INDIANA STATEWIDE FOREST ASSESSMENT
2010

Indiana Department of Natural Resources
DIVISON OF FORESTRY

Indiana Statewide Forest Assessment 2010

Executive Summary

In different ways forests have always sustained societies in Indiana but the relationship between society and forests has not been static and is constantly evolving. The 2010 Statewide Assessment of Forest Resources in Indiana presents a view of society's changing relationship with forests. With an increased demand by a growing human population upon the various benefits forests provide, from timber and lumber to clean air, water and wildlife habitat, there are questions as to the sustainability of the forest resource in the state.

This Assessment is intended to answer those questions but also to highlight important information that is necessary and lacking in order to ensure that these benefits and ecosystems services are recognized, maintained and enhanced into the future. Ultimately, this document should provide some tools that will help to direct a prioritization of efforts in the coming years and in the face of decreasing funds to secure a future forest resource that is reflective of society's needs.

Landscape scale understanding of Indiana's forest issues has required the input of thousands of individual stakeholders, and the statewide scope of this document is based on their concerns, values and insightful direction. Stakeholder participation is valuable because the vast majority of these forests and woodlands, 85% in total, are owned by private individuals and families.

Indiana's unique and high-quality forests are a part of the fabric of Midwestern wealth and development. With this document, Hoosiers are presented information on the forest issues, threats and benefits that have far-ranging impacts on jobs, health, and quality of life, among other things. Answers to the following questions are provided:

- What percent of forests in Indiana are protected and off-limits to conversion and development?
- In which watersheds do forests best protect public drinking water?
- How can we pinpoint the threats associated with exotic invasive species?
- Where in the state are forests likely to have rich biologic diversity?
- What percentage of forestland is open to the public for recreation?
- Which counties have had the most severe loss of forestland since 1992?

Indiana's forests of the future depend on how the answers to these questions are used to effectuate plans and implement changes that positively impact society's changing relationship with forests.

Indiana Statewide Forest Assessment 2010

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Introduction

The Indiana Statewide Forest Assessment 2010 ("Assessment") is the first geospatially based assessment of all private, public, urban and rural forest resources in the state.

The last comprehensive assessment of Indiana's statewide forest resources was produced in August 1981. Before that time and since, Indiana's forests have continued in their constant process of change and evolution. Adding a layer of complexity, forests are also interacting with society in new and different ways.

New technologies have been developed that improve our understanding of complex forest ecosystem interactions, the efficiency with which we harvest, create and market products derived from forests, and how we communicate, learn and disseminate information about this valuable resource. But perennial conflict remains around balancing a resource base with an increasing user population. And society has created new issues and new roles for forests as providers of biomass for electricity generation, feed stock for cellulosic ethanol and storehouses of carbon to mitigate changes in the atmosphere.

As with many others areas of society, "sustainability" has become a buzzword for forestry and natural resources. The word means many things to many people. This Assessment attempts to address the sustainability of Indiana's forest resources and defines sustainable forests as those that can continue to provide broad and diverse benefits, among them ecosystem services and timber production, for generations to come.

Before using the Assessment please read through following sections: goals and objectives, document design and acknowledgments. These sections provide an understanding of the framework, purpose, scope and perspective of the document and will be useful to place the information within a context accounting for the intent of the authors.

The Food, Conservation, and Energy Act of 2008, commonly referred to as the Farm Bill, was enacted on June 19, 2008. The legislation amended the Cooperative Forestry Assistance Act of 1978 (CFAA) and requires each state to complete a Statewide Forest Resource Assessment, followed by the development of a Statewide Forest Resource Strategy in order to receive, or continue to receive, funds under CFAA.

CFAA funds are provided to states through the State and Private Forestry (S&PF) organization of the USDA Forest Service. Currently, Indiana receives these funds annually to assist private forest landowners, promote healthy forest practices, assist communities with their urban forests and protect communities from wildfire. A large portion of the CFAA funding received by the Indiana Division of Forestry is passed to local organizations by way of grants that provide matching funds and additional implementation resources.

Goals and Objectives

The Assessment attempts to show the "state of affairs" of Indiana's private and public forests and analyze the sustainability of forested ecosystems on a statewide or landscape level.

This assessment will be used by (1) Indiana Department of Natural Resources ("IDNR") staff to conduct management and design policy, (2) external partners and stakeholders involved in landscape conservation and stewardship who require statewide data. The information is also intended to be concise while remaining accessible and understandable to the general public.

The Assessment strives to present unbiased findings and conclusions to provide a valuable source of information for others. It should also form a basis for its companion document, the Statewide Forest Resource Strategy.

Document Design

The statewide scope of this document reflects the distribution of benefits and services that are produced by all forests. Forest benefits and services, like clean water, forest products, and wildlife habitat are produced by all forests, statewide. Risks to forests, like fire, insects and disease or development, can occur anywhere and often spread across large areas affecting public and privately owned forests. The scope of this document is statewide, and it is geared toward informing landscape-level decisions. A risk of using statewide data is that at times, a critical issue or threat in one region of the state may be masked by a stable condition statewide. When this became evident in the analysis, the authors assessed the regional threat and determined if it was great enough to highlight and evaluate. When available and valuable to do so, data are presented at other levels, e.g., county, or to show an example data set that would be informative if it becomes available statewide in the future.

Because this is a geospatially based assessment, certain important issues are under-represented due to a lack of transferability into geographic imaging systems. Because of their diffuse or intangible nature, issues like education, will always be more difficult to represent using maps but it is expected that methods will develop that allow for fuller representation in the future, and it is anticipated that data layers will also shift in importance or potentially become inapplicable.

Indiana forest resource conditions, trends, threats and priority areas are presented according to the state's recognized forest issues and their relative importance. It is believed that by using this framework we are encouraging use and application of data at multiple levels and fostering cooperation and common understanding in the state. Indiana's forest issues are also consistent with the USDA Forest Service's national priorities: conserve working-forest landscapes, protect forests from harm and enhance public benefits from trees and forests.

The relative importance of issues and their respective levels of concern were expressed by Hoosier landowners, resource professionals and other stakeholders in a June 2009 survey. Significant focus is placed upon the issues of recognized importance but an effort is made to also consider items that are important but have perhaps not registered across this larger societal spectrum.

Indiana Forest Issue	Relative Importance Score
Fragmentation and/or conversion of forests to another land use	507
Conservation and maintenance of soil and water resources	425
The spread and control of invasive species	421
Conservation of biodiversity	364
Counterproductive government forest conservation related policies	249
Availability of land for public recreation	234
High cost of forest ownership and low incentives to retain	226
Conservation of forests that protect drinking water supplies	206
Overpopulation of white-tailed deer	194
Inadequate public education about forests	166
Sustaining Indiana's forest product industry	160
Lack of active management on forests	146
Sustainable regeneration of oak woodlands	138
Inadequate youth education about forests	94
Lack of healthy woodlands and trees in urban areas	90
The control of forest fires	73
The loss of fire dependent plant communities and habitats	67
Forests not managed for carbon storage	45

Today forested landscapes cover around 5 million acres or 21% of Indiana's land base. All of these forests are important for providing associated benefits and services but certain areas are prioritized as part of the overall Assessment requirements. This is determined through a geospatial layering analysis (See Appendix A for associated methodology) that identifies priority landscape areas with the purpose, as described in S&PF national guidance: "to ensure that federal and state resources are being focused on important landscape areas with the greatest opportunity to address shared management priorities and achieve measurable outcomes." Priority Landscape Areas represent the issues of greatest importance and need. There is also description of multi-state areas that are a regional priority.

This Assessment is designed to initiate an iterative process that will occur every 5 years. Because this is the first geospatially based Assessment to address the sustainability of all forests in Indiana, many data sources are inadequate. Where the authors have considered these "data gaps" important, they are noted in the text and listed and expanded upon in Appendix B. It is expected that these data gaps will be a focus in Statewide Forest Resource Strategy development.

The Appendices include links, references and source information for topics that were beyond the Assessment's scope or already covered comprehensively and expertly through other efforts.

Except where specifically noted, this Assessment is not intended to duplicate or replace statewide plans that currently exist on topics addressed herein. Rather, the intent of the Assessment is to build upon, coalesce and present new information. Effort has been made not to directly present information from existing Statewide Assessments, i.e., USFS Forest Inventory Analysis reports, State Comprehensive Outdoor Recreation Plan and Wildlife Action Plan. Many of these plans do not have a geospatial focus.

A further detailing of efforts to develop this Assessment, coordinate with stakeholder groups and individuals and encourage the widest possible participation makes up the final section of the assessment and includes the names of authors, reviewers and contributors to this effort.

Acknowledgments

The DNR, Division of Forestry is the primary author in consultation with natural-resource professionals across Indiana. The authors have made every effort to not solely present data from the perspective of the DNR. Data sources are from a wide variety of agencies and organizations.

The Assessment has been most influenced by stakeholder input, guidance and participation. Please see the Stakeholder Involvement section under Coordination with Groups and Other Plans. The authors thank the following persons for their contributions and input: Steve Backs, Bill Bull, Sam Carman, John Castrale, Drew Daily, Ben Eddy, Tom Evans, Joey Gallion, Scott Haulton, Carl Hauser, Brenda Huter, Ellen Jacquart, Pam Louks, Phil Marshall, Duane McCoy, Mitch Marcus, Dev Niyogi, Katie Smith, Zach Smith, Mike Seidl, Jeff Settle, Chad Stewart, Sean Sweeney, Rob Swihart and Chris Woodall.

Special recognition goes to Brett Martin of the Division of Forestry, who created the maps in this Assessment.

Forest Conditions, Trends, Threats and Priority Landscape Areas by Issue

Indiana's unique and high-quality forests are a part of the fabric of Midwestern wealth and development. The issues that are paramount in determining the sustainability of forest resources have far-ranging impacts on Hoosier jobs, health, and quality of life, among other things.

Landscape conservation and stewardship requires information and resources to facilitate the many shared goals of organizations and partners in the field. The following analysis should inform decision making related to forestry and land use, and it is presented so that specific issues, like water quality, economic development or public recreation can be considered separately and given a local priority weighting that may differ from any statewide priorities discussed herein. Partners are encouraged to analyze issue components independently where certain factors may be less relevant at more local scales or where initiatives have a more narrowly defined focus. Also, this section should have applications to the Indiana-relevant sections of broader-scale regional work that extends beyond the state's borders. Existing and potential multi-state priorities are discussed briefly in the following section.

Considered together, Indiana's forest issues represent an informed Hoosier perspective on forest threats, benefits and conservation priorities that are reflective of trends in the state. Forest benefits like recreation and biodiversity are recognized and evaluated in juxtaposition with threats to forests like wildfire and conversion. Indiana forest issues form the framework for the major analysis of the Assessment and are developed consistently with the priorities of Indiana forest stakeholders and other interested parties. Using Indiana's forest issues in this way, to prioritize forest importance, offers an analytical opportunity that mirrors the complexity and tradeoffs involved all economic decision making.

Over the past 200 years, Indiana's forests have shown remarkable resilience and present a case study in resource sustainability. The lessons that were learned by society after the cutover that followed the European settling of this state, and the response guided by eminent Hoosier conservationists like Richard Lieber and Charles Deam, among others, are lessons that have application today as society responds to new forest threats and issues.
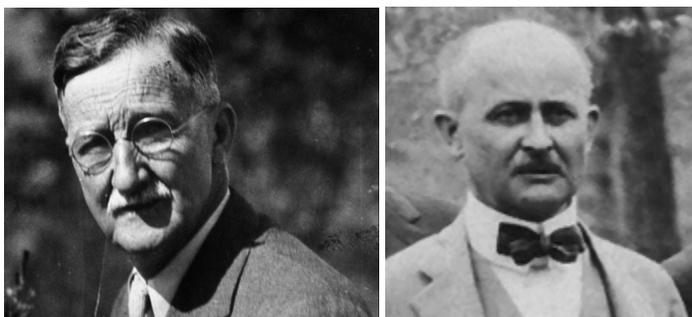
Pictured: (Left) Charles Deam; (Right) Richard Lieber

American ecologist Aldo Leopold said that conservation is a state of harmony between men and land. Such being the case, bringing harmony to society's relationship with forests has become

exponentially more complicated as private individuals, who own 85% of Indiana's forests, have become more numerous and divided ownerships into smaller tracts.

Indiana's forests will never be the forests that existed at the time of European settlement. Major forest ecosystem components, like the passenger pigeon, have been removed forever and cannot be replaced. Similarly, land management practices of the past, like the free ranging of millions of hogs or widespread burning of large areas that were formative for Indiana's forests cannot be practiced on a similar scale today. Forest stewards and conservationists are key partners to assist society in understanding these formative aspects and helping to shape the landscape scale management that is requisite to sustain and enhance the benefits that our forests currently provide.

Indiana's gains after the 20th century recovery in forested acreage are largely thought to have leveled off or peaked in recent years. Data from the land-cover analysis used in this Assessment show an overall net gain of 348,140 acres since 1992, but more research is needed to determine the extent to which these transitioning forests are able to provide benefits and ecological services. The two maps below show the percentage each county contributed to the total loss or gain in forestland across the 17-year period.

Percent Total Forest Loss By County
1992 - 2009

Percent Loss

☐	0.18 - 0.55
☐	0.56 - 0.94
☐	0.95 - 1.37
☐	1.38 - 1.98
■	1.99 - 3.31

This map shows what percent each county contributed to forest that was lost across the entire state from 1992-2009.
This does not show net forest change.

These data that are derived from satiate imagery show 1,272,820 acres of land that weren't forest in 1992 but were forest in 2009. Also 924,680 acres of land that were forest in 1992 but were not forest in 2009.
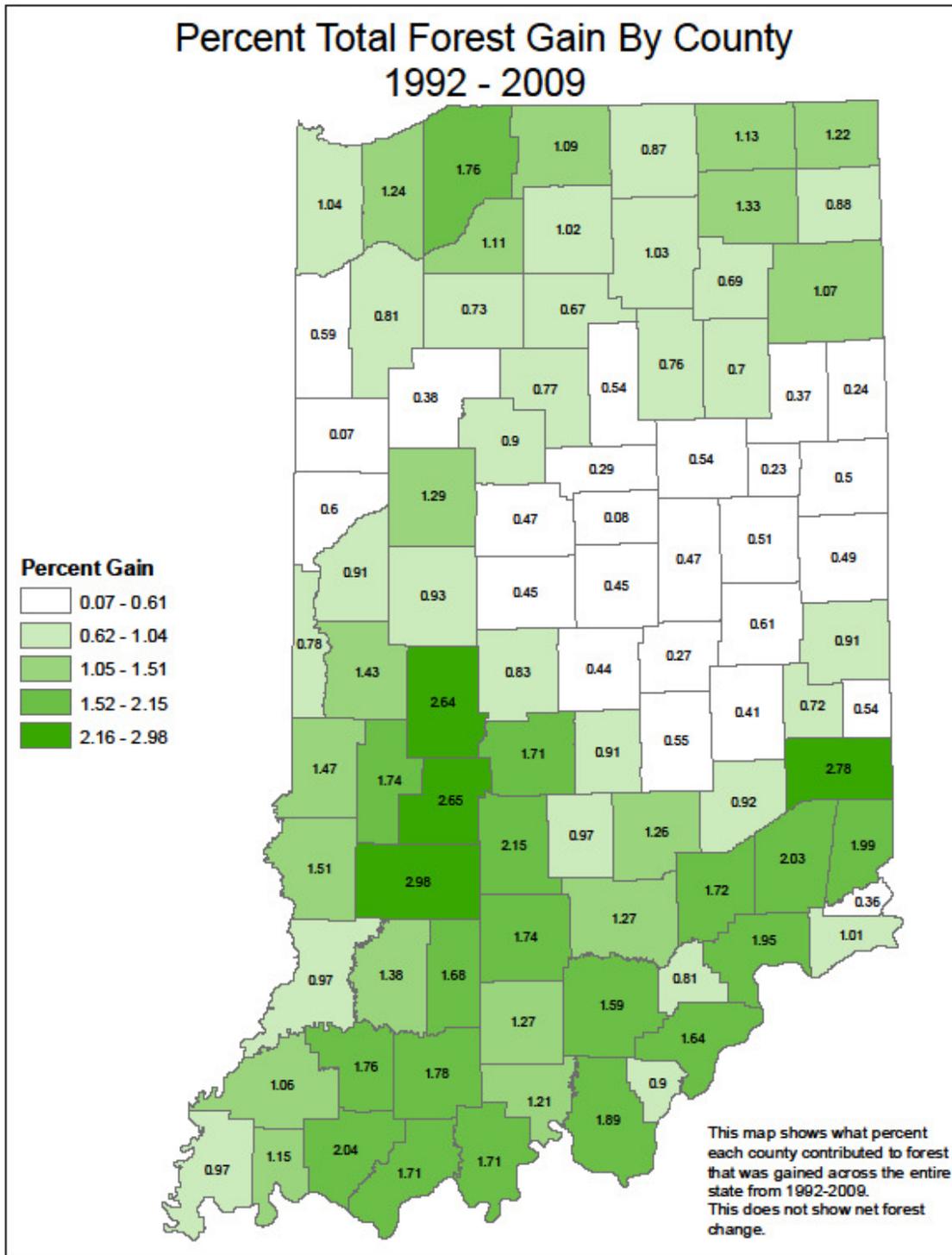
In June 2009, approximately 1,400 natural-resource professionals, academics, industry and private landowners participated in a survey to determine the relative importance and level of concern about issues facing Indiana's forests. The results of this survey define the content in this section and are used in the priority landscape areas analysis to assign weighting to Geographic Information System ("GIS") maps that attempt to spatially represent these issues.

Detailed information about the June 2009 survey, including the full results, summaries and analysis, can be found at:
http://www.in.gov/dnr/forestry/5436.htm

In general, Indiana forest issues presented in this analysis are represented by compiling multiple maps or data layers together to form an "issue map." For example, the conservation and maintenance of soil and water resources or "Soil & Water" issue map is composed of nine data layers, each adding to our understanding of this complex forest issue. For purposes of discussion, in this analysis these data layers are called "component" maps. Component and issue maps are framed with explanatory material and brief textual context. The focus of this section is the spatially explicit prioritization of lands according to the values that underlie particular forest issues. There are links in the index section of the appendix that serve as a guide to more in-depth discussion of the issues themselves. Comprehensive analysis of all the important issues facing Indiana's forests is beyond the scope of this document.
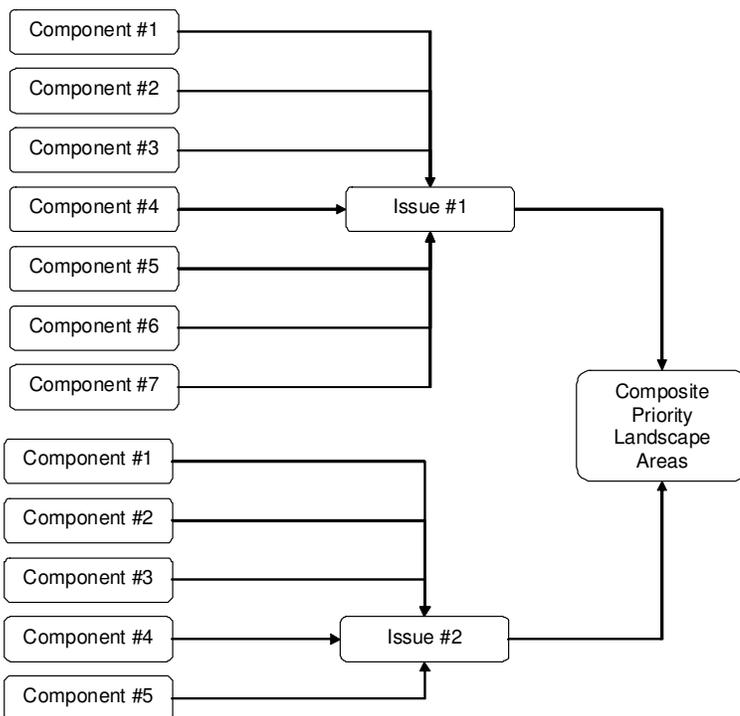
Priority landscape areas for each of the most important Indiana forest issues are defined in this section. These will be used by Indiana Department of Natural Resources professionals and partners in order to facilitate landscape-level conservation and stewardship in Indiana. A composite statewide Priority Landscape Areas map (as well as multi-state areas) is discussed in the following section. This composite map fulfills a Federal Farm Bill requirement but is less applicable to focused initiatives. Schematically represented, **Component** maps feed into **Issue** maps that are weighted to form a **Composite** Priority Landscape Areas map.

The simple diagram (above) conveys the relationships between Component, Issue and Composite Priority Landscape Area maps. There are six issues covered in the Priority Landscape Areas analysis. Each Issue map will not have an equal number of Component maps. Component maps contribute equally in weight to create an Issue map. The methodology and data sets for this analysis are more fully described in Appendix A.

Fragmentation

Fragmentation and/or conversion of forests to another land use is the most important threat to the sustainability of Indiana's forests.

The broadly designated issue, hereafter referred to more simply as "fragmentation," can incorporate many different effects on forests. The effects of fragmentation from logging can be relatively short term and present certain ecological differentiation, whereas conversion of forestland to impervious surface presents wholly different and significantly more severe ecological effects. Likewise, the effects of a contiguous forest patch being converted to low density residential housing differ from those where conversion is to commodity agricultural production.

The long-term sustainability of forested ecosystems is in no small way affected by the ability of these systems to provide genetic response to stress, disease or disasters. Forest systems are complex and genetic transfer is influenced by a multitude of interacting forces from climate changes to fluctuations in wildlife population. Fragmentation inhibits this transfer and weakens the overall systems' ability to adapt and respond to environmental change.

This section considers these ecological aspects of fragmentation as well as those aspects that are driven by economic influences. It considers the growth in human population density and urban areas as well as associated leading indicators, namely roads and existing metropolitan areas. Just as extensive fragmentation can impair the ability of migratory birds to find suitable nesting sites; it can also impair the ability of woodland owners to market timber due to an insufficient product base from which to profitably deduct transportation and removal costs.

Ownerships (specifically parcel divisions), tax assessment categories and zoning categories will have some effect on the fragmentation of forests, and these are not reflected in this analysis. It is hoped that in the future these data will be available to add further insight into understanding this issue. These items are listed as identified Data Gaps in Appendix B. Further information about the forest issue Fragmentation is in Appendix D.

This issue has four equally weighted component maps.

Contiguous Forest Patches

This map depicts contiguous forests, those not divided by state or federal highway, by patch size. Southern Indiana contains the majority of the largest forest patches. There are no forest patches larger than 10,000 acres in Northern Indiana. There are eight forest patches in Southern Indiana larger than 50,000 acres.

These largest forest patches are those most able to provide forest genetic exchange requisite for healthy ecosystem functions.

Fragmentation: Forest Patch Size

Forest Patch Size
- < 50 acres
- 50 - 100 acres
- 100 - 500 acres
- 500 - 1000 acres
- 1000 - 5000 acres
- 5000 - 10,000 acres
- 10,000 - 50,000 acres
- > 50,000 acres

Uses 2008 USDA NASS forest cover, clipped by NRCS CLU boundaries and INDOT state and federally maintained roads
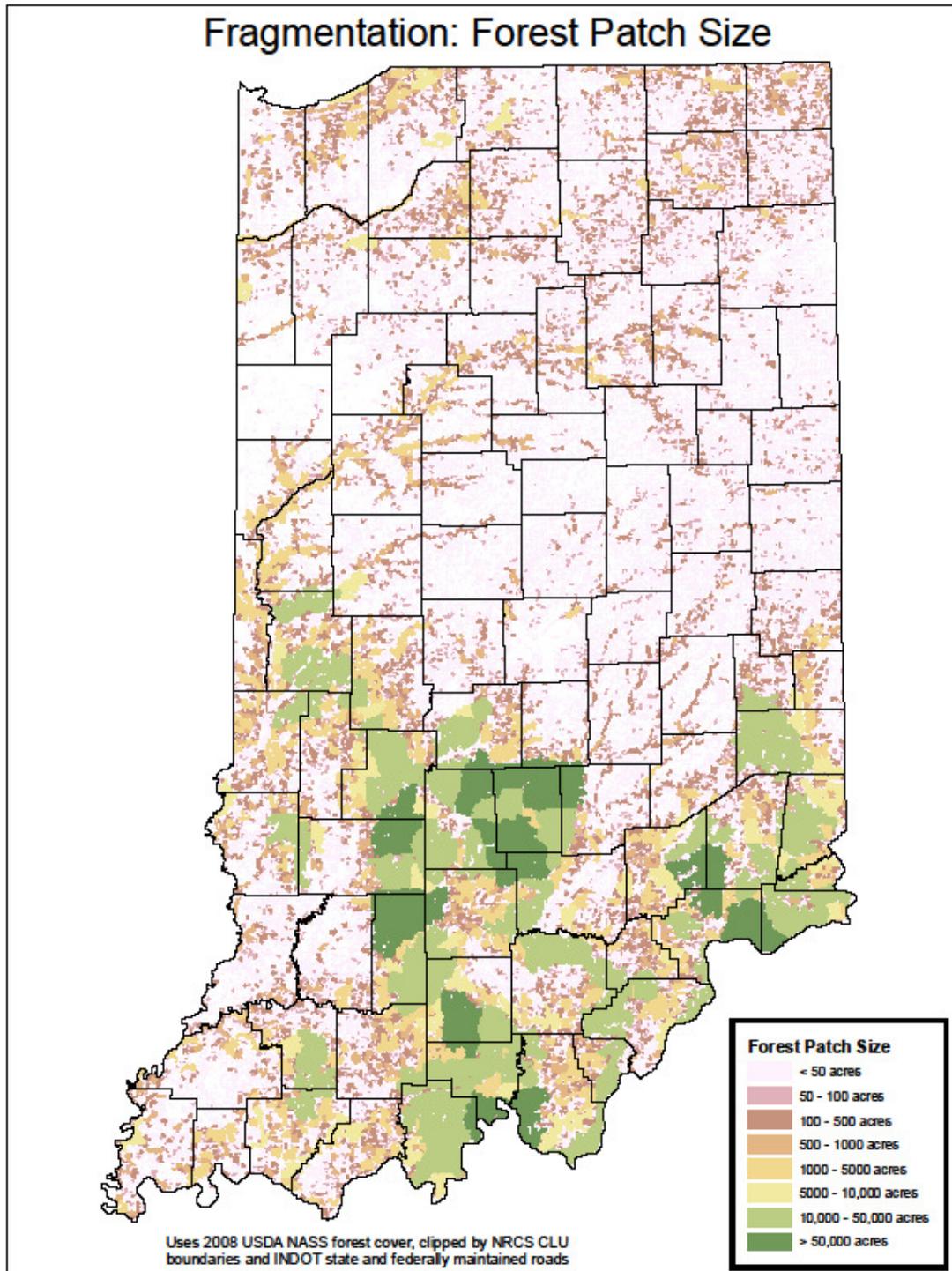
Roadless tracts

This map shows forest tracts that are not divided by federal, state, county or local roads. Fragmentation for home building or other development is generally reliant on connection to local and non-local transportation networks.

This map may also have applications for forest wildlife and plant species to which roads present major barriers for successful dispersal.

Roadless Forest Patches

Forest Patch Size
- Small
- Medium
- Large

This map shows forest derived from 2009 NASS satellite imagery, minus a 15 meter per side buffer around all roads in the state. Forest patches smaller than 10 acres in size were removed since they are too small for inclusion in forestry programs.
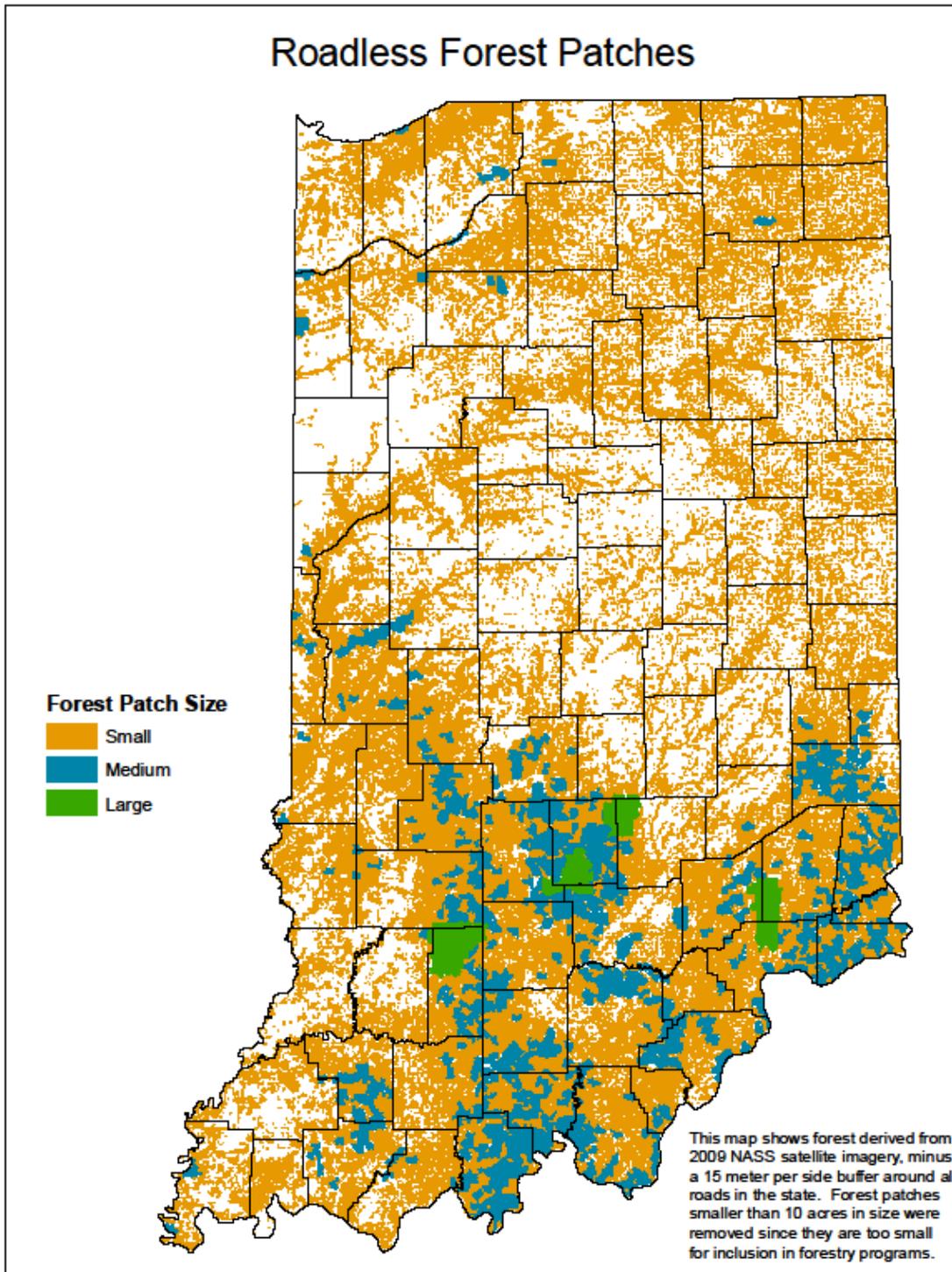
Projected Development Patterns to 2030

The ecological effects of human population density on forested areas can be magnified when development is dispersed rather than concentrated in certain areas.

This map projects development patters with respect to increasing density of home units per acre and is based on a national analysis by Dr. Dave Theobald of Colorado State University. The map legend shows parcels that ranged from 10 to more than 80 acres in size that are projected to be less than 10 acres in 2030. The map does not reflect recent efforts by some communities to guide development with Smart-Planning or Green Infrastructure Plans.

Projected Development Patterns to 2030

Acres/home unit (2000 - 2030)
- Undeveloped - 1.7-10
- Undeveloped - .6-1.7
- >80 - 1.7-10
- 50-80 - 1.7-10
- 40-50 - 1.7-10
- 30-40 - 1.7-10
- 30-40 - .6-1.7
- 20-30 - 1.7-10
- 20-30 .6-1.7
- 10-20 - 1.7-10
- 10-20 - .6-1.7

This map shows lands that were greater than 10 acres in size in 2000 and are projected to be subdivided into parcels smaller than 10 acres by 2030, based on U.S. Census block data. Derived from Dr. Dave Theobald's work on population densities across the conterminous U.S.

Percent Forest Cover in a 1KM Radius

Irrespective of ownerships, this map considers the percentage of forest cover from any point in Indiana. Like the earlier forest patches component map, this map shows those forests in the state that are best able to respond to environmental stress and perform forest ecosystem functions, taking into account the surrounding landscapes.

Also, the proportion of forest cover across a landscape in large part determines the distribution of wildlife, including forest amphibians, bats, and birds.
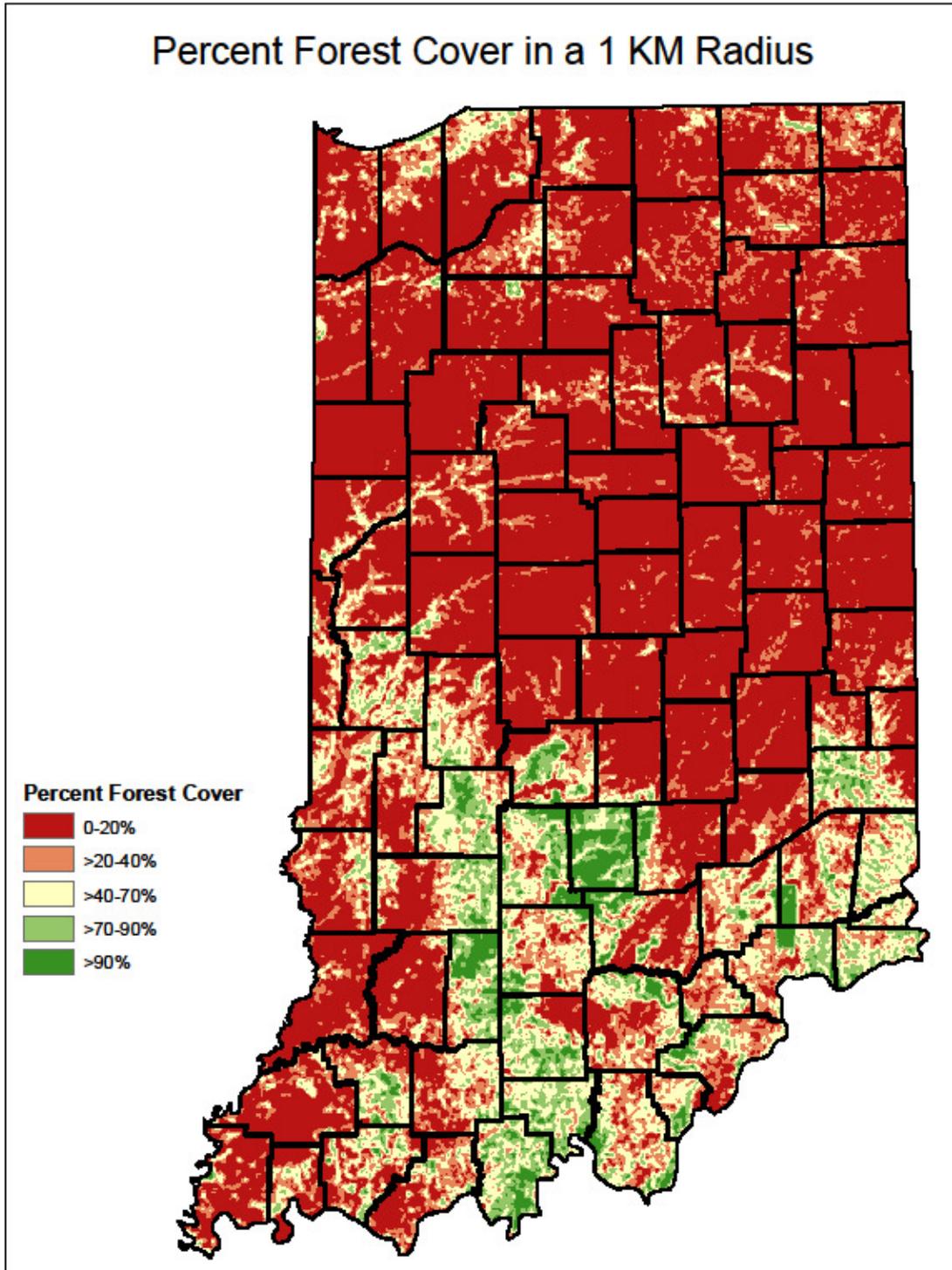
Percent Forest Cover in a 10KM Radius

Expanding on the concept above, this map focuses on the relationship of forest bird populations to fragmentation that has been shown to increase the prevalence of nest loss in the Midwest. Research shows that areas that have very low forest cover (e.g., <15%) had high nest loss at forest edges and within interiors; at moderate levels nest loss was high at edges but not interiors; and in unfragmented areas (>90% forest cover) nest loss was low at both edges and within interiors. (Donovan et al. 1997, Hartley and Hunter 1998, Thompson et al. 2002)

Percent Forest Cover in a 10 KM Radius

Percent Forest Cover

- 0-20%
- >20-40%
- >40-70%
- >70-90%
- >90%
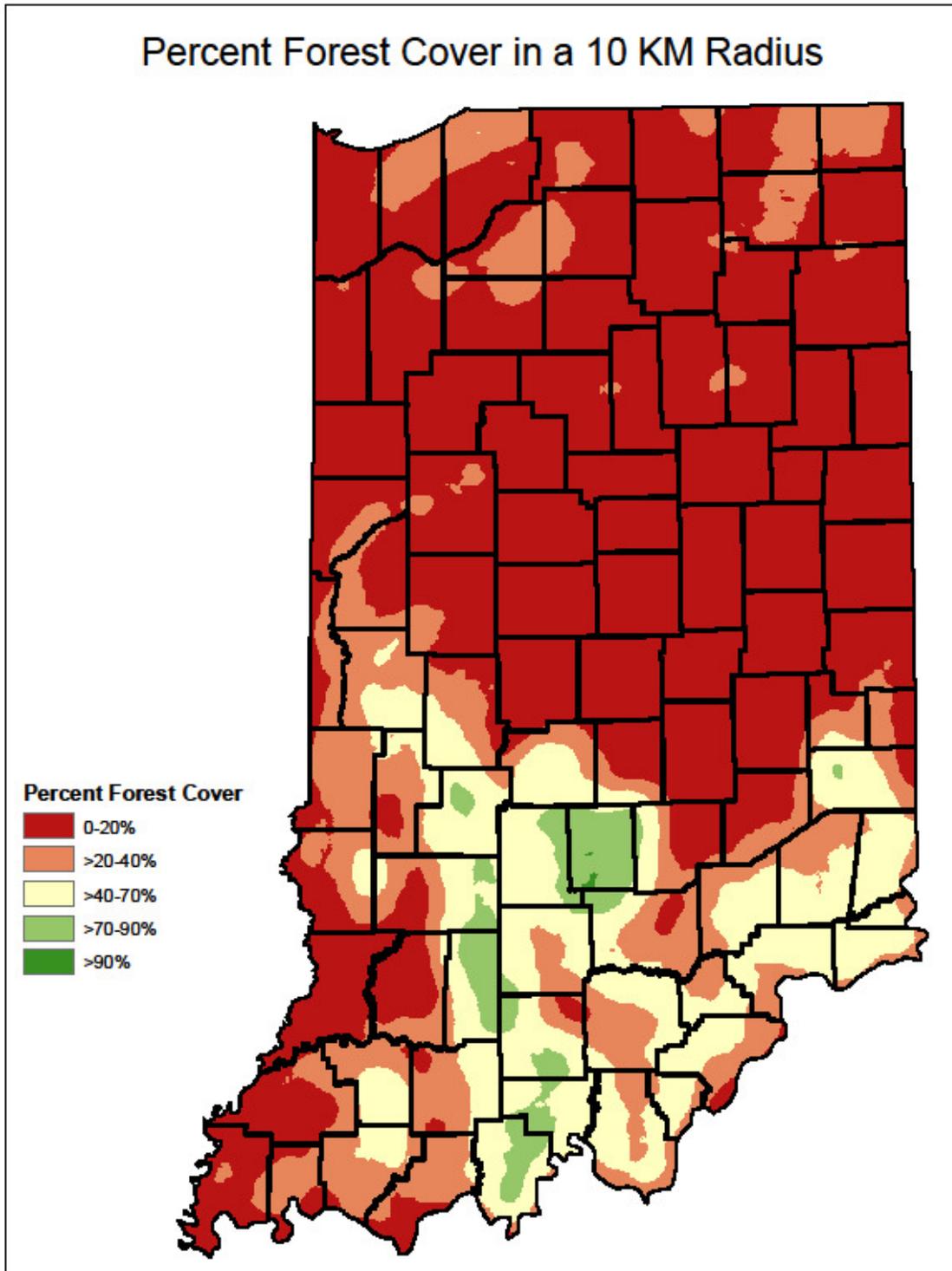
Priority Landscape Areas: Fragmentation

This map should be used for strategy purposes to direct efforts that combat forest fragmentation. It should be noted that strategies will differ in this respect. Areas at high risk for forest fragmentation often carry a higher economic cost, encompass a greater number of ownerships and carry greater inherent ecological denigration. Areas at low risk for forest fragmentation generally contain more intact forest habitats and a greater ability to effectuate landscape scale stewardship and conservation efforts at a lower cost. Thus, conservation efforts to protect against fragmentation should generally be directed to the areas in blue on the map below.
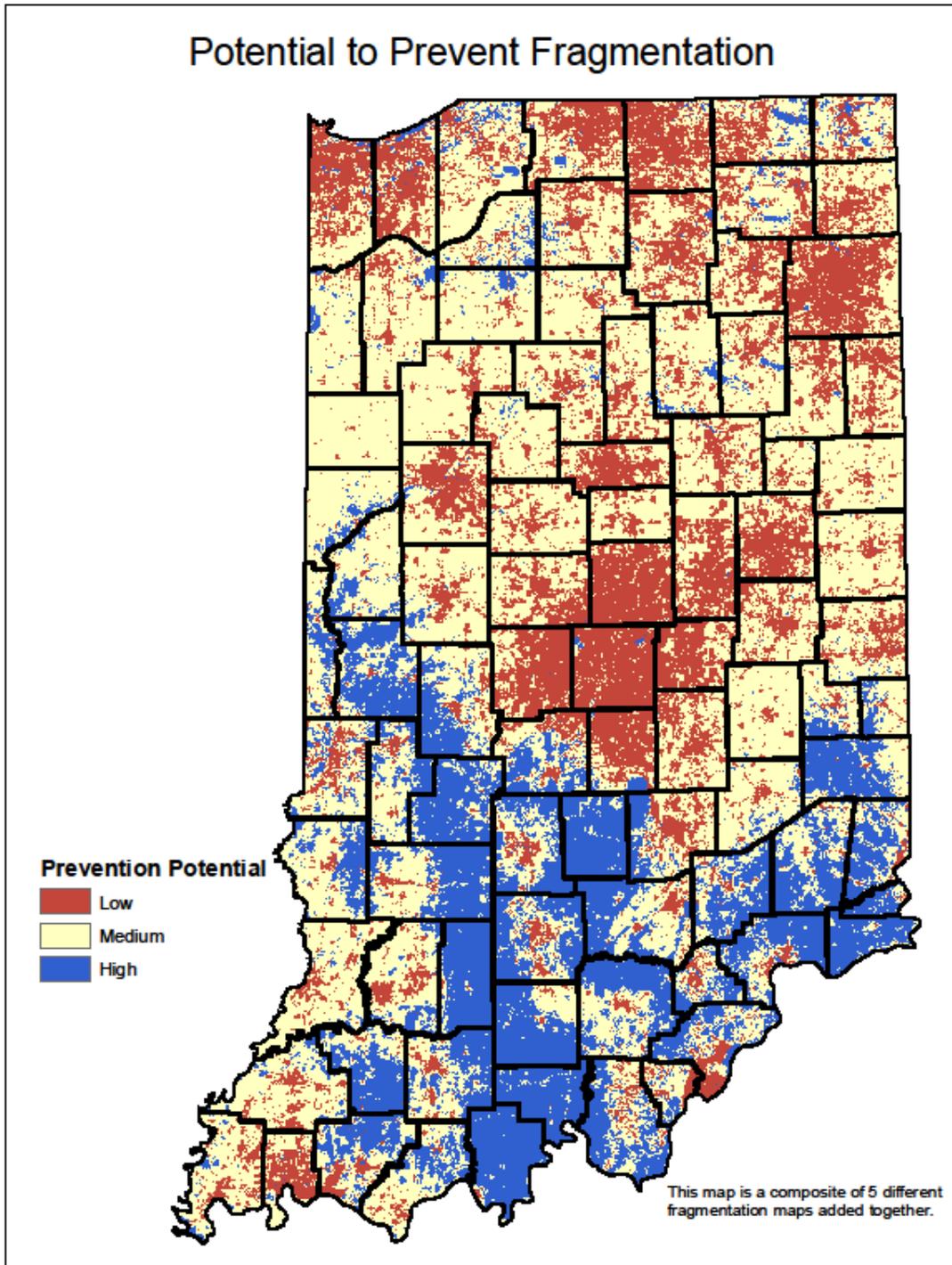
Supplemental map: Lands with Legal Limits to Conversion

This map was not included in any Priority Landscape Areas analysis. It represents lands that are more effectively protected against conversion to another land use in that they have legal restrictions, such as protective easements, or exist in public ownership. The easements reflected in the map are those registered with the Department of Natural Resources, The Nature Conservancy in Indiana and Sycamore Land Trust.

These lands represent 16.1% of the 5.1 million acres of forestland in Indiana.

Lands with Limitations on Conversion

Local Government
State Forests
Other State Lands
National Forest
Other Federal Lands
University Lands
Private Lands

Map Created 1/8/10
by Brett Martin
Indiana Division of Forestry

0   10 20   40   60   80
Miles
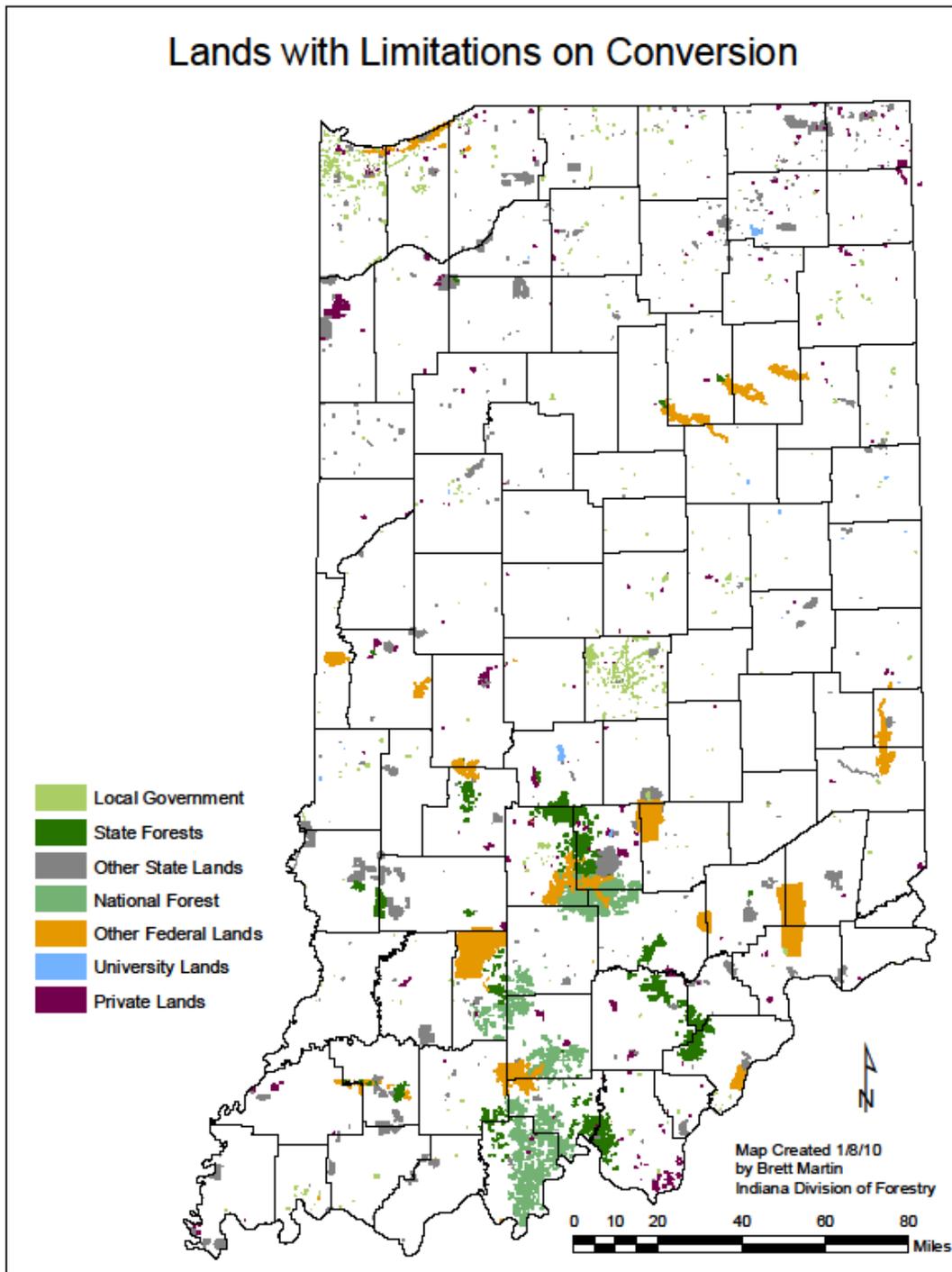
Soil & Water

Conservation and maintenance of soil and water resources, and the conservation of forests that protect drinking-water supplies ("soil & water") are important issues to Indiana forest stakeholders. Only seven of the 1,292 respondents to the June 2009 Survey were "not concerned" about these issues, and depending on how their importance measures are tallied, they are arguably of equal or greater importance than fragmentation (See Introduction page 4).

Undisturbed forests are unsurpassed in their ability to preserve and enhance soil resources and water quality. Forest cover, especially around creek and river bottoms, and along drainages or riparian areas, acts as a buffer inhibiting excessive impairment from surrounding exposed soil or agricultural applications.

Forest cover alone cannot ensure water quality in larger watersheds. Inadequately managed point-source pollution, roadway and impervious surface runoff, sewage overflows, manure, and pesticide and herbicide applications, among other things, can have an effect on the impairment of stream miles across the watersheds discussed.

Best management practices ("BMPs") that protect soil and water quality during timber harvest are required on approximately 26% of forestland managed in the state and practiced on managed lands by responsible stewards to ensure resource quality and availability in the future. Further information about the forest issue Soil & Water can be found in Appendix D.

This issue has nine equally weighted component maps.

Soil erodibility

Natural Resource Conservation Service ("NRCS") erosion hazard ratings incorporate erodibility, slope and length of slope, and are used to assess risk for putting a dirt road or trail on forestland. This measure can inform forestry practices that include constructing log landings and laying out skid or fire trails. Areas shown in gray are developed areas that are largely impervious surface or water. The large number of areas rating "very severe" risk of erosion in Northern Indiana is attributable to a greater extent of windblown soils.

Erosion Potential

Inset Area
(enlarged to show detail)

This map shows NRCS designations of soil erosion risk if a dirt road were built, with an inset showing part of north-central Indiana as an example.

Inset Area

Risk of Erosion
- Slight
- Moderate
- Severe
- Very Severe
- Not Rated
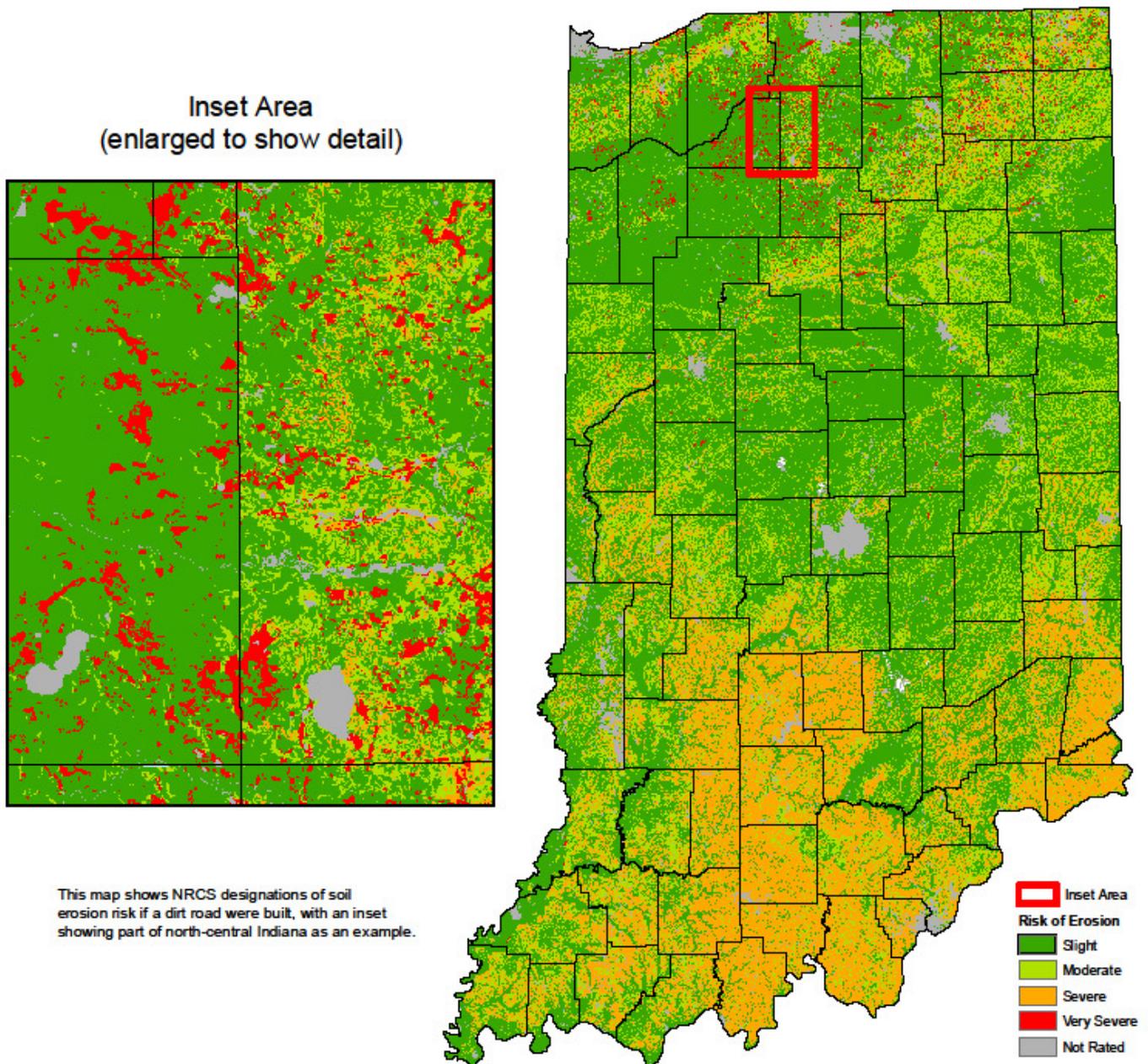
Riparian corridors

Perennial water features are distinguished from intermittent streams by having water flow year round. Across the state, areas in blue will have the most potential to affect local and downstream water quality. Maintaining a forested buffer around perennial watercourses improves water quality, wildlife habitat and protects soil resources.

Buffer of Perennial Water Features

Inset Area
(enlarged to show detail)

This map shows a 300' buffer around perennial water features in Indiana, with an inset showing part of southeastern Indiana as an example

Inset Area
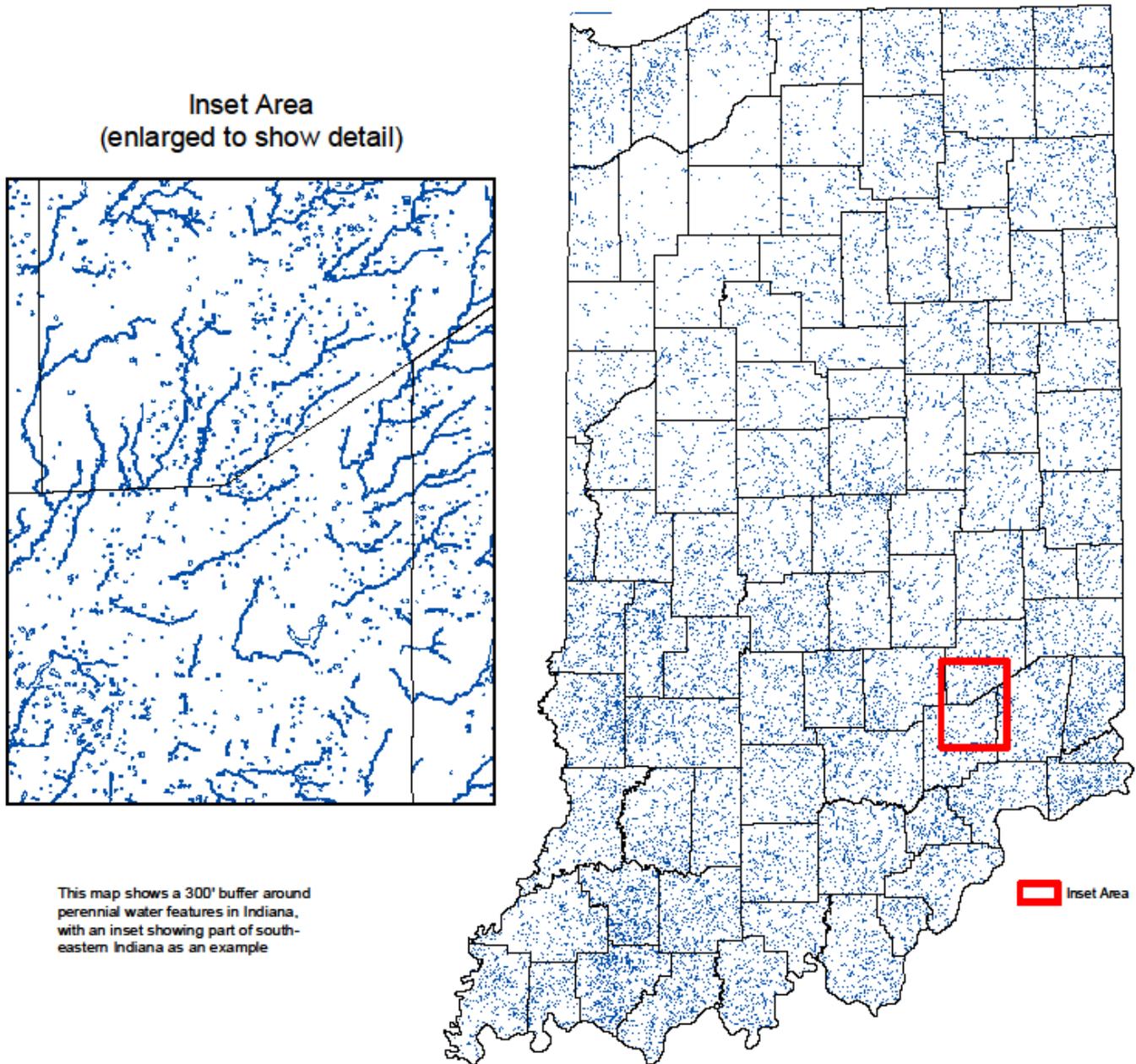
Wells and surface water intake

Public drinking water is particularly important because it is something that Hoosiers cannot live without and there are specific health implications where drinking water contains contaminants or toxic elements. Maintaining forests in these areas can lessen the need for expensive water treatment facilities.

Public Water Supply Areas

This map shows 10-digit watersheds that have surface water intakes for public drinking water, as well as one mile buffers around public wells used for drinking water.
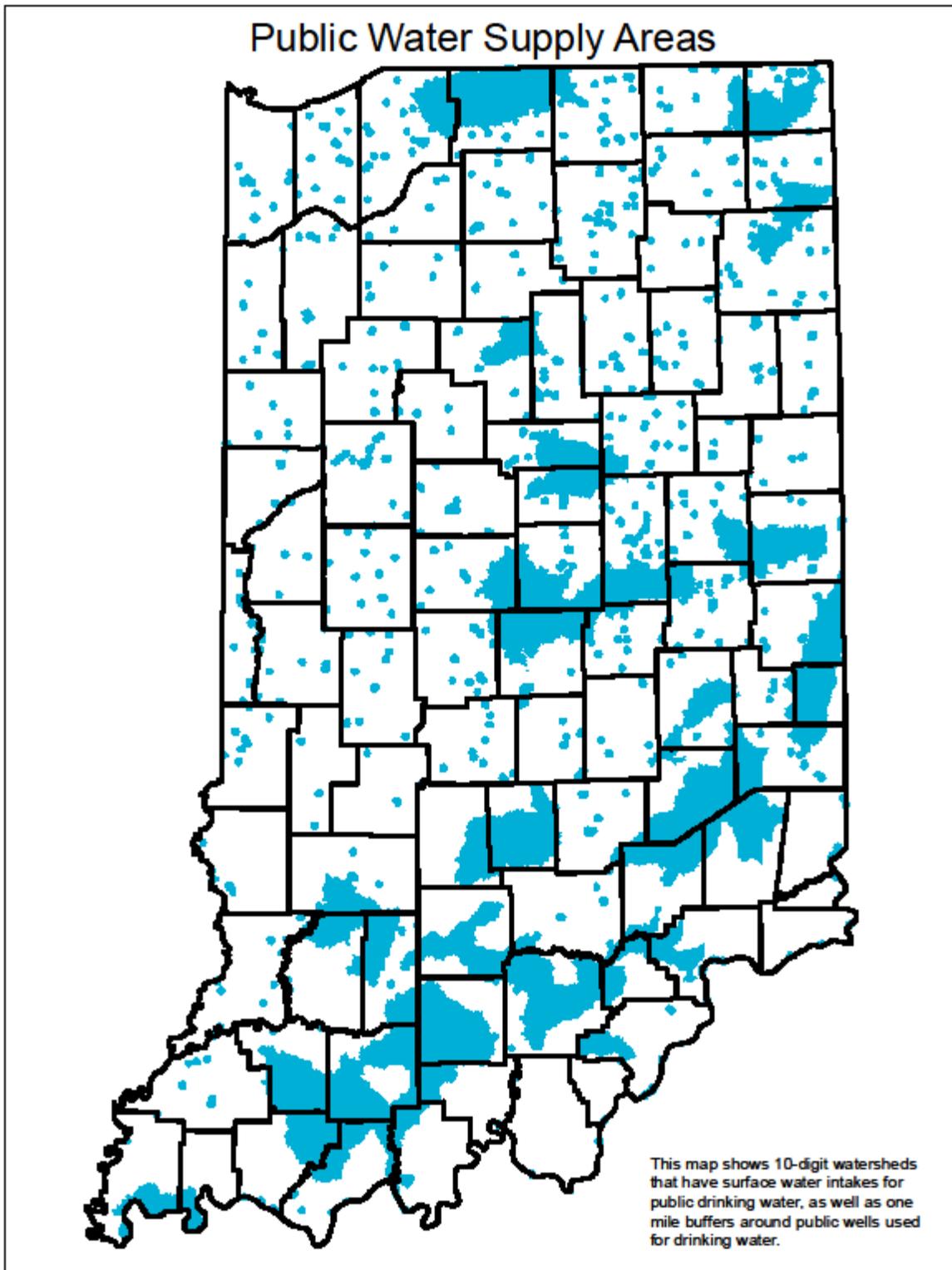
Karst region

Karst regions are particularly susceptible to water-quality issues due to the fragility of subterranean ecosystems and the abrupt entry of surface water into underground watercourses through sink holes, caves, etc. These areas are also important for the federally endangered Indiana Bat.

Karst Features in Indiana

This map shows areas of the state with karst features.
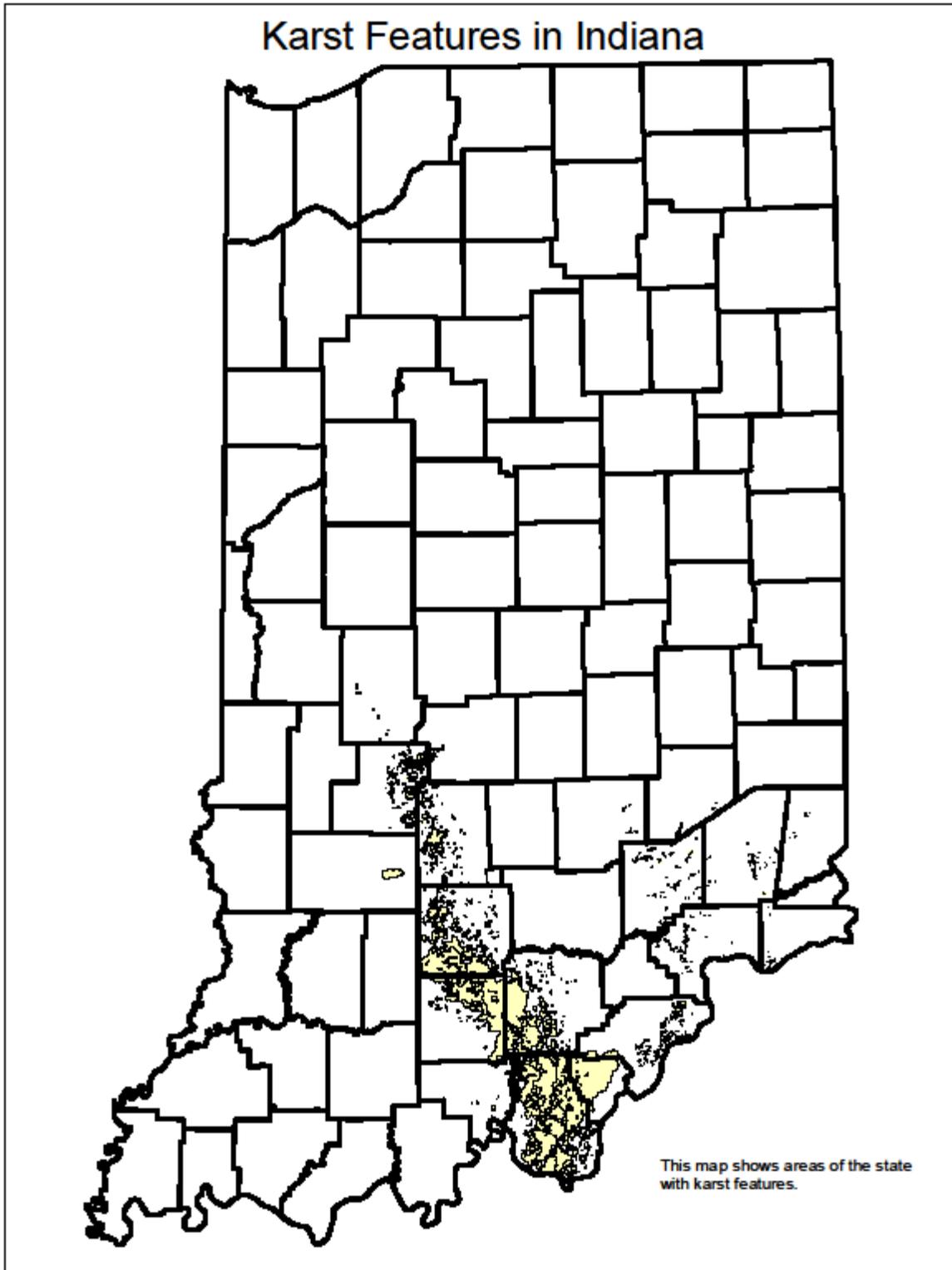
Percent impaired stream length by watershed

Watersheds highlighted in red in this map contain the largest number of impaired streams in the state as classified by the Indiana Department of Environmental Management. Watersheds can be classified as impaired for a variety of reasons. The top causes of impairment in 2010 are E. coli, PCBs in fish tissue, impaired biotic communities and mercury in fish tissue.

Percentage of Impaired Stream Miles by 10-digit watershed

Percent Impaired
- 0
- 0.01 - 10
- >10 - 25
- >25
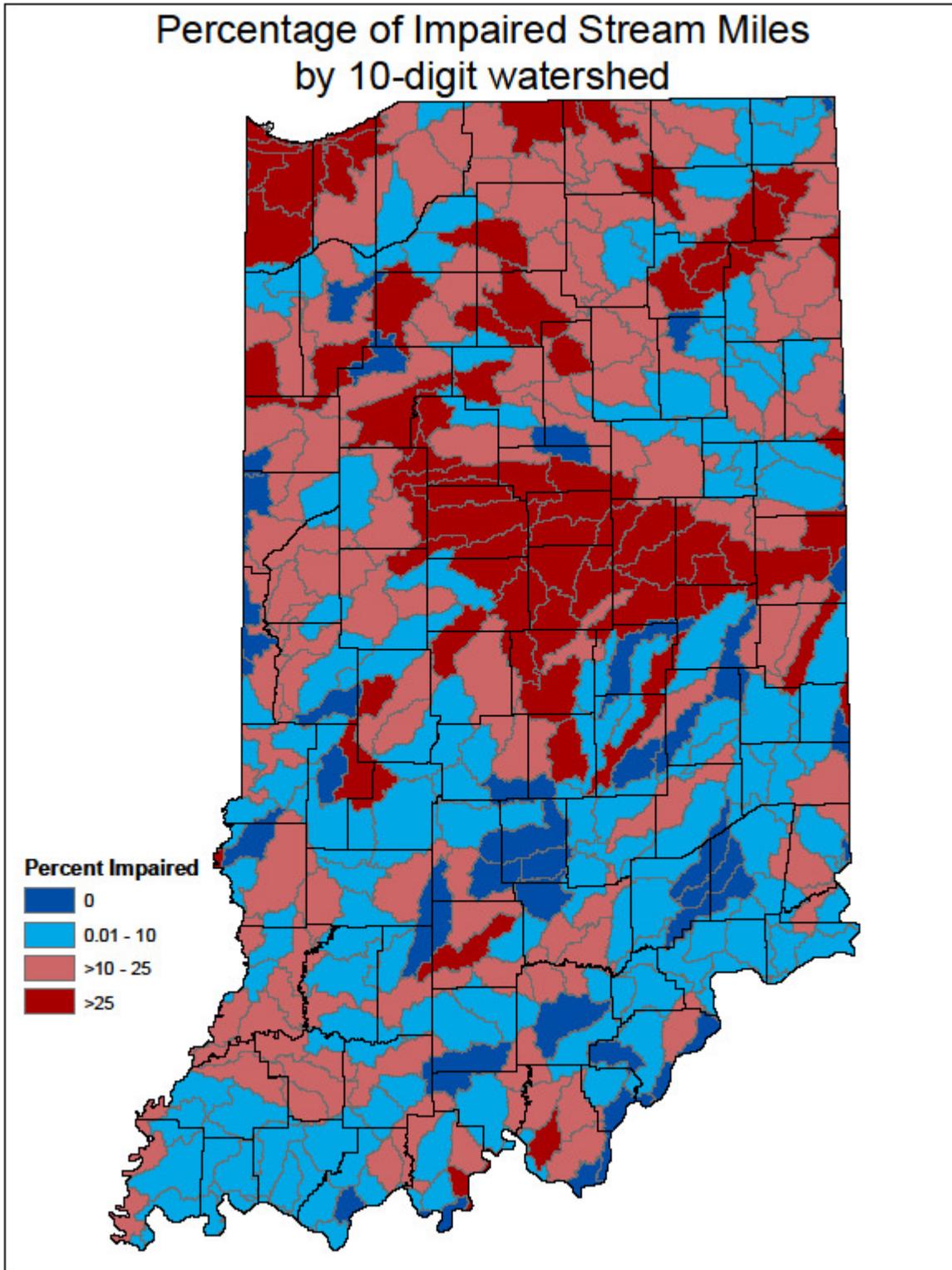
Percent forest cover by watershed

As described above, percentage forestland in a watershed is not the only determinant of a watershed's quality, but the percentage cover correlates well with the above impaired stream miles. Only three of Indiana's 308 watersheds are forested at greater than 80%, and none have impaired stream miles. A total of 17 watersheds have 65-80% forest cover, and of those, 82% have less than 10% impaired stream miles.

Percentage Forestland by 10-digit Watershed

Forest by Watershed
- 0 - 50%
- >50 - 65%
- >65 - 80%
- >80%

This map shows the amount of each watershed that is forested
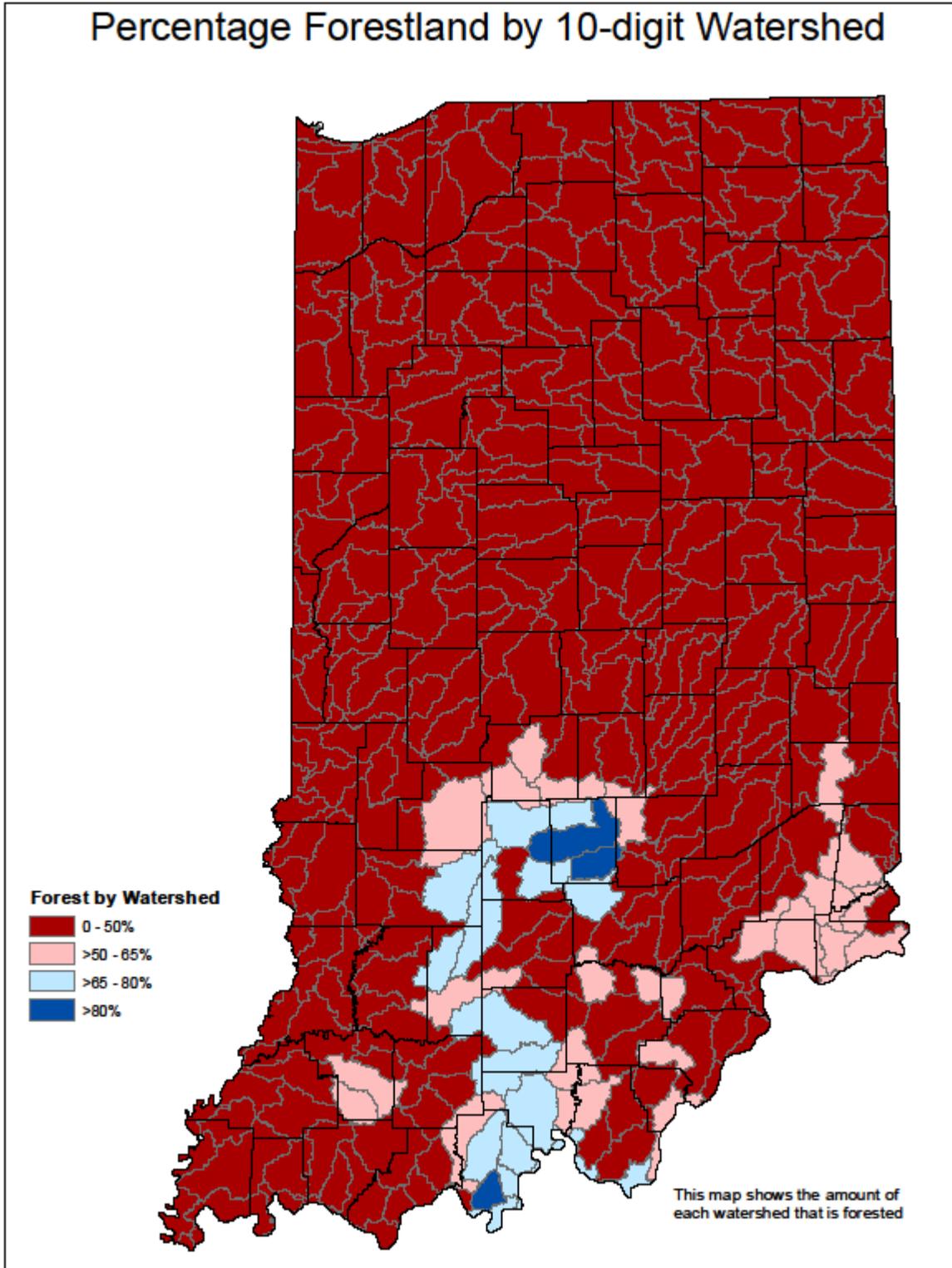
Percent forest cover in riparian corridors

Forested riparian areas are important for the maintenance of soil and water quality and play an important role in regulating stream and river temperatures requisite for aquatic life. Because these areas are prone to flooding and less amenable to row crop agriculture, they are generally less developed and therefore heavily relied upon as wildlife dispersal corridors.


Percentage of Forested Riparian Areas by 10-digit Watershed

Forested Riparian Area
- 0 - 10%
- >10 - 20%
- >20 - 50%
- >50%

"Riparian areas" are defined as a 300' buffer around all perennial water
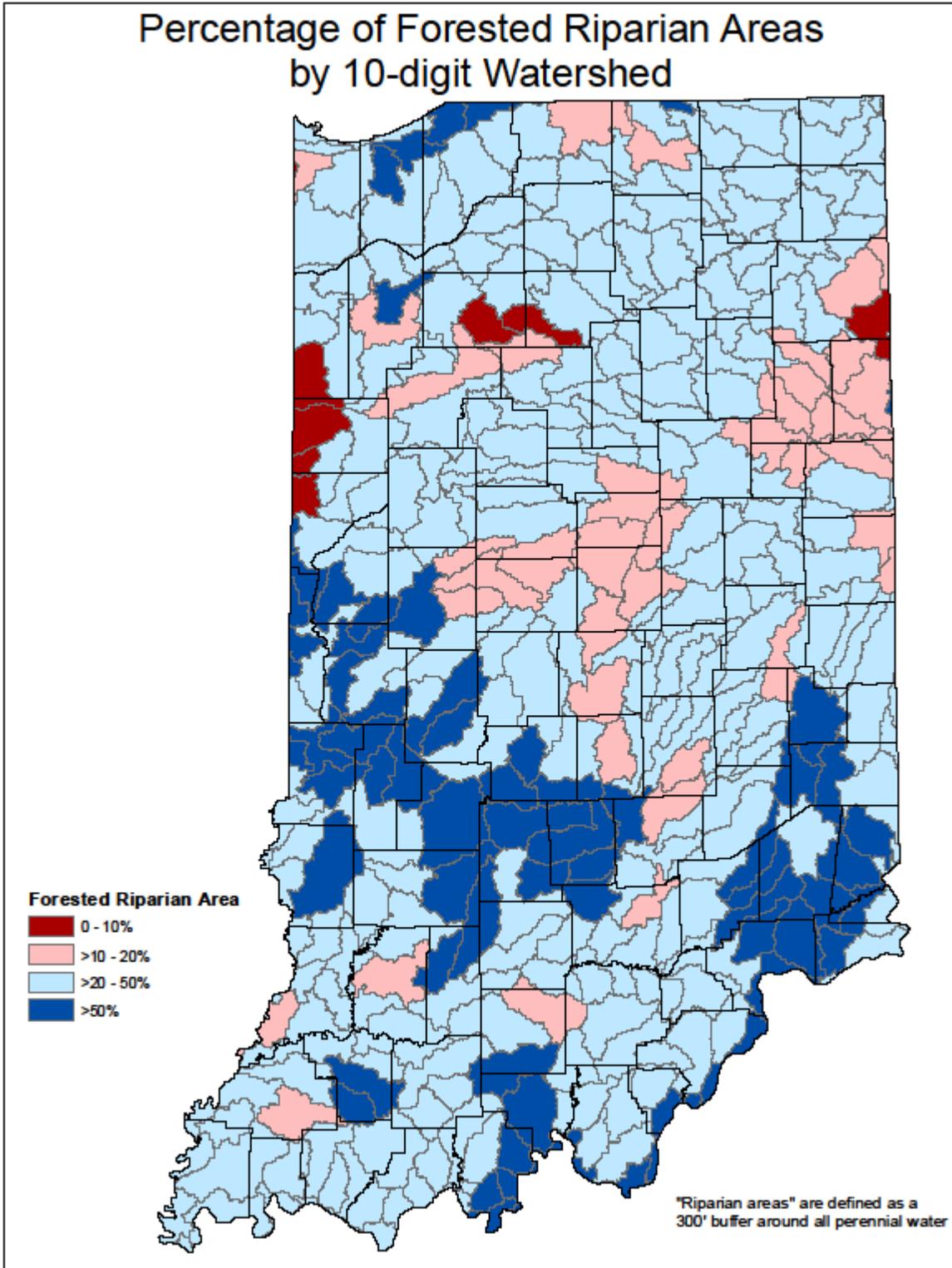
Percent impervious surface by watershed

Toxic and hazardous materials deposited on or associated with roadways and impervious surfaces enter waterways more quickly during rains and floods because they are not filtered or slowed by soil, root, and plant dynamics.

Impervious surface areas are removed from natural ecosystem service functions and comparatively bereft of ecologically beneficial habitat for trees and wildlife. These areas can affect their own climate and create heat islands that further differentiate local ecosystems.

Percentage Impervious Surface by 10-digit Watershed

Impervious Surfaces
- 0 - 2%
- >2 - 5%
- >5 - 10%
- >10%

Impervious surface was calculated using Developed landuse classes from 2009 NASS satellite imagery, and then using the estimate that ~24% of developed land is impervious
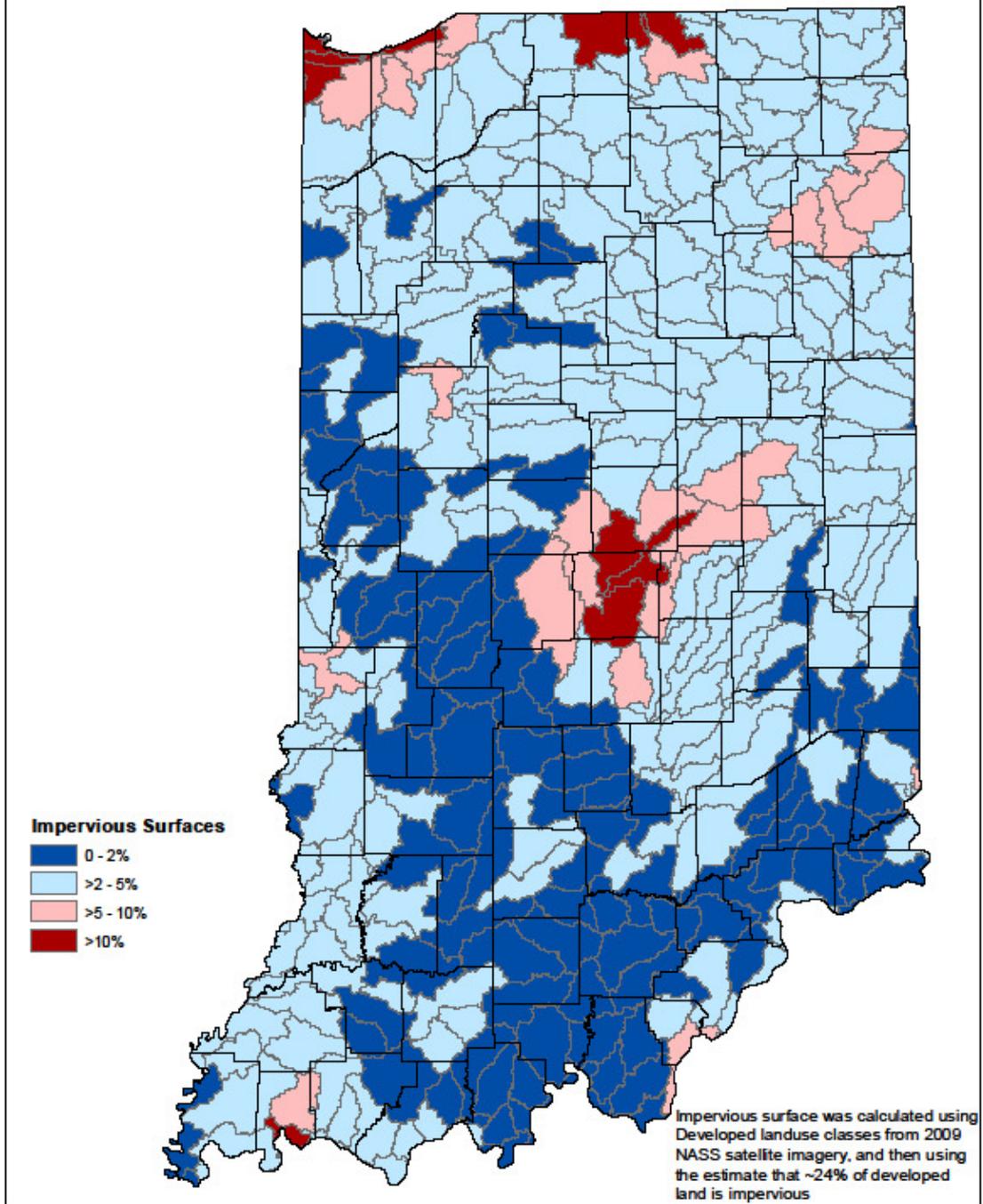
Slope

This map can be considered supplemental to the above NRCS map that also incorporates slope as a factor of importance to forests and the maintenance of soil and water quality. The areas highlighted below are target ranges for forest cover in Indiana based on soil and water conservation cost share requirements. These programs determined that slope ranges above 30% were considered likely to remain forest cover and those below 6% to remain in row crop agriculture.

Targeted Slope Percentages

Inset Area
(enlarged to show detail)

This map shows areas of Indiana where the slope is between 6-30%, which is generally steeper than is ideal for agriculture, but still level enough that it is likely to have some man-made use on it. An inset showing the west-central part of the state along the Wabash river is included to show detail.

Inset Area
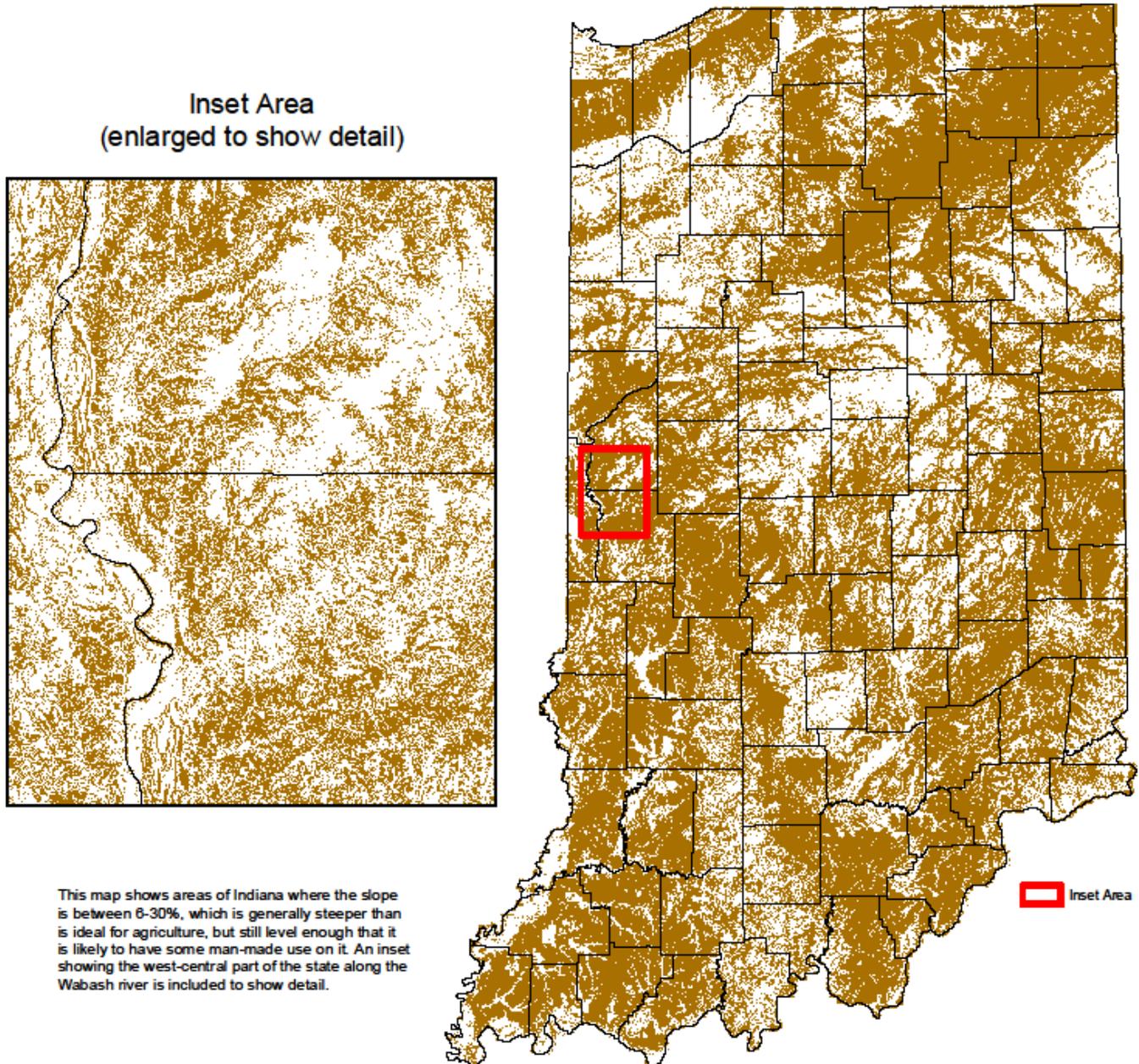
Priority Landscape Areas: Soil & Water

The composite map below shows the importance of lands for the conservation and maintenance of soil and water resources and the conservation of forests that protect drinking-water supplies. This map should be used to direct forestry-related strategic efforts relating to these goals.

Importance of Lands for Soil and Water Conservation

Importance
Lowest
Highest

This map is a composite of 9 different layers of various soil and water factors added together
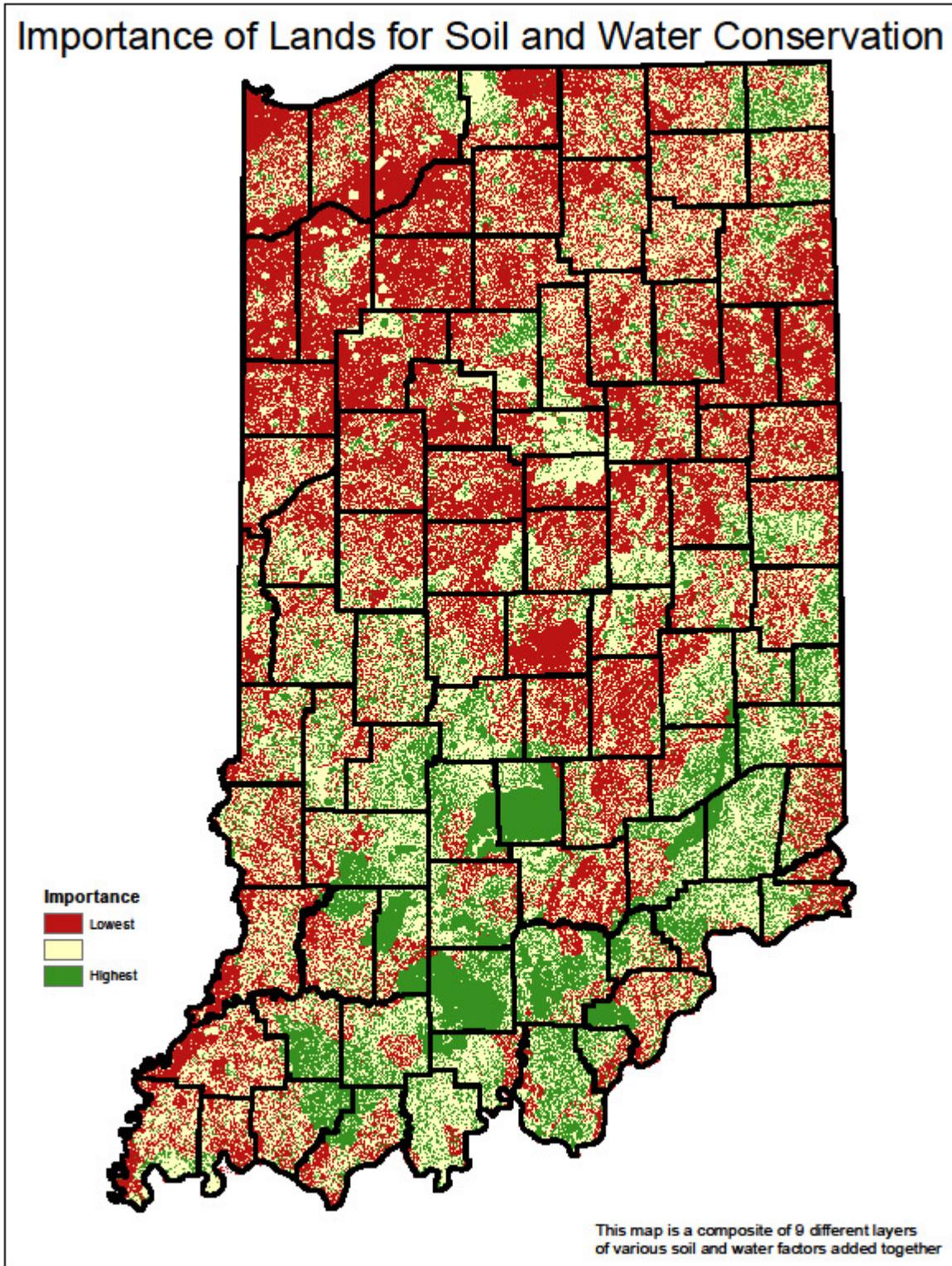
Invasives

The spread and control of invasive species ranked as the third most important forest issue in Indiana. When considering level of concern as opposed to relative importance, forest stakeholders are more concerned about this issue than fragmentation and conversion of forests to another land use. In fact, many invasive plants exude toxic chemicals that make it impossible for other plants to grow and have the effect of converting diverse native forest stands into acres of monoculture.

Invasive plants threaten forest sustainability in Indiana. Invasions can cause great harm to the environment, economies, human health, and aesthetics.

Indiana's distinction as a hub of transportation and commerce also creates pathways and corridors that accentuate invasive-species problems. Humans play a large part in accelerating the introduction and spread of invasive plants in forested communities through the direct planting or seeding of non-native nursery stock. Forest management practices that are conducted without regard for invasive plants or application of BMPs can cause explosive expansions of invasive species like Japanese stiltgrass.

There are a wide variety of plant species able to invade forests. Some, like Japanese stiltgrass and garlic mustard, are shade tolerant and able to establish and spread under undisturbed forest canopies. Others, like Japanese honeysuckle and autumn olive are shade intolerant but can establish in the understory and abide until the canopy is disturbed and light reaches them, enabling their rapid spread.

Control and risk of spread is difficult precisely for these reasons. As the graphic below shows, the public generally becomes aware of an invasive species' inroads only when it may be too late to eradicate it.

Adapted from Hobbs and Humphries 1995
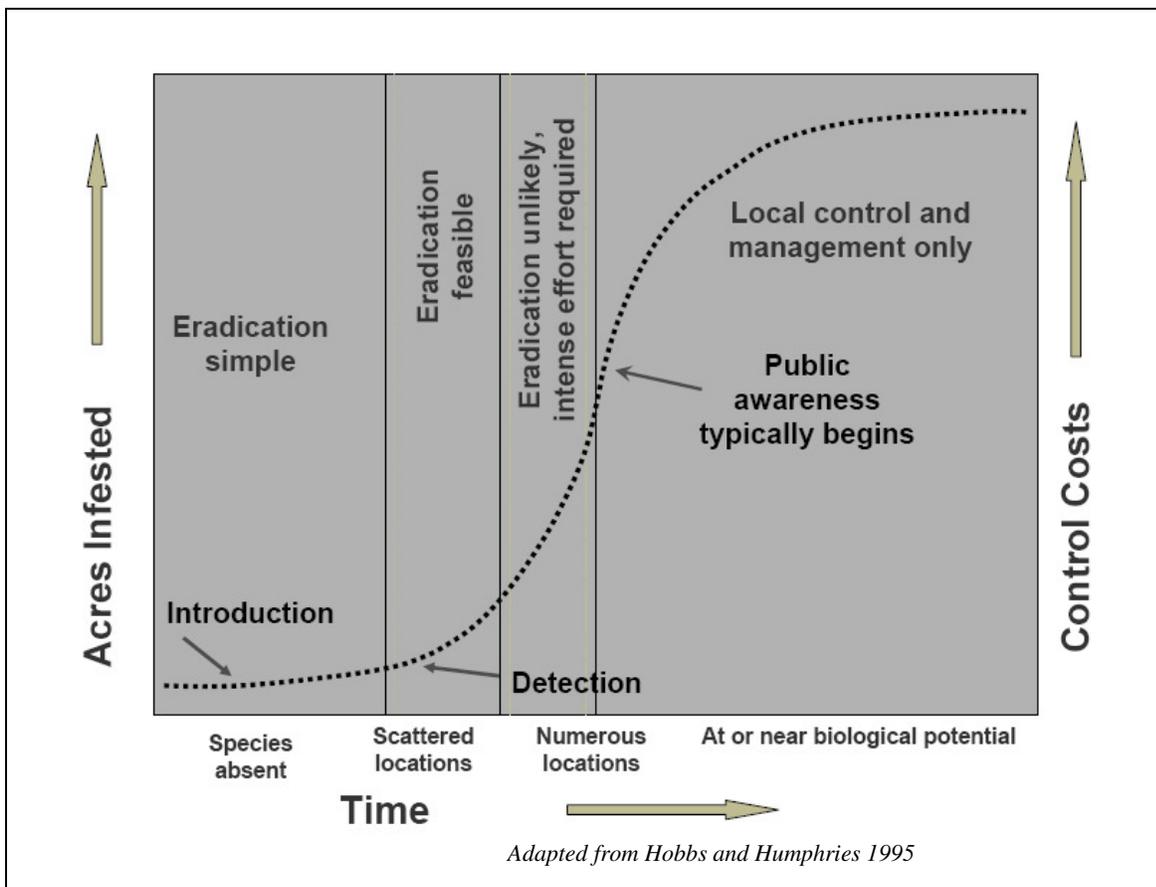
Comprehensive state-level surveys for invasive species do not exist. A coordinated effort to address the impacts of invasive species was legislated Indiana in 2007 and resulted in the creation of the Indiana Invasive Species Council, whose members, as of April 2010, had not yet met.

Different areas of Indiana will face different pressures from invasive species due to differing forest composition, climates and surrounding environments, and directional spread, among other factors. Beyond those plant species listed earlier, there are other plant species like bush honeysuckle and multiflora rose that affect large areas of Indiana's forestland. Links to lists of invasive species to be aware of but have not yet spread to Indiana--as well as invasive species that already are established in certain areas--along with other relevant information, are in Appendix D.

There are three component maps relating to invasive species.

Known statewide invasives occurrence

The IDNR tracks the spread of emerald ash borer and gypsy moth. The USDA Forest Service has provided information relating to known sites of kudzu infestation. These occurrences cover only a small number of the invasive species that threaten Indiana's forests but represent the results of systematic statewide surveys that have occurred over a number of years.

Emerald Ash Borer, Gypsy Moth and Kudzu Locations

- Kudzu Patches
- EAB Quarantined Townships
- Gypsy Moth Established

This map shows Kudzu patches buffered by 1/2 mile, civil townships where emerald ash borer has been found and the area of the state where gypsy moth is permanently established.
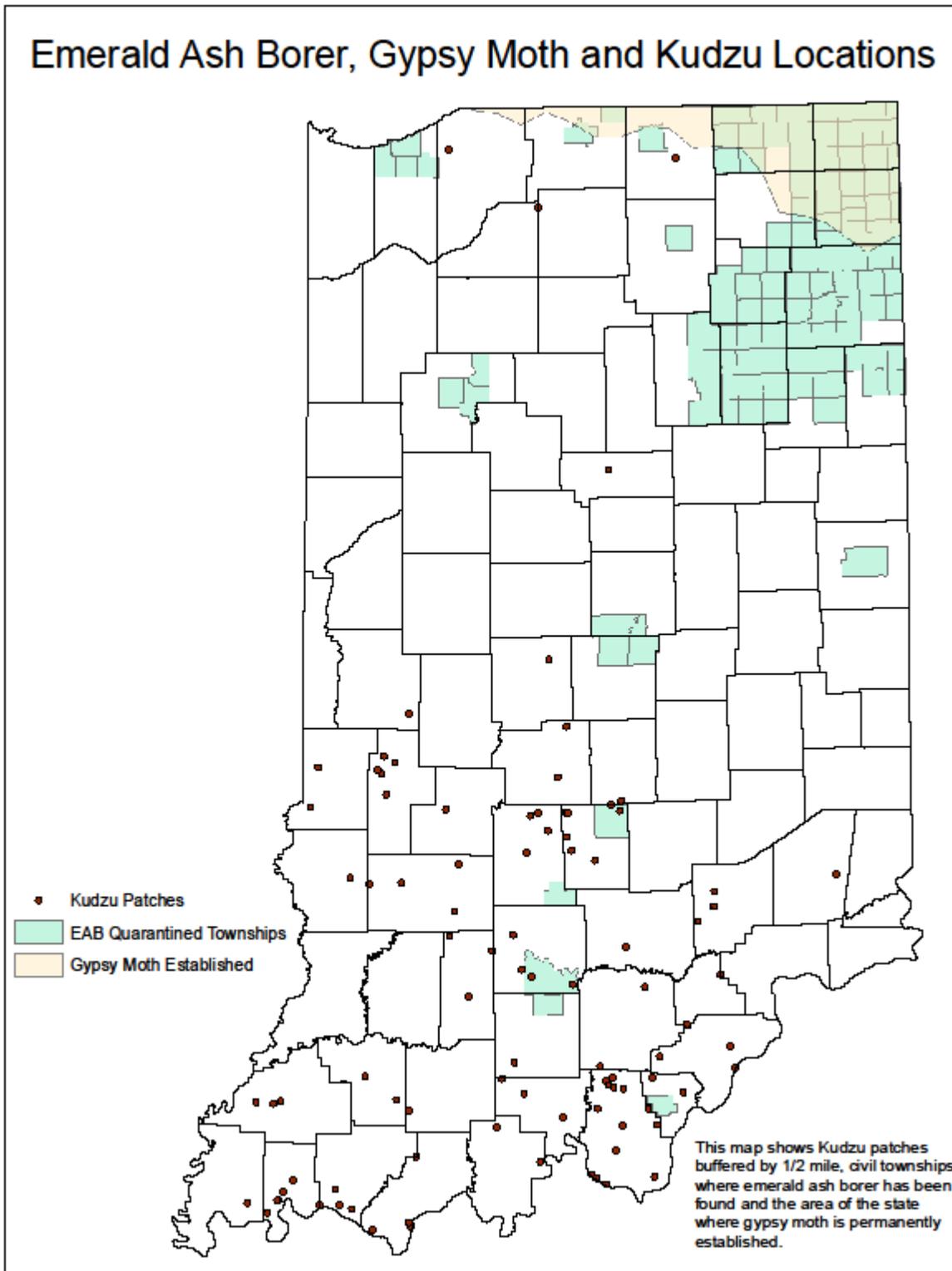
Forest corridors

Invasive species spread by a variety of means but have been shown to travel effectively through maintained forest corridors. Those shown below are traveled by people, machines and animals and are maintained in early successional habitat to promote their accessibility and designated use.

Maintained Corridors Through Forests

Inset Area
(enlarged to show detail)

This map shows corridors (roads, railroads, powerline and pipeline easements, and trails) that pass through forests in Indiana. An inset of the Brown County Hills area is included to better show detail.

Inset Area
Forests
Corridors Through Forests
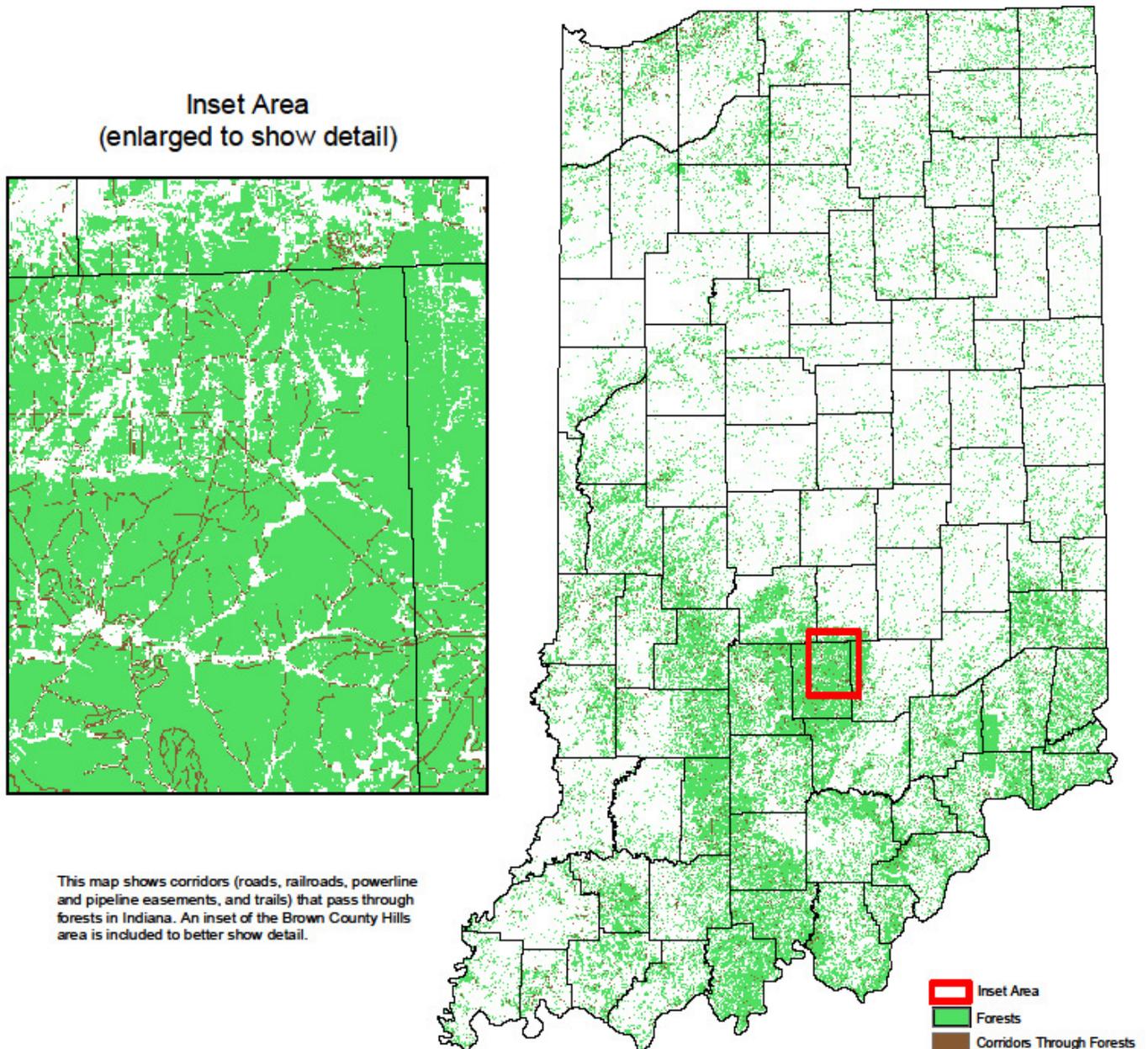
High home density and high forest cover

This map attempts to identify risk to forests from invasive spread through landscape plantings or other methods relating to exchanges between areas of high forest cover and high home density. Nursery catalogs list a number of known invasive species, like autumn and Russian olive that are legally shipped and planted in Indiana. Exotic plants are often promoted and planted before their invasive qualities are fully assessed, because they exhibit disease and pest resistance.

Home Density and Forest Cover

Home and Forest Density
High
Low
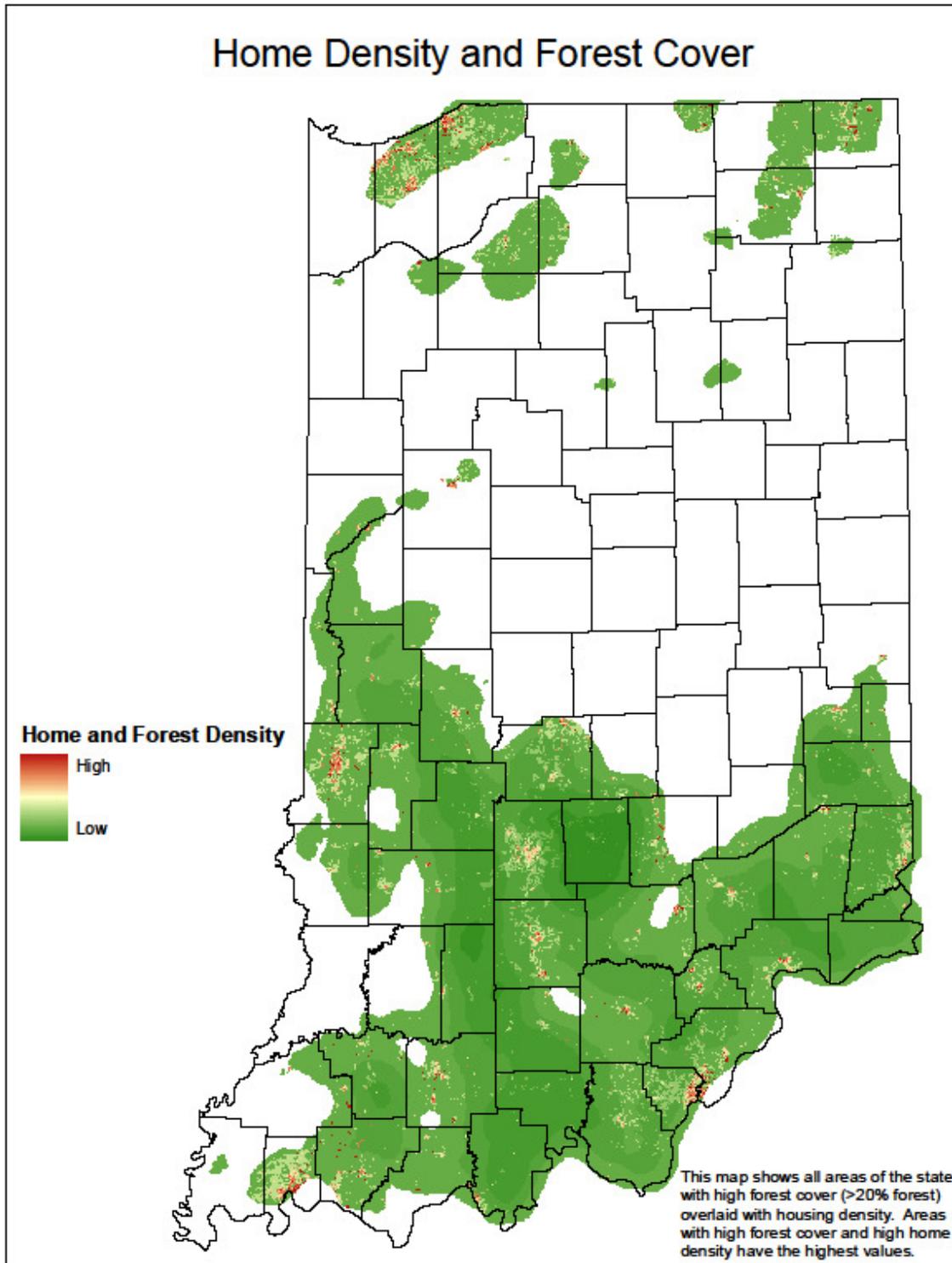
This map shows all areas of the state with high forest cover (>20% forest) overlaid with housing density. Areas with high forest cover and high home density have the highest values.

This map projects invasive species risk based on statewide survey locations of known invasives, forest corridor dispersal and overlapping high forest and high home density areas. Similar to risk of fragmentation, strategies to combat invasive species spread should focus on areas that are listed as low risk.

Potential to Prevent Invasive Species

Prevention Potential

- Low
- Medium
- High

This map highlights forested areas least at risk from invasive species
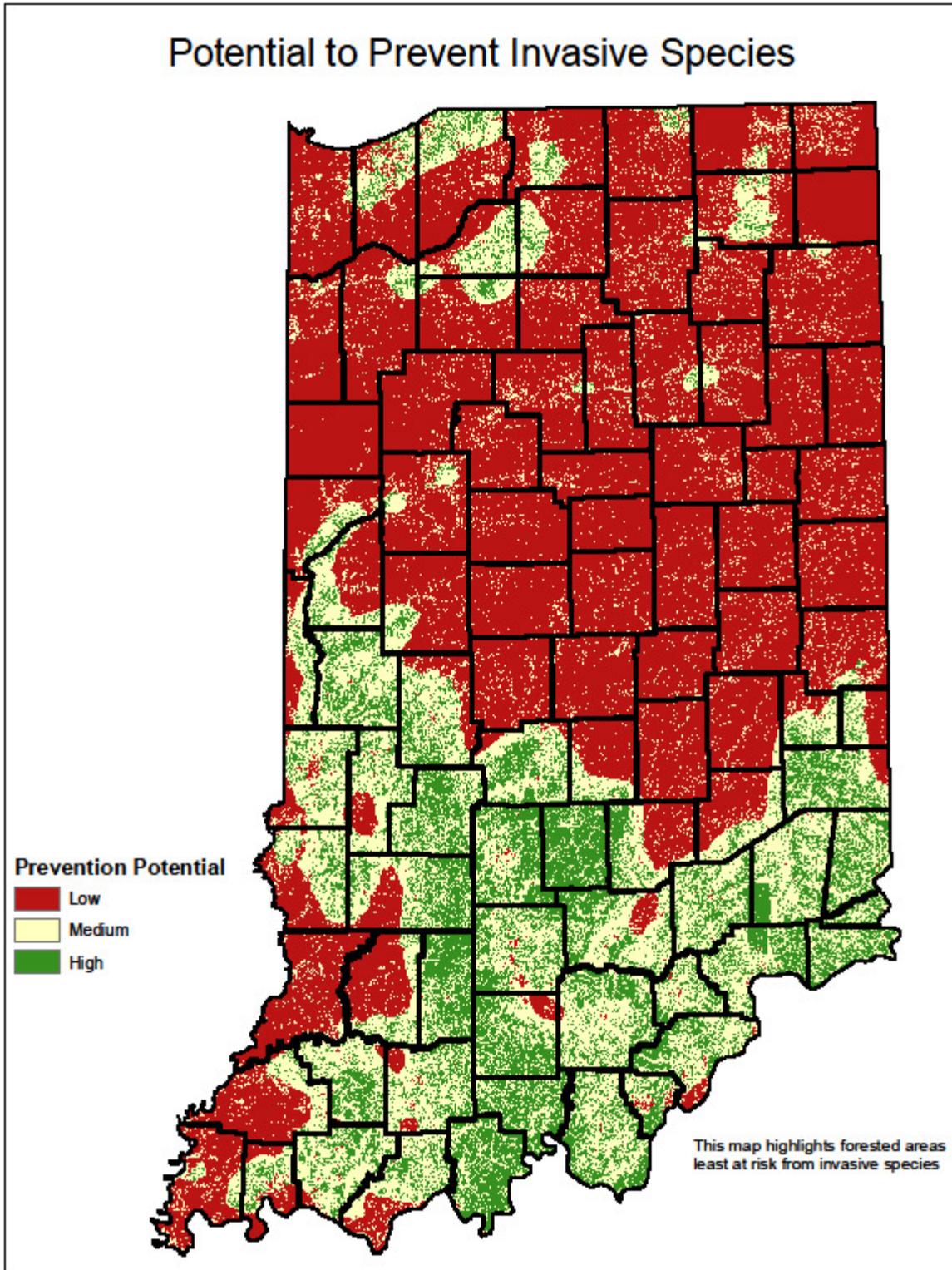
Biodiversity

"To keep every cog and wheel is the first precaution of intelligent tinkering."
• Aldo Leopold

Conservation of biological diversity ranked as the fourth most important issue in the June 2009 Survey of Indiana forest stakeholders and only 15 out of 1,294 respondents were not concerned about it.

Biologic diversity is perhaps the most important overall measure of ecosystem health and well being. Forest stakeholders respond strongly to this issue because it is also a measure of our own health and the well being of society as a whole. Remarkable genetic similarities between humans and other life indicate that the environmental stresses that threaten the existence of certain species affect us as well.

Biodiversity includes all plant and animal species, species of special concern and common species, and it exists upon a similar diversity of habitat types at various states of succession. This vast complexity is difficult to represent spatially.

This section focuses on identifying priority areas relating to forest biodiversity and attempts to delineate areas based on select, defining factors. Statewide survey information relating to stand age and forest type does not exist at a relevant scale to be useful for focused landscape scale initiatives. This is a major data gap that may be addressed in the near future with technological advances in the area of forestry remote sensing (like LIDAR - Light Detection and Ranging).

Without these data it is difficult to address certain other identified issues that have specific relation to forest biodiversity. One example is sustainable regeneration of oak woodlands. Oak species are a great determinant of diversity in certain areas because of the large number of insect and animal species that depend upon them. Beyond the more generally recognized large game species like deer and wild turkey that depend on oak mast, research shows that the *Quercus* genus supports the greatest number

Cerulean Warbler Sightings

Cerulean Warbler
Forest

This map shows general areas where Cerulean Warblers have been found in Indiana

of butterfly and moth species whose larvae are the most important source of protein for Neotropical migratory birds like the forest-dependent and Indiana Species of Greatest Conservation Need, cerulean warbler (see map). (Tallamy, 2008)
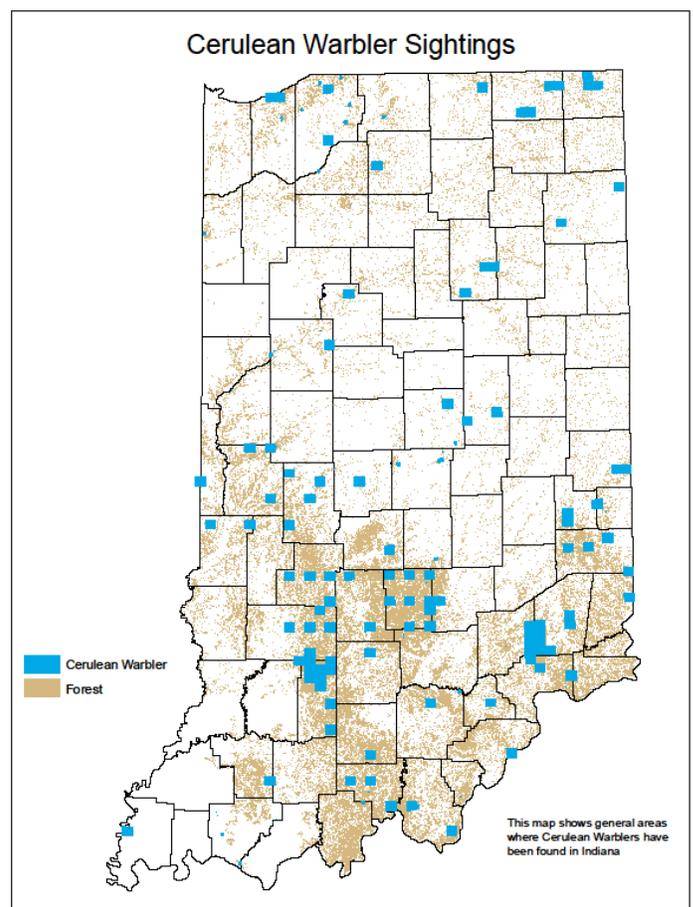
The need for high-resolution stand-age class and forest-type data across the state can be highlighted by considering two statistics from the USDA Forest Service. Their Forest Inventory and Analysis program shows that the oak-hickory forest type (72%) dominates all other forest cover type groups in Indiana. FIA also shows that 90% of stand age classes fall between 20 and 99 years (FIA, 2008). These data point toward unsustainable characteristics that necessitate further research and understanding.

Indiana's oak-hickory component developed largely from existing seed sources maintained by Native American burning practices, regeneration and succession in full-sun, open-canopy conditions and in the general absence of deer herbivory (extirpated from Indiana by 1900). These conditions do not and cannot exist today as they did in the past and there is question whether shade-intolerant species like oaks, butternut and black cherry, among others, will have a place in Indiana's forests of the future without a defined effort to maintain them in the mid- and under-stories of forests. Statewide high-resolution information about these forest characteristics is currently a data gap.

The extreme dominance of age classes between 20 and 99 years threatens ecological simplification. The loss of species diversity, especially among those species traditionally found in Indiana after the forest recovery, like ruffed grouse, depend on early successional habitat.

Species of greatest conservation need associated with early or late successional habitat: ruffed grouse, Allegheny woodrat, golden-winged warbler, timber rattlesnake, cerulean warbler, and whip-poor-will. (IDNR)


Further information about the forest issue Biodiversity is in Appendix D. This issue has four equally weighted component maps.

*Larger than average contiguous forests by eco-region*

The Natural Regions of Indiana were developed by Michael A. Homoya of the IDNR Division of Nature Preserves. These regions represent an ecologically unique partitioning of the state based on natural geologic or climactic factors. A region's biological diversity will be reflective of these inherent elements shaping the surrounding ecosystem. Thus, each natural region can be expected to present unique characteristics that suit particular organisms and forested habitats.

This map shows above-average-size forest patches for all of Homoya's Natural Regions. Average patch size for each natural region is shown next to its name in the map legend. By this method, natural variations should capture unique attributes that might be overlooked with a focus only on species richness. It is assumed that larger forest patches generally offer more suitable habitat for biological diversity and present a greater capacity to exist into the future.

Above Average Forest Patches by Natural Region

Natural Regions (Avg. patch acres)
- Black Swamp (23.7)
- Bluegrass (241.1)
- Central Till Plain (58.2)
- Grand Prairie (68.2)
- Highland Rim (485.4)
- Northern Lakes (54.2)
- Northwestern Morainal (101.8)
- Shawnee Hills (968.1)
- Southern Bottomlands (154.4)
- Southwestern Lowlands (121.4)

Forest Patches

This map shows forest patches that are bigger than the average size for their natural region, only including forest patches 10 acres or greater in size.

Wetlands with buffers

Generally, researchers have found that increases in the proportion of forest cover around wetlands correlates to increases in forest species richness and diversity. For instance, areas with higher proportions of forest canopy within 1 km of forested wetlands often have higher species richness of forest amphibian species (Knutson et al. 1999, Herrmann 2005). This 1 km buffer was applied to locations of wetlands in Indiana to produce the map below. These wetlands vary in size but approximately 90% are larger than ¼ acre.
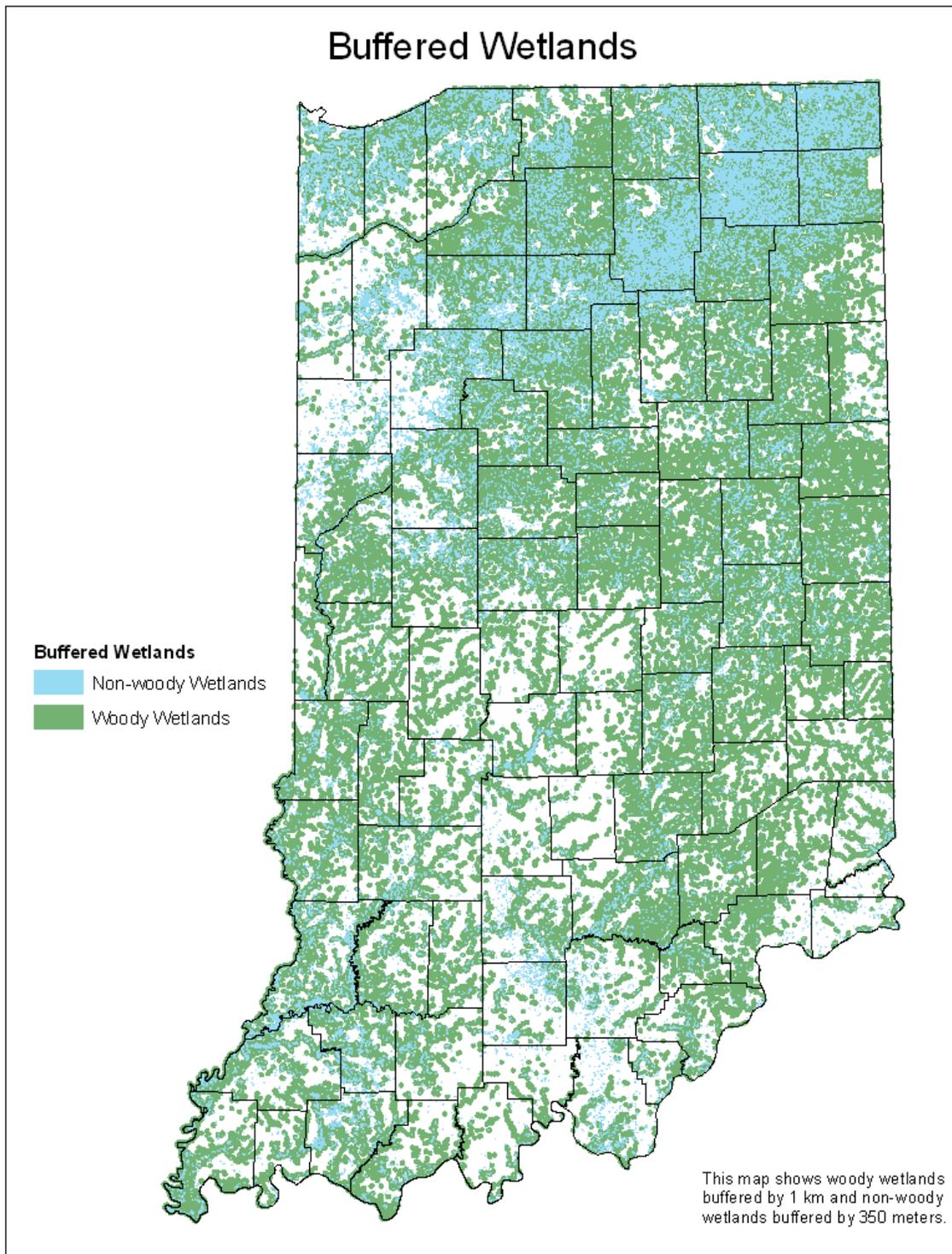
Imperiled natural community types

This map illustrates locations of the best quality occurrences of the various forest community types within the Natural Heritage Database.

The Indiana Natural Heritage Database is a digital, geospatial file containing information on Indiana's rare or otherwise significant natural features, including plant and animal species, natural communities, and animal aggregations. It lists locations and dates of occurrences or sightings, of both federal- and state-endangered species, including specific latitude and longitude for points of occurrence. The database was compiled from numerous sources, including museums, herbaria, publications, and the results of fieldwork by many individuals.

Rare Forest Communities

This map is derived from the Division of Nature Preserves maps of High Quality Natural Communities
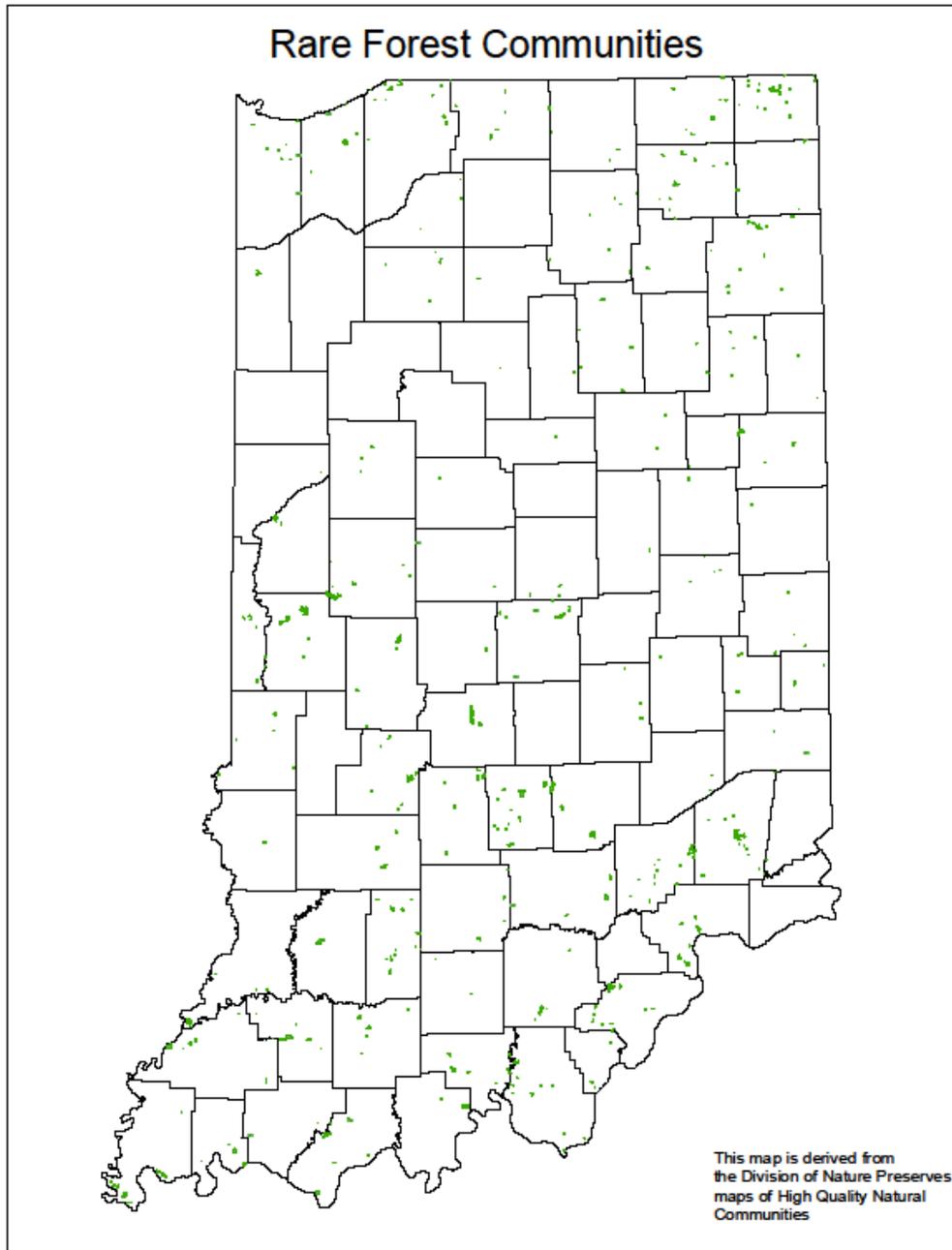
Large forest patches within low forested areas

This map exhibits forest patches of greater than 100 acres in size in areas that have less than 20% forest cover in the surrounding 10 km. It is likely that in many of these areas, these patches can be considered refugia for species that remain and highly important to dispersal, migration and other ecologic functions.


Large Forest Patches in Areas of Low Forest Cover

This map shows forest patches 100 acres in size and greater in areas of the state where there is less than 20% forest cover
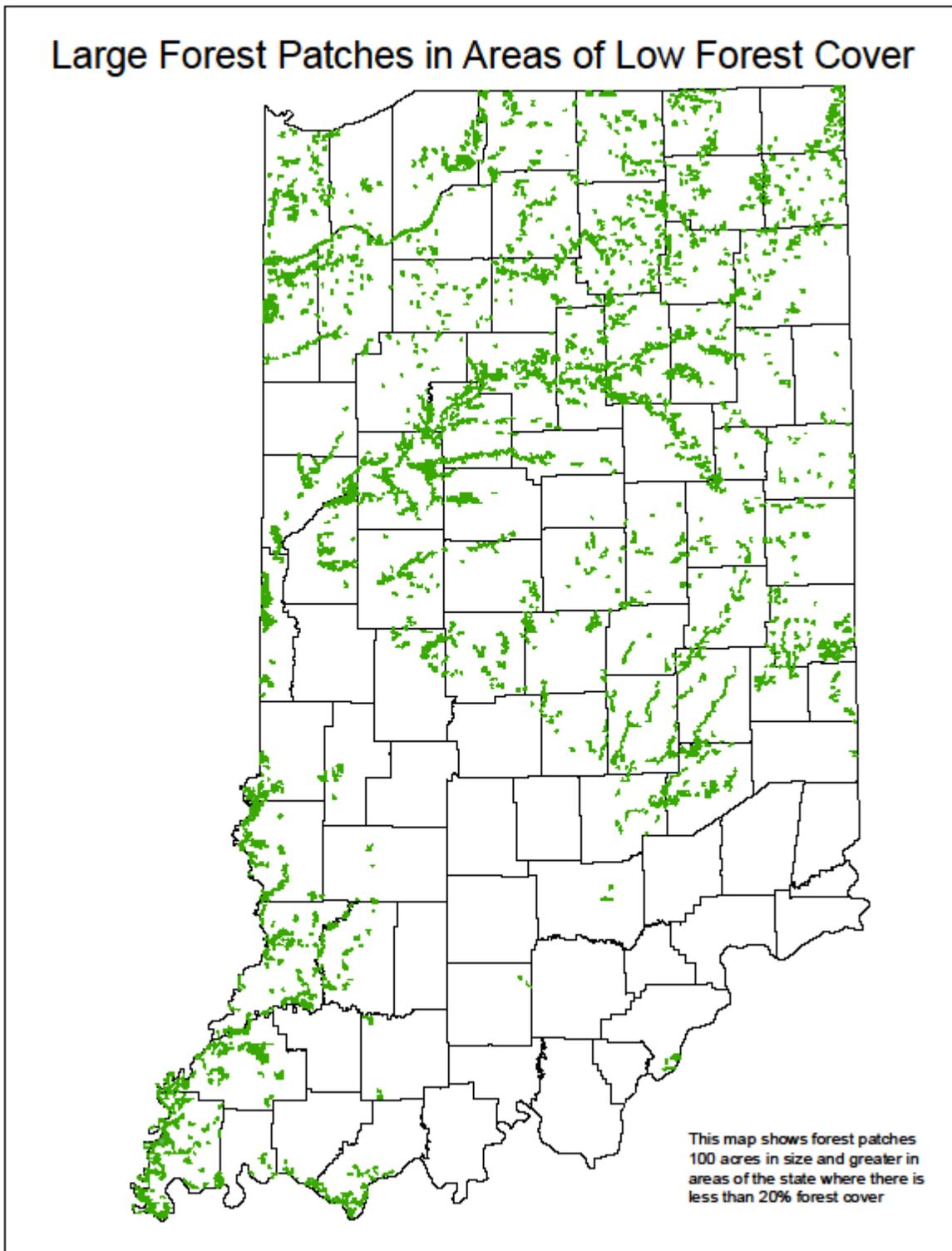
Priority Landscape Areas: Forest Biodiversity

This map combines larger-than-average forest patches by natural region, forested wetlands with a 1 km buffer, rare or imperiled forest communities and large forest patches in areas of low forest cover to indicate locations with a relatively greater propensity to contain forest biodiversity. Areas meeting all four categories are highlighted in bright red.

A significant component of efforts relating to the conservation and maintenance of biological diversity is habitat connectivity and the conservation and maintenance of dispersal corridors. This Assessment does not provide relative importance of lands for connectivity and dispersal corridors. This is a major data gap.

Forest Biodiversity Potential

Inset Area
(enlarged to show detail)

This map is a composite of 4 forest biodiversity maps. White areas met none of the 4 criteria. The southwest corner of the state is shown in the inset for better detail.

Inset Area

**Biodiversity**
N/A
Low
Medium
High
Highest
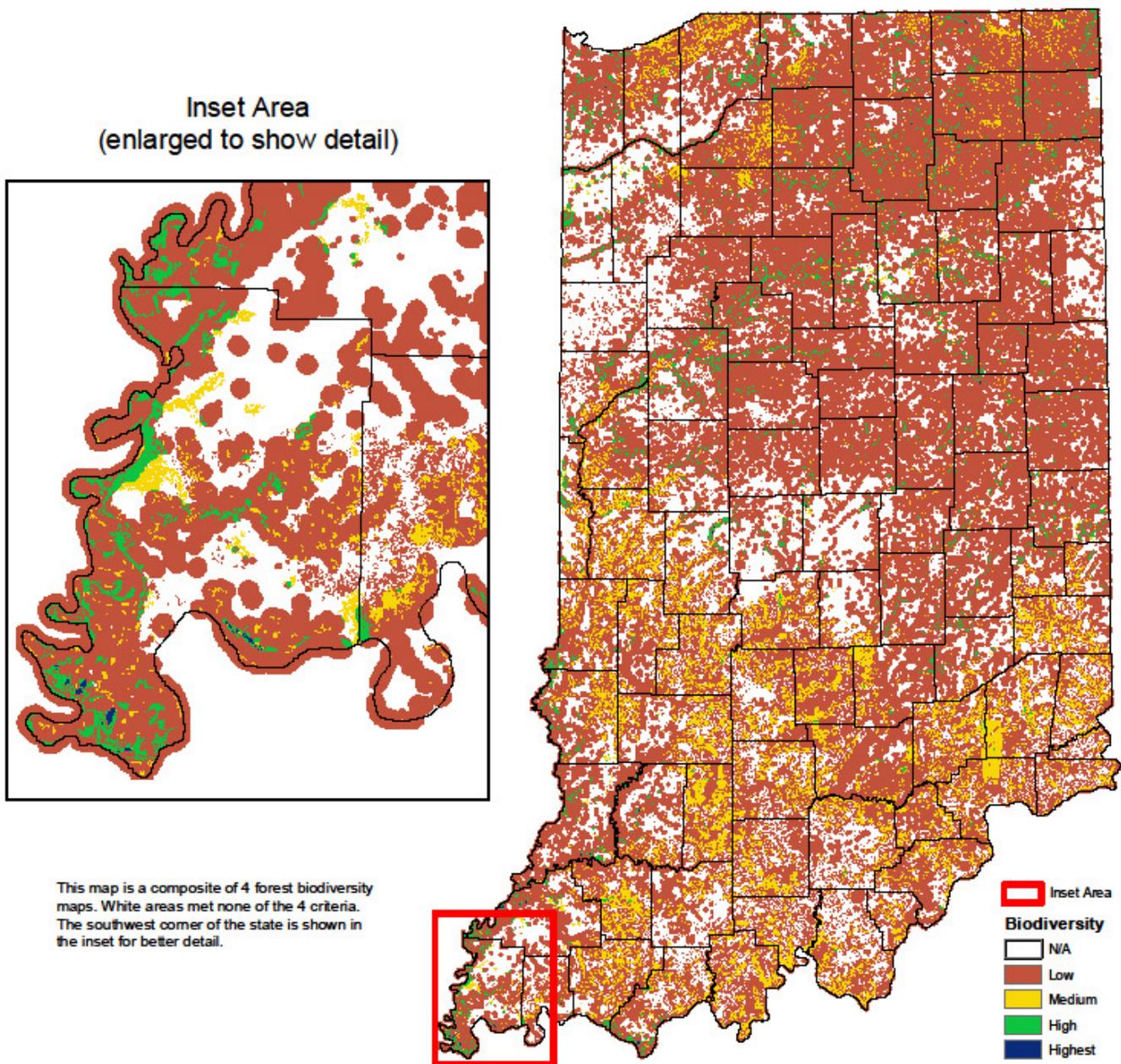
Recreation

The availability of land for public recreation is an important issue for Indiana's forest stakeholders. Its importance rank was significantly less than that of the four issues discussed previously, but recreation, similar to the wood products industry described below, is a significant driver of conservation, research and federal monies dedicated to forests. Both issues offer an opportunity to link economically to the values and benefits that woodlands provide.

Inherent in recreation is the opportunity to address other important and identified forest issues: inadequate public education about forests, overpopulation of white-tailed deer and inadequate youth education about forests. Public and youth education about forests is enhanced and made relevant with increased outdoor experiences. Hunting is a major component of recreation that offers perhaps the only viable method to control deer populations.

This map shows the areas in Indiana that are open to the public for recreation. These lands encompass 12.5% of Indiana's forests. More information about the forest issue Recreation is in Appendix D. This issue has one component map.

Federal and State lands open to the public

Land Available for Recreation

Lands Open to the Public

This map shows lands owned by Federal, State or Local government or by private groups and that are open to use by the public.
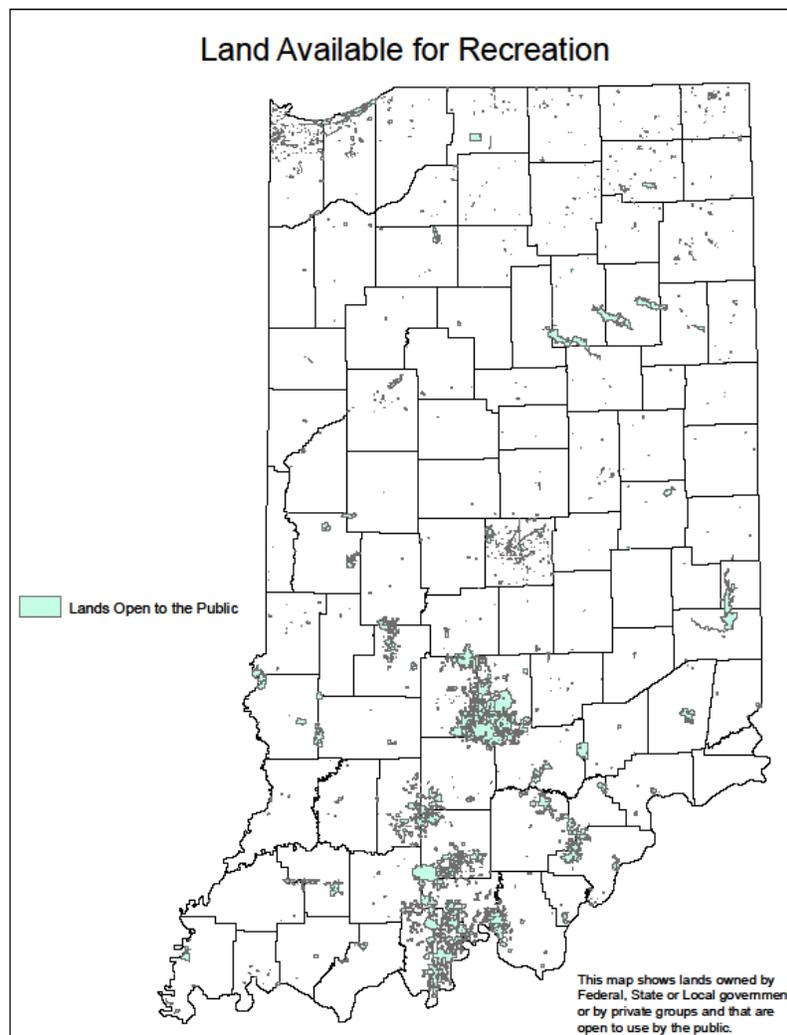
Wood products

Sustaining Indiana's forest products industry is an issue that stakeholders are concerned about, although it does not rank as highly as previous issues in terms of relative importance (see page 2). This section is generally concerned with assessing the importance of forestlands in relation to the provision of a specific ecosystem service, timber production.

Because society demands wood and wood products for a multitude of uses, economic value is assigned to the standing timber that provides the raw material. For Indiana's forests, this is arguably the most important link to an economic system within which forests accrue annual costs of management, oversight and property taxes. Until additional markets for ecosystem services, like the provision of clean water or carbon sequestration benefits, are developed, the harvest and sale of timber will likely continue to be the main contributor to the economic value of forestland, maple sugaring and hunting leases.

Speculative investment in forests for associated development land values that are based on the future parcelization and conversion to another land use and are not reflected in this analysis.

Forestry and wood product manufacturing is a $7.5 billion industry that employs more than 54,000 Hoosiers, and Indiana has developed a global reputation for excellence in hardwood tree production and product manufacturing; however, growing competition from wood product manufacturers in Asia, Latin America and elsewhere threatens the viability of Indiana's hardwood industry (ISDA, 2009).

Seeking to differentiate Indiana's environmentally sound, high-quality and legally sourced wood products has resulted in a branding effort called "Premium Indiana Forest Products," and the third-party certification of sustainably grown, harvested and manufactured forest products through groups like Sustainable Forestry Initiative (SFI) and Forest Stewardship Council (FSC). Sustainably certified forestlands represent a growing share of the managed forests in Indiana, and the majority of these are highlighted in this analysis.

Indiana has ranked first nationwide in recent years in the production of wood office furniture, wood kitchen cabinets, and hardwood veneer, along with several other products. As small family-owned businesses, wood products companies average fewer than 50 employees and play an important role in rural communities (IDNR, 2010). The Division of Forestry has fostered efforts to connect disparate groups with a forest commerce website established recently called The Indiana Forestry Exchange: www.inforestryx.com

Further information about the forest issue Wood Products is in Appendix D. This issue has four equally weighted component maps.

Purdue University logger and primary wood products points

This map shows the distance to sawmills and primary manufacturers who are the major purchasers of standing timber and delivered logs for processing. Transportation costs are an important component of timber production and marketing, and a 30-mile radius is often used in the industry to assess costs.

Access to Mills and Primary Manufacturers

Businesses within 30 miles
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

This map shows the number of mills and primary wood manufacturers within 30 miles of any point in Indiana, and is derived from Dr. Eva Haviarova's work at Purdue University.
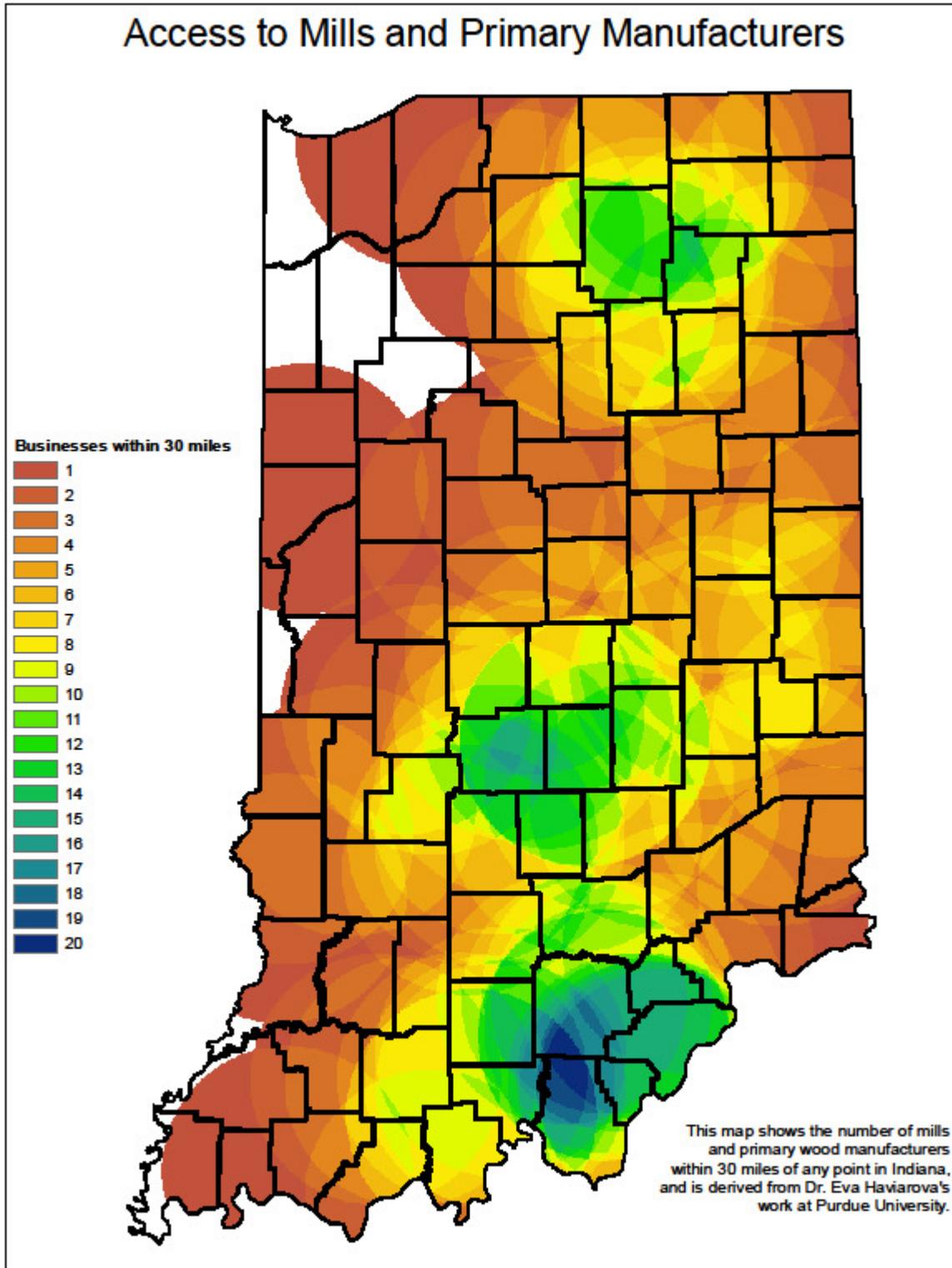
Biomass

The map below shows the above-ground biomass concentration in the state. Biomass can be a relative indicator of potential timber and other industrial use but is not necessarily related to an area's productive capacity. The measure of an area's productive capacity (site index) is not accurately and consistently available on a statewide basis. This is an identified data gap. Research is underway to provide this information across the state.

Above Ground Forest Biomass Per Acre

Biomass
Lowest
Highest

This map shows the above ground biomass of all live trees on a per acre basis based on FIA data from te USFS Northern Research Station
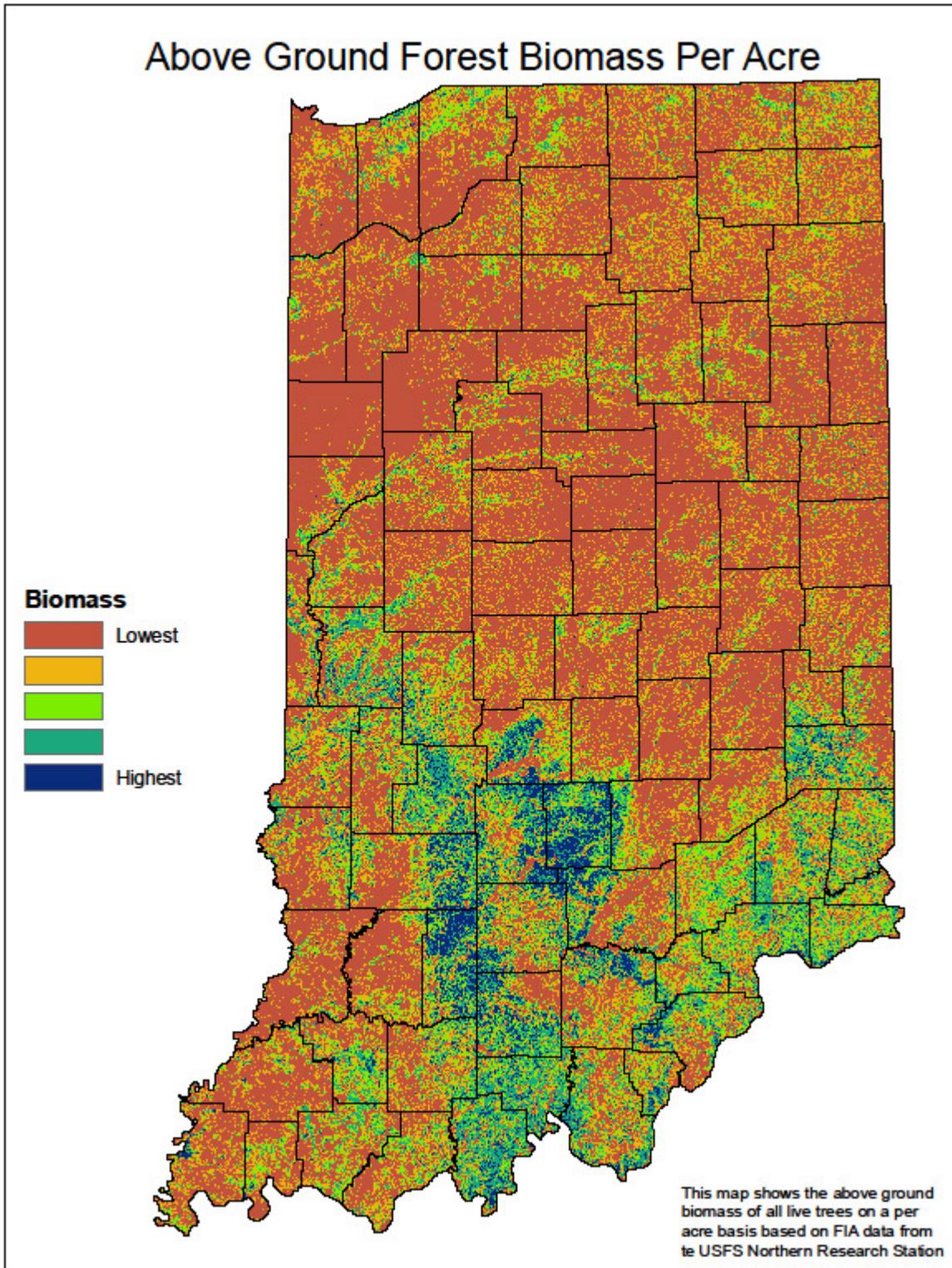
State Forests, Crane and Hoosier National Forest managed lands

This map shows areas of public ownership that currently have a regular or active timber management program on a portion of their property. Public properties that are managed in part for timber make up 44% of public lands in the state. This number is an overestimate because it includes a property's entire ownership and does not select out the areas, like nature preserves in State Forests or the Deam Wilderness in Hoosier National Forest, that do not have regular timber management.

These lands are important because their larger overall areas offer greater opportunity for landscape scale continuity in management and relative economies with respect to harvesting practices. These lands make up 6.7% of the forestland in Indiana.


State and Federal Lands With Active Harvesting

State Forests
Federal Lands

This map shows Indiana State Forests, the Hoosier National Forest, and Crane Naval Weapons Support Center, all of which actively harvest timber.
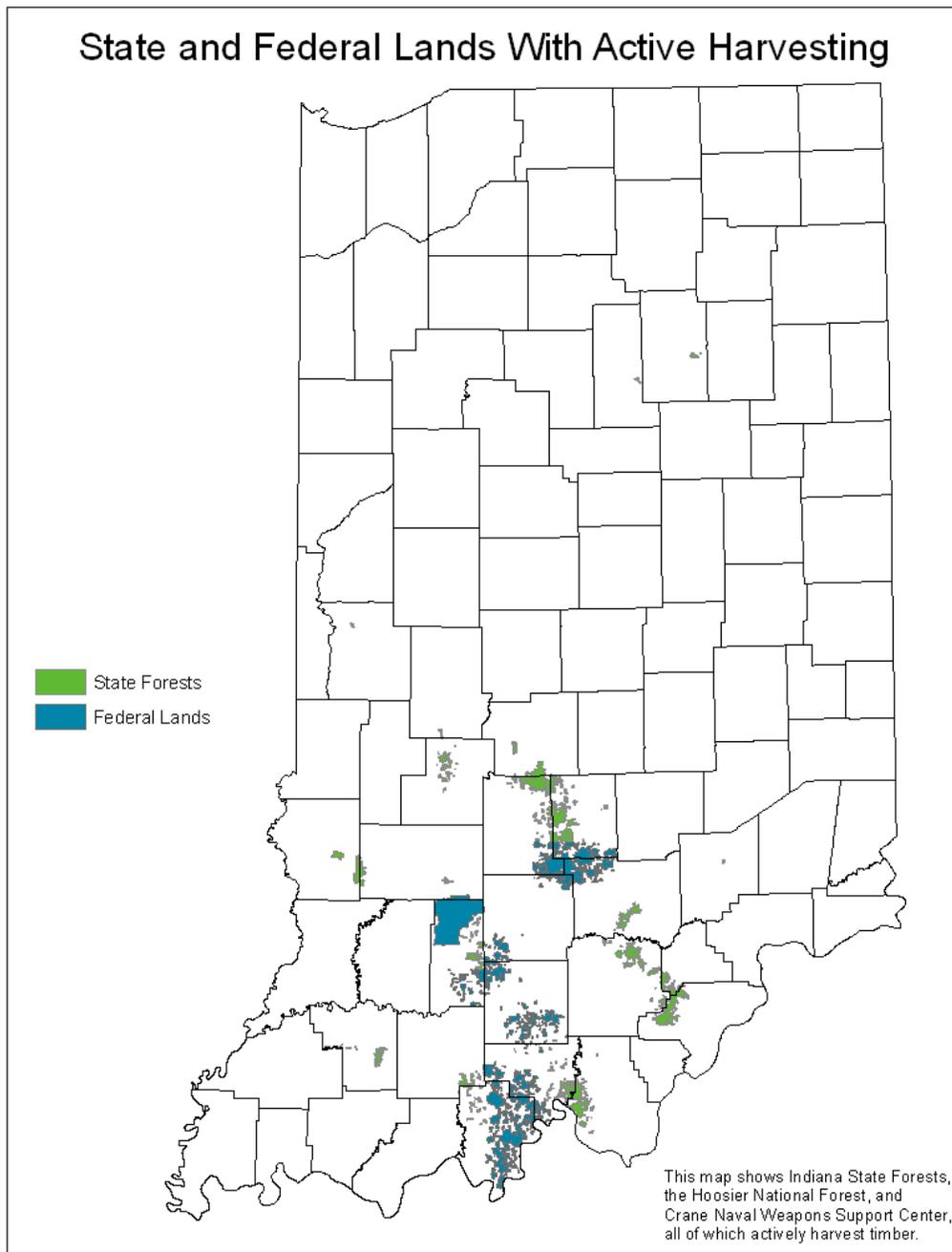
Classified forests

The Classified Forest and Wildlands is a highly successful program initiated in 1921 by the State of Indiana under the leadership of Charles C. Deam, Indiana's first State Forester. It encourages timber production, watershed protection, and wildlife habitat management on private lands in Indiana. Program landowners receive a property tax reduction in return for following a professionally written management plan.

This program is open to enrollment year round by contacting a local State District Forester: http://www.in.gov/dnr/forestry/files/fo-District_forester_list_print_version.pdf

There are currently about 648,000 acres enrolled as Classified Forests and Wildlands, representing approximately 10.7% of forests in Indiana. These private properties reflect a commitment to the retention of forestland and the maintenance of sustainable working woodlands. These properties are a major supplier of timber for the state's wood product needs. It is estimated that these properties annually harvest 35 million board feet of timber. (IDNR, 2009)

Classified Forest and Wildlands

Classified Forest and Wildlands

This map shows lands enrolled in the Division of Forestry's Classified Forest and Wildlands Program.
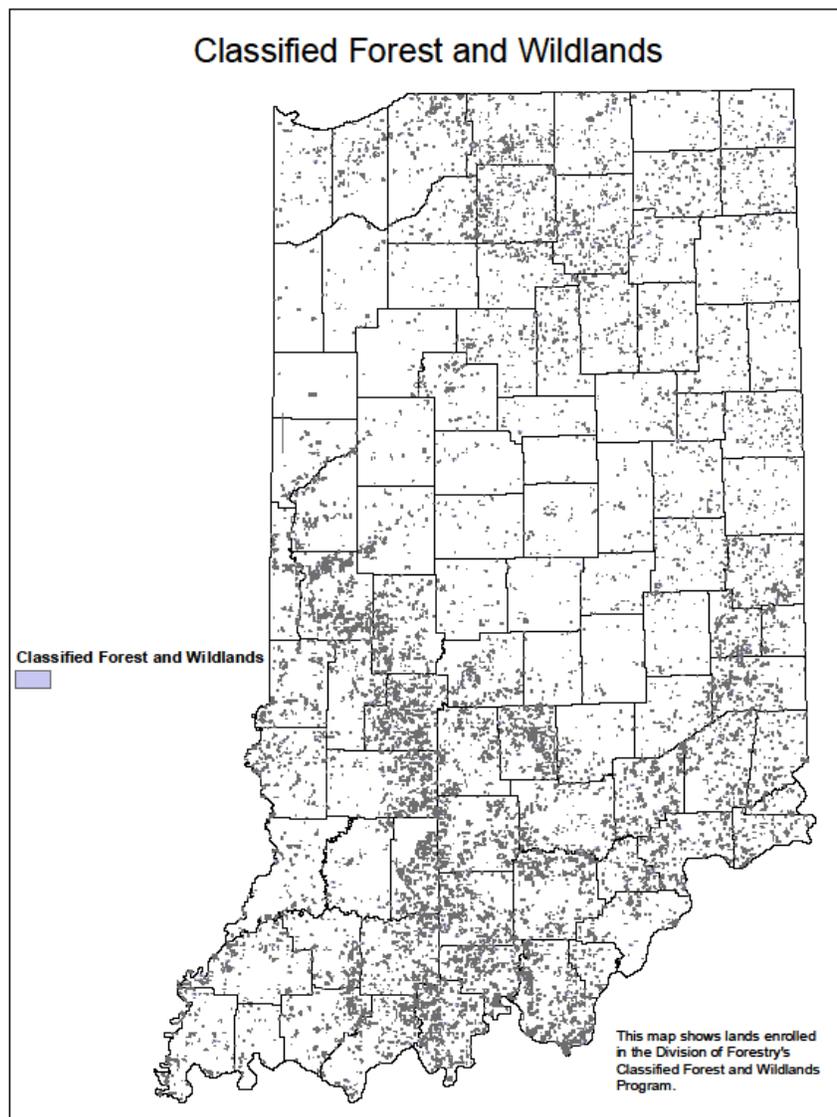
Priority Landscape Areas: Wood Products

This map shows the prioritized importance of forestlands associated with the economic value of timber production and the recognized forest issue of sustaining Indiana's forest products industry. This map should be used by conservation and landscape stewardship partners, whose efforts focus on working woodlands, keeping forests as forests, or working with aspects of rural development.


Wood Product Supply & Demand

Supply & Demand
- Low
- High

This map shows is a combination of 4 layers, showing wood product supply and demand in the state.
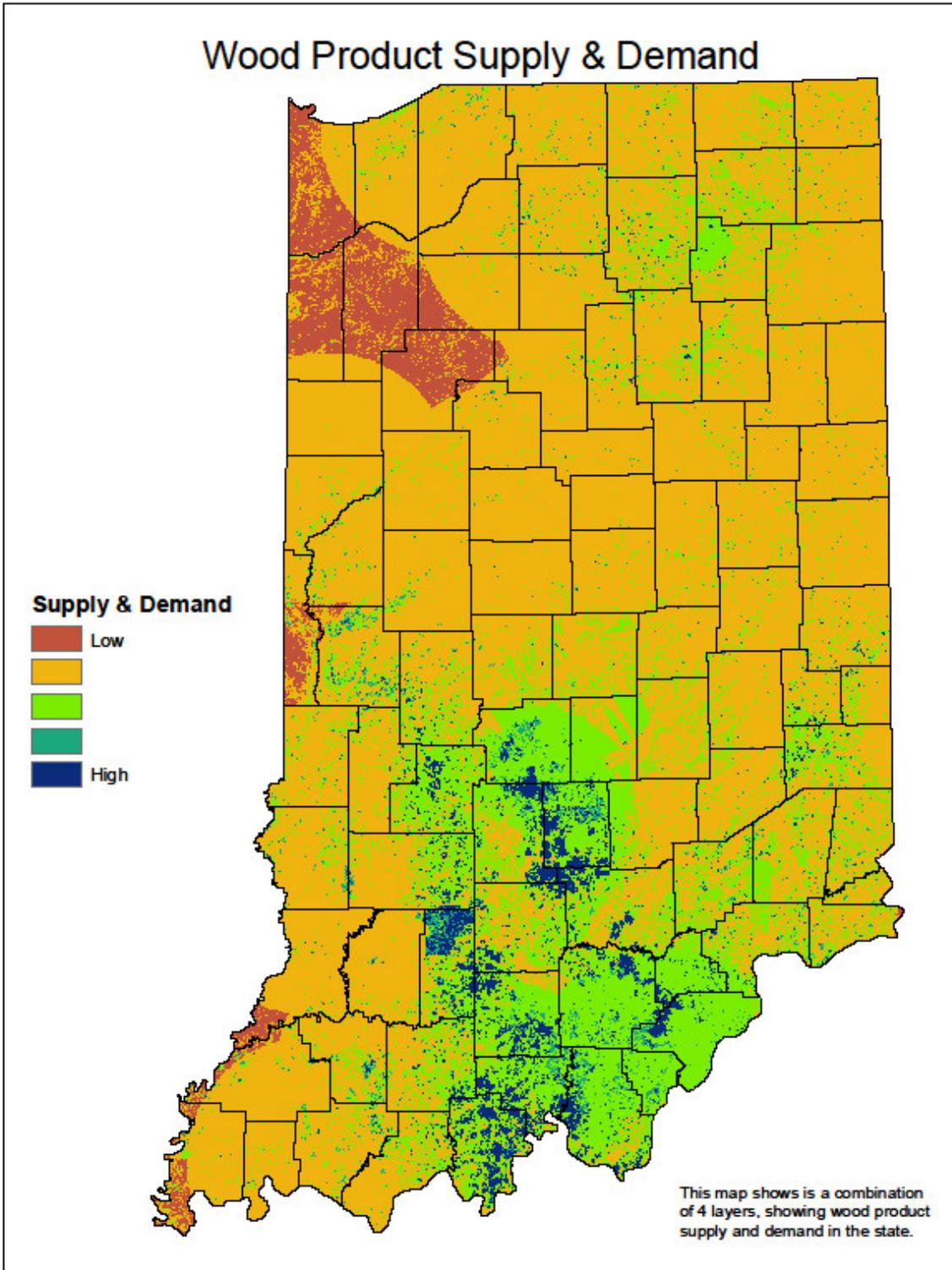
High cost of forest ownership and low incentives to retain

This section includes some supplementary geospatial information that is not of comparable resolution to be included in a Priority Landscape Analysis.

This issue is reflective of a number of identified data gaps (See Appendix B). Costs of forest ownership can be substantial, especially when owners are faced with management costs associated with invasive species. Forest establishment, seedling purchase, weed management, boundary marking, timber stand improvement, invasive control, access-road planning, harvest costs, property tax, severance tax and estate tax can all play a part among other things and, depending on the condition of the forest land considered, in determining the cash outflow relating to forest property ownership.

As discussed in the Wood Products section above, in Indiana the main and most significant economic value associated with woodland ownership is derived from the management and harvest of timber. Currently, there are a number of other potential revenue streams associated with forestland, like maple syrup production, forest herbs and fruit, and hunting leases, but none of these compares with associated timber values.
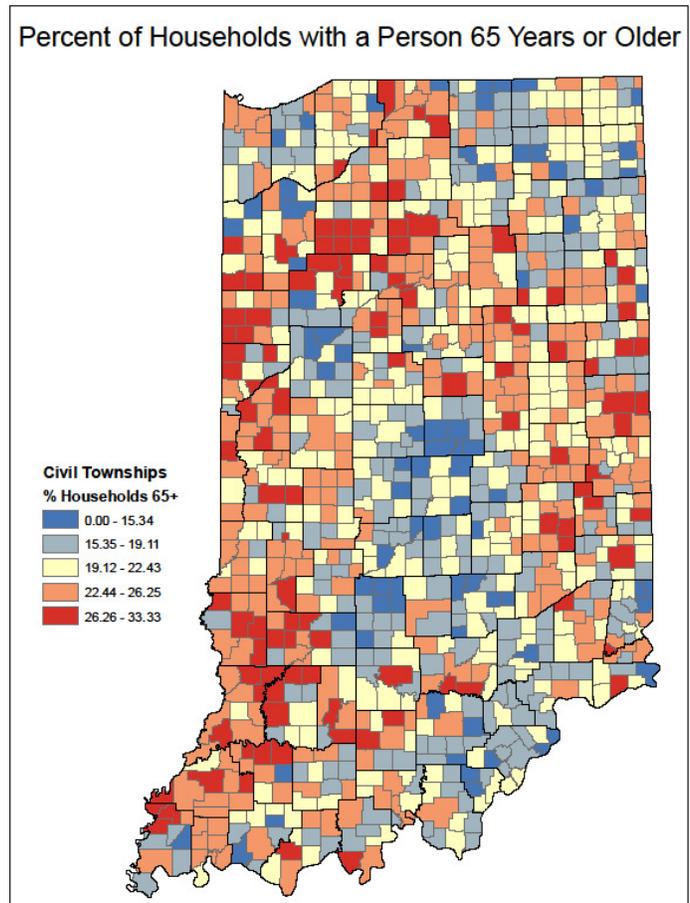
There are efforts underway to provide additional economic value streams to forestland owners that compensate for other ecosystem services that are currently not assigned an economic value. A leader in this effort is the USDA's Office of Environmental Markets. The Office of Environmental Markets is supporting the development of emerging markets for carbon, water quality, wetlands and biodiversity.

This issue recognizes a gap between costs and income from forest ownership, and this can be particularly relevant to persons who are retired or on fixed income. This map (see above) details a demographic by county township for which this issue may be particularly relevant. Demographic patterns in forest ownership can have particular influence when there are transfers of ownership. Often, properties are divided at this time and estate tax assessments influence the remaining property structure, goals and forest quality.

Overpopulation of White-tailed deer

This section includes some supplementary geospatial information that is not of comparable resolution to be included in a Priority Landscape Analysis.

The overpopulation of White-tailed deer is an important issue for many forest stakeholders. The overriding concern is the preservation and maintenance of a diverse and healthy native understory of trees and vegetation that will in succeeding generations determine the composition of the dominant canopy. An overpopulation of deer will limit the biological diversity of an area, denude the understory of choice forage, like oak seedlings, and favor a population of generally unpalatable exotic invasives.

Deer are also a particular concern for those landowners planting and establishing seedlings in forest regeneration or orchard settings. Next to weed pressure, deer browse can be the major factor determining success or failure in these efforts. White-tailed deer are

Deer Collisions in 2008

GPS locations of Indiana State Police responses to deer collisions during 2008

managed by the IDNR, and their populations are controlled mainly by seasonal hunting. Population estimates and high-resolution density data were not provided by the IDNR. The map (at right) that shows the locations of the more than 16,000 deer collisions recorded by State Police in 2008 should not be considered an acceptable "proxy" to defining deer populations within the state.

This map is more a function of interactions between humans and deer, and not representative of the status of deer density within the state. Interstates and cities are clearly defined on this map, where the interface between human activity and the wild deer populations overlap. On this map, rural areas where there may be more deer but fewer humans can be underrepresented in terms of deer population. Likewise, areas with high human populations and lower deer densities may be overrepresented. The IDNR does not collect county-wide deer densities data and recommends using harvest information or trends in harvest information to evaluate populations.
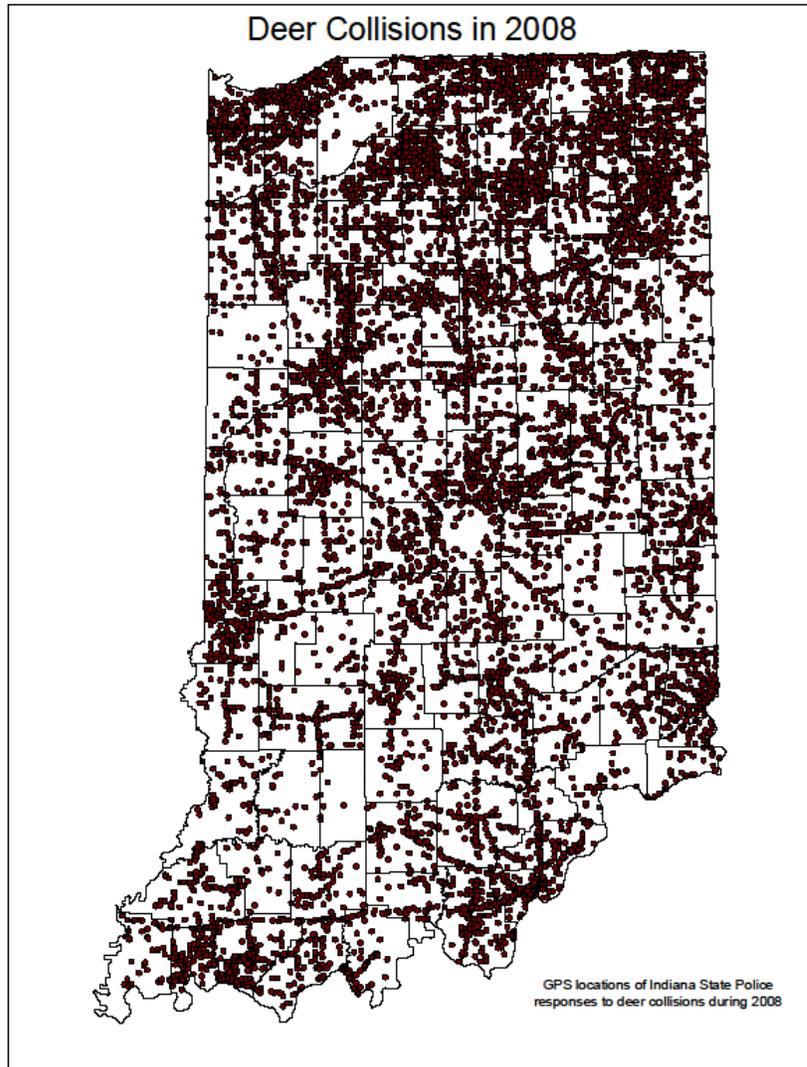
Urban Forests

"Street trees not only absorb CO_2, but they reduce the urban heat island effect and so reduce the need for air-conditioning. They also filter diesel particulates out of the air and help reduce storm water runoff and their presence, statistical studies show, even correlates with improved school performance of children. Besides, streets with trees are simply more pleasant"
- Colin Beavan

About 80% of Hoosiers live in an urban area. Urban forests include city parks, street and yard trees. The map below shows how many urban areas meet the following criteria: greater-than-average population, greater-than-average area, greater-than-average impervious surface and less-than-average tree canopy cover. This is a statewide geospatial dataset that reflects the potential for benefit from increased tree cover among Indiana's urban communities.

Canopy cover is an important component of the urban forest. Leaf surface area directly correlates with the benefits of street trees. The greater the leaf surface area exhibited by a tree, the greater the benefits a particular tree is likely to provide to a community. Trees with large leaves and spreading canopies tend to produce the most benefits.

Street trees and urban forests provide ecological services that include 1) reduced air pollution, 2) storm-water control, 3) carbon storage, 4) improved water quality, and 5) reduced energy consumption. Other, harder-to-quantify benefits include increased job satisfaction, faster recovery time for hospital patients, and improved child development, among other things. Also, aesthetic values associated with increased urban canopy contribute to higher property values. (Kane, 2009)

The Statewide Urban Sample Inventory (SUSI), a detailed report that contains information about the street tree makeup of Indiana's urban forests, urban forest issues, and the functional services the urban forest provides, showed that the state has more than 850,000 vacant street tree planting spaces. This report also indicated a predominance of maple trees, tending toward a lack of overall street tree diversity. The second most common species highlighted in the report is ash, which is facing the spread of the emerald ash borer. Three of the 11 most common tree species are not native to Indiana. The SUSI report also provided documentary evidence of invasive species in the urban forest canopy and an age-class distribution that trends toward ecological simplification.

More information about Indiana's the 52 million trees that grace Indiana's urban areas is in Appendix D.

Urban Areas and Tree Cover

Number of Criteria

- 0 (dark green)
- 1 (light green)
- 2 (yellow)
- 3 (orange)
- 4 (red)

This map shows how many criteria urban areas in Indiana meet, as defined by the Maryland Method. The four criteria, as compared to other urban areas are:
1. Greater than average population
2. Greater than average area
3. Greater than average impervious surface
4. Less than average tree canopy cover
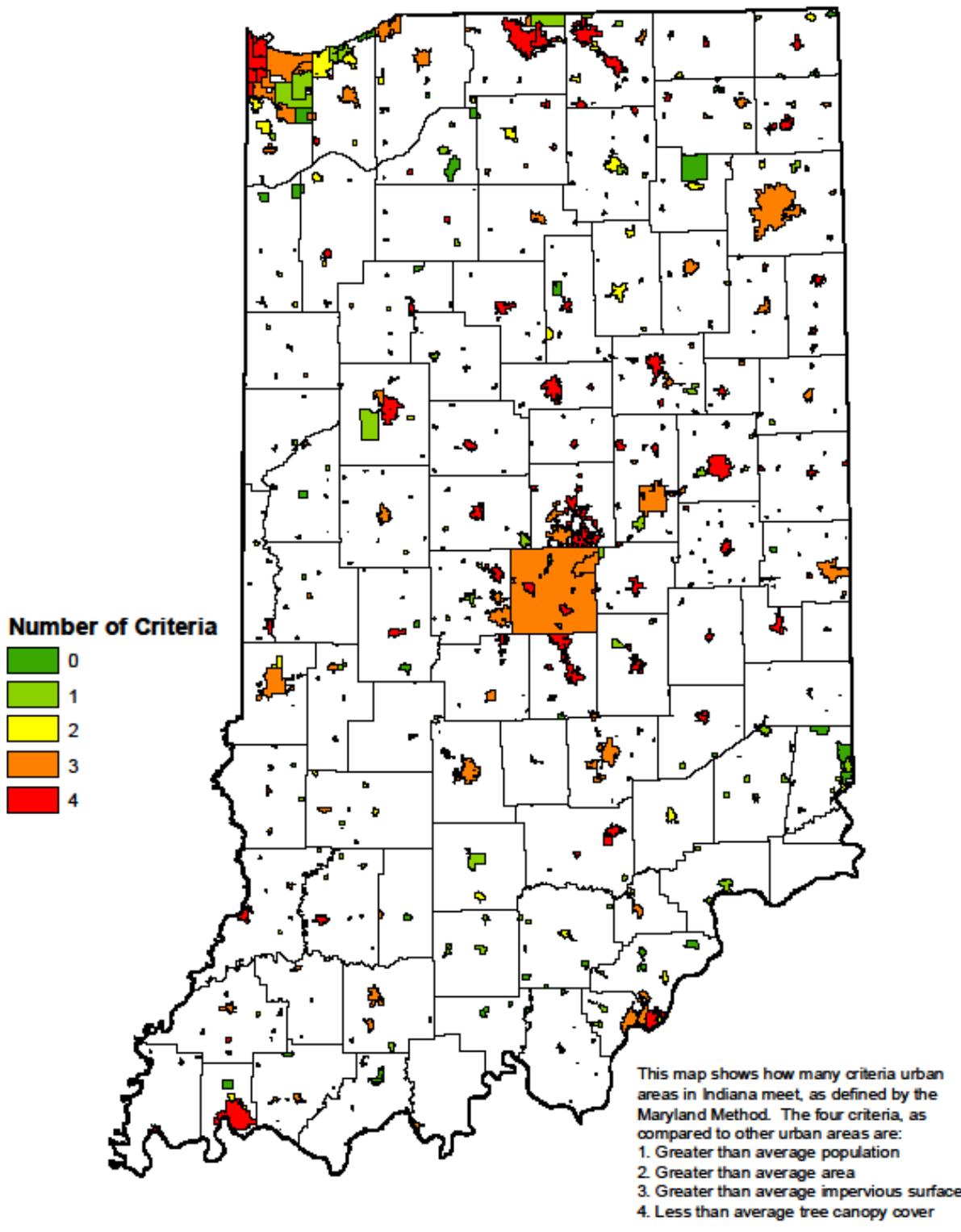
Composite Map & Multi-state Areas

The above section of the Assessment presents geospatial information on a number of recognized forest issues. Based on relative importance, the majority of the most pressing issues are presented with a number of component maps that contribute to topic understanding. The issues that are presented above with corresponding Priority Landscape Areas analysis are:

Indiana Forest Issue	Relative Importance Score
Fragmentation and/or conversion of forests to another land use	507
Conservation and maintenance of soil and water resources	425
The spread and control of invasive species	421
Conservation of biodiversity	364
Availability of land for public recreation	234
Conservation of forests that protect drinking-water supplies	206
Sustaining Indiana's forest product industry	160

To create a composite statewide composite map, issue maps are weighted following a 2009 Survey-determined scale: Fragmentation 24%, Soil & Water 20%, Invasives 20%, Biodiversity 17%, Recreation 11%, and Industry 8%. This methodology is more fully described in Appendix A.

Again, these percentage weights are derived from 2009 Survey responses in which stakeholders ranked the three most important issues facing Indiana's forests. This prioritization and reflection of relative importance coincides with the stated goals of the required Priority Landscape Areas analysis.

Indiana – composite map

This map combines the above Issue maps to generally show areas important for identified forest stakeholder issues. This map will be refined to reflect a growing body of geospatial data and developing understanding regarding forest sustainability among Hoosier stakeholders and citizens. Prioritized strategic areas will be developed from a synthesis of this weighted GIS analysis and a refined weighting of various component and issue maps presented in this Assessment.

Composite Forest Priority Areas

Forest Priority

- Lowest
-
-
-
- Highest

This map is a composite of the Fragmentation, Soil & Water, Invasive Species, Biodiversity, Recreation and Wood Products maps, each weighted based on public input from our survey
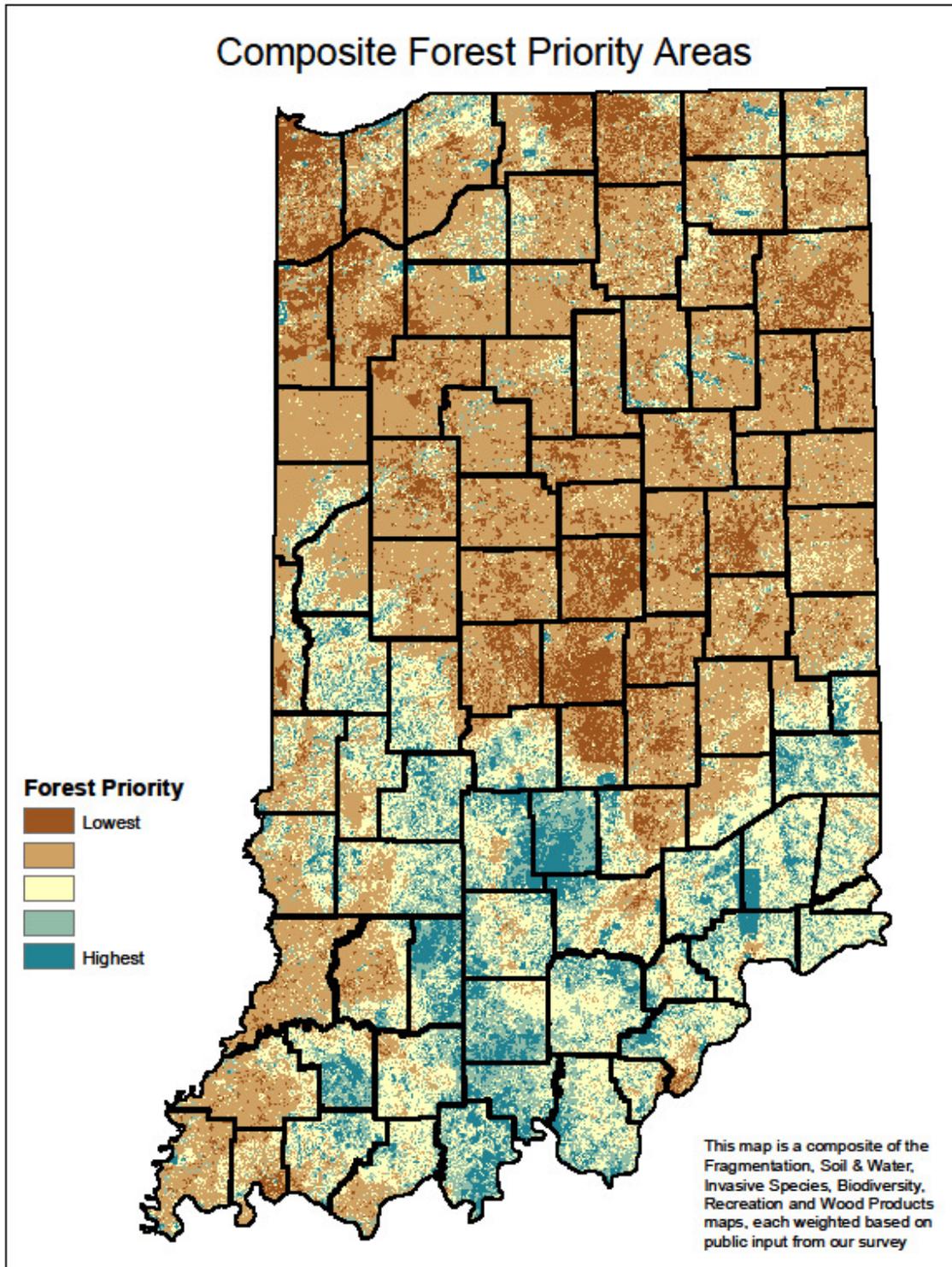
Multi-state

There is a multitude of existing and potential multi-state forestry related efforts and partnerships that involve Indiana. Potential projects will be pursued as capacity allows, and certain multi-state areas may be developed in the Statewide Forest Strategy. The following list identifies certain of the areas and issues for existing and potential multi-state efforts.

- Great Lakes Regional Collaboration
- Ohio River Corridor Initiative
- Big Rivers Fire Compact
- Karst Areas
- Central Hardwood Region
- Chicago/Gary, Chicago Wilderness
- Wabash River Valley
- Invasive Plants, Cooperative Weed Management Areas
- Invasive Insects, Emerald Ash Borer and Asian Long-horned Beetle
- Oak Regeneration
- Hardwood Region--Indiana Bat Conservation
- Western Mid-Atlantic Development
- Interstate Highway Corridors
- Watershed Plans, St. Joseph River Watershed Management Plan
- Fish Habitat Restoration
- National Fish Habitat Action Plan Partnership
- Upper Midwest and Great Lakes Landscape Conservation Cooperative
- Bird Conservation Joint Ventures, Central Hardwoods Joint Venture
- Moraine Forest
- Black Swamp
- Species Migration
- Gulf of Mexico Hypoxia
- Call Before You Cut

Coordination with Groups and Other Plans

This section details the efforts to develop this Assessment, coordinate with stakeholder groups and individuals, and encourage the widest possible participation.

The Division of Forestry has consulted with key stakeholders to ensure that the State Assessment (1) integrates, builds upon, and complements other state natural-resource assessments and plans, and (2) identifies opportunities for program coordination and integration.

A first step in the development of the Assessment was the assemblage and review relevant literature and documents. These documents were identified and reviewed for incorporation through stakeholder assessment input sessions and posted on a series of web pages relating Statewide Forest Assessment hosted by the Division of Forestry to facilitate stakeholder involvement and exchange.

Aspects of Indiana's Priority Conservation Actions for forests and related forest habitats, as well as Species of Greatest Conservation Need were incorporated from the Indiana Comprehensive Wildlife Strategy and included throughout the Assessment's major issues sections. The Indiana Comprehensive Wildlife Strategy contains a wealth of information on Indiana forest species and their habitat needs. Links to this document and other plans incorporated in this process are in Appendix D.

Stakeholder Involvement

The Forest Stewardship Coordinating Committee, an established group representing a range of forestry interests in the state, has participated in the stakeholder process along with IDNR Division of Fish & Wildlife, Natural Resource Conservation Service, Bloomington Ecological Services Office of the US Fish & Wildlife Department, Hoosier National Forest and other federal land management representatives and technical committee members.

A wide and diverse group of stakeholders and individuals who have an identified interest in forestry or forestland use was surveyed and invited to participate in the Indiana Forest Stakeholder Summit that occurred in June and July 2009. More than 300 stakeholder organizations had members participate in this process to refine important forest issues and assess their relative importance.

The Indiana Forest Stakeholder Summit was held at four regional Indiana locations between June 24 and July 2, 2009 – Wabash in the north, Indianapolis in the central region, Bloomington in the south-central region and Huntingburg in the south.

The Summit provided forest stakeholders with an opportunity to provide input, suggestions and comments relating to the development of Indiana's Statewide Forest Assessment. The Summit attempted to refine and clarify the most pressing issues faced by Indiana's private, public and urban forests. Stakeholders also contributed their visions of a desired future forest condition and discussed the implications of priority landscape areas.

The Indiana Forest Stakeholder Summit was successful in bringing together and engaging a wide range of forestry interests and enabling them to share their concerns for the condition and future of our diverse Indiana woodlands.

A detailed list of the groups that participated in the 2009 Assessment-related survey and summit, as well as the names of individuals who reviewed the initial draft of this document, can be found on the Division of Forestry webpage: http://www.in.gov/dnr/forestry/5438.htm.

Document Review Process

A draft of the 2010 Statewide Forest Assessment was available for public review for two weeks ending April 16, 2010. The document was sent to forest stakeholders who had requested to review a copy via the June 2009 survey. It was also e-mailed to an open list of stakeholder groups and individuals assembled for this process. Also, press releases were issued as another attempt to encourage participation in this open and inclusive process. Many news agencies and publications published articles from these press releases.

The Division of Forestry received 14 written responses through the document review process and incorporated informal suggestions in an effort to improve the draft version. The substantial portion of this document represents a snapshot of forest conditions that existed but are constantly changing. It also incorporates the best available measures that existed at the time of production. In light of the significant upcoming research and developing data that will inform these pursuits, this Assessment should be considered a living document that will continue to improve.

The following individuals submitted written comments on the draft Assessment that were incorporated, where possible, to improve the document:

1. Brian Cruser, ACF, TSP
2. Bill Hoover, Purdue University
3. David Haberman, IU Department of Religious Studies
4. Linda Elder, Forest Stakeholder
5. Mary Mulligan, Brownfields Specialist
6. Rhonda Baird, Indiana Forest Alliance
7. Ashley Mulis, Indiana Urban Forest Council
8. Kenneth G. Day, US Forest Service
9. Mark Reiter, Division of Fish and Wildlife
10. David Glista, Indiana Department of Transportation, Office of Environmental Services
11. Elizabeth A. Jackson, Indiana Forestry & Woodland Owners Association
12. Cheryl Gettelfinger, Carmel Urban Forestry
13. Trish Eccles, Trees Inc.
14. Tim Maloney, Hoosier Environmental Council

These review comments can be accessed through the Division of Forestry's Assessment webpage: http://www.in.gov/dnr/forestry/5436.htm.

Appendix A: Priority Landscape Areas Methodology

Forest land in Indiana comes from the 2009 National Agricultural Statistics Survey (NASS) satellite imagery. Classes 141 (Deciduous Forest), 142 (Evergreen Forest), 143 (Mixed Forest), 152 (Shrubland), and 190 (Woody Wetlands) were reclassified to forest, and all other classes were grouped as "other." Then, using cost share boundaries from the USDA Farm Services Agency (FSA), cropland was erased from the forest reclassification to remove any mixed or misclassified pixels. Finally, all interstates, U.S. highways, and state highways were buffered by 15 meters per side (creating a minimum width of 1 pixel for roads) and were also erased from the forest coverage, again to remove mixed or misclassified pixels. This layer was used in many other component maps.

Fragmentation

Component Maps

Forest patches were derived from 2009 NASS forest data reclassed into forest and other, with state, U.S. and interstate highways erased. Acreage was then calculated for each contiguous patch.

Tracts Not Intersected by Public Roads were derived by erasing all public roads in Indiana from the 2009 forest layer.

Projected development patterns to 2030 is based on Dr. Dave Theobald's work out of Colorado State University. Using 2000 Census data and SERGoM v3 model, which predicts future population growth trends, the prediction for the year 2030 was compared with the known data from 2000, and areas of the state that were predicted to have parcel sizes drop below 10 acres were highlighted.

The 1K and 10K maps were created using the same methodology, with differing radii. Using the 2009 forest data, local statistics were used to look at a circle around each point at 1 and 10K radii to determine the percent forest cover. These datasets can be used both to show where there is a high density of forest and where there is a high amount of forest fragmentation.

Fragmentation Issue Map

The above maps were reclassified into a maximum of 6 classes, with the least at risk of fragmentation class getting a value of 10, the next getting a value of 8, etc., down to zero. The five maps were then added together, and using the Natural Breaks classifier in ArcMap, this composite fragmentation map was broken into High, Medium, and Low classes for Potential to Prevent Fragmentation.

Soil and Water

Component Maps

Soil erodibility comes from the K factor of the Natural Resource Conservation Service (NRCS) STATSGO soils, and can be used as a means of finding highly erosive soils that should have trees or some other perpetual ground cover to prevent soil loss.

Riparian Corridors comes from the Indiana component of the high-resolution National Hydrography Dataset (NHD). All perennial features were extracted from this data set and buffered by 90 meters (per side for streams and rivers).

Public Water Supply Areas is derived from data maintained by the Indiana Department of Natural Resources, Division of Water. The 10-digit watersheds with surface water intakes for public drinking water were selected, and public wells used for drinking water were buffered by one mile to create this map.

Karst features comes from Indiana Geological Society data showing sinkhole areas and sinking-stream basins associated with Silurian-, Devonian-, and Mississippian-age bedrock in Indiana.

Impaired Stream Miles by Watershed was created by taking 303d streams from the 2008 impaired stream dataset maintained by the Indiana Department of Environmental Management (IDEM), intersecting that layer with 10-digit watershed boundaries, and then comparing the length of impaired streams and water body boundaries per watershed to the total length of streams and water body boundaries per watershed, using the high-resolution NHD data.

Forest by watershed was calculated by intersecting the forest land layer with 10-digit watersheds, and calculating the amount of forest in each watershed.

Forested Riparian Areas was created by buffering all perennial water bodies by 90 meters (per side for streams and rivers), and clipping the forest land layer to the buffered area. Both the buffer and the forest land layer were then intersected with 10-digit watersheds, and the percent of forest in buffered riparian areas by watershed was calculated.

Impervious Surfaces were calculated by reclassifying the 2009 NASS imagery. Classes 121-124 (Developed/Open Space, Developed/Low Intensity, Developed/Medium Intensity and Developed/High Intensity) were reclassified to urban, and everything else was grouped as "other". The amount of urban land in each 10-digit watershed was then calculated. Using the estimate of ~24% of urban land being impervious, the urban areas were then multiplied by .24 to determine the amount of impervious surface in each 10-digit watershed, which gives an idea of water quality within each watershed.

Slope data was derived from the 2005 DEM, resampled to 30 meter pixels. All slopes between 6 and 30% (as specified in the previous Spatial Analysis Project) were targeted as being lands where development or conversion to agriculture is still feasible, but also steep enough that there is high erosion potential for bare soil.

Soil and Water Conservation Issue Map

The nine component maps for this issue were reclassified into a maximum of six classes, where lands that would most help in protecting soil and water resources received a value of 10, the

next-best class got an 8, down to 0. For example, for the Percent Forest by Watershed map, watersheds with >80% forest got a value of 10, >65-80% got an 8, >50-65% got a 6, and all others got a 4. The nine-layer maps were then added together, and the resultant composite map was broken into three classes using Natural Breaks in ArcMap.

Invasive Species

Risk Component Maps

The emerald ash borer (EAB), gypsy moth and kudzu map was created using kudzu points, as found during Forest Inventory and Analysis (FIA) sampling, EAB-quarantined townships, and all areas of the state north and east of the 10-moth catch line interpolated from gypsy moth traps.

Maintained Corridors through Forests was created by overlaying all roads, railroads, mapped power-line and pipeline corridors, and trails on top of the 2009 forest layer.

Home Density and Forest Cover combined the home density data from 2000 created by Dr. Dave Theobald with the 10K forest cover map to find areas that had high home density and high forest cover. We used data from 2000 because it is the last year using known data; the next statewide dataset will be available after the 2010 census.

Invasive Species Issue Map

The EAB, Gypsy Moth, & Kudzu map and the Maintained corridors map were weighted 10 for at-risk areas and 0 for everywhere else, while the Home Density and Forest Cover map was weighted using the 10, 8, 6 … 0 method described above. The three maps were then added and Natural Breaks was used to classify the composite map into three classes to show the Potential to Prevent Invasive Species.

Biodiversity

Component Maps
Above-Average Size Forest Patches by Natural Region was derived from the 2009 Forest Patches layer and Mike Homoya's Natural Regions map. All forests with their center point in a region were selected, the average forest patch size was calculated, and forest patches above that average size were selected into a new layer.

Wetlands were derived from the 2009 draft version of the National Wetlands Inventory. Woody wetlands were buffered by a distance of 1 km, and all other wetlands were buffered by a distance of 350 meters.

Rare Forest Communities were extracted from the Indiana Natural Heritage Database, maintained by the Indiana Department of Natural Resources, Division of Nature Preserves.

Large Forest Patches in Areas of Low Forest Cover comes from combining the 2009 Forest Patches layer with the 10K Forest Cover layer. For areas of the state with <20% forest cover, forest patches 100 acres or greater in size were selected.

Biodiversity Issue Map

The above four maps were reclassified into binary rosters: either they met the criteria (1) or they didn't (0). These were then added together, and the resultant map was broken into four categories, based on how many component maps overlaid a given pixel. Areas of the state that were covered by none of the four component layers are shown in white on this map, and areas covered by all of the layers were given the highest importance for biodiversity.

Recreation

This map shows lands from the DNR's Managed Lands Database of property open to the public (although some may have restrictions based on seasonality, notification of use, etc.)

Wood Products

Component Maps
Access to Mills and Primary Manufacturers was derived from Dr. Eva Haviarova's work at Purdue University that shows locations of wood product industry sites in Indiana. Mills and Primary manufacturers were selected from her data, and then the number of these sites within 30 miles of any point in the state was calculated.

Above Ground Biomass comes from the US Forest Service's Northern Research Stations analysis of FIA data.

State and Federal Lands with Active Harvesting shows State Forests, the Hoosier National Forest and Crane Naval Weapons Support Center as pulled from the Managed Lands database. It should be noted that this map shows all land in these properties, not just those areas that are harvested.

Classified Forest and Wildlands shows lands enrolled in the Division of Forestry's Classified Forest and Wildlands Program, based on deed descriptions entered into GIS.

Wood Products Issue Map

The first two component maps were reclassified into six classes using the 10, 8, 6…0 weighting, and the last two were turned into binary maps (10 and 0), and the four maps were then added together to show Wood Product Supply and Demand. This map was broken into five categories using Natural Breaks.

Indiana Composite Map

This map was created by taking the six issue maps, reweighting them using the 10, 8, 6…0 method, multiplying them by the importance as determined from the 2009 survey, and then adding them all together. Thus, Fragmentation could contribute a weight of up to 240, while Wood Products could contribute a maximum weight of 80 to any pixel in the state. The resultant map was then broken into five classes using Natural Breaks.

Additional maps not used for compositing

Limited Conversion Lands was created by selecting all public lands and private lands with conservation easements from the DNR Managed Lands database, along with all Nature Conservancy and Sycamore Land Trust properties.

Cerulean Warbler Sightings comes from bird surveys conducted across the state and represents an area in which a cerulean warbler was found.

Percent of Households with a Person 65 Years or older comes from U.S. Census data.

Deer collision data comes from GPS locations where Indiana State Police responded to deer/vehicle collisions in Indiana in 2008.

Urban Areas and Tree Cover was developed using Nowak's "places" layer 2000 Census data, and 2001 National Land Cover Dataset (NLCD) data. Urban areas were compared to each other within each state to look at the following four criteria: Greater-than-average population; greater-than-average area; greater-than-average impervious surface; less-than-average tree canopy cover. The map shows how many of those criteria each urban area met.

Appendix B: List of Data Gaps

These data gaps are discussed in the above text and keenly relevant to the forest issues of recognized importance. Unless otherwise aggregated, high resolution data is 30-meter square pixels statewide.

• All county parcel data (65/92 currently providing GIS data with the State of Indiana)
• Tax rates
• Statewide zoning restrictions
• Forestland sale prices by parcel or at least township
• Perennial vs. annual agricultural vegetative cover
• Comprehensive state-level surveys for invasive species
• Stand age and forest type
• Under-story and mid-story survey–oak distribution
• Forest biodiversity connectivity and dispersal corridors
• Productive capacity (site index)
• Active management of forests, especially timber harvests
• Forest ownership demographics
• Estate tax income from properties greater than 10 acres
• Ecological impact of deer herbivory survey

Appendix C: References

Donovan, T. M., P. W. Jones, E. M. Annand, and F. R. Thompson, III. 1997. Variation in local-scale effects: mechanisms and landscape context. Ecology: 78(7): 2064-2075.

Duchamp, J. E., and R. K. Swihart. 2008. Shifts in bat community structure related to evolved traits and features of human-altered landscapes. Landscape Ecology, 23:849-860.

Hartley, M. J., and M. L. Hunter. 1998. A meta-analysis of forest cover, edge effects, and artificial nest predation rates. Conservation Biology, 12(2):465-469.

Hermann, H. L., K. J. Babbitt, M. J. Baber, and R. G. Congalton. 2005. Effects of landscape characteristics on amphibian distribution in a forest-dominated landscape. Biological Conservation, 123:139-149.

Knutson, M. G., J. R. Sauer, D. A. Olsen, M. J. Mossman, L. M. Hemesath, and M. J. Lannoo. 1999. Effects of landscape composition and wetland fragmentation on frog and toad abundance and species richness in Iowa and Wisconsin. Conservation Biology, 13(6):1437-1446.

Thompson, F. R., III, T. M. Donovan, R. M. DeGraaf, J. Faaborg, and S. K. Robinson. 2002. A multi-scale perspective of the effects of forest fragmentation on birds in eastern forests. Pages 8-19 in T. L. George and D. S. Dobkin, eds., Effects of habitat fragmentation on birds in western landscapes: contrasts with paradigms from the eastern United States. Studies in Avian Biology, 25.

Trzcinski, M. K., L. Fahrig, and G. Merriam. 1999. Independent effects of forest cover and fragmentation on the distribution of forest breeding birds. Ecological Applications, 9(2):586-593.

Appendix D: Glossary & Index (with links to external information)

This Assessment focuses on the most important issues facing Indiana's forests according to the June 2009 Stakeholder Survey. In an effort to provide additional information on topics that are not addressed in this Assessment or supplement the text, this Glossary & Index is provided with text and relevant links to other statewide plans, documents and organization websites. The information contained in this Appendix has contributed to the creation of this Assessment. These websites were last accessed June 2010.

BMP – Best Management Practices for harvesting timber and preserving soil and water quality.
    Indiana Forestry BMPs
    http://www.in.gov/dnr/forestry/2849.htm

    Wisconsin's Forestry Best Management Practices for Invasive Species
    http://council.wisconsinforestry.org/invasives/forestry.php

Biodiversity
    Indiana Biodiversity Initiative
    http://www.indiana.edu/~spea/faculty/meretsky-vickyj.shtml

    Lepidopteran Use of Native & Alien Ornamental Plants
    http://copland.udel.edu/~dtallamy/host/

    Indiana Comprehensive Wildlife Strategy
    http://www.wildlifeactionplans.org/indiana.html

Community Wildfire Protection Plans
    Community Wildfire Protection Plans are developed to reduce the risk of wildfire. They exist in 2 out of 92 Indiana counties, Lawrence and Perry, and are incorporated here by reference. Communities at risk are encouraged to develop these plans.
    http://www.stateforesters.org/files/cwpphandbook.pdf

Climate Change
    Climate Change and Indiana's Non-Timber Forest Resources
    http://www.indiana.edu/~cree/documents/Climate_change_IN_nontimber_forest_resources.pdf

    Impacts of Climate Change for the State of Indiana
    http://www.purdue.edu/climate/pdf/ClimateImpactsIndiana.pdf

Fragmentation
    US Forest Service - Fragmentation and Land Use Change
    http://www.nrs.fs.fed.us/disturbance/land_use_fragmentation/

    Birds in Forested Landscapes – Cornell Lab of Ornithology
    http://www.birds.cornell.edu/bfl/gen_instructions/fragmentation.html

GIS – Geographic Information System - is any system that captures, stores, analyzes, manages, and presents data that are linked to location.

Indiana Geographic Information Council
http://www.igic.org/

Greening the Crossroads
Central Indiana Land Trust
A Green Infrastructure Vision for Central Indiana
http://www.conservingindiana.org/gi.html

Hoosier National Forest Land Resource Management Plan 2006
http://www.fs.fed.us/r9/hoosier/planningdocs/final_docs/2006_documents.htm

IDNR – Indiana Department of Natural Resources
http://www.in.gov/dnr/

IDNR Division of Forestry Strategic Plan 2008-2013
http://www.in.gov/dnr/forestry/files/fo-Forestry-Strategic-Plan-2008-2013.Final.pdf

Indiana's Natural Heritage –
http://www.naturalheritageofindiana.org/

Indiana Comprehensive Wildlife Strategy –
http://www.in.gov/dnr/fishwild/files/CWS_MANUSCRIPT.pdf

http://www.wildlifeactionplans.org/indiana.html

Indiana State Department of Agriculture – Strategic Plan
http://www.in.gov/isda/2539.htm

Invasive Species –
Indiana Invasive Species Task Force & Invasive Plant Species Assessment Working Group
(IPSAWG) - http://www.in.gov/dnr/3123.htm

Indiana Cooperative Agricultural Pest Survey (CAPS)
http://extension.entm.purdue.edu/CAPS/

Indiana Native Plant and Wildflower Society
http://www.inpaws.org/

Southern Indiana Cooperative Weed Management Area
http://www.fs.fed.us/r9/hoosier/docs/plants/sicwma.htm

Karst – an irregular limestone region with sinkholes, underground streams, and caverns.

Land Use Planning –
Purdue Land use Team

http://www.ces.purdue.edu/anr/landuse/

Planning With Power
http://www.planningwithpower.org/

Local Decision Maker
http://ldm.agriculture.purdue.edu/

NRCS –Natural Resource Conservation Service
Indiana NRCS
http://www.in.nrcs.usda.gov/

Recreation –
Indiana SCORP
http://www.in.gov/dnr/outdoor/files/06scorpintro.pdf

Soil & Water –
Indiana Association of Soil & Water Conservation Districts
http://iaswcd.org/

IDNR – Division of Water
http://www.in.gov/dnr/water/

Indiana Department of Environmental Management
http://www.in.gov/idem/

S&PF – State and Private Forestry, section of United States Forest Service
http://www.fs.fed.us/spf/

Statewide Forest Assessment and Strategy Steering Committee – This is the committee that includes the State Forester that is responsible for compiling, drafting, editing and revising the Statewide Forest Assessment and Strategy with guidance from forest stakeholders.

Statewide Forest Strategy 2010 –
http://www.in.gov/dnr/forestry/5436.htm

TNC Indiana Chapter Strategic Plan of Conservation Activities – July 1, 2007 – June 30, 2012
http://www.nature.org/wherewework/northamerica/states/indiana

Urban Forests –
Statewide Urban Sample Inventory
http://www.state.in.us/dnr/forestry/files/Fo-INUrbanForestBenefits709.pdf
http://www.state.in.us/dnr/forestry/files/Fo-INSpeciesDistributionUrbanTrees709.pdf

Subject: North Central East States Urban Forest Report
http://nrs.fs.fed.us/pubs/34693

Indiana Urban Forest Council

http://www.iufc.org/

IDNR – Community & Urban Forestry
http://www.in.gov/dnr/forestry/2854.htm

USFS – United States Forest Service
http://www.fs.fed.us/

Hoosier National Forest
http://www.fs.fed.us/r9/hoosier/

National Priorities
http://www.fs.fed.us/spf/redesign/redesign-themes.pdf

Wood Products -
Indiana's Hardwood Industry: Its Economic Impact
http://www.in.gov/dnr/forestry/files/fo-IHI_economic-impact.pdf

Premium Indiana Forest Products
http://www.indianawoodisgood.org/

The Sustainability of Indiana's Forest Resources
http://www.in.gov/dnr/forestry/files/fo-SIFR%28lowres%29.pdf

Sustainable Forestry Initiative
http://www.sfiprogram.org/

Forest Stewardship Council
http://www.fsc.org/

Indiana State Department of Agriculture's Strategic Plan
http://www.in.gov/isda/2539.htm

Primary and Secondary Forest Products Industry Directory
http://www.state.in.us/dnr/dnr_forest/index.html

Appendix E: Additional Maps

Lindsey's Presettlement Vegetation Types

This map defines vegetation types that existed at the time of European expansion into Indiana and helps understand historical landscapes. It should be noted that large areas that were previously wetlands have altered hydrology and have mainly been drained using agricultural tile to promote conditions amenable to row crop commodity agricultural production.

**Natural Divisions of Indiana with Presettlement Vegetation Types**

from **Lindsey, Natural Areas in Indiana and Their Preservation**

Natural Divisions
I. Lower Wabash Division
II. Southwestern Lowland Division
III. South-central Oak and Mixed Woods Division
IV. Southeastern Till Plain Beech-Maple Division
V. Tipton Till Plain Beech-Maple Division
VI. Northeastern Moraine and Kettle Division
VII. Northwestern Prairie and Wetlands Division
VIII. Calumet Lake Plain Division

Presettlement Vegetation
- Fagus - Acer
- Fagus - Quercus - Acer - Carya
- Prairie
- Quercus - Carya
- Wetlands
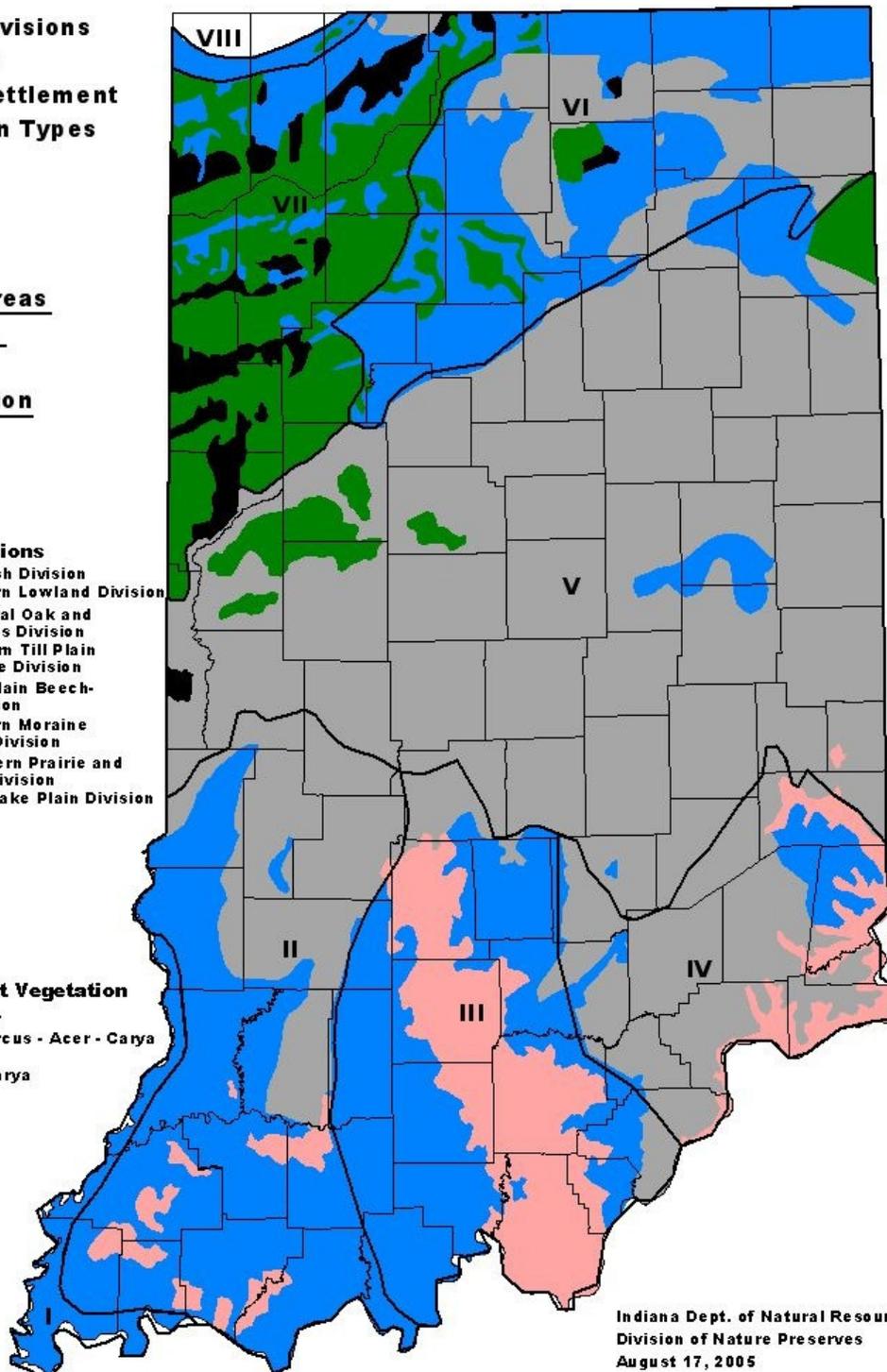
Indiana Dept. of Natural Resources
Division of Nature Preserves
August 17, 2005

Ruffed Grouse Distribution

This information should be considered supplementary to relevant discussions in the Biodiversity section above.

"The distribution of ruffed grouse (*Bonasa umbellus*) in Indiana has historically fluctuated with changing land use. In 1931, ruffed grouse occurred in only 12 counties. Following reforestation, natural range expansion and successful restoration efforts, the grouse distribution expanded to 41 counties in 1983, the widest distribution since 1856. A reassessment of grouse distribution in Indiana was initiated in 2008 using reports of ruffed grouse made during the last 5 years. Compared to the 1983 distribution, it is highly probable that ruffed grouse are now extirpated from 15 counties and likely to exceed 25 counties within a few years if no major forest disturbance occurs. Preliminary data from the Indiana Breeding Bird Atlas (2005-2010) indicate ruffed grouse occurred in less than 1% of the priority blocks surveyed compared to 10% for the same blocks during the 1985-1990 atlas." From *The distribution and status of ruffed grouse in Indiana: 25 years of decline* by Steve Backs and John Castrale, wildlife biologists.
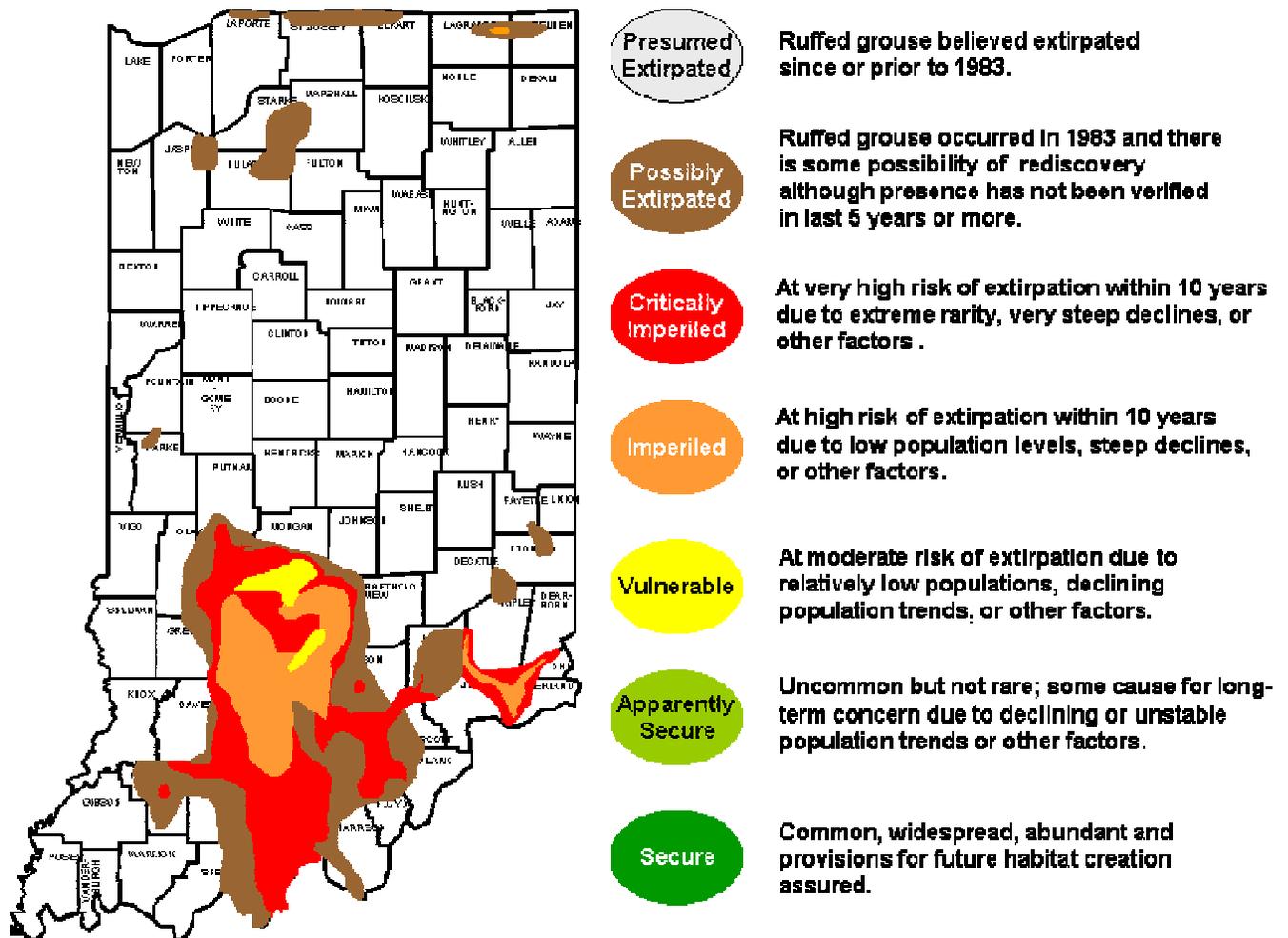
Ecological Subregions of Indiana

Similar to Homoya's Natural Regions used in the above analysis, this map identifies unique ecological regions in the state. It was decided to use Homoya's Natural Regions in the analysis because it offered increased opportunity for information overlap and project specific use in the state. The map below was created by the USFS.

Ecological Subregion Subsections of Indiana

USFS Ecological Subsections
- Bluffton-Ann Arbor Till Plains
- Bluffton Till Plains
- Brown County Hills
- Crawford Escarpment
- Crawford Uplands
- Eastern Grand Prairie
- Entrenched Valleys
- Kalamazoo-Elkhart Moraines and Plains
- Kankakee Marsh
- Kankakee Sands
- Lower Ohio-Cache-Wabash Alluvial Plains
- Lower Wabash Alluvial Plain
- Miami-Scioto Plain-Tipton Till Plain
- Mitchell Karst Plains
- Muscatatuck Flats and Valleys
- Northern Bluegrass
- Northern Dripping Springs
- Outer Western Coalfields
- Scottsburg Lowland
- Southeast Lake Michigan Moraines
- Southeast Lake Michigan Plains and Dunes
- Southern Grand Prairie
- Southwest Indiana Glaciated Lowlands
- Steuben Interlobate Moraines
- Valparaiso Moraine
- Wabash Uplands
- Water
- Western Bluegrass
- Western Knobs
- Western Paleozoic Plateau