA FS 2003a). OHV's provide an opportunity for the members of the public to explore public lands. Many people feel the hilly terrain and fragile soils in the Hoosier make OHV use unsuitable and destructive to the natural habitat. However, some users, even those who view OHV use as an unfavorable activity, recognize that all residents should have the opportunity to engage in activities of their choice in the Forest (Welch *et al.* 2001).

The Statewide Comprehensive Outdoor Recreation Plan (SCORP) provides useful information about trail use in Indiana. However, it is difficult to determine OHV trail needs based on the

SCORP, as all motorized vehicle activities (ATV, OHM, ORV, pleasure driving, and snowmobiling) were included as one category. Motorized vehicle use ranked as the fourteenth latent demand activity (IDNR 2000b). Again, latent demand is a measure of activities people would be most likely to participate in if adequate facilities were available. There have been no formal studies addressing the demand for OHV trails by type and amount in Indiana. Because of this, it is difficult to determine what user preferences are and what the exact need is.

Currently, there are six State, county, or privately owned OHV riding areas in Indiana (IDNR 2004). At the time of the last forest planning process, there were no organized OHV-riding opportunities in Indiana.

Illegal use of OHV's is a problem on the Forest. Illegal use includes riding on roads, trails, and unclassified roads closed to OHV's. The Forest is working with local law enforcement officials to help identify and cite individuals who ride illegally.

The Forest Service is currently developing national policy to help national forests properly manage designated OHV trail systems. This policy will address unmanaged recreation (traveling off designated trails) and may limit OHV use to a well designed and constructed trail system.

Region 9 has also developed suggested standards and guidelines for OHV trail systems. Specifically, it suggests prohibiting the use of unclassified roads and trails. Unclassified roads and trails are routes not needed or managed as part of the Forest transportation system. These include unplanned user-created routes, abandoned roads, or other routes not designated as a road or a trail. It has also been strongly recommended that OHV trails on national forests not provide challenge, mud hole, scramble, or hill climb areas (USDA FS 2003b).

Vehicle Analysis

Off-highway vehicles recreation includes the use of vehicles such as ATV's, dune buggies, four-wheel drives, motorcycles, and snowmobiles. Each activity then ranges from casual family use to intense competition (Boston *et al.* 1997). The Forest does not have the land base or the physical terrain to provide a broad array of opportunities for all types of OHV users or all experience levels. Only a finite amount of activity can be placed on any given piece of land (Fogg 2002). For example, south central Indiana does not receive adequate snowfall to accommodate snowmobile use. Similarly, the lack of beaches and large open sandy areas precludes opportunities for dune buggies. For this analysis, OHM's, 4-wheel drive vehicles, and ATV's were considered.

Off-highway motorcycles require a relatively smooth trail with some obstacles (USDA 1991). Trail design for OHM's and ATV's are very similar. However, if a multi-use trail is not designed well for the variety of users, none of the user groups would be likely to enjoy the area. OHM's can cover more distance than other forms of OHV's. An experienced rider can ride approximately 50 miles in an average day. Some riders can cover over 100 miles of trail (USDA 1991). Fogg (2002) also suggests OHM trails up to 100 miles in length. An area to accommodate an adequate OHM trail system does not exist on the Forest.

Four-wheel drive vehicles require a route design different from what is needed for other forms of OHV's. Four-wheel drive routes should be very rugged and technically challenging: They should test both the equipment and driver's skills (Fogg 2002). Four-wheel drive routes can have a greater disturbance on the resource to meet the challenges required for both the driver and equipment. Four-wheel drive routes require a larger footprint on the land and, for safety

purposes, should be two-way roads (Fogg 2002). Some activities such as hill climbs, rock runs, winch runs, and other challenge courses used by four-wheel drive recreationists would not be in accord with the proposed Forest Service regulations and Region 9 guidance.

Four-wheel drive vehicles have been, and will continue to be, used within the boundaries of the Forest on roads open to the public. However, the existing public road system does not provide a rugged and technically challenging opportunity. Closed Forest Service roads, such as logging roads, would also not provide challenging opportunities.

Off-highway vehicle recreation, particularly the use of ATV's, continues to be among the fastest growing outdoor recreational activities (State of New Hampshire Department of Resources and Economic Development 2003). All-terrain vehicles require a relatively smooth trail with some obstacles (USDA 1991). All-terrain vehicle trails require at least 15 miles of trail to provide a 3- to 6-hour ride (Fogg 2002).

In isolated instances, certain trails, by their nature, are appropriate for single use (Collins 1994). The single most important key is adequate mileage of high quality and competently designed trails (Wernex 1994). Limitations established by regional and national direction, OHV resource protection restrict the opportunities to develop OHV areas on the Forest. Only Alternative 3 would allow OHV use, and it would limit such use to a specified trail system that could be developed under that alternative. It would emphasize family-oriented trails for ATV's only. These trails would be intended for families and individuals to enjoy scenic beauty, wildlife viewing, and other recreational opportunities, but not offer technically challenging opportunities such as hill climbs and muddy areas. Families often combine a trail-riding weekend or vacation with camping, fishing, hunting, visiting other tourist attractions, and other active recreational activities such as mountain biking or canoeing (AMA 1995). The objectives of this type of use differ little from the objectives of non-motorized trail users (Gaede 1997).

Analysis Area

Alternative 3 proposes an ATV trail system. The Hoosier would not consider some areas on the Forest for a potential ATV trail system because of current land management strategies. The Charles C. Deam Wilderness (MA 5.1) cannot be considered because the 1964 Wilderness Act and Public Law 97-384, 96 Stat. 1942 prohibited motor vehicles, motorized equipment, and other forms of mechanical transport in the Wilderness. The Hoosier also excluded from consideration areas on the Forest with a ROS class of primitive or semi-primitive (MA 6.2 and MA 6.4). In addition, the Hoosier excluded developed recreation areas (MA 7.1) from consideration because of their limited size and potential conflict with developed recreation users. In addition, the Forest also eliminated from consideration areas with special management requirements (MA's 8.1, 8.2, and 8.3) because of their limited size and because they are managed for research and protection of biological, botanical, and geological resources. Finally, MA 2.4 was eliminated due to concerns for riparian values in these areas. Only MA 3.5 would be considered for a potential ATV trail system.

The Hoosier is very fragmented, which makes it difficult to find a location suitable for a long-distance trail system. There would be 48 different MA 3.5 areas on the Forest with Alternative 3. Twenty-seven of these areas are less than 100 acres and 38 are less than 1,000 acres. Of the 10 areas in MA 3.5 greater than 1,000 acres, many have county roads or existing multiple-use trails, are adjacent to wilderness, or have linear or narrow ownership patterns.

Distance and Acreage Needs

To provide appropriate opportunities for OHV users, a system needs to be long enough to provide quality riding experiences. According to the American Motorcycle Association, trail planners should provide at least 60 miles of trail in a trail system (Wernex 1994). Another OHV construction guidebook states the minimum length should be at least 15 miles (Fogg 2002). The Daniel Boone National Forest in Kentucky states that trail-riding opportunities should be at least 15 miles or more in length (USDA FS 2004d). The Hoosier will not consider any ATV trails less than 15 miles in length.

To support a long-distance trail system as required for OHVs, additional space for parking, sanitary facilities, picnicking, and camping would also be needed. Environmental constraints would also affect actual trail density. Site requirements are always greater due to constraints and adverse conditions. Calculated space requirements should be doubled to determine the area needed (Fogg 2002). According to Fogg (2002) to accommodate a minimum of 15 miles of ATV trail system, approximately 1,700 acres would be required. However, the Hoosier considered areas 1,000 acres or greater.

Alternatives and the Effects of Management on Trails

All Alternatives

Under all alternatives, the Forest would continue to provide trail opportunities, and trail use would continue.

Recreational use of a trail inherently leads to a number of impacts, and such impacts would likely continue. These may include human and horse waste accumulation, litter, soil erosion or compaction, user conflicts such as overcrowding, and vandalism. However, education, enforcement, and proper design and maintenance minimize such impacts. Experience with managing these impacts over the last planning period indicates their effects on the environment are generally minimal. Potential management actions for dealing with horse trail impacts on the Forest are documented in a recent trail study conducted by Virginia Tech (Aust 2005).

All alternatives require the Forest to continue to manage the trails. Management activities include, but are not limited to, brushing, drainage control, educational programs, hardening, hazard tree removal, law enforcement, mowing, new trail construction, trailhead maintenance, trail relocation, trash pickup, and vegetation removal.

On roads, trails, and areas where OHV uses are prohibited, motorized access may be allowed for law enforcement, emergencies, firefighting, and other administrative purposes.

Roads also affect recreation by providing or not providing access to facilities and areas of the Forest. Most of the road mileage needed on the Forest for access is already provided by the existing system, but small amounts of additional access would likely be provided by the alternatives.

Cumulative Effects

A cumulative effect of all alternatives would be the continued contribution toward meeting the overall need for trail opportunities in Indiana. In general, trail use is on an upward national trend (Cordell and Overdevest 2001), and the lack of public land for trail use has been identified as a statewide issue (IDNR 2000b). The State of Indiana, in concert with other governmental and

non-governmental organizations, has identified a goal of acquiring 60,000 additional acres statewide for public use by the year 2016 (Indiana Heritage Trust 2004). If successful, this action could provide additional land where the Hoosier could construct new trails that would supplement what is offered on the Forest. It is unknown if this effort would be successful, if it would be enough to meet demand, or if these acquisitions would occur close enough to the Hoosier to influence demand on the Forest. The IDNR ended a long-time ban on mountain bikes and is now offering this opportunity on some properties. This action will help meet the statewide demand for that trail-related activity.

Areas, roads, or trails where OHV use is prohibited for the general public also apply to persons with disabilities because a program cannot be fundamentally altered for the purpose of their access. However, an exception is the use of a wheelchair (meeting legal definition) wherever foot travel is allowed (Paterson 2002).

Illegal OHVuse would likely continue at current levels, as would the Forest Service's ability to enforce OHV closures.

Alternatives 1, 4, and 5

These alternatives focus on multiple-use trails open for year-round use. There would be no short-term change from the current conditions. Some users prefer single-use trails. These alternatives would allow an expansion of multiple-use and hiking-only trails if demand were to increase. These alternatives would not provide any OHV opportunities.

Cumulative Effects

These alternatives would help alleviate the statewide shortage of trail opportunities for horse and bike use, and to a lesser degree for hiking. The SCORP documents these shortages (IDNR 2000b). Not providing OHV opportunities in the Forest means that riders would have few places to ride on public lands in Indiana. Those interested in riding OHVs would have to travel to locations in Indiana that provide opportunities or to adjacent states.

Alternative 2

This alternative proposes several changes from existing policy:

- focus on hiking trails by limiting new construction only to hiking trails with no net increase in horseback and mountain bike trails
- close some trails to horse and bike use during wet weather seasons

One effect would be the inability of the Forest to respond to any increases in demand for horse and bike use. Currently, most of the large blocks of the Forest are occupied by multiple use trails that require longer miles, and have limited opportunities for expansion. Hiking trails would be easier to accommodate because they require fewer miles and less acreage.

The seasonal closures would likely be helpful in maintaining the trail surface on those trails that have not been hardened or are in particularly wet areas. However, enforcement would be difficult given few law enforcement officers and the dispersed and remote locations of the trails. These closures could result in more concentrated use elsewhere, which might cause more impacts on those trails that were not seasonally closed. Users may be unhappy with the loss of riding opportunities during the closure period.

This alternative would not provide any OHV opportunities.

Cumulative Effects

This alternative would help alleviate the identified shortage of hiking opportunities in Indiana but would not contribute to alleviating statewide shortages identified for horse and bike trails. The SCORP documents these shortages (IDNR 2000b). Not providing OHV opportunities in the Forest means that riders would have few places to ride on public lands in Indiana. Those interested in riding OHVs would have to travel to locations in Indiana that provide opportunities or to adjacent states.

Alternative 3

This alternative would require a seasonal horse trail closure in the Charles C. Deam Wilderness and an ATV trail system.

The seasonal closures would likely be helpful in maintaining the trail surface on those trails that have not been hardened or are in particularly wet areas. This is more of a concern in a Congressionally designated wilderness because trail maintenance must be done using primitive means, and for that reason, maintenance is generally more expensive, difficult, and time consuming. Enforcement would be feasible because the Wilderness has only five access points and is a relatively small area to patrol. These closures could result in more concentrated use outside of the wilderness, which might cause more impacts on other trails. Users may be unhappy with the loss of riding opportunities during the closure period.

ATV Trail System

Alternative 3 would allow development of an ATV trail system, but only after following site-specific environmental analysis. The Forest would develop an ATV trail system where appropriate, while meeting environmental and social concerns. A trail system would have to be at least 15 miles in length to be considered.

Managed motor vehicle challenge areas and trails developed to include activities such as mud holes and scramble areas are not an appropriate use of national forests and will not be considered.

Trespass on Private Land

Potential trespass of ATV's on private land surrounding an ATV trail system has been a concern of our neighbors for some time (USDA FS 1987). Trespass is also a concern to the Forest Service. The potential for trespass exists with any adjacent landowner, but is aggravated when one owns land adjacent to public property where public use is greater.

Limiting ATV's to designated trails would reduce the potential for riders to leave the trail system and accidentally ride on private property. An ATV trail system would be a focal point for trail ranger and law enforcement patrol to help keep riders on the designated trail system.

Noise

The presence of ATV's on public lands has created many conflicts between motorized users and non-motorized users. Some non-motorized recreational users on the Forest may find ATV engine noise obtrusive. Trail developers may use the natural characteristics of a trail to minimize the effects of sound. Trails located on the backside of ridges, as well as trails that face away from neighboring homes or other sensitive areas, would be quieter than trails built on top of ridges or facing noise-sensitive areas. Vegetation such as thick grass or shrubbery could

also help reduce the distance that ATV sounds travel (Wernex 1994). Studies in Minnesota have shown that noise impacts can be minimized using vegetative screening and sound-proof distances from other public use areas.

To comply with noise regulations, many national forests require that all ATV's have a properly functioning spark arrestor and muffler (USDA FS 2002c).

The United States Environmental Protection Agency (EPA) has recently adopted noise emission standards for new non-road engines. In the long-term, this standard would reduce total noise levels as older non-regulated vehicles are replaced (EPA 2002b). The Forest would take appropriate measures to ensure that an ATV trail system complies with the EPA noise standards, Indiana noise standards, and the Noise Control Act. However, compliance with noise standards does not mean that everyone would find noise levels acceptable. Different people have different sensitivity levels to noise.

Emissions

All-terrain vehicles produce combustion-related emissions, including aldehydes, carbon monoxide, hydrocarbons, nitrogen oxides, particulates, and other compounds. Studies have shown that high traffic areas can exceed air quality standards, but effects are localized and temporary (MDNR 1995).

The EPA has recently adopted emission standards for new non-road engines. In the long term, these standards would reduce total emission levels as older non-regulated vehicles are replaced (EPA 2002). The Forest would ensure that an ATV trail system complies with the Clean Air Act and EPA and Indiana air quality standards.

Cumulative Effects

The opportunity for expansion or additions of new trails for other types of users may be limited if an ATV trail system takes up available space.

A cumulative effect of this alternative is the contribution to meeting the need for trail opportunities in Indiana. In general, trail use nationally is trending upward (Cordell 1999), and the lack of public land for trail use has been identified as a statewide issue (IDNR 2000b). Nationwide, there has been a 600 percent increase in OHV use since 1972 (USDA FS 2003a). This alternative would contribute somewhat to alleviating the overall shortage of ATV opportunities in Indiana by offering family trail riding opportunities.

This section refers to effects of legal use of ATVs on the Forest. Illegal ATV use on the Forest is likely to continue.

Provide a Useable Landbase

The Forest recognizes the importance of a usable landbase to provide opportunities for recreational use and a diverse ecosystem. The Hoosier land adjustment program strives to provide an accessible landbase and protect watersheds, culturally rich areas, and other unusual areas, such as riparian areas and cave and karst features. The Forest places an emphasis on locating boundary lines to identify NFS lands for forest users and to protect the public's interest in these lands. The Forest is committed to a viable acquisition and exchange program to consolidate NFS lands.

Topics addressed in this section include land ownership and adjustment and the transportation system.

Land Ownership and Adjustment

Historically, national forests in the eastern United States were established in areas where land values, land productivity, and economic levels were low. The hill country of Indiana was no exception.

The Forest boundary delineates the area within which the Hoosier may purchase lands from willing sellers. The area inside the Forest boundary is about 644,130 acres; however, NFS land comprises a net ownership of approximately 31 percent.

The Hoosier continues to acquire lands through purchase or exchange. The Forest Service purchases land from willing sellers when funds are available. Congress allocates money for acquiring land through the Land and Water Conservation Fund.

The Hoosier acquires lands through donations and exchanges of isolated NFS lands for private tracts that further consolidate NFS lands and meet the land adjustment strategy. Land exchanges with the Forest Service allow both private and public ownerships to become more efficient to manage. The Forest negotiates land adjustment activities with a willing seller or land exchange proponent.

Appendix E of the Forest Plan contains a land adjustment strategy.

An active land exchange and acquisition program allows the Forest to acquire areas with special or unusual features. If these lands become NFS land, they can be better protected and their special qualities maintained into the future. After acquisition, the Hoosier would place a newly acquired national forest tract in the management area of the surrounding or adjacent lands. Use of the land by the former owners is discontinued upon acquisition, although in rare cases a reservation is negotiated with the former landowner.

National forests in the East and Midwest are intermingled with private and other public lands. Close coordination with State, county, and city governments, as well as with private individuals, is necessary to ensure compatible land use and the accomplishment of resource management objectives.

The ability of the Forest to provide benefits to the public depends on the size, shape, and location of NFS lands. Consolidation of NFS lands facilitates the public's enjoyment of the Forest without a fear of trespass on private land.

Many of the traditional issues surrounding the Hoosier result from an inadequate landbase. Current ownership has not been adequate to meet the conservation and outdoor recreation demands placed on the Forest. Several interest groups desire use of the same area. A larger landbase could more easily provide areas for these conflicting uses.

Alternatives and the Effects of Management on Land Ownership and Adjustment

All Alternatives

As the NFS land area increases in Indiana, the effects of forest stewardship become more evident. This may influence attitudes toward land management philosophies on private as well as public lands.

Forest Service land exchanges provide both private and public ownerships the opportunity to become more efficient to manage. Acquiring or exchanging land alters access and use patterns on the Forest as well as on adjacent lands. Acquisition of rights-of-way could increase traffic in an area, thereby increasing its use. Properly located and marked ownership boundaries reduce the potential for trespass.

Land adjustments could identify new areas or add to existing areas of biological, cultural, ecological, geological, or scientific interest and help protect and manage these resources.

Acquisition of private in-holdings may reduce the need to provide road across NFS land to private lands. Land adjustments could also provide access to NFS land parcels without access. The need for access to private lands would be evaluated on a case-by-case basis. Private land sometimes blocks access to NFS land. In addition, much of the NFS land is on ridges away from streams and potential lake development sites, which limits public access to existing and potential recreational water.

Consolidation of NFS land in all alternatives improves access for recreational activities and opportunities for trail development, lake construction, and stream access. This would also reduce the potential for trespasses.

Some land adjustments eliminate the need for maintenance of individual road segments. Roads may no longer be needed as access to private land if the need is eliminated by land adjustments. A county may abandon or vacate roads no longer needed for Forest or private access.

Land adjustments would change the local tax base. Further discussion on the effects from land adjustments on county tax bases can be found in the effects section of Provide for Human and Community Development.

Cumulative Effects

Land ownership and land adjustment affect all Forest activities and programs. A suitable accessible landbase is required to provide public outdoor recreation opportunities, protect unique or important features and areas, protect water quality and riparian habitat, provide suitable habitat for sensitive species and other wildlife species, and provide a visually pleasing landscape for future generations of forest users. Although relatively small compared to the

acreage of other national forests, the Hoosier provides an important “island of green in a sea of people” for the people of Indiana.

Private lands may provide many opportunities for outdoor recreation, but most private landowners cannot provide opportunities for wilderness or backcountry experiences such as found on larger tracts of NFS land.

Private farmland acquired in land adjustments represents a very small decrease in the total farmland in the state. Water quality in streams would benefit from the decrease of farm fertilizers and chemicals used in flood plains. Adjacent private landowners may still use chemicals and fertilizers, but no (or little) chemical or fertilizer use on NFS land would contribute to a slight improvement in water quality.

The Hoosier manages forested land acquired in land adjustments for wildlife habitat, diverse biological habitats, and healthy forest conditions. The effects of a landbase managed for a variety of uses differs greatly from private forested lands where the main intent is management for timber production. The cumulative effect of both ownerships is diverse wildlife habitat.

Some lands formerly under NFS management but now private lands because of land exchanges are managed as private forest lands with timber management as the main objective. Adding these lands to the private timber management landbase provides jobs and materials to rural areas of the state. Some former NFS land may be divided into small rural tracts.

Transportation Network

The Forest road network consists of 1,890 miles of roads that serve southern Indiana and the Forest. Most of these roads are under the jurisdiction of local governments or the State of Indiana. Major highways intersect the Forest in both the east-west and north-south directions, including Interstate 64, U.S. Highways 50 and 150, and State Highways 37, 58, 60, 64, 135, 145, and 446.

County governments maintain approximately 825 miles of all-weather roads that are a part of the Forest road network. An additional 150 miles of county roads presently exist on NFS lands but are not maintained. Four-wheel drive vehicles are being used on approximately 50 miles of these unmaintained roads. The remaining 100 miles are generally overgrown and impassable. Approximately 432 miles of State-maintained all-weather roads are a part of the Forest road network.

The remaining 483 miles of roads are under Forest Service jurisdiction. Of these, 436 miles are seasonal, high clearance vehicle roads under Forest Service jurisdiction and are generally gated and used for administrative purposes.

When the term Forest road network is used, it includes all Forest Service roads on NFS lands and State and county roads outside of Forest Service ownership. For example, portions of roads used to access the Forest from a logical thoroughfare such as US Highway 50 or State Highway 145 are included. Network roads can even be outside of the Forest boundary. Table 3.53 displays inventoried and maintained roads on the Forest by maintenance level. Maintenance levels are described below.

Table 3.53

EXISTING INVENTORIED AND MAINTAINED ROADS
BY MAINTENANCE LEVEL

Maintenance Level	Miles
Maintenance Level 1:	401
Maintenance Level 2:	46
Maintenance Level 3:	51
Maintenance Level 4:	5
Maintenance Level 5:	0

Road Maintenance Level criteria summary:

- Maintenance Level 1: This level is assigned to intermittent service roads during the time management direction requires that the road be closed or otherwise blocked to traffic. Basic custodial maintenance is performed to protect the road investment and to keep damage to adjacent resources to an acceptable level. Drainage facilities and runoff patterns are maintained.
- Maintenance Level 2: This level is assigned where management direction requires that the road be open for limited passage of traffic. Roads in this maintenance level are intended for use by high clearance vehicles. Passenger car traffic is not a consideration. Administrative, permitted, other specialized use, or log haul may occur at this level.
- Maintenance Level 3: This level is assigned where management direction requires the road to provide a moderate degree of user comfort and convenience at moderate travel speeds.
- Maintenance Level 4: This level is assigned where management direction requires the road to provide a moderate degree of user comfort and convenience at moderate travel speeds.
- Maintenance Level 5: This level is assigned where management direction requires the road to provide a high degree of user comfort and convenience.

Numerous miles of uninventoried and unmaintained roads exist on the Forest. These are primarily unsurfaced, two-track roads that originated at the turn of the twentieth century when rural farm populations were at their peak in this area. These roads include old farm lanes, wagon trails, and logging roads. Most of these evolved through specific usage and followed the most practical route available at the time. No consideration was given to engineering design and location. Some of these roads are now entrenched up to 10 feet because of compaction and erosion. Erosion depths of 3 feet are common, but the erosion rates have decreased in recent years because limited use by motorized vehicles has allowed them to partially “heal.”

Most of these “old woods roads” are too poorly drained, too overgrown, or too steep for modern wheel-driven vehicles. However, an estimated 50 miles of these roads are receiving considerable unauthorized use by four-wheel drive and high clearance vehicles.

An estimated 30 miles of roads on NFS lands that are not claimed under any jurisdiction represent an additional concern. These include roads to cemeteries, roads or driveways to private in-holdings, and roads to reserved or outstanding mineral resources. The standards, conditions, and levels of use of these roads vary considerably.

Road Development and Operation

Road development and operation activities include constructing, designing, maintaining, managing, planning, reconstructing, rehabilitating, relocating, reusing, and surveying roads. Some of the on-the-ground activities associated with road development and operation are shown below.

Construction, Reconstruction, Relocation, Rehabilitation, or Reuse of Roads

This often involves clearing of rights-of-way timber and other vegetation; earthmoving work; installing culverts and other drainage structures; placing surfacing materials; seeding, mulching and other erosion control work; and erecting gates and signs.

Maintenance of Roads

This includes mowing, brushing, grading, replacing surfaces, cleaning out or replacing culverts and other drainage structures, and re-establishing vegetative cover destroyed by traffic or grading.

Traffic Management

This includes erection of regulatory, warning, and guide signs; imposition of load limits or use restrictions on Forest Service roads; and installation and maintenance of gates or other road closure devices.

Road Closures

Road closures include temporary, intermittent, and permanent closures. Road closure activities can occur on both inventoried and uninventoried Forest Service roads.

Temporary, intermittent, or permanent closure of existing roads to public motorized vehicles is usually done to:

- Protect resources, such as wildlife, heritage resources, soil, or water
- Reduce road or facility management and maintenance costs
- Reduce the impacts to recreation from motorized vehicles

The Forest closes roads (temporarily or intermittently) to public motorized vehicles by installing boulders, earth mounds, gates, posts, or other barricades, and appropriate signing. Permanent closure methods include installing boulders, earth mounds, treetops, or other natural appearing barricades, while allowing natural vegetation to overtake the roadway. Other closure activities include earth-moving work, mulching, seeding, and erosion control work to return the road corridors to their natural conditions. In the case of non Forest Service jurisdictional roads, the Forest Service would gain consensus before initiating the closure.

Alternatives and the Effects of Management on Road Development and Operation

All Alternatives

Table 3.12 displays potential road development by alternative for the next 10 years. These projections are based on the SPECTRUM model, which forecasts timber harvest and its associated activities such as road construction and reconstruction. In general, existing roads would be used. The Forest would use site-specific project planning and appropriate public input to determine exact road lengths and standards for the upgrades of road sections.

Estimates of the miles of construction or reconstruction of all-weather roads open to public motorized vehicles vary from 1 mile (Alternative 2) to 3 miles (Alternative 4) for the first 10 years. These figures are small compared to the total miles of existing all-weather State and county roads on NFS land.

Alternatives 1, 3, 4, and 5

In general, these alternatives have more land in the suitable timber base. Alternatives 1, 3, 4, and 5 would require more dry-weather road construction, reconstruction, and reuse.

Transporting forest products to market places demands on the existing road system. If existing roads are inadequate, they must be reconstructed to make them useable; and useable roads must be maintained to remain serviceable. New roads may sometimes need to be constructed to provide access to remove or manage timber. Trucks hauling timber products increase traffic volumes and the risk of vehicle collisions. Establishing weight limits on haul loads, posting speed limits, and identifying roads open for use are ways to help minimize these impacts.

The Forest expects all four of these alternatives to include construction of canoe and boat access points and associated parking lots along major streams, rivers, and lakes. Some of these facilities would be located in riparian areas and floodplains. The Forest would use proper location, construction, and erosion control measures to mitigate damages to water or riparian values.

Roads disperse use more widely across the Forest. This helps avoid problems with overuse. Linking dead-end roads would increase recreational opportunities in selected areas of the Forest, but most roads constructed or reconstructed would be dead-end access roads.

To be enjoyed and appreciated, the Forest must be accessible. The availability of roads, therefore, is an important consideration for management. Every area does not need a road, and every road need not be open, but providing accessible areas on the Forest and having a comprehensive transportation plan are fundamental. They also provide access for the physically challenged or those otherwise unable to visit areas of the Forest. Properly located and designed roads also allow for a safer, more enjoyable experience.

Removing products from the forest requires roads, and roads are also needed to maintain ponds, wetlands, and openings. Many of these roads are not open to public use, but the Forest Service needs access periodically to perform management activities efficiently. Roads are also important in fire suppression activities. Easy access to an area can minimize damage in the event of a wildfire. Roads also act as a firebreak, slowing or containing the spread of a fire.

Increased public access to public lands would increase the likelihood of dumping, littering, vandalism, and other illegal uses.

Adjacent landowners and the counties generally welcome the construction and maintenance of roads, because they increase local access. Since more roads also bring more people, some who seek a quiet peaceful lifestyle may not appreciate the increased access. Roads may improve access to private property; this change in access may result in a need for rights-of-way or special use permits.

Road reconstruction and maintenance may not be compatible in areas associated with protecting unique features. This could make implementation of management prescriptions for those areas more difficult.

The Forest would meet Recreation Opportunity Spectrum requirements when constructing or reconstructing roads. Roads would be built to the minimum standard width and length necessary to accomplish the intended purpose. The Forest would use special requirements to meet the visual quality objectives for road design, construction, and maintenance. The Forest may designate scenic byways to protect outstanding scenic road corridors.

Road construction and improvements would provide access for resource protection and management. Once this need is met, most roads would be closed to motorized vehicles and may be used for hiking and walk-in access. When the Forest constructs or upgrades roads, it improves them to the minimum standard required to accomplish management activities, which minimizes adverse effects on the characteristics of an area.

Where new roads are constructed, access and use generally increase.

Cumulative Effects

The cumulative effect of any one of these four alternatives in combination with the effects of past actions, ongoing actions and trends, and foreseeable future actions is a landscape with a large number of roads. The roads provide access to many areas and for many uses. Roads make it possible to manage the land and suppress wildfires. Roads may also lead to misuse and vandalism. They can bring disturbance and such uninvited guests as arsonists to the Forest, but Forest Service and other law enforcement officials can use the same roads and cite those who break the laws. Most roads reconstructed or constructed by these alternatives are temporary and would be closed after being used. The Forest may construct woods roads and logging roads to intersect with connector roads. In combination with efforts to protect and enhance the forest and wildlife species, the roads are likely to make enjoyment of the Forest available to many citizens and aid in protecting the resources.

Alternative 2

The Forest does not anticipate that Alternative 2 would result in any road construction. This alternative would not remove any timber products from the Forest, so the Forest would likely reconstruct fewer roads, thus limiting access to remote areas for fire suppression and other administrative activities.

Maintenance for public safety would continue. Existing roads that are currently contributing to the degradation of resources would continue to do so.

Road Closures

Road closures reduce maintenance expenditures yet provide access by foot travel. Closure methods vary and have different degrees of impacts on resources. Roads closed with a dirt mound would experience some soil loss during the construction. Once the disturbed area has become revegetated, erosion potential would be reduced.

Once closed, the road would revegetate. Monitoring will help identify erosion problems. Typical activities available where roads have been closed include hiking, backpacking, backcountry camping, walk-in hunting, and fishing.

Roads closed by obliteration eliminate all future motorized road use. Road obliteration includes reshaping the road to the original contour and revegetating it. Roads closed by gates eliminate public motorized traffic and reduce administrative traffic to only that required in support of management activities.

When closing roads, the Forest may disk and seed them to prevent erosion. The Forest uses a seed mix containing native grasses and forbs to stabilize the soil, provide a protective ground cover, and promote natural re-establishment of sites by native plants. Over time, roads where compaction was not too severe would have pioneer tree seedlings growing in the roadbed and would eventually revert to a forest condition.

Cumulative Effects

The cumulative effects analysis for transportation includes both NFS roads and roads under other jurisdictions inside the national forest boundary.

As mentioned above, roads provide access to the Forest for many uses. Roads also increase noise, sedimentation, and other ecological effects. Alternative 2 would close many lower level Forest roads or allow them to become closed. There would be no appreciable increase in miles of road on the Forest.

The effects of this alternative, in combination with the effects of other past, ongoing, and foreseeable future actions, would be less administrative access and, to some extent, less access for the public. Some administrative costs could increase because of more limited access.

Provide for Human and Community Development

The goal is to be a good neighbor and assist local communities in various ways. The Forest meets many individual, community, and national needs.

Many people find considerable value in the knowledge that the forest is there and will continue to be there and that natural places are available. Communities depend on the Forest for economic balance in providing products, commodities, and services to people. The nation looks to the national forests to provide for national needs such as clean water, minerals, recreation, and timber. The Forest will strive to meet each of these needs.

The topics addressed in this section are social and economic impacts, special uses and utility corridors, minerals, and public health.

Social and Economic Impacts

People have inhabited the Forest area for over 12,000 years, but the pattern of settlement reflected in the current social structure of the area dates to the late 1700's and early 1800's. Settlers removed the trees from the hills and converted them to agricultural uses.

During the 1800's, population increased, peaked in the 1890's, and then, in the Hoosier area, began to steadily decline. Table 3.54 summarizes the census data from 1890 to 2000 for the political townships that lie within the national forest boundary (Stats Indiana website 2005). Although the Forest obtained the numbers from census data, they are presented only as estimates, since only portions of each township are within the Forest boundary.

Table 3.54

POPULATION ESTIMATES FOR HOOSIER AREA

Twps by County[1]	Year of Census											
	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
Brown	5,272	4,669	3,834	3,124	2,418	3,044	3,110	3,425	4,392	5,238	5,897	6,215
Crawford	12,432	11,978	10,341	9,493	8,648	8,641	7,861	7,043	6,721	8,051	8,185	8,758
Dubois	8,818	8,217	7,682	7,956	7,642	7,904	7,994	8,187	8,966	9,707	10,000	10,496
Jackson	6,153	6,679	2,797	4,954	4,559	4,748	4,560	4,635	4,684	4,835	5,140	5,224
Lawrence	9,246	10,394	12,329	10,796	11,755	11,834	11,204	11,975	12,576	14,865	15,148	16,494
Martin	8,375	9,135	9,101	8,477	7,702	8,746	9,930	9,919	10,337	10,347	9,688	9,639
Monroe	5,086	5,449	4,825	4,207	4,765	4,841	5,003	6,046	11,186	15,971	17,011	18,231
Orange	11,915	6,653	13,966	13,828	14,349	14,260	13,778	13,629	13,528	14,873	14,659	15,220
Perry	18,240	18,778	18,078	16,692	16,625	17,770	17,367	17,232	19,075	19,346	19,107	18,899
Total	85,537	81,952	82,953	79,527	78,463	81,788	80,807	82,091	91,465	103,233	104,835	109,176

[1]Only those Townships within the Forest boundary were included.

Like the population census data, farm census data is also useful in understanding private land uses prior to the acquisition of lands by the Forest Service. By 1930, most of today's NFS lands contained small farms. Agricultural census information indicates 2,300 farms within the Hoosier area in the 1920's.

Railroads opened up commerce to the area when lines were built to Bedford and Bloomington via the Louisville-Chicago rail line by the 1880's, but the railroads largely bypassed the rest of the region. Sawmills became dominant in Indiana after 1860.

Indiana played a critical role in national forest management even before the turn of the century. Indiana Congressman William Steele Holman is now credited with authoring Section 24 of the Forest Reserve Act of 1891 (Steen 1992). Gifford Pinchot, the first Chief of the Forest Service, called this legislation, "the most important legislation in the history of forestry in America … [and] the beginning and basis of our whole national forest system." This congressman from Indiana inserted the language in a bill which was to set aside the first forest reserves for eventual creation of national forests.

Indiana was one of the first states to establish state forests with the legislation in 1903 authorizing the purchase of Clark State Forest. In 1904, Charles C. Deam was the first official state forester. Deam was a pioneer in his field and developed guides on trees and botany that are still referenced today as well as established nurseries for reforestation and championed management of state and private forest lands (Fischer 1993).

National markets for hardwood lumber emerged in the 1870s, while most of Indiana's original forests were still intact. Indiana led the nation in production of several hardwood species. In 1899, Indiana was providing 28 percent of the nation's black walnut lumber. That same year a group of lumberman established the Indiana Hardwood Lumberman's Association, which helped eventually mold nationally accepted marketing rules and practices (Fischer 1993).

Table 3.56 provides a summary of Indiana's hardwood lumber production, indicating the timber resources harvested at the time. The species cut had a profound effect on the composition of the forest that remained, but also tell us something about the historical stands of forests that once grew in southern Indiana. The estimated total cut of hardwood sawtimber during the period of 1869 to 1903 was approximately 30 billion board feet. This means an average yearly cut of about 800 million board feet. The records of lumber cut are conservative because some operating sawmills did not report their cut.

Table 3.56

HARDWOOD LUMBER PRODUCTION IN INDIANA
(Millions of Board Feet)

Year	Oak	Maple	Beech	Yellow Poplar	Black Walnut	Red Gum	Others	Total
1869	415	30		78		2	105	630
1879	690	20		60		5	87	862
1889	690	25		70		10	83	878
1899	682	27		56	10	34	223	1,032
1905	294	16	31	18	9	12	1	381
1915	80	16	31	6	11	8	36	188
1925	65	29	20	5	16	2	41	178
1935	42	15	8	3	3	1	13	85
1945	64	13	17	5		3	44	146
1996	278	60	12	62	15	1	225	653

As discussed in the Heritage Resources section, the economic depression of the 1930's placed great financial pressure on small farmers across Indiana. Indiana's governor at that time, Paul V. McNutt, asked the Forest Service to purchase abandoned land for the eventual creation of a national forest. This action ultimately led to the creation of the Hoosier National Forest in 1934.

The administration of the Hoosier was combined with the Wayne National Forest in Ohio in 1949, and the Wayne-Hoosier National Forest was officially designated in 1951. The administration of the two forests was separated in 1993. The boundaries of the Forest have been adjusted many times. The first adjustment resulted from executive orders between 1941 and 1942 that established the Naval Support Activity Crane from some of the NFS land in Martin County. The second adjustment occurred in 1971 to recognize changes in land-use patterns, resource management needs, and programs of other agencies. The Forest has also exchanged areas with the State of Indiana near Ferdinand, Morgan-Monroe, Martin, and Yellowwood State Forests.

The main counties included within the Forest boundary are Brown, Crawford, Jackson, Lawrence, Martin, Monroe, Orange, and Perry. In addition, a small acreage is in Dubois County, so data for that county is not always shown. Table 3.57 shows the populations of these counties for selected years (as noted in past census data) and projected populations.

Table 3.57

POPULATION IN FOREST AREA OVER TIME

County	1920	1950	1980	1990	2000	Projected 2010[1]
Brown	7,019	6,209	12,377	14,600	14,957	16,419
Crawford	11,201	9,289	9,820	11,300	10,743	12,284
Jackson	24,228	28,237	36,523	38,800	41,335	41,827
Lawrence	28,228	34,346	42,472	44,900	45,922	46,176
Martin	11,865	10,678	11,001	10,700	10,369	10,381
Monroe	24,519	50,080	98,785	101,800	120,563	132,940
Orange	16,974	16,879	18,677	19,800	19,306	20,047
Perry	16,692	17,367	19,346	19,200	18,899	18,709

[1] Projected by Indiana Business Research Center at Indiana University

Monroe County differs from the other counties because of the high degree of urbanization in and around the city of Bloomington. Monroe County has experienced substantial urban growth since the 1940s (Welch *et al.* 2001).

Dubois, Jackson, and Lawrence Counties share similar population indicators and have a relatively high percentage of jobs in manufacturing compared to the other counties. Brown, Orange, and Perry Counties have lower populations, with a density of 45 to 50 people per square mile. Martin and Crawford Counties have the lowest populations with a population density of just 30 persons per square mile (Welch *et al*. 2001).

Indiana is generally growing slower than the rest of the country. The national average state population growth is approximately 1.2 percent versus 0.6 percent rate of population growth for Indiana. Indiana is also less culturally diverse than the rest of the country. Table 3.58 shows the areas population by race. American Indian, Asian, Hawaiian, and some other racial groups are not displayed in Table 3.64 because outside of Monroe County they comprise only a very

small part of the population. Indiana's population is approximately 87 percent Caucasian versus the national average of 75 percent Caucasian. The nine-county area averages 87 percent Caucasian, 8 percent African American, and 3 percent Hispanic. Other racial groups make up the rest of the population. Monroe County has a sizeable Asian population (3 percent of the county), but otherwise the area parallels the state's census figures (U.S. Census Bureau 2000). Ethnic populations tend to be geographically distinct in the area. The phenomenon is referred to as a "salad bowl" rather than a "melting pot," because different ethnic groups tended to preserve their own cultures and communities in the area (Sieber and Munson 1994).

Table 3.58 shows U.S. Census data for eight of the counties that have NFS land in them. People in the eight-county area are slightly older than the Indiana average, with the exception of Monroe County.

Table 3.58

POPULATION DEMOGRAPHICS IN FOREST AREA (2000)

County	Total Population	Caucasian	African-American	Hispanic	People < Poverty Level	% < Poverty Level	Median Age 2002
Brown	14,957	14,682	32	131	1,314	8.1	40.8
Crawford	10,743	10,557	17	100	1,644	15.1	37.3
Jackson	41,335	39,736	227	1,112	3,910	9.4	35.8
Lawrence	45,922	44,969	178	416	4,378	9.5	38.2
Martin	10,369	10,258	16	42	1,179	11.2	38.5
Monroe	120,563	109,510	3,615	2,235	12,137	11.7	27.6
Orange	19,306	18,900	122	108	2,665	13.4	37.5
Perry	18,899	18,447	274	133	1,690	9.1	38.0
State Total	6,080,485	5,320,022	510,034	214,536	588,765	10.0	35.2

Population density in the Forest area is relatively low. There are towns adjacent to the Forest (Bedford, Bloomington, English, French Lick, Mitchell, Paoli, and Tell City), but other than small crossroad communities, there are no large towns in the Forest area.

The Hoosier social assessment (2000) provided socioeconomic and cultural information and measured perceptions, interests, and expectations about the Forest. Researchers from Indiana University completed the assessment. The researchers interviewed 101 respondents, selected from key community leaders and those interest groups who frequently interact with the Hoosier. Many of the perceptions noted here are based on research done for this social assessment. Respondents were not picked randomly and cannot be said to represent a scientific sampling of the population.

The hilly counties of southern Indiana are different economically from the rich farmland areas in the rest of the State. In contrast to these areas, the Forest area contains a large portion of rural people engaged in marginal agriculture. Most families have one or more members who are employed either full time or seasonally to supplement their agricultural income. Per capita income in Indiana as a whole in 2002 was $28,032; in the eight main counties on the Hoosier, the per capita income was $23,908 (Indiana IN Depth Profile website).

In comparison with the rest of Indiana and northern Kentucky, the area in and near the Hoosier contains a concentration of households and communities that are consistently ranked lowest on a variety of poverty indicators (Welch *et al*. 2001). Most of the counties have more than 9 percent of their populations below the poverty level. Five counties--Crawford, Lawrence, Martin, Orange, and Perry – rank among the lowest in the State with regard to several indicators of economic well-being.

Important indicators of economic activity are the value of output, personal income, and the number of jobs. Value of output is a measure of the overall level of economic activity in the study area. Personal income is a measure of how much money households have to spend on consumption and savings. Jobs reflect economic opportunity of workers.

In the nine-county area, the manufacturing division is the largest in terms of value of output, producing $6.7 billion dollars in 2000. Leading manufacturing industries were household refrigerators and freezers, motor vehicle parts and accessories, miscellaneous plastic products, and wood office furniture (Fox 2004).

The services division was second in terms of value of output, producing $2.2 billion dollars in 2000. It was followed by the trade division, which produced almost $1.8 billion dollars. This division provided the largest number of jobs, employing almost 45,000 people. Manufacturing provided almost 43,000 jobs and trade over 41,000 jobs. Of the individual sectors, employment in education provided the highest number of jobs, employing over 21,000 people (Fox 2004).

Manufacturing was the largest source of personal income, over $2.2 billion dollars. Government was the second highest division, providing over $1.4 billion in personal income, and services was third with over $1.2 billion dollars. Table 3.59 shows the economic conditions for the nine-county area.

Table 3.59

OUTPUT, EMPLOYMENT, AND PERSONAL INCOME

Hoosier Study Area, Year 2000

Industry Division	Industry Output[1] ($ millions)	Employment[2] (jobs)	Personal Income[3] ($ millions)
Agriculture	$378	7,969	$108
Construction	1,453	13,287	513
Finance, Insurance, Real Estate	1,564	7,164	960
Government	1,564	34,789	1,456
Manufacturing	6,731	42,864	2,226
Mining	160	1,039	76
Services	2,206	44,948	1,223
Transportation, Communication, Utilities	930	6,746	423
Trade	1,769	41,438	1,015
Total	$16,755	200,244	$8,000

Source: Minnesota IMPLAN Group, IMPLAN model with modification by Northwest Economic Associates

[1]Industry Output: Represents the total value of production by industry for the given year. MIG derives these data from a number of sources, including Bureau of Census economic censuses, Bureau of Economic Analysis output estimates, and the Bureau of Labor Statistics employment projections.

[2]Employment: Represents the annual average number of jobs for each industry, and includes both full-time and part-time workers. These employment numbers also include the self-employed. These data come from ES202 employment security data, supplemented by county business patterns and REIS data.
[3]Personal Income: income from all sources, including employment income, capital income, and transfer payments.

Many people who live near the Forest, especially those in Crawford, Martin, and Perry Counties, do not work in their counties of residence. In these counties, as many as 35 percent of the working population commute out of the county or even across the river to Kentucky to work. Farm employment is a small portion of the economy in the Forest area and tends to be declining over time. Four counties--Brown, Crawford, Monroe, and Perry--lost more than 12 percent of their farmed land to other uses between 1982 and 1992 (Carver and Yahner 1997).

Some local residents view the Hoosier as an economic resource because it raises their property value. Others residents value the Hoosier more for its ecological functions and its ability to provide for biodiversity, clean air, clean water, and improved quality of life (Welch *et al.* 2001). Several studies have determined that forestland and open space are important in attracting both working people and retirees to an area as well as increasing property values. Some studies even suggest that people will accept lower salaries to live in forested rural areas with easy access to outdoor recreation. (Kline *et al* 2004). Living costs and amenities seem to be increasingly important in determining migration patterns (Niemi 1997), and where people choose to live.

Any forest management decision will increase job opportunities for some and diminish them for others. In general, the adoption of a particular decision will suppress property values in some places and increase them in others (Niemi 1997).

Apart from business and job opportunities, outdoor recreation contributes other benefits to society. The American Recreation Coalition reports that Americans who participate in outdoor recreation during childhood and adulthood have an overall higher quality of life (TRCA 2000).

The models that evaluate the competition for forest resources on public land have become more complex over time as the demand for public land increases. According to research done by Ernie Niemi and Ed Whitelaw there are four categories of competing demands for forest resources. The first two are those who have a direct economic stake: those who benefit from a particular use of the resources and those who incur costs from activities. The third category are those who see the resources as an element of quality of life, and fourth, those who place an intrinsic value on the resources. In the decision-making process, forest managers seek to find a balance in meeting these demands.

Educational levels of the population affect other components of the social system. The region of southern Indiana and northern Kentucky has a notably lower percentage of high school graduates than other areas of Indiana, the exceptions being Monroe and Brown Counties and those around Naval Support Activity Crane in Martin County (Welch *et al.* 2001).

The rural nature of the area influences recreational activities, and many people hunt and fish. The rural residents are frequent users of the Forest for hunting and gathering forest products, but few depend on it for their livelihood. These people tend to view the Forest as an extension of their adjacent private property. They express these pseudo-rights of ownership to the Forest and defend their use of the Forest. This applies also to recreation users who tend to go to the same location on the Forest year after year (Welch *et al.* 2001).

Sense of place is the features and opportunities that people associate with the Hoosier National Forest. This is what makes the Hoosier unique to residents and visitors. Some individuals may attach importance to the mix of activities that occur; others may attach importance to attributes such as vegetative composition, scenic quality, historic cultural sites, etc. Many of these places allow us to feel relaxed and safe, and to connect with the environment around us. “Places” play a defining role in the economic, social, and personal lives of the people who visit the Forest. Land use planning includes values as well as science (Hoover 2001).

The social assessment showed various reactions to the suburbanization of areas close to the Hoosier and the increasing number of users. Some viewed this as a positive change from an economic standpoint since property values were going up and this increased tax revenues. Others felt it was negative, preferring the rural character of the region and not wanting to see that change (Welch *et al*. 2001). Some residents noted an aversion to “outsiders” who treat the area as a resort and erode the sense of community that has developed among generations of those who consider the area their home. Others worry that suburbanization of areas like Corydon, with the advent of the casinos and the sprawl from Louisville residents looking for a rural lifestyle is profoundly changing the landscape of the area. These people worry about this trend as it moves closer to their homes.

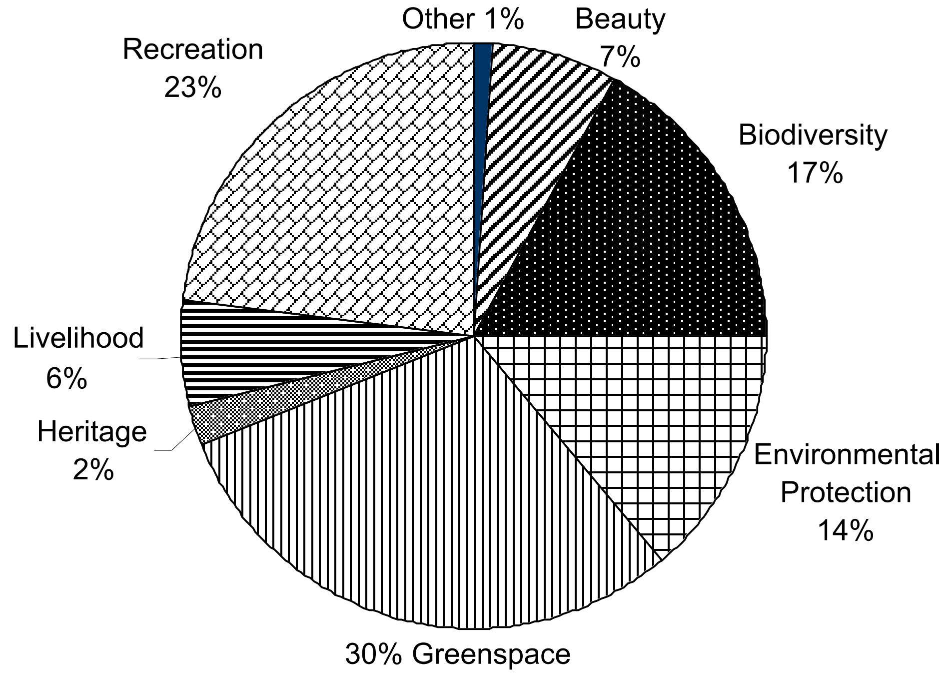
Many people believe the Forest has an important role in environmental educiton and in providing a healthy place for children to experience nature. American children now have fewer unstructured outdoor activities than previous generations had. Though children learn about tropical rainforests and tundra, most know very little about the native forests in their own states, and many have never climbed a tree or hiked a trail. In a recently published book, Richard Louv has coined the term “nature deficit disorder” to describe the lack of outdoor awareness (Gardner 2005). Many see the Hoosier as having a responsibility to not only provide areas for nature study but also to take the lead in environmental education.

Residents around the Forest area (with the exception of Monroe County) are less active in environmental issues, and they tend to be more concerned about the Forest Service as a neighbor and specific activities that happen near their homes. The cutting of timber, wildlife population levels, access needs, boundary line locations, and other practices are a concern to this group of people.

Most visitors to the Hoosier come from Indiana and northern Kentucky. The population centers that affect the Forest are Chicago, Evansville, Indianapolis, Louisville, and to some extent Cincinnati. Visitors mentioned the region’s “Hoosier hospitality” and spoke of the feeling of community as being an important aspect of the area. The service industry that benefits from these visitors is most pronounced in Brown and Perry Counties.

Those conducting the social assessment found that there was no clear consensus among the respondents on how the Forest should be managed. Figure 3.25 displays what the participants considered most important about the Forest when asked to prioritize seven values. Some feared the health and integrity of the Forest would decrease because interest groups cannot agree on any one management direction. Other people voiced a frustration with the complexity of the decision-making process on the Forest. This heterogeneity of views complicates management of the Hoosier (Welch *et al*. 2001).

Figure 3.25 Participant values of the Hoosier



Participants in the assessment were asked to select how closely they could align with three "viewpoints" on management of the Hoosier. Table 3.60 presents a summary of their opinions (Welch *et al.* 2001). Respondents represented all three philosophical approaches. Fifteen of the respondents agreed with all three statements, indicating they felt some areas of the Forest should be preserved, some areas conserved, and other areas could sustain more use than they are receiving now (Welch *et al.* 2001).

Table 3.60

PARTICIPANTS VIEWPOINTS ON FOREST MANAGEMENT

Viewpoint	Strongly Agree	Agree	Neither/ Other	Disagree	Strongly Disagree
Lands need to be preserved in the Forest: to leave them as they are for nature, wildlife and some recreational use.	35%	23%	19%	10%	13%
Lands need to be conserved in the Forest to have the lands managed sustainably for use and harvesting for the long run.	26%	28%	26%	9%	11%
Lands can sustain more usage than they do now. There are too many limits placed on the use and harvesting in the Forest right now.	25%	17%	25%	8%	25%

Horseback riders tended to have a positive or neutral view of all uses. They did not fall in any one category. Hikers, backpackers, and environmentalists had a positive view of only non-timber collection, nature study, hiking, and camping. People who categorized themselves as environmentalists tended to be preservationists. Hikers and backpackers tended to be most closely aligned with conservationists (the terms 'preservationist' and 'conservationist' are used here in the same general sense as the terms 'preserved' and conserved' in Table 3.60). Hunters and ORV users tended to be most in favor of increased use of and access to the Forest (Welch *et al.* 2001).

Due to the scattered ownership pattern on the Hoosier, there are many isolated tracts of NFS land of varying sizes. Many of these are inaccessible because of rights-of-way problems. Private landowners are reluctant to allow access across their land, resulting in very limited management.

One concern involves the management of timber and the role timber harvesting plays in the local economy. The average American annually consumes the equivalent of 73 cubic feet of new wood, which is equivalent to one cord of wood--or two 18-inch trees 50 feet tall. Increasing population is expected to lead to a 40 percent increase in the demand for wood products in the next 50 years while the total forested area is likely to shrink (Shifley 2002). Although laws and policies govern environmental impacts associated with forest management, environmental impacts associated with consumption of forest products are rarely considered.

A study done by Purdue University in 2003 and 2004 found that almost all respondents (97 percent) agreed with the idea of "harvesting as a management tool" with only 1 percent expressing disagreement. A lower percent (51 percent) agreed with harvesting for economic reasons. This study found that respondents were opposed to the idea of preservation and leaving the forest untouched by humans but supported the idea of leaving a forest legacy for the future including harvesting for multiple objectives. There was, however, a distinction as to where people believed harvesting should occur. In the study 56 percent of the respondents disagreed with cutting trees on public land. More individuals who lived in the same state as their public land held attitudes supportive of timber harvesting than those who did not (Schaaf *et al*. in press).

Clearcutting receives less public support than other types of harvest. During a study in the 1990s, only 14 percent of the public felt clearcutting should be allowed on Federal lands (Bliss 2000). Aesthetics were the main concern voiced by those who opposed this practice, but many also linked the practice with deforestation, exploitation, and environmental degradation. The opposition is based less on knowledge and understanding than on personal experience, beliefs, and values (Bliss 2000).

Increased numbers of wildlife on public land are beneficial to people who enjoy wildlife, whether for hunting or viewing. The Hoosier is one of the largest areas available for public hunting in the State. Timber harvesting, regardless of the method used, is generally beneficial to game species and many non-game species found on the Forest today.

Although southern Indiana has a relatively low total acreage of timberland, the average volume of wood per acre is among the highest in the region due to the high site quality and maturity of Indiana's forests (Shifley 2002). The ratio of growing stock to removal in Indiana in 1998 was 2.6 to 1, with 138 million cubic feet more net growth per year than volume removed (Shifley 2002). In recent years, the ratio of growth to removal on the Hoosier has been 9 to 1.

Timber harvesting introduces changes in forested landscapes. Forest users tend to view abrupt changes as a disruption to the forest environment and see them as distracting. Traditional users of specific sites may view harvesting activities as nuisances, and examples include increased road traffic and noise from logging vehicles. Statewide, 19 percent of Indiana's landbase is forested and capable of growing commercial timber. Almost all of that forested area is in the region of the Hoosier.

Between publication of the draft and final EIS for the Hoosier, the Indiana Department of Natural Resources issued its Strategic Plan for 2005 through 2007. This plan stated that during that period the State would increase timber production and enhance wildlife habitat on State-owned lands. The State estimated they would increase timber harvests from 3.4 million board feet per year to approximately 10 to 17 million board feet per year. If the State's plan is implemented it would have an effect on the economic climate in the Hoosier area. Any proposals will be included in project level, site-specific analysis that implements the Forest Plan.

Laws require the Forest Service to manage national forests for multiple uses. Vegetation management is an efficient way to enhance or perpetuate wildlife habitat. It also contributes to maintenance of healthy vigorous forest ecosystems and ensures the existence of renewable timber resources for future generations and viable wildlife populations. The cost of management is often higher on public lands because of rules and regulations that direct the management of public lands, causing additional expenses the Forest incurs that private landowners would not incur.

Many of the costs attributed to a timber sale benefit other resources as well. Road construction is one example. Initial costs of a road are charged against a single timber sale, but the road provides access for forest visitors, hikers, hunters, and wildlife projects. The Hoosier considers objectives such as providing vegetative diversity and accessing areas for wildlife habitat development as high priorities. A timber sale is often the most cost-effective method of achieving the objective.

The Hoosier's timber sale program has fluctuated through the years. In 1986 the Forest shifted away from even-aged management, which affected the timber volume produced by the Forest. A hiatus followed the appeal of the 1985 Plan. In the last 10 years, few timber sales for purposes other than salvage have occurred. Table 3.61 displays the average volumes sold per year during certain periods.

Table 3.61

AVERAGE ANNUAL TIMBER SALE PROGRAM, FY 1964-2003

Volumes shown in million board feet

	1964-1977	**1978- 1985**	**1986-1992**	**1993-2003**
Total Volume Sold/Year	4.25	9.45	0.43	1.10

Table 3.62 presents the volume sold in individual recent years. Since 1988, sales have been small, a mixture of pine salvage sales and hardwood sales. The exception was in 1997, when the Hoosier offered numerous hardwood and pine sales to salvage snow-damaged trees and also damaged trees following a tornado.

Table 3.62

TIMBER SALE PROGRAM, Fiscal Year 1993 - 2003
Volumes shown in million board feet

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total Volume Sold	0.03	0.89	0.96	0.17	9.28	0.34	0.07	0.13	0.03	0.10	0.08

Forest-based manufacturing provided $3.5 billion in value added and $7.9 billion in value of shipments to Indiana's economy in 1997 (Bratkovich *et al.* 2002). Currently, the state has 12 veneer mills which process high value hardwoods, 225 sawmills, 1 pulp mill, and 2 stave mills (USDA NCES 2003). In 1990, the nine Indiana counties that contain NFS lands had nearly 100 sawmills that produced more than 85 million board feet of lumber per year. In 2000 the area still had the highest concentration of wood-using mills in the State, although numbers have dropped due to reductions in harvesting on the Forest and throughout the area. In 2000 there were 78 sawmills, 5 veneer mills, 2 cooperage mills, 1 handle plant, and 1 cabin log mill in the area. The area produced 37.5 million cubic feet of industrial roundwood, 46 percent of the total in the State.

Indiana, with over 480 companies, ranks third nationally behind North Carolina and Pennsylvania in the number of secondary manufacturing companies. These are mostly small family-owned businesses manufacturing furniture products. Of the 56,000 people working in Indiana's timber industry, almost 86 percent work for secondary manufacturers making cabinets, flooring, doors, window frames, and pallets (Indiana Forest Products 2003). For every acre of Indiana timberland, $325 of payroll is generated annually (Bratkovich *et al.* 2002).

Demand analysis for timber indicates that lumber production in Indiana tripled between 1955 and 1985. Between 1990 and 1995, veneer log production in Indiana increased by more than 41 percent. Sawlog production was down from 1990 to 1995, but demand remains high. Most of the decline was associated with red oak, sycamore, white oak, and yellow poplar (Hackett 1998). Despite increasing forest inventories, the State is becoming more dependent on imports from other states to feed Indiana sawmills. During the period 1980 to 1984, the amount of lumber produced from timber imported to Indiana doubled and the amount exported dropped by half. Eighty-five percent of Indiana's timberland is in private ownership. The Hoosier contains 4 percent of the State's timberland. Other State and Federal agencies own 11 percent. In 2002, only three percent of timberland owners owned more than 100 acres (USDA NCES 2003).

Veneer is another important Indiana product. Since 1966, the State has been producing less veneer from cottonwood, hard maple, walnut, and yellow poplar, but slightly more veneer from oak (60 percent of total). Even in veneer, less than one-third of the volume is from Indiana-grown wood. Future reductions in the size of trees cut in the State could affect both veneer and lumber manufacturers.

Increased awareness, coupled with the upward price trend, has increased the acreage available to harvest. Higher prices and recent low farm incomes have led more private landowners to harvest their timber to keep their farms solvent.

Many landowners harvest timber stands for immediate income. Most private landowners harvest all the merchantable trees that are 14 inches DBH or greater. Over time, this practice reduces the size and quality of the timber, and eventually shade-tolerant species such as maple and beech would dominate the species composition. Beech and maple are generally slow growing and sometimes lower valued. Timber buyers have already seen a trend towards smaller, lower quality logs coming from private woodlands.

Another issue of concern involves property taxes. Some participants in the social assessment felt that the presence of the Forest cut into their county's tax revenues. Some indicated that the suspension of timber sales has exacerbated this shortfall of funds. Some participants held a negative view of environmentalists and cited the closure of sawmill operations as the amount of timber harvesting dropped off. A few viewed the Forest and public lands as barriers to economic development (Welch *et al.* 2001).

Many Special Areas harbor sensitive plant and animal communities. These communities have special qualities that have evolved over time to survive in their particular niche in the environment. People generally recognize that protecting the land, specifically Special Areas and the plants and animals found there, is a responsibility everyone shares. As a steward of public land, the Forest Service is entrusted with perpetuating all areas of NFS land including these "special" areas.

Aquatic habitats satisfy those recreational demands that revolve around water. People like to see lakes, ponds, and marshes. People equate lakes and ponds on the Forest with serenity and feel good about seeing them or coming across them by chance when they visit the Forest. The Forest provides opportunities to enjoy scenery, fish, hunt, and observe wildlife.

Of the total public lands available for recreation in Indiana, 27 percent are on the Forest. The Hoosier is one of the largest providers of remote recreation habitat in the state. "Get away from it all" experiences are very important to many people. Physical activities such as hiking, horseback riding, and swimming are also important to many people's efforts to keep fit and offer a measure of stress reduction to those able to visit the Forest periodically. Additional benefits include family togetherness, forest smells, scenic beauty, solitude, sounds of nature, wildlife viewing, and many other non-market values of a natural environment.

The opportunities available on the Forest enrich the quality of life of local people and of people outside the area. Indiana has a rich heritage, and the public scrutinizes the Forest for impacts on what they view as their rightful heritage. Futurists predict natural environments will become increasingly popular, and perhaps essential, in providing a balance in personal lifestyles as society moves toward an impersonal high-tech existence.

Partnerships with local organizations and agencies are a tremendous asset to the Forest in stretching scarce resources. The Forest has relationships with an array of partners including law enforcement and fire agencies, recreation and environmental groups, state agencies, other Federal agencies, and universities. These partners assist in completing forest projects that includes activities such as environmental education, fish and wildlife improvements, archaeological research, monitoring, and cooperative fire and law enforcement agreements. Partnerships also ensure the Forest is managed in context with local communities.

Alternatives and the Effects of Management on Human and Community Development

All Alternatives

Social Well-Being

The public perceives anything "natural" as being good. Every acre of the Forest is natural in a broad sense, but in certain areas of the forest, under some alternatives, vegetation management would manipulate the forest and mimic natural processes. In other areas of the Forest or in other alternatives, no manipulation would be allowed, and only the processes of nature would affect the forest. Some people trust natural processes more than they do reasoned and careful human intervention. In all alternatives, Management Areas 5.1, 6.2, 6.4, 8.1, 8.2, and 9.2 (also 9.3 in Alternative 2) provide non-market values such as beautiful landscapes, clean air, clear water, wild creatures, forest sounds and smells, and solitude without any likelihood of vegetative management. Natural processes prevail in these management areas. All alternatives would provide additional areas such as riparian areas that would provide these values, but their acreages are not included in Table 3.63.

The ability of the forest to provide greenspace and forest land for quality of life and improved property values does not change across alternatives.

One of the features valued by many visitors is the ability to experience solitude and quiet in a forest environment. All alternatives provide acres as shown in Table 3.63, though the alternatives differ in the acreage of forests managed for natural processes without active human management. Alternative 2 manages the majority of the Forest (minus the developed recreation sites) for “natural processes of forest succession.”

Table 3.63

MANAGEMENT FOR NATURAL PROCESSES OF FOREST SUCCESSION

	Approximate Acres				
	Alt. 1	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**
NFS land	90,100	192,200	78,900	78,900	90,100

Areas categorized as MA 8.1 and 8.2 reflect a national commitment to preserve natural legacies, all alternatives protect these areas. Protection and maintenance of these areas provide the public opportunities to learn about unusual plant and animal communities, geologic features, or historic areas.

The Forest Service cooperates with the IDNR, The Nature Conservancy, USDI Fish and Wildlife Service, and others to identify and protect special areas on the Forest. The value of these lands provides a sense of place not only to those who would visit them or live in the area, but also to those who study the plant and animal ecosystems that exist there. There is also a sense of place provided to those who only read about the forests and just want to know they are there. A diverse variety of opportunities under all alternatives will continue to contribute to the sense of place for existing users while serving to enhance the quality of life for area residents and visitors.

For some people a single activity may be important to their sense of place or quality of life. For example, in the case of an avid hunter, the opportunity to continue to pursue hunting activities may be a significant element in what provides value from the Forest. For another person who moved to the area to live in the midst of what they perceive to be old growth forest, the threat of impending timber sales may jeopardize their quality of life and sense of place. Each of these alternatives affects the social well being of people slightly differently in these respects.

Boundary marking and land acquisition continue to be the greatest administrative needs in providing remote recreation. The patchwork ownership pattern and need for boundary marking cause problems for adjacent landowners, since it is often difficult for recreational visitors to avoid straying off NFS land.

Increased recreational use can affect adjacent landowners, primarily through trespass.

Private landowners can gain economic benefit by providing services to the visiting public such as canoes, lodging, restaurants, and supplies.

Land Ownership and Social Fabric

Occasionally, acquired tracts of land contain a small amount of productive agricultural land. NFS lands tend to require fewer public services than lands in private ownership. Families moving out of the more remote parts of the Forest results in reduced or curtailed need for fire protection, police, school bus routes, and trash collection. In some instances, abandoning homes eliminates the need for maintenance of county roads.

Conversely, people often desire to live close to NFS land, which increases the cost to provide services to these remote areas.

Properly located and marked boundaries benefit adjacent landowners by reducing the likelihood of trespass.

Providing Road Access

The Forest must be accessible to be enjoyed and appreciated by people. In some alternatives timber harvesting would require road access, and following a timber harvest, the Forest may make firewood available for home use. Users would need roads to access these areas. Driving on roads is a form of recreation and a "back to nature" experience for many.

Road construction proposals may lead to controversy. Many people oppose road construction because of concerns about damage to soils, watershed, and forest solitude. Others want more roads to provide easier access to the Forest.

Road closures could change use patterns or cause people to use other areas. Individuals who have been using certain roads for motorized access may be critical of the practice. Others would be happy to see motorized use in these areas discontinued.

Fire Management

Suppressing wildfires benefits private landowners and protects natural resources. Suppression of wildfire on NFS land stops the spread of fire onto private property. The Forest Service would suppress all wildfires that may occur on NFS lands. Cooperative agreements are in place to help suppress fire on adjacent property that would threaten NFS land as well.

Economic Effects

Individual businesses that profit from recreational use would benefit from increased use of the Forest. There are opportunities for outfitters or special use permittees to capitalize on the increased numbers of visitors to the Forest who may not have the equipment needed to enjoy a remote recreation experience.

There is potential for area businesses to profit from trail use. There has been a surge of businesses revolving around the use of trails on the Forest. Sales of trail tags benefit local vendors who sell Forest trail permits.

The private sector may develop facilities in conjunction with recreational opportunities on the Forest. For instance, horse camps have been developed near multiple-use trail systems. All alternatives allow for a sustained level of recreation use, and none of them would deter entrepreneurs from developing businesses associated with trails or recreational opportunities.

Concessionaires operate Forest Service campgrounds and often improve recreation facilities to increase their revenues. Local contractors provide some of the maintenance and improvement of these facilities, as well as heavy maintenance and reconstruction on trails. This results in jobs in the communities. The Hoosier often contracts to local businesses such jobs as constructing water bars, hauling gravel, and mowing vegetation. Increased recreational use would also benefit the local economy, as more visitors would patronize local businesses.

Construction activities associated with the development of lakes, ponds, or wetlands may require the use of local labor and contractors, as well as the purchase of materials. This would have a beneficial effect on the local economy and employment. The Forest may use volunteer or prison labor or cost-share programs with individuals, organizations, or other agencies to help implement some construction activities. Other than the lack of these projects in Alternative 2, there is not a large difference in the economic impact between the alternatives from these types of activities. Table 3.64 shows the comparison in output, jobs, and income by alternative. Alternative 2 provides slightly less opportunity for trail-related business activities, and Alternative 3 provides slightly more. The estimates are very similar, and the variations may well be within the margin of error for estimating activities and effects (Fox 2004).

Table 3.64

OUTPUT, JOBS, AND INCOME SUPPORTED BY RECREATION

Hoosier Study Area, Year 2000

Indicator	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Output ($ Millions)	$14.080	$14.050	$14.354	$14.080	$14.080
Employment (Jobs)	185	184	189	185	185
Income ($ Millions)	$3.618	$3.608	$3.702	$3.618	$3.618

Source: Minnesota IMPLAN Group, IMPLAN model with modification by Northwest Economic Associates

Table 3.65 displays the output, income, and employment related to the alternatives, as evaluated by the IMPLAN model. Alternative 2 provides the most change from Alternative 1, and most of the change is a result of decreased timber harvesting. Alternative 4 provides the greatest increase over Alternative 1, again primarily due to the level of timber harvest

(increased). Alternatives 1 and 3 are very similar in their economic effects. Alternative 5 is identical to Alternative 1.

Table 3.65

OUTPUT AND INCOME SUPPORTED BY ALL FOREST PLAN ALTERNATIVES

Indicator	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Output ($ millons)	47.154	24.520	49.038	52.942	47.154
Income ($ millions)	16.802	7.057	17.642	20.498	16.802
Employment (jobs)	551	242	573	672	551

Source: Minnesota IMPLAN Group, IMPLAN model with modification by Northwest Economic Associates

Land Ownership and the Economy

Land acquisition would change the local tax base. All NFS lands, although off the tax roles, provide reimbursement to counties. From 1908 to 2001, counties with NFS land inside their boundaries annually received 25 percent of the receipts from mineral activities, recreation fees, special use permits, and timber sales on NFS land.

Counties receive payments from the national forest through the State under the Secure Rural Schools and Community Self-Determination Act of 2000 (P.L. 106-393). All nine counties chose to participate and chose the full payment option as described in P.L. 106-393. These funds replaced the former Federal revenue sharing of 25 percent of all fees collected on NFS land from activities such as camping, special use permit fees, and timber sales. The legislation for this funding expires in 2006. Although one may assume Congress would continue to authorize some type of funding, no information is available regarding the formula that might be used after 2006 or if it would differ by alternative. The funds are distributed to counties based on NFS acreage in the county, and are used for roads and schools.

Congress provides additional revenues to units of local government called "payments in lieu of taxes" (PILT). The Federal government makes PILT payments to those counties that are the principal taxing bodies and providers of services in local areas. Unlike the 25-percent fund, PILT payments have no restrictions on their use by counties.

To provide an example of payments, Table 3.66 shows the amount counties received in 2003. These amounts would not vary by alternative unless the law changes on how funding is determined or distributed.

Table 3.66

2003 PAYMENTS TO COUNTY INFORMATION

County	NFS Acres	Payment in Lieu of Taxes	Full Payment [1]	Total
Brown	18,362	$18,572	$11,367	$29,939
Crawford	24,167	21,872	14,364	36,236
Dubois	412	564	207	771
Jackson	23,091	21,142	14,570	35,712
Lawrence	16,001	11,277	10,024	21,301
Martin	9,550	6,360	5,787	12,147
Monroe	18,995	20,495	12,194	32,689
Orange	31,030	27,517	18,704	46,221
Perry	58,591	52,341	36,201	88,542
TOTAL	200,199	$180,140	$124,416	$303,558

[1] P.L. 106-393

Cumulative Effects

All alternatives continue to provide for the safety and well-being of Forest users. There is no indication that any of the alternatives would adversely or disproportionately affect American Indians or any other racial minorities or low-income groups.

National forest management contributes to a flow of goods and services in the area of the Forest. Examples include the promotion of tourism and the production of raw materials. Management of public assets on a national forest generates receipts to the Federal government and local counties.

The significance of social and economic impacts depends on how closely related management of a Forest is to local communities and a way of life. Some local communities may not always be sensitive to change in Forest programs. The severity of impacts would depend on the rate at which such changes occur. Although most of the economic and social effects are local in nature, some effects may extend beyond local communities to regional and national economies.

Economic impacts result from selling forest outputs, from users of the Forest spending their income, and from the Forest Service purchasing goods and services from the local economy for management activities.

Some of the cumulative effects of the alternatives are small enough that they warrant no further consideration. These include population dynamics, lifestyles, attitudes, social organizations, civil rights, and minority populations.

Table 3.65 displays the output, income, and employment for the alternatives as evaluated by the IMPLAN model. Alternative 2 would provide the most change from Alternative 1, and most of the change would be a result of decreased timber harvesting. Alternative 4 would provide the greatest increase over Alternative 1, again primarily due to the level of timber harvest (increased). Alternatives 1 and 3 would be very similar in their economic effects. Alternative 5 would be identical to Alternative 1.

Many factors affect employment, income, and outputs, which in turn may affect community stability in the study area. However, the analysis shows that recreation and tourism employment related to forest management remain relatively constant between the alternatives and only the timber-related factors vary appreciably.

Alternatives 1, 3, 4, and 5

Social Effects of Timber Harvesting

The Forest Service mission is based on providing for multiple uses, including timber production. Some people believe forests should be preserved and disagree with managing trees for a perpetual supply of renewable resources. Even-aged silviculture is currently not commonly understood and often not well received by an increasingly urbanized public. Many people prefer uneven-aged harvesting practices to even-aged management, largely due to the more subtle visual impacts. Other people feel that forest management provides benefits to wildlife and can be used to mimic natural disturbance.

Alternatives 4, 3, 5, and 1 in that order are expected to be most favored by those seeking hunting opportunities. These alternatives increase early seral habitat conditions favored by many game species. Wildlife viewing would be favorable under all alternatives; however, the mix and abundance of species may vary depending on the habitat conditions. Alternatives 4, 3, and 5 will provide more diverse habitats including those used by early and late successional species. However, all alternatives favor late successional habitats and will result in their increase. Because of the mix of seral conditions, Alternatives 3, 4, and 5 may provide a slightly better variety of viewing opportunities.

The Hoosier provides a variety of opportunities for gathering forest products for personal use. Gathering opportunities for forest products such as mushrooms or geodes would not vary significantly among the alternatives. However, areas where timber harvests have occurred are likely to have more berries and grapevines since these plants thrive in full sunlight.

Dust and increased traffic associated with management activities may affect adjacent landowners. These problems would be considered during site-specific analysis and project implementation. Property boundaries between private land and NFS land are to be clearly marked to avoid trespass. Clearly established boundary lines also benefit owners of private land.

Economic Effects of Timber Harvesting

The objective for managing vegetation on the Hoosier is not economic. However, economic benefits do result from vegetation management. The Hoosier would design timber management activities in a manner that would set a high standard for environmental protection in a multiple-use forest management setting.

The most important species to the export market are red and white oaks and black walnut. These three species groups accounted for 67 percent of the veneer log exports and 89 percent of the sawlog exports (Bratkovich *et al.* 2002). Levels of even-aged harvesting and prescribed burning have a direct correlation to the future species mix of oak and black walnut and to the future economic returns from these stands.

In south-central Indiana, the acreage of oak and hickory in the Forest area decreased by nearly 19,000 acres between 1986 and 1998, and the maple beech type increased by 15,000 acres (Leatherberry 2002).

Oaks are the most economically important tree species in Indiana, but the relatively few young oaks compared to other species means oaks may not be able to sustain their current stocking levels. Species trends show declines in Indiana's most valuable species such as black walnut and oak, as more shade-tolerant and less valuable species displace them (Bratkovich *et al.* 2002). The anticipated decline with these alternatives would be appreciably less than with Alternative 2. Each alternative's plan for harvesting and burning would affect the amount of oak regeneration as well as future economic returns.

A market demand analysis determined that the Hoosier could offer and sell 23.6 million board feet per year of hardwood timber and 4.7 million board feet per year of pine (Thake 2002). Hardwood pulp and pine products are the limiting factors on Hoosier timber sales, as they are in the least demand. The development of pine sawtimber markets could potentially increase the demand for pine.

Market demand alone does not determine the level of timber to harvest from the Hoosier. Harvest levels were established based on sustainable output from suitable acres. By analyzing and identifying market demand, the Hoosier can ensure that the harvest level established would be within the amount that could be effectively marketed and below sustainable levels. The share of the market supplied by the Hoosier could vary appreciably each planning period. Demand can shift, as can the portion of that demand satisfied by timber sales on NFS lands.

National forests sell timber sales on a bid basis to private contractors. Timber sale contracts specify mitigation requirements, constraints, and sideboards the contractor must meet to harvest the timber.

The Forest reserves a percentage of the proceeds from each timber sale to use on related projects in the timber sale area after the sale is closed (known as K-V projects). A portion of the money received from timber sales may be returned to the Treasury. Table 3.67 suggests the differences in economic returns.

Table 3.67

POTENTIAL ECONOMIC RETURNS FROM TIMBER SALES (FY 2004-2014)
Volumes shown in million board feet – first 10 Years – SPECTRUM Model

Measure	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Average Annual Volume Available	5.76	0	6.23	9.45	5.76
Hardwood	4.23	0	2.39	5.22	4.23
Pine	1.53	0	3.84	4.23	1.53
Estimated Value ($ Million)	2.27	0	1.77	4.28	2.27

In addition to the above outputs, the maximum timber benchmark indicated the entire Forest was capable of producing 18.34 MMBF per year with a long-term sustained yield of 25.2 MMBF and a maximum present net value of $72.8 million.

Intermediate Silvicultural Techniques

The expense of intermediate treatments, mostly pre-commercial thinning, is an important consideration. Following harvest, prescribed burning could also thin or release stands, which would help stratify the forest. Money invested in thinning is recouped later when higher quality products are harvested. With the present pulpwood markets in southern Indiana, commercial thinning on the Hoosier is not cost-efficient until hardwoods reach 60 to 70 years of age.

Based on an assumption of an average rotation of 100 years for hardwoods, analysis has shown that one thinning at age 20 is the most cost-efficient intermediate treatment (Leak *et al*. 1969). If more intensive treatment is desired, the next most cost efficient treatment is two thinnings at age 60 and 80. Individual tree release and grapevine control at age 10 is beneficial when a certain species or group of species is desired but would potentially be lost due to competition. The Forest generally contracts intermediate treatments to private individuals or companies and thus helps provide additional jobs to the local community. Alternative 4 would provide the most intermediate treatments, followed by Alternatives 3, then Alternatives 1 and 5, which are the same.

Managing Forest Openings

These alternatives would maintain forest openings. Forest openings provide habitat for many wildlife species that in turn attract people who enjoy the outdoors. Openings also provide ideal areas for the production of berries (blackberries and raspberries) and wildflowers that people enjoy seeing and gathering.

Cumulative Effects

The long-term production of wood products is based on the ability of the land to produce wood fiber in perpetuity, or its sustained yield capacity. In the recent past, actual harvests have been below the sustained yield capacity of the forest (Fox 2004). Table 3.68 shows the outputs, employment, and income that each alternative would support at the sustained yield level.

Table 3.68

OUTPUT, JOBS, AND INCOME SUPPORTED BY TIMBER
Hoosier Study Area, Year 2000

Measure	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Output ($ millions)	$20.534	$0	$21.159	$30.020	$20.534
Employment (jobs)	188	0	193	275	188
Income ($ millions)	$4.520	$0	$4.658	$6.608	$4.520

Source: Minnesota IMPLAN Group, IMPLAN model with modification by Northwest Economic Associates

Alternative 3 provides for an increase in timber output over Alternative 1 and 5. Alternative 3 would support an increase of $625,000 in output, five additional jobs, and almost $140,000 in income. Alternative 4 supports an increase in output of almost $9.5 million dollars, 87 more jobs, and over $2 million dollars in income than Alternative 1 and 5 (Fox 2004).

Although wood products employment and outputs fluctuate considerably between alternatives, it is a very small part of the study area's overall economy and not likely to produce cumulative economic effects (Fox 2004).

Alternatives 3, 4, and 5

Social Effects of Concentrating Timber Harvesting

These three alternatives would implement a significant percentage of the even-aged timber harvesting in Management Area 3.3. The location of this management area is along the county line between Perry and Crawford Counties, and the acreage is split almost equally between the two counties.

Forest Inventory Analysis, as compiled by North Central Research Station, is another source of information on comparable management practices on private lands. A query of private lands showed only five counties in the Hoosier region have stands in the 0 to 10 year age class. The counties with private lands having stands in the 0 to 10 year age classes were: Crawford (1,254 acres), Jackson (5,181 acres), Lawrence (7,406 acres), Martin (1,360 acres), and Perry (1,642 acres). This indicates where timber management may be occurring on private lands in the area. If the propensity of landowners to manage their own forest were an indication of social acceptance of timber management, these counties would appear to have a higher acceptance of such management.

Alternatives 1 and 5

Mineral Management

Mineral exploration and development activities, though unlikely, may affect adjacent landowners in several ways. Development of Federal oil, gas, and other minerals (except as stated below) would only be allowed if it were done on adjacent private land. Law allows development of outstanding or reserved mineral rights on Federal land.

Noise and increased traffic in the area of exploration and road access could be disruptive. However, this disruption would be of short duration. Once a well is determined to be either dry or productive, impacts are minimal. If dry, the site would be rehabilitated and abandoned, and if there were a producing well, the site would be visited infrequently for inspection during the duration of production operations.

There are no expected impacts during this planning period on local employment from the unlikely event of a gas or oil well on adjacent private land accessing federal minerals, on outstanding or reserved minerals on NFS lands, or expanding gypsum production. However, some additional jobs could result from mineral activities.

Cumulative Effects

Projections from the gypsum industry show a low likelihood of any development on or under NFS lands in the next 50 years (Smith 2004, pers. comm.) There have been no wells drilled during the past planning period, and none is expected during the current period; therefore, no cumulative effects are expected.

Alternative 2

This alternative would implement little to no vegetative management and would forego the benefits of such management to ecosystem sustainability, wildlife habitat, visuals, recreation, and the economy. There would be no income from harvesting and little from contracts to perform other work on the Forest. This alternative would create few to no jobs to assist in the timber industry or to work on other contracts performing forest management work. The

alternative would result in fewer dollars returned to the U.S. Treasury, and there might be no fuelwood available in the Forest for local citizens.

Some work might be performed on recreation projects, and fees would still be collected at recreational facilities to aid in the maintenance of those facilities. Because of the increasingly dense forest, there would be increased opportunities for the feeling of solitude. This alternative also optimizes those forest values associated with preservation.

Cumulative Effects

Alternative 2 provides the most change from the current condition, with economic output decreasing by 48 percent, jobs by 56 percent, and income by 58 percent (Fox 2004). This alternative would provide the amenities derived from an unmanaged forest, and only limited areas in Indiana provide this benefit.

Special Uses and Utility Corridors

Every year the Hoosier receives numerous requests and applications for special use permits. This section discusses permits and land use activities that have not been covered elsewhere, such as pipelines and utility corridors. The Forest would review special use requests on a case-by-case basis. Special use authorizations include:

- Tower sites - includes requests for radio repeater, microwave tower, and other electronic sites
- Utility corridors - includes above and below-ground telephone cables, electric lines, fiber optic lines, gas lines, and water lines
- Water supply - includes all reservoirs, springs, and wells
- Other municipal uses - includes permits for a variety of activities such as group activity areas, landfills, and airports
- Recreation - includes recreation events such as orienteering, adventure races, and other group events
- Roads - allows road construction or road use for access to private property

Due to the amount of private land within the Forest boundary, there are many communities either within the boundary or influenced by proximity to NFS lands. The interspersion increases the likelihood of requests for special use permits

Private landowners are scattered throughout the Forest. These people have property adjacent to or surrounded by NFS ownership that requires access, roads, and services. Although these neighbors have a right to services, the utilities affect the character of the land and limit the opportunities to provide large blocks of forests for people desiring remoteness or solitude. The Forest has also issued special use permits to private individuals or groups for a variety of purposes. Table 3.69 displays those permits at the time of the Plan revision according to a report taken from the Special Uses Database System.

Table 3.69

HOOSIER SPECIAL USE AUTHORIZATIONS

Permit Type	Number of Permits	Area Affected	Fees Collected Annually	Outstanding Uses Prior to FS Acquisition
Oil and Gas Pipelines	4	157 acres 100-feet wide	$5,641	50 acres
Power Lines Cross-country	3 electric transmission	160 acres 100-feet wide	($5,258)[1]	75 acres 200-feet wide
Power Lines, Distribution	6 REC's with 30 permits	125 acres 20-40 feet wide	($4,234)[1]	130 acres
Telephone REA Loan Exemption	2	35 acres 20 feet aerial 10 feet buried	($1,270) [1]	20 acres
Telephone Fee	2	19 acres 10 and 20 feet	$617	10 acres
Water Distribution	12	45 acres 10 feet buried	$1,013	5 acres
Private Roads or Driveways	19	2.35 acres 20 feet wide clearing width	$500	
Public Road Agency – County	21	42 acres 40 feet wide	Free	150 acres outstanding- no easement[2]
State Highways	9	87 acres	Free	55 acres outstanding[2]
Dept. of Trans. County/State	9	115 acres	Free	
Corps of Engineers Roads	2	44 acres	Free	
Rec. Events	9	Temporary use	$1,012	
Outfitter/guide	1	15 acres	$800	
Permits for Connector Trails	9	18 acres 10 feet wide closed canopy	$711	
Communication Site	5	Radio repeater micro-wave	Free to govt agencies	
Archaeological Research	2	Various	Free	
Campground Concessionaire	1	1660 acres	$25,000	

[1] These annual fees are waived because the permittee is a utility participating in a Federal program.
[2] According to Federal regulation, private, county, and State roads cannot be enlarged beyond the width at time of purchase without a road easement. Many Federal parcels were purchased in the 1930's and

1940's. According to State Statutes (Board of Commissioners of Monroe County v. Hatton 427 N.E.2d 696), county road right-of-way should be 40 feet wide and State road right-of-way should be 66 feet wide. Without fee purchase or condemnation taking, they cannot be enlarged beyond the "driven way, excluding the berm."

Road easements and permits specifically exclude third party rights. Therefore, road agencies do not have the right to issue utility permits to utility companies unless they own the land in fee or through condemnation. Forest Service regulations (36 CFR 251.5, Forest Service Manual 2720) require special use authorizations for all utilities constructed across NFS land since acquisition of the land by the United States. A special use authorization is required for all utility upgrades or installations in outstanding rights-of-way. For example, if a phone company has an outstanding right for an aerial wire line and adds a fiber optic line, a special use authorization would be required, as the action would be an upgrade.

Alternatives and the Effects of Management on Special Uses

Effects Common to All Alternatives

Routine maintenance of utility corridors may compact soils from repeated vehicle traffic. Trenches for cables or pipelines disturb the soil profile in the corridor. Construction of water supply facilities could affect soils in a manner similar to the effects of development of mineral well sites and recreation facilities and the construction of lakes.

As demand for services provided by utilities increases, utility companies would likely propose to widen existing corridors. The Forest would analyze changes in corridor size on a site-specific basis. Relocating cross-country utility corridors to a roadside location is preferred to maintaining a cross-country utility corridor. New utility corridors should use the latest technology in placing their lines, such as an underground electric line or fiber optic line.

Corridors of cross-country utility lines would increase fragmentation of the Forest, with an increase in the straight-line visual effects that they cause. There have been no requests for major cross-country utility corridors since 1985. All recent utility permits were for locations along road corridors. Removing aerial powerline corridors from cross-country locations and reconstructing them along road corridors has reduced fragmentation. Some recent utility permits are for fiber optic lines or electrical upgrades from single phase to three phase electric utilities. The companies either bury these in the road corridor or attach them to existing poles. The Forest expects no increase in cross-country corridor mileage and acreage during this planning period. From 1992 to 2003, approximately 20 acres of right-of-way openings have reverted to natural vegetation as the companies removed aerial utilities through land acquisition or moved from their cross-country location to roadside corridors.

Special use permits for utility lines generally include clearing and periodic maintenance of the utility corridor. This changes vegetative composition and structure. Maintenance on most utility corridors occurs every 3 to 5 years. Periodic maintenance provides habitat similar to pasture or forest openings, which are mowed and regenerated on the same maintenance cycle. Maintenance procedures would be similar to those used for forest openings. This kind of management would maintain habitat diversity and influence local populations of wildlife species. Removing vegetation, planting, and seeding a special use permit site can establish, maintain, and improve native plant communities associated with open habitats, such as barrens, glades, and other prairie-like habitats.

Road corridors are the primary and preferred location for utilities. In larger NFS land tracts, utilities should be buried. In scattered NFS ownership, there is an increased requirement for roads and aerial utilities to private residences. Where possible, these roads and utility lines are combined into single corridors to reduce impacts.

Roads and trails associated with utility corridors provide additional access. They typically lead to more vehicle and foot traffic and have the potential to increase disturbance to some species of wildlife. Harvests (legal and illegal) of game species on the Forest may increase because of the additional access provided by utility corridors. The Hoosier does not anticipate an increase in cross-country utility corridors or associated road access this planning period. Utility companies often use aircraft, particularly helicopters, to inspect utility corridors. Low-level flying associated with this activity has potential for disturbing wildlife in and adjacent to the corridor especially during the breeding season.

Development of water supply reservoirs would have the same effects as constructing lakes. In addition, water level fluctuations often associated with water supply facilities could adversely affect fish and other aquatic organisms.

Utility corridors may affect the type of recreation in their vicinity. Generally, utility corridors lower the potential for the more dispersed type of recreation. Occasionally, they provide a clearing for a vista, and sometimes they coincide with the location of a trail. Utility corridors and special-use roads may open the Forest to activities such as illegal OHV use. However, the access points may be fenced and gated to minimize unauthorized use.

Energy-regulating agencies, municipalities, and public utility corporations could potentially have interests in Forest lands as providers of space for public services. Such parties could propose to locate corridors, tower sites, water supplies, or other municipal uses on portions of the Forest. The Forest allows private landowners to have access to their properties landlocked by NFS land. The Forest reviews applications for access on a case-by-case basis and rarely grants them if another route exists on non-Federal land. Recreation events use developed recreation sites such as parking areas, multiple use trails, and general forest area for orienteering.

Special use connector trails bring many horse and bike riders to remote areas of the Forest. Trails are located on forest soils, and experience has indicated a need to surface the trails with aggregate rock to avoid soil compaction and erosion. These connector trails provide safe, easy access from commercial camps to the Forest trail system. Although open to the general public, they are maintained by the permittee. Special use permits generate fees paid to the government (Table 3.69).

Minerals

For common variety minerals, also see Streams under Maintain and Restore Watershed Health.

Mineral and energy resources are an important part of the nation’s natural resource legacy. Some areas of the Forest have potential to contribute to America’s need for oil and gas resources. The potential for other mineral development is small. The Hoosier has received very few requests or applications for mineral permits or requests for exploration in recent years. The potential for mineral development is small and sources located on non-Federal land are

meeting the demands at this time. The previous Forest Plan made no lands available for oil and gas leasing, because:

- There was limited development potential for oil and gas resources.
- Historically, there had been little interest in oil and gas development on lands of any ownership in this area of the State.
- Oil and gas exploration was not compatible with other goals of the Forest.

The Proposed Plan proposed to extend this prohibition on leasing of oil and gas for this planning period. The recent passing of the Energy Policy Act of 2005 (PL 109-58) encourages the availability of Federal lands for oil and gas development. The Forest reconsidered the direction made in the Proposed Forest Plan and Draft EIS and made some of the Hoosier's oil and gas resources available. Applications for permits or leases would be processed and evaluated, with public involvement, on a case-by-case basis.

The United States Department of Interior, Bureau of Land Management (BLM), in cooperation with the Forest Service, handles the technical administration of mineral operations. All proposed drilling and related surface-disturbing activities must be approved in advance by the BLM, with concurrence of the Forest Service. The Mining and Minerals Policy Act of December 31, 1970 states the Forest Service policy for mineral resource management. Any mineral development must comply with all applicable State and local laws and regulations. The State regulates oil and gas in the Indiana Code (IC) 14-37 and 14-38.

All activities on Federal minerals must be done in accordance with standard and special lease stipulations, oil and gas operating regulations (43 CFR Part 3160), and Onshore Oil and Gas Order No. 1 for approval of operations. The requirements provide protection for surface resource values on the lease.

In 1989, the BLM completed a mineral development analysis for the planning period of 1990 to 2000 (USDA FS 1991b). The analysis included all land within the Forest boundary, and this boundary has not changed, although the Hoosier has acquired land within the Forest boundary since the analysis. According to a BLM Staff Geologist the mineral development analysis is still applicable today (Appendix C). The planning files contain the original analysis.

Between the analysis done in 1989 and late 2003, there have been 53 oil and gas exploration and production wells drilled in the townships located within the Hoosier boundary. Twenty-six of the Forest's 44 townships had no drilling activity since 1989. Only two townships without a history of production have become productive since 1989. The remaining townships have continued in the previous trends with very little additional production established. Indiana had 1,553 producing natural gas wells in 2001. The number of gas wells has remained constant for several years.

The trend of exploration for new resources and the application of secondary recovery techniques will depend on the worldwide prices for crude oil and natural gas as well as the availability of prospective lands for exploration and development.

The Charles C. Deam Wilderness is the only area formally withdrawn by Congress from mineral development. Designated management areas dictate the amount of mineral activity in their definition.

The Forest negotiates land adjustments to include the mineral estate with the surface estate whenever possible. In rare instances, the Forest purchases land where other parties hold

mineral estates. To date, no other parties holding mineral rights have made application for oil, gas, or mineral development. However, as oil and gas prices increase, there may be a greater likelihood that these rights could be exercised.

In the future, there may be some commercial interest in oil and gas. Several strata containing oil and gas and capable of producing commercial volumes are known to exist under the Forest. The Forest has no pending mineral applications for oil and gas and no oil and gas development or leases. No oil or gas wells were drilled on NFS land in the last planning period.

There is a potential for additional gas storage wells under NFS land near Dutch Ridge. The Leesville and Unionville gas storage fields, both adjacent to the Forest boundary, provide ample gas storage. Indiana has a total underground gas storage capacity of 113,000 million cubic feet with almost all of that in use as of 2001. Gas is often stored in depleted oil or gas reservoirs. As energy companies abandon more oil and gas wells on adjacent private lands due to the end of their productive potential, the wells then become opportunities for the gas storage industry.

There may be limited commercial quantities of clay, refractory silica, sand and gravel, gypsum, building stone, and whetstone on the Hoosier. Development of minerals is unlikely, based on the relative abundance of these minerals on private lands. There is limited coal present on the southern and western edges of the Forest, but it cannot be economically mined by any method other than strip mining. The Surface Mining Control and Reclamation Act of 1977 does not allow mining of Federally owned coal on Eastern national forests by this method. Though limestone and whetstone are commercially quarried in the area of the Forest, there are adequate quantities of high quality stone remaining on private lands to satisfy needs for the foreseeable future. Gypsum deposits are under much of the NFS land. Gypsum is mined only underground, so the mining has little or no impact on the surface of the Forest.

Traces of minerals containing lead, zinc, and barium have been found in Indiana limestone, but no commercial deposits are known. Gold has also been found in minute quantities in glacial outwash north and east of the Forest. Recreational gold panning occurs on the Forest.

Alternatives and the Effects of Management on Minerals

All Alternatives

Wells could be drilled on Federal lands if another party held the mineral rights under NFS lands. This is known as a private acquired lease and occurs only when the Forest Service acquires land with a valid pre-existing oil and gas lease. If this were the case, construction of access roads, well pads, and pipeline corridors could result in removal of vegetation, exposure of soil to erosion by rain and wind, and removal of topsoil. Erosion potential tends to increase with an increase in slope, although soil types and amount of vegetation directly influence erodibility of slopes.

Typical oil and gas or mineral developments are classified in six categories or stages: leasing, exploration, drilling, production, transportation, and abandonment. The leasing phase is the process of making Federal minerals legally available for exploration and production. A lease is allowed only after environmental analysis of the potential development impacts. The degree of access permitted and the mitigation measures required are included as terms of the lease. Terms may range from no surface occupancy of the lands above the lease to access with the standard surface use restrictions applied to all Federal oil and gas leases.

Activities in the exploration phase could include surface geological mapping, geochemical surveys, aeromagnetic, and gravity and seismic exploration. All of these may be conducted before or after leasing. Of these activities, only seismic activities require a permit from the Forest Service, since this may have an impact on the surface of NFS land. The other exploratory techniques involve walking on the surface or flying above the lands.

During the drilling and production phases, construction of access roads and well sites would affect the visual qualities of the immediate area of the mineral development. The degree of impact would depend on the location of activities in a viewshed. Most of these impacts would be of short duration. Once production activities begin, visual impacts would result primarily from the presence of facilities.

During the production phase, the wellhead or gas meter must be accessible for Federal and state inspectors and company service personnel. In general, most of the footprint of the drilling rig is reclaimed at the time the production equipment is installed. After that, there is rarely a need for larger vehicles to enter the site. Most inspections and servicing can be done with access by light truck or even by foot. If oil or water were produced in small quantities, it may be necessary to empty the collecting tanks periodically into a large tank truck. If gas were produced, a pipeline would generally transport it.

After a well is no longer commercially productive, the well is plugged and abandoned. Plugging operations require access to the site by relatively heavy machinery. At this time, cement is placed in the well bore, the wellhead is removed, and the ground is returned to its original contours and reseeded according to specifications provided by the Forest. If the Forest does not need the road for other purposes, the road is graded and planted.

Three negative impacts to water quality could result from oil and gas operations:

- surface pollution resulting from leakage or rupture of the reserve pits and runoff from the well pad
- pollution of the subsurface aquifer(s)
- offsite (downstream) sedimentation and erosion resulting from construction activities and drilling operations

Locating a well in a floodplain could result in property damage, injuries, and pollution if a flood occurred. Unless removed, reserve pit fluids and cuttings could enter local waters during flooding and cause increased sedimentation. Storage tanks could float and capsize, causing brine pollution in local waters.

If surface-disturbing activities include draining, polluting, or filling-in of any wetlands, riparian zones, or floodplains, they would change existing environmental conditions. They would displace animal communities and affect biological diversity. They would also interrupt nutrient cycling, and ecological systems would adjust to different environmental conditions.

Local traffic may be affected when equipment is moved in to construct the access road and well site, when the drilling rig is moved in, and when equipment is moved to complete wells and construct any pipelines needed. The impacts affecting existing roads differ between paved roads and gravel or shale-based roads. Heavy vehicles could cause paved roads to crack, form potholes, and deteriorate, especially along the edges. Gravel or dirt roads, on the other hand, could be subject to the formation of ruts, potholes, and washboard effects. Construction of new access routes in the Forest for mineral exploration or development would provide the public with

increased access and provide an increased opportunity for disturbance or destruction of forest habitat. On the other hand, the increased access could be beneficial to the Forest in accomplishing resource management activities or as potential trails for recreational purposes.

Mineral exploration or development could have an effect on logging activity depending on the location and timing, such as both activities needing access over the same road during the same period. Roads created by these activities could be used later for access to areas for other resource management activities.

Disturbance to wildlife and wildlife habitat would result from mineral exploration or development activities. Construction of roads, well pads, and pipeline corridors may displace wildlife. Noise and the presence of humans would affect some wildlife near oil, gas, or mineral operations. Surrounding habitats would initially absorb displaced individuals, thus influencing territory size, interspecies competition for available resources (food, water, cover, and space), and habitat quality. Timing of activities could magnify or reduce these effects; for instance, disturbance during periods when wildlife are nesting, denning, or raising young could result in reduced or failed reproduction. When a mineral activity site is revegetated, openings created by the activity may be beneficial to many wildlife species found on this Forest. In general, the effect of having these openings would be similar to effects on wildlife of providing openland and shrubland habitat.

If mineral operations were allowed, they could indirectly affect fish and aquatic ecosystems. If activities occur within a stream channel, habitat would be altered. Changes in water quality may displace certain species, thus causing a change in the ecosystem.

Depending on exact locations and type of mineral activities, there may be some loss of recreational opportunities involved with exploration and construction of access roads and sites. Operations during seasonal hunting periods may displace both game and hunters due to noise and surface disturbance.

No major impact on local employment is expected, but some additional jobs could result from mineral activities.

Mineral exploration and development activities may affect adjacent landowners in several ways. Noise and increased traffic in the area of exploration, road access, and development construction may be disruptive.

Cumulative Effects

The cumulative effects of prohibiting most mineral activities include a potential slowing down of exploration and development activities.

Alternatives 2, 3, and 4

In addition to the possibility of outstanding or reserve rights, the BLM could require the Federal lease holder or operator to take protective action – that is, drill a well or relinquish the lease. If a well were drilled on adjacent private land and leased Federal minerals were being drained, a protective well could be drilled into the leased Federal minerals so the government could recoup its royalties. The likelihood of such a well being drilled is very low.

These alternatives otherwise recognize the potential incompatibility of mineral exploration and development and forest management activities.

Cumulative Effect

No significant cumulative effects would occur as a result of the unlikely scenario of wells being drilled to recoup Federal minerals.

Alternatives 1 and 5

These alternatives allow exploration and development of gypsum only in Management Area 2.8 in Martin and Orange Counties.

Both alternatives also allow oil and gas exploration activities that do not disturb the land surface. These exploration activities are likely to include mapping and seismic activities and would have no environmental impacts on the land. These alternatives would not allow seismic activities that rely on boreholes or explosives. Exploration using a technique known as Vibroseis, a vibrating mechanism mounted on large trucks, would be allowed. Unlike dynamite, the Vibroseis signal is not impulsive, but rather lasts from 7 to 40 seconds. To emit its signal, the Vibroseis source sweeps through a range of frequencies from about 10 Hz to 60 Hz.

The Vibroseis buggy has enormous flotation tires, almost 4-feet high with deep tread designed to spread the weight of the trucks. Such equipment would use existing road and trail networks where feasible. No dozing or heavy equipment would be used to clear vegetation.

Mineral exploration of NFS lands is not considered likely at this time, but if demand increases further interest could be focused on NFS minerals.

The gypsum industry does not anticipate a need for further mining under NFS lands for the next five decades; however, rich gypsum deposits do underlie NFS lands in Orange and Martin Counties, and gypsum mines are currently adjacent to NFS lands. This alternative provides for the expansion of these mines if needed.

These deep shafts have minimal surface impacts except for the occasional need for an air shaft to the surface. Surface air shafts are constructed to be safe to the public, have minimal visual impact, and be low to the ground. They are, however, somewhat noisy when the fans are operating. The sound from an air shaft might carry for 0.25 mile in the forest.

Cumulative Effects

The provision allowing gypsum exploration and development is an acknowledgement of the importance of this mineral to local industry and economies. The actual mining of gypsum on NFS lands is unlikely in the next 50 years unless demand or supplies change drastically from predicted levels.

Alternative 5

In this alternative, the areas available for leasing with no surface occupancy or disturbance are limited to parts of Management Areas 2.8 and 3.3 in the Crawford Upland and Brown County Hills Ecological Subsections. Lands in Management Area 2.8 located in the Mitchell Karst Plain and the Crawford Escarpment are not available because of the karst features prevalent in these regions. Allowing for oil and gas in these two management areas is more in keeping with the level of disturbance (noise) already found in these management areas. Other management

areas prohibit mineral development to protect the solitude and characteristic of the management area.

Wells may be drilled on adjacent private land close to NFS boundaries to access Federal oil and gas. According to Indiana law (312 IAC, Chapter 16), a well must be located at least 165-330 feet from a property line, depending on the geological formation. However, if both the private landowner and NFS agree to the lease, the well could be located on private land closer than this distance to allow an oil field under NFS lands to be tapped and include both ownerships in the drilling unit. A typical well can drain 10 acres of oil and 40 acres of gas. Locating wells near the boundary of NFS land may allow a well to tap more of the oil and gas fields. Directional drilling from private land to tap into a field primarily under NFS land would be a possibility under this alternative.

Leasing with no surface occupancy or disturbance allows the Federal government to collect royalties from leases and have a means to enforce environmental standards for wells located adjacent to NFS land.

If the Hoosier did not allow leasing, drilling permits could be issued as close as 165 feet from NFS boundary lines but the Forest would have no control of the resulting well developments and no revenues from the oil and gas produced.

The wording in Alternative 5 removes the concern for recouping drainage from private wells mentioned in the 1991 Plan Amendment and in Alternatives 1, 2, 3, and 4. According to State regulations, drainage is unlikely due to the required spacing rules.

Cumulative Effects

The provision to allow for leasing with no surface occupancy recognizes the Hoosier's role in meeting the nation's demand for oil and gas while protecting surface resources. Energy sources may be developed that supersede the need for tapping into smaller low yielding reservoirs such as those located on the Hoosier.

Public Health

Public health includes hazardous materials, noise, and law enforcement.

Hazardous Materials

Any material that is corrosive, ignitable, reactive, or toxic is potentially hazardous. Hazardous materials include numerous chemicals in gaseous, liquid, and solid states. Frequently, hazardous materials are transported across or near the Forest. An accidental spill of a hazardous material could have detrimental effects on the forest environment as well as human life. Many materials used on the Forest are considered hazardous and would cause environmental harm if a spill were to occur.

The Forest has developed a Hazardous Material Spill Plan to provide personnel with guidelines for quick and efficient response with the least risk of further adverse effects to the environment and human health. The Forest would respond to each hazardous material in a different manner, depending on location, amount, and type of material involved. The Hoosier provides training to

employees concerning responses to hazardous material situations and cooperates with local law enforcement agencies.

Noise

Noise levels on the Forest vary depending on time, wind direction, and location. Sources of noise include aircraft, developed area activity (such as generators, music, and voices), motorboats, and road traffic. In some locations, one can hear noise from lands adjacent to Forest (for example, dogs, quarries, equipment, people, and tractors). One can also hear military aircraft on the Forest. Project implementation and administrative activities (such as bulldozers, chainsaws, construction equipment, emergency vehicles, and helicopters) also result in noise. Noise on the forest is generally concentrated and most apparent in developed areas and along roads.

Natural sounds dominate the forest. These include sounds made by animals, water, wind, and other natural phenomena. Natural quiet does not mean a complete absence of sound.

Law Enforcement

Nine Indiana counties contain NFS lands. The proximity of the Forest to major metropolitan areas creates law enforcement concerns on the Forest. The Forest is within a 45-minute to 5-hour drive of Chicago, Cincinnati, Indianapolis, Louisville, and St. Louis. This proximity creates a challenging atmosphere when protecting public lands and Forest visitors.

Objectives of the law enforcement program are:

- protect the public, employees, natural resources, and other property under the jurisdiction of the Forest Service,
- investigate and enforce applicable laws and regulations pertaining to NFS land, and
- prevent criminal violations through informing and educating visitors and users of applicable laws and regulations.

The proximity of the Hoosier to major metropolitan areas brings the problems associated with large urban areas. Off-highway vehicle use is currently not permitted on the Forest. However, illegal use is a major problem Forest-wide. Although the Forest Service works closely with other law enforcement agencies, illegal use still occurs.

Marijuana cultivation and methamphetamine laboratories have been discovered on public lands. In addition to being illegal, the dangerous chemicals and fertilizers used during these operations pollute the ground water, wash into streams, and can poison animals and humans.

Vandalism and defacing government property is a continuing problem.

In the past, opposition to timber harvesting has resulted in protests at Forest offices and work sites. More recently, activist groups have claimed responsibility for criminal incidents that have occurred on property in proximity to the Forest. Examples of incidents include arson on construction sites, damage to equipment on a logging and road construction site, spiking trees in a State forest, and tree sitters noted on State and private lands.

Alternatives and the Effects of Management on Hazardous Materials, Noise, and Law Enforcement

All Alternatives

Hazardous Materials

The Forest has developed a Hazardous Material Spill Plan to provide personnel with guidelines for quick and efficient response with the least risk of further adverse effects to the environment and human health. The alternatives would respond the same to a hazardous materials incident. Response would not vary by alternative.

Noise

Management Areas 5.1 and 6.2 would likely offer less noise than other management areas. These areas are non-motorized and have a lower road density than the general forest area, resulting in less motorized traffic. Noise originating from other users may be evident. One can expect high noise levels in MA 7.1 due to the concentration of people, vehicles, and activities at developed recreation sites. Some wildlife may be temporarily displaced in MA 7.1.

Law Enforcement

Law enforcement would not vary by alternative.

Alternatives 1, 3, 4, and 5

Noise

Noise associated with site preparations, planting, and timber harvest would be local and of short duration. Equipment used in these activities, such as chainsaws, bulldozers, and augers, can affect wildlife and recreational experiences. All alternatives would generate noise during road construction, reconstruction, and maintenance. However, all alternatives are expected to consider only minimal amounts of new road construction. The effects of these activities are expected to be local and short term. On roads closed to the public, noise from vehicle use for project implementation would be short term.

In Alternatives 1 and 5 additional noise impacts from mineral exploration and development and its related traffic, although unlikely, could occur in MA 2.8. The Forest would consider and analyze such impacts on a case-by case, site-specific basis.

OHV use in Alternative 3 would be expected to increase noise in localized areas. The section addressing OHV use on the Forest analyzes these effects.

Alternative 2

Noise

Due to minimal management, noise impacts would be limited. Minimal amounts of maintenance may be needed to meet safety standards for Forest visitors. Noise associated with this type of work is of short duration and local.

Irreversible or Irretrievable Commitment of Resources and Unavoidable Adverse Effects

An irreversible commitment of resources is one that results from actions that alter an area and prevent it from returning to its natural condition for an extended time or one that uses nonrewable resources such as cultural resources and minerals.

Irreversible Commitments

Minerals

Gas, oil, and minerals that are located and developed. This is unlikely to occur.

Fossil fuels and common variety minerals used in administration of the Forest.

Irretrievable Commitments

Irretrievable commitments of resources occur when opportunities are forgone to use or produce a specific resource for a time while favoring the production of another resource. These commitments are irretrievable rather than irreversible because reversal of management decisions would allow these resource uses to occur again. Only the loss sustained during the period of unavailability would be irretrievable (benefits foregone).

Soils

The amount of productive soil lost in each alternative from construction of recreational facilities, permanent roads, oil and gas sites, dams, and administrative facilities (all alternatives, but little in any of them) is an irretrievable commitment.

The amount of soil temporarily affected by temporary roads and log landings (Alternatives 1, 3, 4, and 5) is an irretrievable commitment.

Visual Quality

Loss of natural landform and an interrupted forested landscape due to oil and gas developments, permanent road construction rights-of-way, recreation facilities, wildlife habitat developments (all alternatives), and silvicultural treatments (Alternatives 1, 3, 4, and 5) is an irretrievable commitment.

Cultural Resources

Over time, some previously unidentified cultural resources will likely be damaged unintentionally by ground-disturbing projects. The increased access to archaeological sites provided by other activities will likely increase the level of damage to sites by vandals. Some significant sites will be damaged by natural weathering because they have not yet been identified or because funds will not be available to maintain them (all alternatives).

Vegetation

Loss of commercial timber management opportunities in Management Areas 2.4, 6.2, 6.4, 7.1, 8.1, 8.2, 8.3, 9.2, and 9.3 (all alternatives) is an irretrievable commitment. Loss of commercial timber management opportunities in all management areas (Alternative 2) is an irretrievable commitment.

Adverse Effects That Cannot Be Avoided

Implementation of any of the alternatives may result in some adverse environmental effects that cannot be avoided. The Forest can minimize the degree of severity of the adverse effect by adhering to direction provided in the Plan as Forest-wide guidance and direction for individual management areas, but some effects generally cannot be avoided if any management activities occur.

This section describes those adverse effects that cannot be avoided as a result of acting on the management opportunities described in this document. These effects are not necessarily unacceptable; they are simply unavoidable or cannot be completely mitigated.

Direction in the Plan will limit the occurrence and the degree of most unavoidable adverse effects. Some of the unavoidable effects of management practices simply cannot be mitigated and perhaps should not be, such as providing recreation sites and commitment of lands to exclusive uses. Whether an effect is adverse or positive is often a matter of personal opinion. The Hoosier will also use information contained in the Forest Service manual and handbooks in site-specific project design. This will help prevent some adverse effects.

These effects include:

Visual Resource

Silvicultural, construction, and other management activities cause a temporary change in the landscape (construction: all alternatives but limited in Alternative 2; silvicultural activities: Alternatives 1, 3, 4, and 5). Debris on the ground, understory vegetation disturbance, and open corridors normally result from project activities.

Air Quality

Silvicultural, construction, prescribed burning, and other management activities will cause a slight temporary change in local air quality (mostly in Alternatives 1, 3, 4 and 5). This change, which occurs only during the actual construction, harvesting, and burning, will be in the form of increased dust in the air as well as smoke.

Noise

Silvicultural, construction, increased vehicle and campground use, and other management activities will cause additional noise (silvicultural and road construction activities are much more limited in Alternative 2). The effects will be localized.

Recreation

Such project activities as timber sales, road construction, and other management activities may temporarily disrupt recreation uses by reducing or changing the type of recreation that would normally occur on the area (Alternatives 1, 3, 4, and 5).

Wildlife

Wildlife will occupy all ecological niches, but different emphasis among the alternatives would cause gains in habitat for some species and losses for others. It is unavoidable that some habitat will decline while others increase (all alternatives).

Soil Productivity

Development activities such as road construction or recreation site development will adversely affect soil productivity on the occupied site (mostly Alternatives 1, 3, 4, and 5).

Chapter 4

LIST OF PREPARERS

A team representing many disciplines was responsible for the majority of details that went into preparing the Plan revision documents. The ideas and philosophy that guided this team came from their professional experience, Forest Service guidance, the public, and other Forest Service personnel who worked with them.

Core Interdisciplinary Planning Team

JUDITH A. PEREZ – Land Management Planner

- Education: BS Forest Management
- Experience: 16 years experience in forest planning and timber management
- Responsibility: Planning Team Leader, prepared sections on noise, hazardous materials, and law enforcement, document review and editing, analyzed public comments and prepared responses

CYNTHIA M. BASILE – Wildlife Biologist

- Education: BS Environmental Science
  MS Biology
- Experience: 8 years in wildlife management
- Responsibility: Prepared sections on animal communities, T&E, sensitive species, MIS, SVE, and cave and karst; contact for SVE panels, LANDIS, and HSI modeling; prepared the biological evaluation and contributed to the biological assessment; document review and editing; analyzed public comments and prepared responses

RONALD C. ELLIS – NEPA Coordinator

- Education: BA English
  MF Forest Management
- Experience: 15 years with project-level NEPA analyses on 4 national forests; 30 years with Federal land management.
- Responsibility: Prepared sections on analysis process and management situation; NEPA consistency, document review and editing, analyzed public comments and prepared responses

TEENA M. LIGMAN – Public Affairs Specialist

- Education: BS Forest Management
- Experience: 27 years of experience with forest management and public affairs
- Responsibility: Prepared sections on social and economics impacts, public comment, document review and editing, analyzed public comments and prepared responses

ERIC J. SANDENO – Outdoor Recreation Planner

- Education: BS Recreation Resource Management
- Experience: 12 years with recreation, trails, and wilderness management

- Responsibility: Prepared sections on Wilderness, roadless areas, Wild and Scenic Rivers, Recreation Opportunity Spectrum, off-highway vehicles, and recreation economics, document review and editing, analyzed public comments and prepared responses

Expanded Interdisciplinary Planning Team

DEBORAH ALBRIGHT – GIS Specialist (retired)

- Education: BA Geography
- Responsibility: Prepared GIS data and maps

KEVIN R. AMICK – Resource Information Specialist/GIS Specialist

- Education: BA Geography
- Experience: 8 years with Federal government
- Responsibility: Prepared GIS data and maps

KENNETH G. DAY – Forest Supervisor

- Education: BS Forest Resources Management
MS Forestry
- Experience: 29 years in Forest Management
- Responsibility: Project oversight

JAMES E. DENONCOUR – District Ranger

- Education: BS Wildlife Management
MS Wildlife Ecology
- Experience: 27 years in forest management
- Responsibility: Project oversight

GARY B. DINKEL – Ecosystem Program Manager

- Education: BS Forest Management
- Experience: 25 years experience in silviculture and nursery management
- Responsibility: Prepared sections on fire and air quality, reviewed Ecosystem and Watershed sections

JASON A. ENGLE – Wildlife Biologist

- Education: BS Wildlife and Fisheries Sciences
MS Wildlife and Fisheries Sciences
- Experience: 3 years GIS specialist and 2 years as a Wildlife Biologist
- Responsibility: Reviewed wildlife sections

ANGIE R. KRIEGER – Heritage Resource Specialist/Forest Archaeologist

- Education: BA Anthropology
- Experience: 19 years as Archaeologist
- Responsibility: Prepared section on heritage resources, analyzed public comments and prepared responses

THOMAS R. KRUEGER – Special Uses Program Manager

- Education: BS Forestry
- Experience: 29 years, including 9 years as Special Use Program Manager

- Responsibility: Prepared section on special uses

PAMELA S. KRUSE
- Experience: 24 years in support functions
- Responsibility: support services and database management

KIRK W. LARSON - Botanist
- Education: BA Biology
- Experience: 15 years botany and wildlife management
- Responsibility: Prepared sections on NNIS, RNA, Special Areas, and associated appendices, contributed to section on plant communities, and helped prepare biological evaluation, including HSI models for plants and selected SVE animal species, prepared responses to public comments

FRANKLIN A. LEWIS – Public Affairs Officer
- Education: BBA Marketing
  MEM Forest Management
- Experience: 27 years resource management
- Responsibility: Prepared communications plan and Chapter 5, assisted with release of DEIS and FEIS to public and media, document review and editing

RICHARD B. LIDELL – Engineering Program Manager
- Education: BS Civil and Environmental Engineering
- Experience: 22 years in civil engineering
- Responsibility: Prepared section on transportation, document review and editing

CLARK D. MCCREEDY – Wildlife Biologist
- Education: MS Wildlife Ecology
  PhD Environmental Toxicology
- Experience: 8 years experience in wildlife management
- Responsibility: prepared biological assessment, contributed to biological evaluation, contributed to T&E section

WILMA MARINE - Public Affairs Officer (deceased)
- Education: BA Journalism
- Responsibility: prepared communication plan for NOI and workshops

PATRICK C. MERCHANT – Soil Scientist
- Education: BS Agronomy
- Experience: 37 years as soil scientist
- Responsibility: prepared section on soils, contributed to section on watershed and related appendix

NANCY A. MYERS – Outdoor Recreation Planner
- Education: BS Political Science
  MS Forest Recreation Management
- Experience: 8 years in recreation
- Responsibility: Prepared section on visual resource, analyzed public comments

KELLE A. REYNOLDS – Wildlife Biologist (transferred)
- Education: BS Wildlife Science
- Responsibility: Coordinated SVE panels, LANDIS, and HSI modeling

MARGUERITE SCHUETTER – Assistant Fire Management Officer
- Education: AS Forestry
- Experience: 14 years in fire and timber management
- Responsibility: Contributed to section on fire

MARY J. SCHOEPPEL – District GIS Specialist
- Education: BS Forestry
- Experience: 9 years as interdisciplinary team leader; 6 years as GIS specialist
- Responsibility: prepared GIS data and maps

ROSS H. TAYLOR – Lands Program Manager
- Experience: 16 years as a Licensed Land Surveyor, 27 years total surveying experience
- Responsibility: Prepared sections on land acquisition and associated appendix

REGIS TERNEY – Forest Planner (transferred)
- Education: BS Forest Science
- Responsibility: Developed Need for Change and Notice of Intent and served as Planning Team Leader prior to transfer.

THOMAS R. THAKE – Silviculturist
- Education: BS Forest Resource Management
- Experience: 26 years in silviculture and timber management
- Responsibility: Prepared timber section, contributed to plant communities, contact for SPECTRUM and LANDIS models, prepared responses to public comments

CHRISTOPHER D. THORNTON – Forester
- Education: BS Forest Management
- Experience: 14 years experience in silviculture and timber management
- Responsibilities: Contributed to section on plant communities

ANNE L. TIMM – Aquatic Ecologist
- Education: BA Biology
  MS Environmental Science
- Experience: 5 years aquatic research and aquatic resource management
- Responsibility: Prepared sections on water resources, water quality, aquatic habitat and species, riparian habitat, and contributed to section on soils

LESTER A. WADZINSKI – Recreation Program Manager
- Education: BS Recreation
  MS Recreation Resource Management
- Experience: 30 years in recreation and public land management
- Responsibility: Prepared sections on trails and recreation. Primary reviewer of sections on visual resources, heritage resources, Wilderness, OHV, and Wild and Scenic Rivers

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- Zhaofei Fan - Post Doctoral Scientist
- Stephen Shifley - Research Forester
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Chapter 5

LIST OF RECIPIENTS

This chapter contains the list of agencies, organizations and persons who were sent either one, all, or some combination of the following documents: the LRMP, EIS, or Record of Decision.

IDNR, Division of Nature Preserves	IDNR, Division of Fish & Wildlife	Indiana Wildlife Federation
Lincoln Hills RC&D	Vincennes University Horticulture Dept.	Larry Allen
Harold Allison	Doug Allman IN Deer Hunters Assoc. IN Sportsmen's Roundtable	Steve Andrews
Bob Armstrong Lost River Conservation Assoc.	Steve Backs Forest Wildlife Headquarters	Michael Baker
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Bracken Library Govt. Publications Service Ball State University	Brown County Library	Brownstown Library
Butler University Library	Cannelton Library	Colorado Su Library Judy Smith

Crawford County Library	Cunningham Library Indiana State University	Evansville Library Vanderburg County Central Library Reference
Forestry Library University of Minnesota	Frances L. Folks Library	Frankfort Community Library
Gary Public Library	Indiana State Library Indiana Division	Indiana University Library Documents Department
Indy-Marion County Library	IUPUI University Library	Jackson County Library
Jasper Public Library Dubois County	Knox County Library	Kokomo-Howard Library
Louisvilee Free Library Branch Libraries Middletown	Louisville Free Library Branch Libraries Fern Creek	Louisville Free Library Branch Libraries Jeffersontown
Marian College Library	Melton Public Library	Mitchell Library
Monroe County Library Indiana Room	Morgan County Library North East Branch	Morgan County Library
Muncie Public Library C/O Reference Librarian	New Albany Library Floyd County	Orleans Public Library Town & Twp

	Owen County Public Library	Paoli Public Library
Purdue University Library Main Library-Fiscal Planning	Shoals Public Library Martin County	St. Joseph County Library
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Chapter 6

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Chapter 7

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