Let the Sun Shine In – Indiana
Oak-Hickory Ecosystem Stewardship Strategy for Southern Indiana

Historically, oak-hickory woodlands were common in southern Indiana and supported rich plant and animal communities. Many early-successional and woodland birds of conservation concern such as Red-headed Woodpecker, Prairie Warbler, and Eastern Whip-poor-will call oak-hickory woodlands home. Acorns and hickory nuts are important, nutrient-dense foods for species such as Wild Turkey, white-tailed deer, black bear, and small mammals. Hundreds of species of insects, particularly caterpillars of many moth and butterfly species, are dependent on oaks for survival and reproduction (Tallamy 2021). In fact, oaks support more life forms than any other tree genus in the United States. Additionally, the open-canopy, sunny nature of oak-hickory woodlands enables a structurally and biodiverse ground layer of grasses, forbs, and shrubs to flourish. For all these reasons, oaks are considered keystone species – species critical to an ecosystem's function and persistence.

Today, the oak-hickory ecosystem, and the benefits it provides to people and wildlife, is slowly disappearing. Fire exclusion and a lack of active management are changing the nature of southern Indiana forests, to the detriment of the plant and animal communities they support. Action must be taken to restore and maintain the oak-hickory ecosystem and the benefits it provides to wildlife and people.

Let the Sun Shine In – Indiana

Let The Sun Shine In – Indiana (LSSI) is a collaboration focused on recovering and maintaining oak-hickory ecosystems for the benefit of both wildlife and the people of southern Indiana. This public/private collaboration consists of partners with a mutual interest in healthy, sustainable forests and watersheds and improved wildlife habitat. The partnership educates the public about the benefits of active, science-based forest management, identifies priority areas in need of management, and combines resources to increase regional forest management aimed at restoring oak-hickory ecosystems.

A key component of the LSSI strategy for restoring and maintaining functional oak-hickory ecosystems in southern Indiana is working collaboratively with partners in focus areas called *Forest Stewardship Collaboratives (FSC)*. This document is intended to facilitate and guide management of Let the Sun Shine In - Indiana FSC across southern Indiana.

Ecology and History of Oak Ecosystems

Oak-hickory woodlands, characterized by open canopies (30% to 80% canopy cover), a sparse midstory, and rich plant and animal communities, were maintained for thousands of years by Native American burning and natural disturbance events such as wind and ice storms, tornadoes, and damage caused by massive flocks of Passenger Pigeon. Open canopies allowed sunlight to reach the forest floor, resulting in a rich ground layer of grasses, forbs, and shrubs. Mast produced by oaks and hickories was an invaluable source of wildlife food. These conditions supported innumerable woodland and early-successional plant and animal species.

In general, upland oak species evolved to thrive on harsh sites: dry ridgetops and south- and west-facing slopes that receive many hours of direct sunlight a day. Oaks also have many traits that make them highly tolerant of fire such as thick bark, dense wood, and extensive root systems. Fire helps oak-hickory stands

persist by reducing competition and maintaining an open stand structure that allows sunlight to reach the ground. Oak seedlings require adequate sunlight to recruit into the midstory and, ultimately, the upper forest canopy. Oak seedlings that remain in dark, shaded understories for several years will languish, and ultimately die.

Oak seedlings can repeatedly resprout following top-kill from above-ground disturbance, primarily due to stored energy reserves in their root systems. This trait makes oaks strong competitors in systems where low- to moderate-intensity surface fires occur at high frequencies. Throughout the East, the regular use of fire by Native Americans allowed fire-adapted species such as oaks to flourish prior to European settlement (Abrams 2005; Nowacki and Abrams 2008). This aligns well with descriptions of southern Indiana forests around 1800, which suggests that ridgetops and south- and west-facing slopes were dominated by oak and hickory species (Sieber and Munson 1992). As Europeans began to populate eastern North America, they continued the disturbance regime, sometimes increasing fire frequency, which maintained fire-adapted oak species.

Starting in the 1920s, fire suppression was promoted throughout the region, altering the historic disturbance regime and causing drastic reductions in oak-hickory regeneration (Wagner et al. 2018). This has created a deficit in the number of competitive oak-hickory seedlings needed to maintain oak ecosystems on the landscape, as well as the loss of most of the herbaceous layer. As mature oak and hickory trees die, they are replaced by shade-tolerant and fire-sensitive species such as maple and beech that currently dominate smaller diameter classes in lower canopy positions. As beech and maple mature and move into the upper canopies, their branching and leaf structure do not allow sunlight to penetrate to the forest floor, thus excluding regeneration of shade-intolerant species such as oak and hickory.

Science-Based Forest Management

Forestry is the art and science of managing forests. Silvics, the study of the biology and ecology of trees and forests, is the scientific foundation of forestry. Professional foresters use their knowledge of silvics and practical experience to manage forest establishment, composition, and growth to achieve specific objectives. Major universities and the USDA Forest Service, among other entities, conduct research to advance our knowledge of forest ecology and management.

Landowners seeking to implement science-based forest management should consult a professional forester. Professional foresters continually refresh and improve their skills by attending trainings to remain current on the latest management techniques and best management practices. The first step in forest management is creating a forest management plan (FMP). Management plans can be written for entire forests or individual stands, are based on landowner goals and objectives, take into account the condition of the existing forest, and the soils, aspect, and slope of the site, among other considerations. Based on this, the practices needed to obtain the desired results are determined, and a timeline for implementation is developed. Foresters can also aid in finding financial assistance for practice implementation.

Wildlife

Proper management benefits both forest health and wildlife communities. Recent decades with little-to-no active management have resulted in many Indiana woodlands shifting to closed-canopy forests. In the absence of sufficient sunlight, forest floors no longer support a rich, biodiverse layer of grasses, forbs, and shrubs needed for wildlife cover and food. None of Indiana's estimated 260 terrestrial vertebrate wildlife species are currently known to require old growth (130 + year old) forest conditions. Conversely, nearly 70% of Indiana's terrestrial vertebrate wildlife species require forests less than 40 years old for at least part of their

habitat requirements (Managing Forest & Wildlife Resources: An Integrated Approach, Purdue University Cooperative Extension Service and US Fish and Wildlife Service, FNR-125-W).

Diverse plant communities support vibrant wildlife communities. Various regeneration techniques and intermediate practices such as forest stand improvement and prescribed fire may be used to open and maintain the forest canopy to encourage herbaceous plant and shrub growth. A primary objective when managing forests for wildlife is creating a diverse forest landscape interspersed with young and mature forest stands with varying species composition and structure. Interspersing young and mature stands, and using different management techniques across the landscape ensures a wide variety of habitats are available to support a diverse wildlife community.

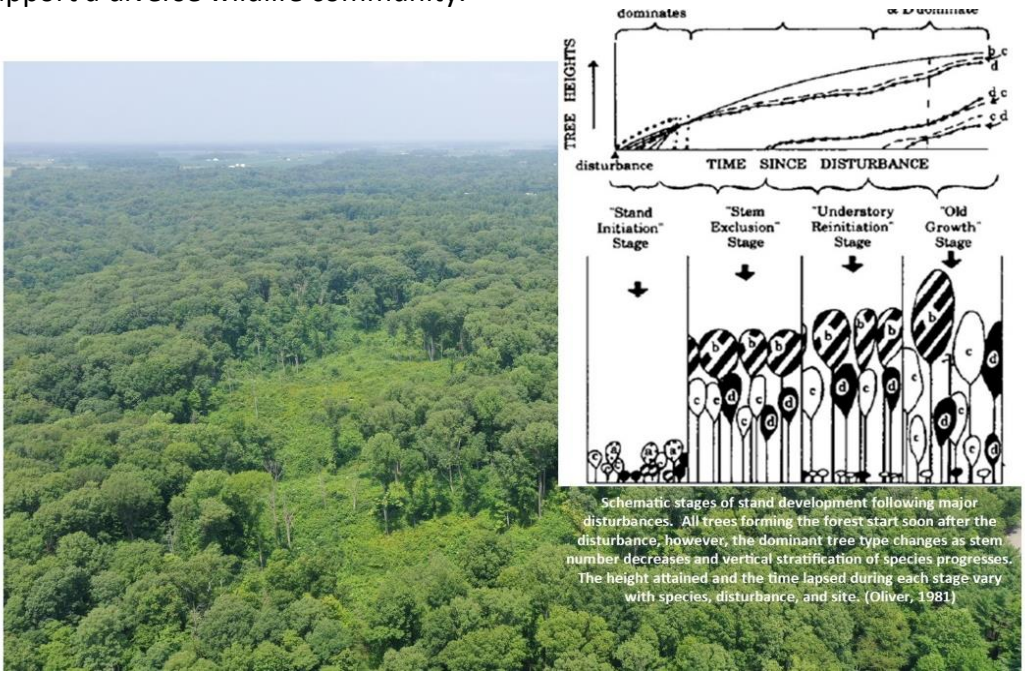


Figure 1: The use of a variety of management practices, such as this regeneration opening within a mature closed-canopy forest, creates a mosaic of diverse habitats across the landscape as forest stands develop. (Drone photo credit: Jarred M. Brooke, Purdue Extension Service)

Forest fragmentation is another major threat facing wildlife. Fragmentation creates barriers to movement and dispersal for many wildlife species and increases the risk of predation for many interior and area-sensitive bird species. The lack of continuity between forested tracts across FSCs restricts the abundance and diversity of wildlife. A proven strategy for creating larger blocks of contiguous habitats is utilizing existing large forested tracts such as National Forests as anchor areas and restoring and managing private lands around them. When adjacent public and private forests utilize similar science-based management it creates a larger, continuous forested landscape, increasing habitat for wildlife.

The Indiana Department of Natural Resources maintains the Natural Heritage Database, designed to inventory and track Indiana's natural ecosystems, plant and animal species, and landscape features. This database includes a list of known occurrences of rare, threatened, or endangered species, sortable by county. https://www.in.gov/dnr/nature-preserves/heritage-data-center/endangered-plant-and-animal-species/county/.

Non-Native Invasive Species

Non-native invasive plants are increasingly common, and disrupt the ecology of forests. They also complicate our ability to manage forests. These species compete for sunlight and water and displace native species. The

most common terrestrial invasive plant species affecting our forests are tree-of heaven, Japanese barberry, autumn olive, Japanese stiltgrass, Asian bush honeysuckle, Japanese (vine) honeysuckle, blunt-leaved privet, multiflora rose, oriental bittersweet, wintercreeper, and garlic mustard. Treating invasive species is a priority on private and public lands.

Climate Change

Climate change will impact southern Indiana forests and ecosystems. Winters in southern Indiana are anticipated to become warmer and wetter, whereas summers will be hotter and drier. Rainfall patterns will be erratic, with increased extreme precipitation events and summer droughts (Phillips et al., 2018). It is important that Indiana forests are resilient to these changes, particularly the increasingly hot and dry growing seasons. Thick bark, dense wood, and extensive root systems make most oaks well-suited to hot and dry growing conditions. However, Indiana's drought-resistant oak and hickory species are being replaced by more mesic, drought-intolerant species such as yellow-poplar and sugar maple. This developing mismatch of future climate and vegetation is a long-term problem. Repeated years of summer drought could impact the growth and survival of drought-intolerant, mesic species, and therefore the viability of forests. The greater resilience of the oak-hickory ecosystem to a changing climate is yet another reason to restore and maintain oak and hickory on appropriate sites.

Objectives for Oak-Hickory Ecosystems

The goal of LSSI Indiana is a fully functioning oak-hickory ecosystem, consisting of a landscape with oak woodlands of various stand sizes, diameters, and age classes spread across southern Indiana on ecologically-appropriate sites. The forest overstory, midstory, and understory should be populated with a diverse mixture of oak, hickory, and associated species, with a biodiverse understory of grasses, forbs, and shrubs. This will provide habitat for declining birds and other wildlife and maintain the ecological integrity of the land. This diverse and varied oak-hickory ecosystem should be managed and maintained on both public and private lands. Prescribed fire, forest stand improvement, and adaptive silviculture will be utilized to maintain these conditions. All treatments will be science-based and follow best management practices. Public outreach and education will better inform the public about the value of oak-hickory ecosystems and the management necessary to maintain them.

Forest Stewardship Collaboratives

Conserving fully functional oak-hickory ecosystems requires partners working together to manage large, intact blocks of forest and woodland. No single landowner, public or private, can accomplish this goal on their own; it will take the collaboration of public, private, and non-governmental organization (NGO) landowners to make a true large-scale, long-term difference. Furthermore, the LSSI Indiana partnership does not have sufficient resources to effectively address the decline of oak-hickory woodlands across the entirety of southern Indiana. Therefore, 13 Forest Stewardship Collaboratives (FSC; Figure 2) were designated in which voluntary, cross-boundary, landscape-scale collaborative management efforts will take place.

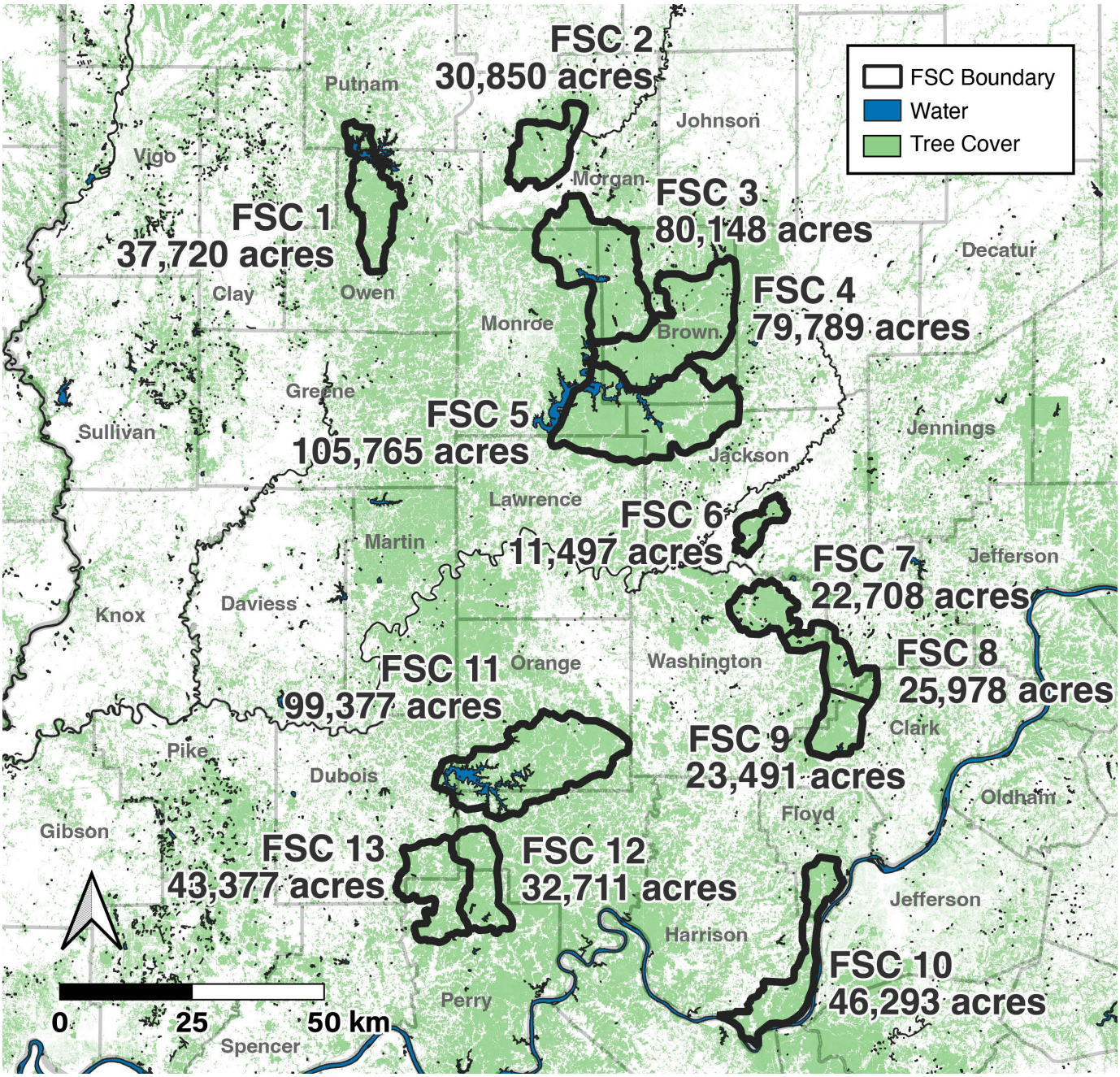


Figure 2: Locations of the thirteen Forest Stewardship Collaboratives across Southern Indiana

These areas were determined based on a number of ecological and social factors: high levels of forest, large public forest landholdings, NGO landholdings, natural landcover type (areas historically consisting of oak-hickory), current forest condition, low levels of forest fragmentation, proximity to urban populations, and areas with strong populations of Central Hardwoods Joint Venture (CHJV) priority bird species such as Wood Thrush, Worm-eating Warbler, and Prairie Warbler. Large blocks of public forest will serve as core areas for the FSC. These core areas are anchors upon which to expand and build landscape-scale forest tracts with similar management strategies. Large intact blocks of oak-hickory woodlands will be created by implementing oak-hickory management on public, NGO, and private forest lands. All actions taken on private lands will be voluntary. Restoring large blocks of oak-hickory ecosystem will improve plant and wildlife diversity across southern Indiana. By managing across boundaries, collectively we can impact enough land to make a difference. Currently, the LSSI program is focusing on a subset of four FSC.

Forest Stewardship Collaborative 1

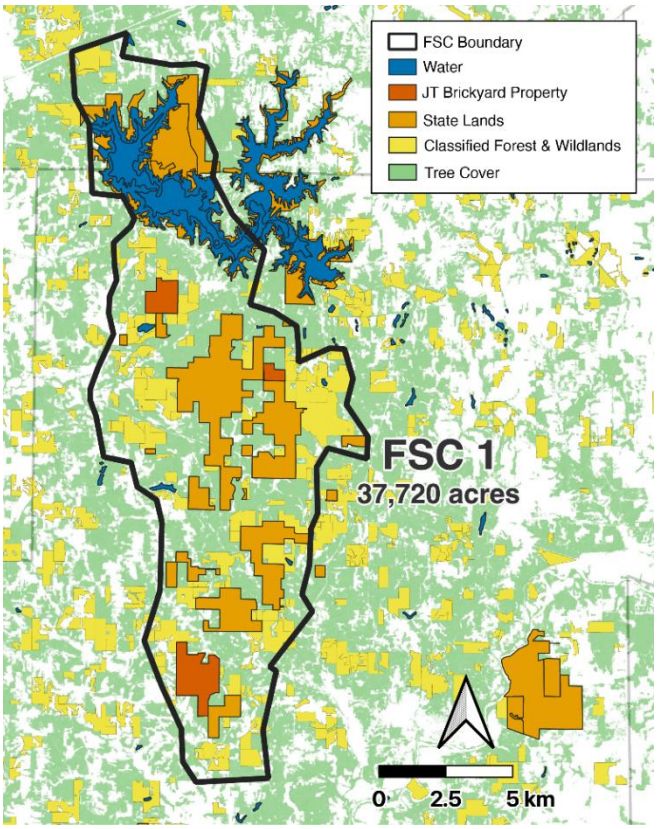


Figure 3. Forest Stewardship Collaborative 1; portions of Putnam and Owen Counties.

Site Characteristics

Soils, Topography, Hydrology

FSC 1 is in the Shawnee Hills Natural Region, Crawford Upland Section (Figure 3; Natural Region Map found in Appendix 2). It is characterized by rugged hills with sandstone cliffs. Characteristic soils are well-drained acidic silt loams of the Wellston-Zanesville-Berks Association. The upper slopes consist of an oak-hickory assortment, with a more mesic component in the coves. The barrens community is a minor component of this area, and only a few high-quality remnants remain (Homoya, Abrell, Aldrich, Post, 1985). In general, a barren is an area with shallow soil and harsh, dry growing conditions. These areas are typically covered with sedges, grasses, and other short-statured, herbaceous species. The topography of FSC 1 varies from nearly-level ground on the ridge tops to moderate slopes.

Historic Cover

Historic vegetation patterns of Indiana State Forests were summarized from the General Land Office (GLO) Survey notes by Hannah Ryker and AJ Ariens in 2018. They noted that between 1811 to 1820, when the Putnam and Owen County townships were surveyed, the distribution of beech and maple trees in Owen-Putnam State Forest suggested a more mesic landscape, supporting shade tolerant species. Oaks and hickories thrived on the upper slopes and ridge tops (Ryker and Ariens, 2018). FSC 1 is unique among the FSC, in that evidence indicates it historically contained a high percentage of mesic forest. LSSI management efforts will be targeted towards oak-hickory sites. Sites that historically supported mesic species will be managed accordingly.

A comparison of species noted in the GLO records, collected between 1804 and 1849, and species noted in Division of Forestry Continuing Forest Inventory (CFI) plots can be used to show changes in state forest composition over the previous 200 years (Ryker and Ariens, 2018). The CFI is an inventory of State Forest properties based on a sample of 3,867 plots located randomly across state forests, providing a sampling rate of one plot every 40 acres (Gallion, 2015). When comparing species noted in the GLO records from 1811 – 1820 to species noted in the CFI plots collected between 2010 – 2014 on Owen-Putnam State Forest, a 6% decline in oak-hickory is seen over the past 200 years. The northern state forests (IDNR Division of Forestry map, Appendix 3) differ from the forests found farther south in Indiana; they also show a decline in the populations of beech and maple. These species were likely replaced by other dominant species after crop fields were abandoned, and forest stands developed over time. GLO records noted a single barren on the northern end of the State Forest property, and several areas of fallen timber, with one patch covering an area

nearly one-half mile long, indicating a major windstorm or tornado struck the area shortly before the survey (Ryker and Ariens, 2018).

Current Land Cover

FSC 1 contains 31,414 acres of forest (Table 1). Remaining lands are used for agriculture, or are developed, naturally open, or water.

Table 1: Area of land cover types in Forest Stewardship Collaborative 1.
Land cover type legend and descriptions are found in Appendix 1. Data obtained by Southern Indiana Sentinel Landscape from the 2021 National Land Cover Database. Note that the total acreage in Table 1 does not match the acreage in Figure 2, above; both totals were obtained using GIS mapping tools which contains a margin of error.

Land Cover Type	Acres
Barren Land (Unknown use)	63
Cultivated Crops	615
Deciduous Forest	29,350
Developed	2,194
Developed, Low Intensity	257
Evergreen Forest	198
Hay/Pasture	644
Herbaceous	952
Mixed Forest	1,866
Open Water	1,543
Shrub/Scrub	71
Woody Wetlands	86
Total	37,634

Forest Ownership

In FSC 1, 26% of forest land is privately owned and enrolled in the IDNR Classified Forest and Wildlands Program (Classified Forest; Table 2) By enrolling land as a Classified Forest, landowners receive tax benefits and forest management assistance from IDNR Division of Forestry. Periodic contact with a District Forester encourages landowners to actively manage their forests. Managed public forest land accounts for 21% of this FSC. IDNR State Forests and private lands enrolled in the Classified Forest Program are required to have a written Forest Management Plan (FMP). Overall, this means 47% of FSC 1 has a written FMP. Private forest lands not enrolled in the Classified Forest Program, 38% of the forest land in FSC 1, in addition to 15% of publicly owned forest land possibly do not have written FMPs, and therefore have unknown levels of management.

Table 2: Forest ownership in Forest Stewardship Collaborative 1.
Calculated from data obtained by Southern Indiana Sentinel Landscape from the Indiana Department of Natural Resources Division of Forestry through a public records request and from the 2021 National Land Cover Database.

Land ownership type	Acres
Private Forestland	
Classified Forest (enrolled)	8,138
Other (not enrolled)	12,186
Total private	**20,324**
Public Forestland	
Federal/US Army Corps of Engineers	3,927
Indiana DNR Forestry	6,718
Indiana DNR Nature Preserves	28
Indiana DNR State Parks	728
Total public	**11,401**
Total Forest Land	**31,725**

Publicly-owned lands in FSC 1 include Lieber and Cataract Falls State Recreation Areas and Owen Putnam State Forest. Some management occurs on State Recreation Areas, but does not specifically target improving forest stands. State Forest property is managed for multiple uses, with oak-hickory ecosystem restoration and management being a top priority. JT Brickyard Timberland, LLC, also owns property in FSC 1 and implements oak-hickory management. All JT Brickyard Timberland property is enrolled in the Classified Forest and Wildlands Program, and is certified under the Sustainable Forestry Initiative (SFI). To qualify for SFI certification, forests must meet rigorous standards for wildlife and water conservation and practice climate-smart forestry.

Management Strategies Specific to FSC 1

- Owen Putnam State Forest and land owned and/or managed by JT Brickyard Timberland, LLC will serve as core areas around which to build additional oak-hickory woodland.
- Targeted outreach will be conducted to private landowners surrounding core areas. Specific landowners and areas for targeted outreach will be determined in partnership with IDNR District Foresters and private consulting foresters. Landowners will be informed about the LSSI program and will be invited to manage and/or restore land appropriate for oak-hickory ecosystem restoration. Classified Forest landowners (22% of the total area) will be the primary audience, with non-enrolled landowners (32% of the total area) the secondary audience. Interested landowners will be provided with technical assistance and options for financial assistance.
- FSC 1 is located in the project area of the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)/Forest Service (USFS) Joint Chiefs Program *Ready-Set-Fire in White Oak Woodlands* project. The Joint Chiefs Program is a collaborative effort between NRCS and USFS that aims to work with private, state, and Tribal landowners to conserve forest and agricultural lands alongside federally-managed lands. The project will fund prescribed fire along with numerous forest management practices in an effort to improve habitat for at-risk species and reduce wildfire risk. Landowners interested in forest conservation and management on their land should reach out to their local USDA Service Center for information and to submit applications for funding. LSSI staff will provide written information about funding availability to landowners in FSC 1.
- Additional strategies applicable to all FSCs are detailed below.

Forest Stewardship Collaboratives 3,4,5

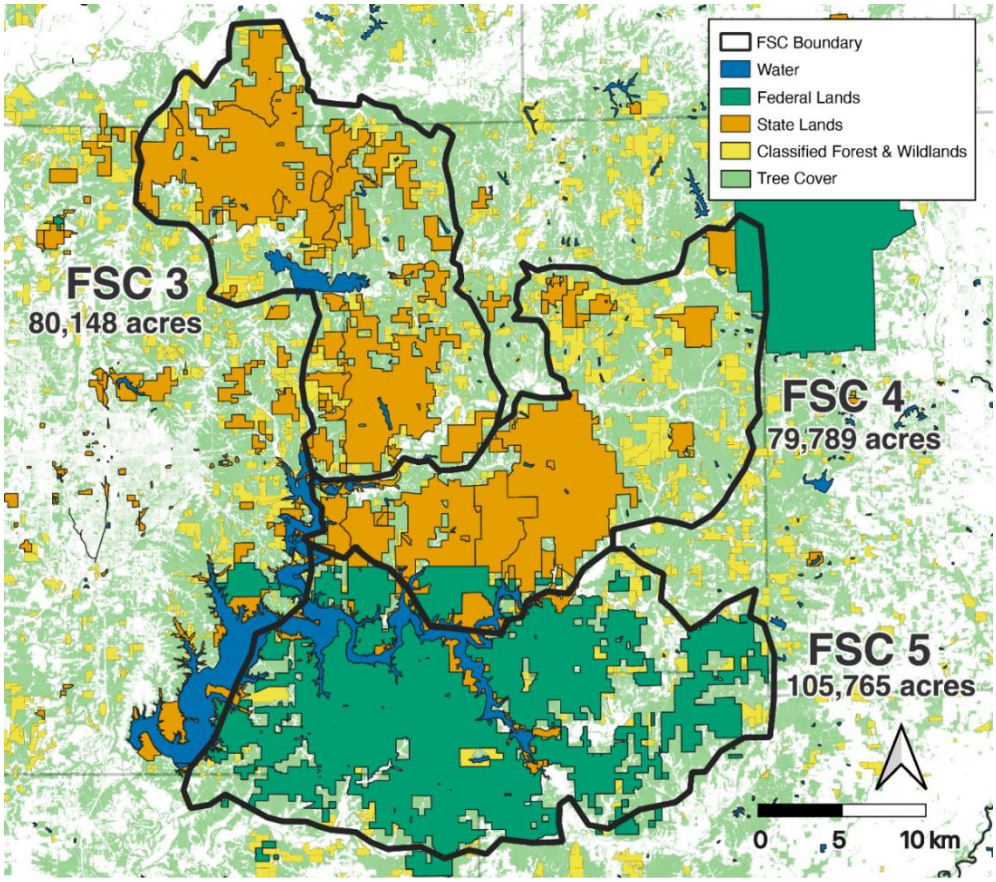


Figure 4. Forest Stewardship Collaboratives 3,4,5; portions of Morgan, Monroe, Brown, Lawrence, and Jackson Counties.

Site Characteristics

Soils, Topography, Hydrology

FSCs 3,4, and 5 are located in the Brown County Hills section of the Highland Rim Natural Region, and have deeply dissected uplands underlain by siltstone, shale, and sandstone (Figure 4). The soils are typically well-drained silt loams, of the Berks-Gilpin-Weikert Association, with bedrock near the surface. The natural communities are uniform in composition with uplands dominated by oak-hickory, and ravines dominated by mesic species. Typically, the upper slopes are populated by chestnut oak, greenbrier, low-growing shrubs, and many species of sedges. Yellowwood trees are found in a small area of the Brown County Hills within Brown County State Park and Yellowwood State Forest (Homoya, Abrell, Aldrich, Post, 1985). Currently, no naturally-occurring yellowwood trees are documented on private lands.

This area of Indiana is scenic, with many State parks, State Forests, and the northernmost part of the Hoosier National Forest. Narrow ridges, steep slopes, and narrow, V-shaped valleys are typical of this region (Sieber and Munson, 1992). Morgan-Monroe and Yellowwood State Forests are in FSC 3, and Brown County State Park and portions of the Hoosier National Forest are in FSC 4. The bulk of the Hoosier National Forest, including the Charles C. Deam Wilderness, is located in FSC 5, along with USDA Hardin Ridge Recreation Area, and Allen's Creek, Cutright, and Pine Grove State Recreation Areas, all of which surround Lake Monroe, a 10,750-acre lake constructed between 1960 and 1965, managed by the US Army Corps of Engineers. Lake Monroe serves as the drinking water supply for the City of Bloomington, located to the northwest of the lake. The lake and the public land surrounding it are heavily used for recreation.

The land owned and managed by the USDA Forest Service in the Brown County Hills Section, FSC 4 and 5, has been broken down into landtype associations, ecological landtypes, and ecological landtype phases to help guide management decisions on individual sites within the Hoosier National Forest.

Landtype associations (LTAs) are typically identified at the landscape scale and are defined by general topography, geology, soils, potential natural community patterns, and local climate. FSC 4 contains the Mixed Oak Dry-Mesic Upland Hills LTA, covering 100% of the area owned by the Forest Service. FSC 5 contains four LTAs: Chestnut Oak Dry-Mesic Upland Hills, covering 44.6% of the Forest Service area; Mixed Oak Dry-Mesic Upland Hills, covering 0.15%; Oak-Maple Calcareous Upland Hills, covering 35.1%; and Oak-Maple Mesic Upland Plateau, covering 20.1%. Landtype associations are further broken down into Ecological Landtype Phases (ELTP) to identify areas with similar management potential (Table 3).

Table 3: Ecological Landtype Phases on USDA Forest Service Land in FSC 4 and 5.

Ecological Landtype Phase	Acres	Percentage
Acer Saccharinum/Boehmeria, Bottomlands	5,126	5.0
Acer Saccharium/Asarum-Boehmeria, Bottomlands	7,262	7.1
Fagus-Acer Saccharum/Arisaema, Mesic Bottomlands	2,532	2.5
Fagus-Acer Saccharum/Arisaema, Mesic Ridges	1,147	1.1
Platanus/Asarum, Wet-Mesic Bottomlands	5,155	5.0
Quercus Alba-Quercus Prinus/Smilax-Vaccinium, Dry Slopes	27,537	26.9
Quercus Alba/Vaccinium, Dry Ridges	232	0.2
Quercus Alba/ Acer Saccharum/Parthenocissus, Dry Mesic Ridges	15,251	14.9
Quercus Alba-Acer Saccharum/Parthenocissus, Dry Mesic Slopes	1,436	1.4
Quercus Alba-Prinus/Carex Picta-Vassinium, Dry Slopes	29,553	28.9
Quercus Alba-Prinus/Vaccinium, Dry Ridges	3,318	3.2
Water	3,730	3.6
Total	**102,279**	**100**

Vegetation in all LTAs is dominated by oak species on the uplands. White oak is often common in the overstory, with red maple and sassafras common understory associates. Greenbrier, blueberry, and sedges often dominate the ground layer. Mesic sites are dominated by sugar maple, American beech, and northern red oak in the overstory. White ash was once a common overstory associate on mesic sites, but healthy trees are now rare due to mortality from emerald ash borer. Mapleleaf viburnum, spicebush, jack-in-the-pulpit, and panicgrass are common in the ground layer on mesic sites.

Ecological Landtype Phases can be utilized to help determine silvicultural treatment options and as a guide to predict and understand expected vegetative responses to silvicultural treatments. Prior to any management, the modeled ELTs and ELTPs are verified by on-the-ground field visits and analysis of forest inventory data. Refer to McNab and Avers (1994) for descriptions of broad scale ecological units and Zhalnin and Parker (2005) for descriptions of finer-scale ecological units on the Hoosier National Forest.

Historic Cover

Early 1800's General Land Office (GLO) survey records of the area that is now Yellowwood and Morgan-Monroe State Forests in FSC 3 show that oak and hickory species dominated the southeastern area, while beech and maple were more prevalent to the northwest, along the White River valley. The central area was a mesophytic forest, with a mix of species including basswood, beech, red elm, sugar maple, red oak, white oak, yellow poplar, and walnut in the canopy. The Yellowwood/Morgan-Monroe complex had a higher percentage of sassafras than the other state properties surveyed, which suggests the area had been subjected to fires but had time to reforest with pioneer species before the land survey was conducted (Ryker and Ariens, 2018).

Lindsey et al. (1965) used original GLO land-survey records and modern soil maps to reconstruct the distribution of pre-European settlement vegetation across Indiana. Their analysis showed that the oak-hickory cover type was dominant across much of the unglaciated portions of southern Indiana, including FSC 4 and 5.

FSC 3,4, and 5 are located in the Central Hardwoods Region, USA (Hanberry et al., 2017). The Central Hardwoods region contains over 100 native tree species and a wide range of environmental conditions, with oak and hickory being the most common (Palik and D'Amato, 2024).

Each State Forest property has a comparison of species noted in the GLO records, collected between 1804 and 1849, and species noted in Division of Forestry CFI plots that can be used to show changes in state forest composition over the previous 200 years. When comparing the GLO species records with the CFI plot data taken in Yellowwood and Morgan-Monroe State Forests between 2010 and 2014, there was a 25% decline in oak-hickory species, and a 11% increase in beech-maple over a 200-year period (Ryker and Ariens, 2018).

Current Land Cover

FSC 3, 4, and 5 is 87% forested (232,162 acres; Table 4). Remaining lands are used for agriculture, or are developed, naturally open, or water.

Table 4: Area of land cover types in Forest Stewardship Collaboratives 3, 4, and 5.
Land cover type legend and descriptions are found in Appendix 1. Data obtained by Southern Indiana Sentinel Landscape from the 2021 National Land Cover Database.

Land Cover Type	Acres
Barren Land (Unknown Use)	119
Cultivated Crops	5,384
Deciduous Forest	218,315
Developed	11,359
Emergent Herbaceous Wetlands	422
Evergreen Forest	2,165
Hay/Pasture	8,035
Herbaceous	1,371
Mixed Forest	11,682
Open Water	5,974
Shrub/Scrub	220
Woody Wetlands	703
Total	**265,749**

Forest Ownership

In FSCs 3, 4, and 5, 11% of forested land is enrolled in the Classified Forest Program (Table 5). By enrolling land, owners receive tax benefits and forest management planning and assistance from IDNR Division of Forestry. Periodic contact with a District Forester encourages landowners to actively manage their forest. Land managed by the IDNR Division of Forestry or USDA Forest Service (47%), and private lands enrolled in the Classified Forest Program are required to have a written FMP. With land owned by NGOs, also with FMPs included, 59% of FSCs 3, 4, and 5 has a written FMP. Private lands not enrolled in the Classified Forest Program and some of the publicly held forest land possibly do not have written FMPs. Therefore, an estimated 41% of the FSCs have unknown levels of forest management.

Table 5: Ownership of forested land cover in Forest Stewardship Collaboratives 3, 4, and 5.
Calculated from data obtained by Southern Indiana Sentinel Landscape from the Indiana Department of Natural Resources Division of Forestry, through a public records request and from the 2021 National Land Cover Database.

Land ownership type	Acres
Private Forestland	
Classified Forest (enrolled)	25,974
Other (not enrolled)	64,910
Non-Governmental Agency/Land Trust	2,136
Total private	**93,020**
Public Forestland	
Federal/US Army Corps of Engineers	12,018
Federal/USDA Forest Service	63,400
Indiana DNR Forestry	45,436
Indiana Museums & Historic Places	193
Indiana DNR Nature Preserves	1,226
Indiana DNR State Parks	16,324
Indiana University	543
Total public	**139,140**
Total Forest Land	**232,160**

Publicly-owned land in FSCs 3, 4, and 5 includes that owned by IDNR Division of Forestry, USDA Forest Service, and The Nature Conservancy (TNC), all of whom actively manage their properties to maintain the oak-hickory ecosystem (Table 4). Generally speaking, land owned by the Army Corps of Engineers is leased to the IDNR Division of State Parks or Reservoirs. State Parks and Reservoir properties receive limited forest management, and that management is not specifically for the enhancement of forest cover. IDNR Nature Preserve lands may fall within the boundaries of a State Forest or State Park. However, their management is independent to ensure protection of the resource concern that led to the nature preserve designation.

FSC 3 has two State Forests to serve as core areas, in addition to land owned by the Sycamore Land Trust. Privately held classified forests and non-classified forests surround the State Forests. The State Forest and NGO land can serve as anchor areas, and outreach will be targeted to surrounding Classified Forest owners to encourage them to implement oak-hickory management, creating a larger cross-boundary oak-hickory ecosystem across this FSC.

FSC 4 has a large block of land in Brown County State Park with limited forest management opportunities. A nature preserve located within the boundary of Brown County State Park is managed with prescribed fire. Yellowwood State Forest's ecosystems are managed according to the Division of Forestry's approved

management strategies. FSC 4 has a sizable amount of land in classification as well as land owned and managed by TNC, some of which serves as a LSSI Indiana demonstration area. Classified Forest owners located near the core area of Yellowwood State Forest and TNC properties will be encouraged to implement complementary oak-hickory ecosystem management strategies.

In FSC 5, 57% of the land is owned and managed by the USDA Forest Service. Some of this land is classified as wilderness, so active forest management is prohibited. Federal legislation was introduced in 2024 to expand the wilderness area. If reintroduced and passed in the future, this will further reduce the opportunity for active forest management. Furthermore, litigation has hampered implementation of large-scale forest management projects on the Hoosier National Forest. Nature Conservancy has landholdings in FSC 5, and there are limited amounts of private land in the classified forest program.

Management Strategies Specific to FSC 3,4,5

- Morgan-Monroe and Yellowwood State Forests, the Hoosier National Forest, and land owned/managed by The Nature Conservancy and Sycamore Land Trust will serve as core areas around which to build large blocks of restored and managed oak-hickory woodland.
- Targeted outreach will be conducted for private landowners surrounding core areas. Specific landowners and areas for targeted outreach will be determined in partnership with IDNR District Foresters and private consulting foresters. Landowners will be informed about the LSSI program and will be invited to manage and/or restore land appropriate for oak-hickory ecosystem restoration. Classified Forest landowners (11% of total area) will be the primary audience, with non-enrolled landowners (28%), a secondary audience. Interested landowners will be provided with technical assistance and options for financial assistance.
- TNC demonstration areas will be utilized for field days and tours.
- Visitors will be invited to utilize the Forest Management Trail at Yellowwood State Forest.
- FSC 3, 4, and 5 are located in the Indiana project area of the USDA NRCS/USFS Joint Chiefs program. The *Ready-Set-Fire in White Oak Woodlands* project is a collaborative effort between NRCS and USFS that aims to work with private, state, and Tribal landowners to conserve forest and agricultural lands alongside federally-managed lands. The project will fund prescribed fire along with numerous forest management practices in an effort to improve habitat for at-risk species and reduce wildfire risk. Landowners from these counties that are interested in forest conservation and management on their land should reach out to their local USDA Service Center for more information and to submit applications for funding. LSSI staff will provide written information about funding availability to landowners in FSC 1.
- FSC 3, 4, and 5 are located in the project area of the Lake Monroe Water Fund USFS Landscape Scale Restoration Grant. This project targets land in the watershed around Lake Monroe for invasive species control, and education and outreach efforts about the importance of protecting water quality in the lake. Interested landowners should contact the Lake Monroe Water Fund for more information (https://www.lakemonroewaterfund.org; info@lakemonroewaterfund.org).
- FSC 3, 4, and 5 are located within the Southern Indiana Sentinel Landscape (SISL). Sentinel Landscapes are areas where conservation, working lands, and national defense interests converge. SISL's NRCS Regional Conservation Partnership Program (RCPP) funds forest restoration focused on oak-hickory ecosystems, forest easements, and agricultural conservation. Interested landowners from these counties should reach out to their local USDA Service Center for more information and to submit applications for funding.
- Additional strategies applicable for all FSCs detailed below.

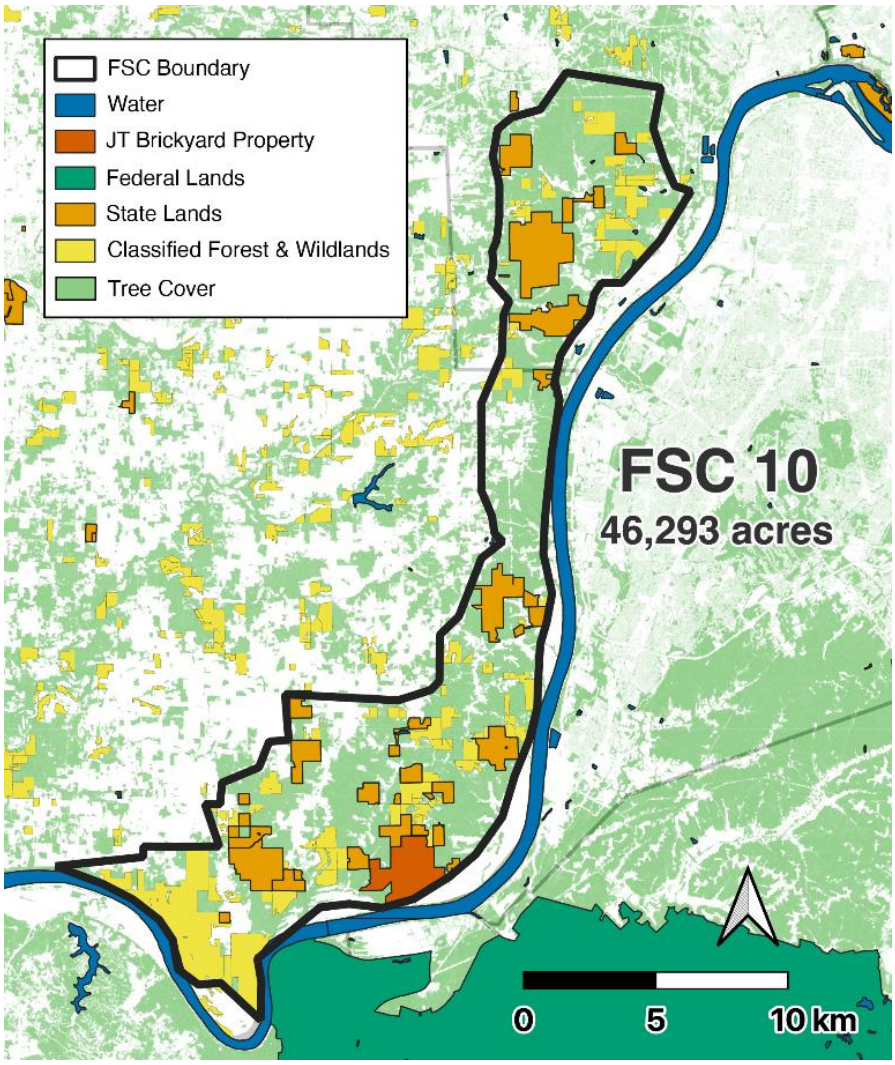


Figure 5. Forest Stewardship Collaborative 10; portions of Floyd and Harrison Counties.

Site Characteristics

Soils, Topography, Hydrology

FSC 10 is located in southeast Indiana along the Ohio River, in the Highland Rim Natural Region (Figure 5). The southern portion of FSC 10 is unglaciated. Karst topography is found throughout the region, along with cliffs and rugged hills. Much of the area was forested in pre-European settlement times, with large areas of barrens, and smaller areas of glades. The Highland Rim region is divided into three sections, and FSC 10 straddles two; the Mitchell Karst Plain and the Knobstone Escarpment Sections.

The northern half of FSC 10 is in the Knobstone Escarpment Section. This section has deeply dissected uplands underlain by siltstone, shale, and sandstone that appear as "knobs" on the landscape. The knobs are the most significant series of hills in Indiana, with the highest knobs near the Ohio River towering 610 feet over the surrounding valley. The soils are well-drained acid silt loams, with minor amounts of loess.

Bedrock is near the surface but rarely crops out. This section is noted for wide differences in forest community composition: plant species are found here that are not otherwise found in Indiana. Virginia pine was co-dominant with American chestnut at the time of European settlement, according to GLO Survey records. Today, Virginia pine is co-dominant with chestnut oak. Glades are present on south-facing slopes; these areas feature an unstable substrate, thin soils, and hot and dry conditions where trees cannot thrive, but support herbaceous plants that are normally found on prairie sites. Scattered clumps of little bluestem, bird-foot violet, and St. Andrew's cross can be found in the glades. Xeric (dry) forests of blackjack oak, chestnut oak, and scarlet oak border the glades.

The Mitchell Karst Plain forms the southern half of FSC 10. The terrain features limestone cliffs and rugged hills. The soils are silty loams derived from loess and weathered limestone. Acid, cherty Baxter silt loam is found, which correlates with the barrens community, and Corydon stony silt loam correlates with the limestone glade and cliff community. Species found in the prairie-like barrens include Indian grass, big bluestem, little bluestem, rattlesnake master, and prairie dock, among many others. The upland hills and cliffs are forested, featuring western mesophytic type species, including white oak, sugar maple, shagbark hickory,

and pignut hickory. Near the glades, xeric forest species such as post oak, chinkapin oak, and blue ash are found (Homoya, Abrell, Aldrich, Post, 1985).

Lindsey et al. (1965) used original GLO land-survey records and modern soil maps to reconstruct the distribution of pre-European settlement vegetation in Indiana. Their analysis showed that the oak-hickory cover type was dominant across much of the unglaciated portions of southern Indiana, including the southern portion of FSC 10. This FSC is located in the Central Hardwoods Region (Hanberry et al., 2017). The Central Hardwoods region contains a wide range of environmental conditions and over 100 native tree species. Oak and hickory are the most common, and the forest type is broadly classified as oak-hickory (Palik and D'Amato, 2024).

Harrison-Crawford State Forest is located to the west of FSC 10. The GLO survey notes places on the State Forest where the trees had been destroyed by fire. When the State Forest was surveyed between 1805 and 1806, oak dominated the landscape, with a diverse mix of other species present, i.e., ash, cedar, dogwood, and elm. The report notes that those portions of the study area that reside in the Crawford Highlands and the Escarpment Section near the Ohio River contained a mix of beech, maple, oak, and hickory, and could be considered a mixed-mesophytic forest. When comparing the GLO survey data collected on state forests between 1804 and 1849 with CFI plot data collected on Harrison-Crawford State Forest between 2010 and 2014, there was a 40% loss in oak/hickory species, and a 21% increase in beech/maple, over the 200-year period (Ryker and Ariens, 2018).

Current Land Cover

Forest comprises 80% of FSC 10 (36,917 acres, Table 6). Remaining lands are used for agriculture, or are developed, naturally open, or water.

Table 6: Breakdown of Land Types in FSC 10.
Land cover type legend and descriptions are found in Appendix 1. Data obtained by Southern Indiana Sentinel Landscape from the 2021 National Land Cover Database.

Land Cover Type	Acres
Barren Land (Unknown Use)	6
Cultivated Crops	2,101
Deciduous Forest	34,330
Developed	2,108
Emergent Herbaceous Wetlands	20
Evergreen Forest	583
Hay/Pasture	4,212
Herbaceous	217
Mixed Forest	2,004
Open Water	179
Shrub/Scrub	96
Woody Wetlands	380
Total	**46,237**

Forest Ownership

In FSC 10, 33% of land is enrolled in the Classified Forest and Wildlands Program (Table 7). By enrolling land in classification, landowners receive tax benefits and forest management assistance from IDNR Division of Forestry. Periodic contact with a District Forester encourages landowners to actively manage their forest.

Private lands enrolled in the Classified Forest Program are required to have a written FMP. Combining Classified Forests and TNC land, which utilizes written management plans, indicates that 43% of FSC 10 has a written FMP. Private land not enrolled in the Classified Forest Program (49%) and some of the other forest land (8%) possibly does not have written FMPs. Therefore, an estimated 57% of the FSCs has unknown levels of forest management.

Table 7: Breakdown of Land by Ownership.
Data calculated from GIS data obtained by Southern Indiana Sentinel Landscape from Indiana Department of Natural Resources Division of Forestry through a public records request, and from the 2021 National Land Cover Database.

Land Ownership Type	Acres
Private Forest Land	
Classified Forest	12,212
Other (not enrolled)	18,040
RDI Caesars, Inc.	107
The Nature Conservancy	3,545
Total private	**33,904**
Public Forest Land	
Harrison County Park Board	145
Newalb-Floyd Park Board	123
Indiana DNR Nature Preserves	2,744
Total public	**3,012**
Total Forest Land	**36,916**

Sherman Minton Nature Preserve, 1,452 acres, dedicated to preserve rare siltstone glades is in the northern section of FSC 10, along with county-owned public land. IDNR Nature Preserve land management ensures protection of the resource concern that led to the nature preserve designation. A private business, JT Brickyard Timberland, LLC, owns property in the southern portion of FSC 10 and implements oak-hickory management. All JT Brickyard Timberland property is enrolled in the Classified Forest Program, and is certified under the Sustainable Forestry Initiative (SFI). The Nature Conservancy either owns or manages 7,203 acres, some of which is Classified Forest. These managed lands will serve as core areas, and outreach will be targeted to surrounding Classified Forest owners to encourage them to implement oak-hickory management, creating a larger cross-boundary oak-hickory ecosystem across FSC 10.

Management Strategies Specific to FSC 10

- Many nature preserves are located in FSC 10. Using mapping tools, target specific locations of TNC property and nature preserves being managed to recover and sustain the oak-hickory ecosystem. These properties, along with JT Brickyard properties, will serve as core areas, around which to build large blocks of the oak-hickory ecosystem.
- Targeted outreach will be conducted for private landowners surrounding core areas. Specific landowners and areas for targeted outreach will be determined, in partnership with IDNR District Foresters and private consulting foresters. Landowners will be informed about the LSSI program and will be invited to manage and/or restore land appropriate for oak-hickory ecosystem restoration. Classified Forest landowners (33% of total area) will be the primary audience, with non-enrolled private landowners (49%) a secondary audience. Interested landowners will be provided with technical assistance and options for financial assistance.

- FSC 10 is located in the Indiana project area of the USDA NRCS/USFS Joint Chiefs program. The *Ready-Set-Fire in White Oak Woodlands* project is a collaborative effort between NRCS and USFS that aims to work with private, state, and Tribal landowners to conserve forest and agricultural lands alongside federally-managed lands. The project will fund prescribed fire along with numerous forest management practices in an effort to improve habitat for at-risk species and reduce wildfire risk. Landowners from these counties that are interested in forest conservation and management on their land should reach out to their local USDA Service Center for more information and to submit applications for funding. LSSI staff will provide written information about funding availability to landowners in FSC 10.
- Additional strategies applicable for all targeted FSCs detailed below.

Forest Stewardship Collaborative 12

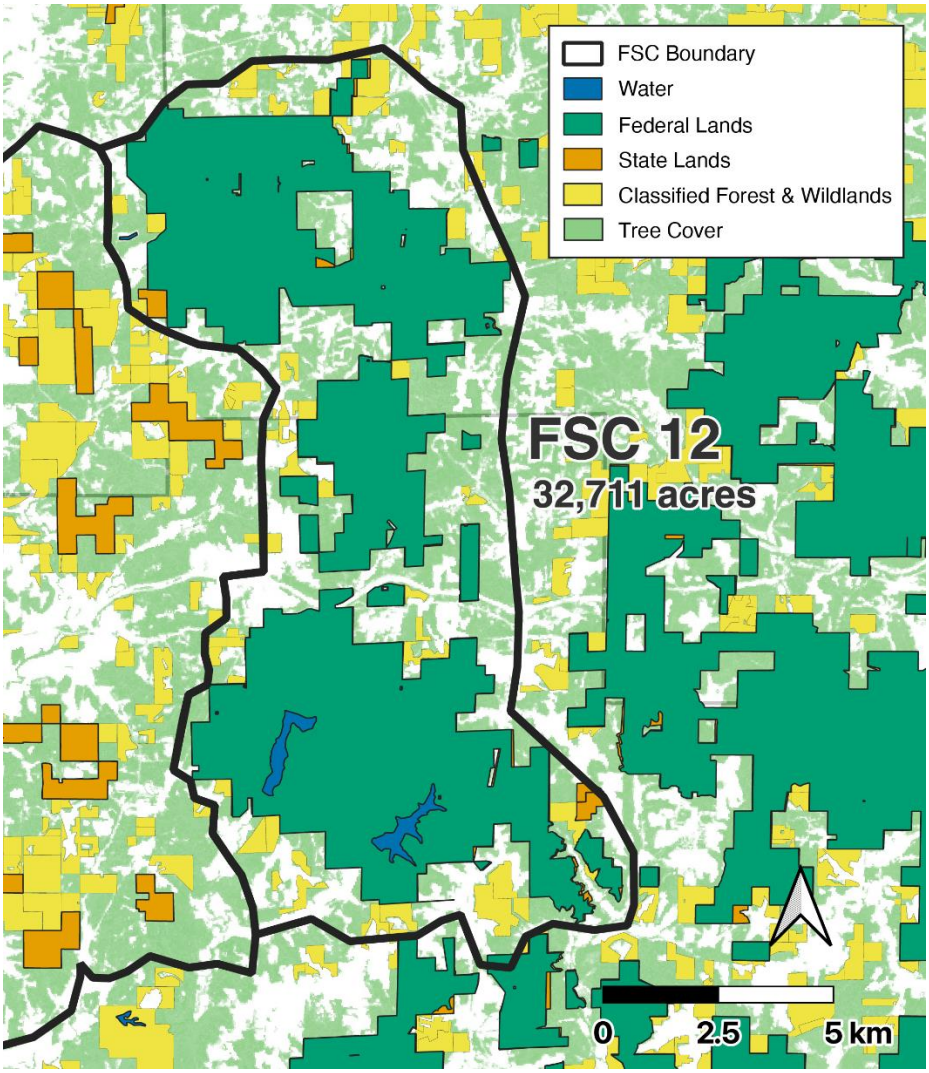


Figure 6. Forest Stewardship Collective 12; portions of Crawford and Perry Counties.

Site Characteristics

Soils, Topography, Hydrology

FSC 12 sits in the Crawford Upland Section of the Shawnee Hills Natural Region (Figure 6). Bedrock, mostly sandstone, crops out to form cliffs and rockhouses, shallow caves at the foot of cliffs. It is a rugged and sparsely-populated area, with primarily upland forest types and a few glades, gravel washes, and barrens. Well-drained silt loams of the Wellston-Zanesville-Berks Association are typical for the area.

The forest vegetation consists of an oak-hickory type on upper slopes, with more mesic components in the coves and valleys. The Hemlock Cliffs area of the Hoosier National Forest provides an environment for species with Appalachian affinities, such as mountain laurel and hemlock. Barrens are a minor component of this section, with only a few remnants remaining (Homoya, Abrell, Aldrich, Post, 1985).

Mineral and freshwater springs are another feature common to the Crawford Uplands. Homes and farms were established near larger springs, and mineral (salt) springs were attractive to game animals, and were good hunting spots (Sieber and Munson, 1992).

The Crawford Upland Section of the Shawnee Hills Natural Region has been further broken down into landtype associations, ecological landtypes, and ecological landtype phases to help further guide management on individual sites. Each of these ecological units have been modeled and mapped for all Forest Service lands within FSC 12, along with portions of non-Forest Service properties, totaling 25,431 acres within the FSC (Table 8). These ecological units are currently being revised and will soon cover all public and private land in FSC 12.

Table 8: Ecological Units Mapped in FSC 12.

	Ecological Landtype				
Ecological Landtype Phase	Bottomland	Cliffs	Ridge	Slope	Total
Fagus-Acer Saccharum/Arisaema, Mesic Ridges	0	0	6,846	0	6,846
Fagus-Acer Saccharum/Arisaema, Mesic Slopes	0	0	0	6,013	6,013
Quercus Alba-Quercus Prinus/Smilax-Vaccinium, Dry Slopes	0	0	0	5,371	5,371
Quercus Alba-Acer Saccharum/Parthenocissus, Dry Mesic Slopes	0	0	0	2,019	2,019
Acer Saccharum/Asarum-Boehmeria, Bottomlands	1,177	0	0	0	1,177
Platanus/Asarum, Wet-Mesic Bottomlands	1,174	0	0	0	1,174
Fagus-Acer Saccharum/Arisaema, Mesic Bottomlands	883	0	0	0	883
Acer Saccharum/Asarum, Wet-Mesic Slopes	0	0	0	870	870
Quercus Alba/Vaccinium, Dry Ridges	0	0	679	0	679
Quercus Alba-Acer Saccharum/Parthenocissus, Dry Mesic Ridges	0	0	285	0	285
Acer Rubrum-Quercus-Fagus /Hydrangea, Cliffs	0	111	0	0	111
Acer Saccharum, Arisaema-Jeffersonia, Mesic Slopes	0	0	0	3	3
Total	**3,234**	**111**	**7,810**	**14,276**	**25,431**

FSC 12 contains two LTAs. The Mixed Oak Dry Upland Hills LTA covers 59% of the area, while the White Oak Dry-Mesic Upland Hills LTA covers the remaining 41%. Vegetation in both LTAs is dominated by oak species on the uplands. White oak is often common in the overstory, with red maple and sassafras common understory associates. Greenbrier, blueberry, and sedges often dominate the ground layer. Mesic sites are dominated by sugar maple, American beech, and northern red oak in the overstory. White ash was once a common overstory associate on mesic sites, but healthy trees are now rare due to mortality from emerald ash borer. Mapleleaf viburnum, spicebush, jack-in-the-pulpit, and panicgrass are common in the ground layer on mesic sites.

During formulation of silvicultural treatment alternatives, ELTPs can be utilized as a guide to predict and understand expected vegetative responses to silvicultural treatments. Prior to any management, the modeled ELTs and ELTPs should be verified by on-the-ground field visits and analysis of forest inventory data. Refer to McNab and Avers (1994) for descriptions of broad scale ecological units and Zhalnin and Parker (2005) for descriptions of finer-scale ecological units on the Hoosier National Forest.

Historic Land Cover

Lindsey et al. (1965) used original GLO land-survey records and modern soil maps to reconstruct the distribution of pre-European settlement vegetation in Indiana. Their analysis showed that the oak-hickory cover type was dominant across much of the unglaciated portions of southern Indiana, including the entirety of FSC 12.

Ferdinand State Forest lies to the west of FSC 12, with 75 acres occurring in the FSC. GLO survey records indicate that oak was the dominant tree species on the uplands in the state forest, with beech noted in the valleys. Other tree species noted were ash, dogwood, gum, hickory, maple, and yellow poplar. Survey notes record an area killed by fire. When comparing the GLO survey notes collected between 1804 and 1849 in the state forests with CFI plot data collected on Ferdinand State Forest between 2010 and 2014, a 44% loss in oak-hickory is noted, and a 21% increase in beech/maple over the 200-year period (Ryker and Ariens, 2018).

The vegetation pattern in the Crawford Uplands region has changed dramatically from what it was 200 years ago. Sieber and Munson (1992) noted that around 1800, nearly the entire area was "old growth" forest. Ridge tops and south- and west-facing slopes were dominated by oak and hickory trees, while north- and east-facing slopes had more varied tree cover. This offered a range of plant foods for humans, their livestock, and wild game animals (Sieber and Munson, 1992)

Current Land Cover

Forests comprise 77% of FSC 12 (25,150 acres; Table 9). Remaining lands are used for agriculture, or are developed, naturally open, or water.

Table 9: Breakdown of Land Types in FSC 12. Land cover type legend and descriptions are found in Appendix 1. Data obtained by Southern Indiana Sentinel Landscape from the 2021 National Land Cover Database.

Land Cover Type	Acres
Barren Land (Unknown Use)	4
Cultivated Crops	1,207
Deciduous Forest	19,995
Developed, High Intensity	18
Developed, Low Intensity	250
Developed, Medium Intensity	101
Developed, Open Space	1,522
Emergent Herbaceous Wetlands	0
Evergreen Forest	1,258
Hay/Pasture	3,709
Herbaceous	244
Mixed Forest	3,897
Open Water	284
Shrub/Scrub	195
Woody Wetlands	1
Total	**32,685**

Multiple forest inventories have been conducted on Forest Service land within FSC 12 over previous decades. This data is often used to define current ground conditions and assist with management decisions. Two summary statistics that are often utilized to assess project areas at the landscape scale are forest type and age class. Table 10 gives a breakdown of these statistics for Forest Service land within FSC 12. Importantly, note the absence of 0-9, 10-19, and 20-29 year-old age classes in the oak-hickory forest type. The total lack of younger age class oak-hickory stands is a clear problem for the sustainability of that forest type and the plants and animals it supports. The Hoosier National Forest 2006 Land and Resource Management Plan and current and proposed projects seek to address this resource concern and ensure the long-term persistence of the oak-hickory forest type.

Table 10: Forest Types and Age Classes of Forest Service Land in FSC 12.

	FOREST TYPE								
Age Class	Oak-Hickory	Mixed Upland Hardwoods	Non-Native Pine	Hardwood-Pine	Mixed Lowland Hardwoods	Beech-Maple	Opening	Water	Grand Total
0-9	0	520	0	0	0	0	0	0	520
10-19	0	0	0	0	0	0	0	0	0
20-29	0	0	0	0	53	0	0	0	53
30-39	241	64	59	56	109	26	0	0	557
40-49	339	604	758	112	165	29	0	0	2,034
50-59	240	325	766	289	85	0	0	0	1,705
60-69	226	269	511	328	0	4	0	0	1,338
70-79	356	229	179	110	35	0	0	0	909
80-89	484	186	313	2	82	0	0	0	1,067
90-99	1,177	421	12	0	48	32	0	0	1,690
100-109	1,474	416	0	37	0	109	0	0	2,036
110-119	1,150	321	6	0	9	91	2	0	1,579
120-129	1,185	153	20	0	0	70	0	0	1,428
130-139	360	32	0	0	0	24	0	0	416
140+	140	7	0	0	0	34	0	0	181
Unknown	18	569	26	0	0	0	0	0	613
Null	0	0	0	0	0	0	877	290	1,136
Total	**7,390**	**4,116**	**2,650**	**934**	**586**	**419**	**877**	**290**	**17,262**

Forest Ownership

In FSC 12, 9% of land is enrolled in the Classified Forest and Wildlands Program (Table 11). By enrolling land in classification, landowners receive tax benefits and forest management assistance from IDNR Division of Forestry. Periodic contact with a District Forester encourages landowners to actively manage their forest. The Hoosier National Forest and Ferdinand State Forest in FSC 12 accounts for 69% of the total acreage. Combining classified forests and publicly owned managed forests, which require management plans, 77% of FSC 12 has written forest management plans. Private land not enrolled in the Classified Forest Program (23%) possibly does not have written FMPs, and therefore has unknown levels of forest management.

Table 11: Breakdown of Land by Owner. Data calculated from data obtained by Southern Indiana Sentinel Landscape from Indiana Department of Natural Resources Division of Forestry through a public records request, and from the 2021 National Land Cover Database. Note that this total includes private lands owned by land trusts that are open to the public.

Land Ownership Type	Acres
Private Forest land	
Classified Forest	2,075
Other (Not Enrolled)	5,746
The Nature Conservancy	87
Total private	**7,908**
Public Forest Land	
Federal/USDA Forest Service	17,166
Indiana DNR Forestry	75
Total public	**17,241**
Total	**25,149**

Over half of FSC 12 is owned and managed by the USDA Forest Service, Hoosier National Forest. There are two ongoing landscape-scale vegetation projects in this portion of the National Forest that align with LSSI Indiana objectives. The most current and best available science was used to guide proposed forest management activities. The purpose of these projects is to:

- Provide high quality early-successional forest habitat for wildlife (0-9 years);
- Restore dry hardwood ecosystems that have been degraded by a lack of fire and limited oak-hickory regeneration;
- Create healthy and resilient stands that can withstand and reduce the effects of insects, disease, and climate change, and;
- Reduce the amount of non-native pine in project areas to provide more suitable habitat to a wider array of wildlife species.

Management Strategies Specific to FSC 12

- The Hoosier National Forest will serve as a core area around which to build large blocks of oak-hickory ecosystem.
- Targeted outreach will be conducted for private landowners surrounding core areas. Specific landowners and areas for targeted outreach will be determined, in partnership with IDNR District Foresters and private consulting foresters, landowners will be informed about the LSSI program and will be invited to manage and/or restore land appropriate for oak-hickory ecosystem restoration. Classified forest landowners (9% of total area) will be the primary audience, with non-enrolled private landowners (23%), a secondary audience. Interested landowners will be provided with technical assistance and options for financial assistance.
- FSC 12 is located in the Indiana project area of the USDA NRCS/USFS Joint Chiefs program. The *Ready-Set-Fire in White Oak Woodlands* project is a collaborative effort between NRCS and USFS that aims to work with private, state, and Tribal landowners to conserve forest and agricultural lands alongside federally-managed lands. The project will fund prescribed fire along with numerous forest management practices in an effort to improve habitat for at-risk species and reduce wildfire risk. Landowners from these counties that are interested in forest conservation and management on their land should reach out to their local USDA Service Center for more information and to submit applications for funding. LSSI staff will provide written information about funding availability to landowners in FSC 12.
- Additional strategies applicable for all FSCs detailed below.

Management Practices and Strategies for All Focal Stewardship Collaboratives

Management Practices

Commonly used practices for restoring and managing oak-hickory forest stands include the following. Often, a combination of practices will be utilized.

Forest Stand Improvement (FSI)

Non-commercial intermediate practices utilized to influence forest stands to meet specific management objectives such as forest health, plant community composition, and creating wildlife habitats (Harper 2020). FSI is used in oak-hickory restoration and maintenance to release oaks and hickories from competition with other species and to improve wildlife habitats. Completed by cutting down or girdling competing undesirable shade-tolerant trees to release oaks and hickories. Herbicide should be used on cuts to deaden trees. For smaller diameter stands, basal bark application of herbicide can be used to deaden less-desirable trees.

Midstory Removal

Deadening or felling trees in the midstory, while leaving most of the overstory intact. This provides partial sunlight to the forest floor, aiding the survival and growth of oak and hickory seedlings. Vigorous oak seedlings should be present prior to midstory removal. Shade-tolerant and other undesirable tree species such as beech and maple should be targeted for removal. Timing midstory removal to coincide with bumper mast crops maximizes the potential for oak and hickory regeneration.

Non-Native Invasive Species (NNIS) Removal and Control

Non-native invasive plants compete with native plants for sunlight and water. Ongoing control of NNIS is critical to successful forest management. NNIS plant control is strongly recommended prior to initiating management activities. Management practices that increase sunlight to the forest floor can exacerbate NNIS infestations if NNIS are not controlled prior to practice implementation. Invasive species offer poor nutrition for wildlife compared to nutritionally rich native species.

The Indiana Terrestrial Plant Rule (effective 4.18.2020) designates 44 species of plants as invasive pests in the State of Indiana, making it illegal to sell, gift, barter, exchange, distribute, transport, or introduce these plants. More information about invasive plants and their locations can be found in the Guide to the Regulated Terrestrial Invasive Plant Species of Indiana: https://www.sicim.info/s/A-Guide-to-the-Regulated-Terrestrial-Invasive-Plant-Species-of-Indiana-web.pdf.

Prescribed Fire

Planned, low-intensity surface fires that deaden or top-kill small trees and shrubs in the understory and midstory. Gives fire-tolerant oak regeneration an advantage over that of fire-intolerant species. Reduces leaf litter on the forest floor, allowing acorns to sprout by placing them in contact with the soil. The use of fire may help suppress or control invasive species. Requires a written management plan.

Shelterwood Systems

Even-aged regeneration technique which consists of a sequence of harvests to encourage successful advanced regeneration and development of oak trees. Typically begins with midstory removal to provide partial sunlight

to oak seedlings to encourage regeneration and development. Once advanced regeneration is established, overstory trees are removed to fully release oak seedlings to become the next stand.

Silvicultural Clearcut
Even-aged regeneration technique that involves removing all trees, regardless of size or form, in one operation. Used to regenerate shade-intolerant species.

Single Tree Selection
Uneven-aged regeneration method in which single trees are removed throughout a stand to improve growing conditions for the remaining trees.

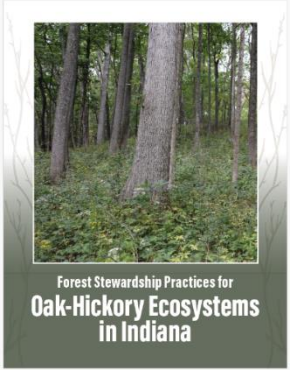
Group Selection
Uneven-aged regeneration technique in which small groups of trees are removed throughout a stand instead of single trees. Group selection openings (typically one acre or smaller) allow sunlight to penetrate the opening and release oak trees competing for space. Single tree selection typically favors regeneration of shade-intolerant species, whereas group selection favors a mix of shade-tolerant and shade-intolerant species.

Supplemental Planting
Planting tree seedlings in the understory of an oak-hickory dominated forest that has received midstory removal, or planting tree seedlings in forest openings to help influence forest composition and diversity. Typically requires tree protection in the form of tree tubes, cages, or fencing to be successful.

Tree Planting/Reforestation
Tree establishment through planting seedlings or direct seeding. Species planted, location, and planting density based on site conditions such as soils, existing vegetation, and aspect. Common cause of failure in tree plantings is lack of ongoing management to control competition from natural regeneration of undesirable species and excessive herbivory especially in the form of deer browse.

Deer Population Control
Mitigation of negative impacts of overabundant deer herds to reduce damage to young oak and hickory seedlings. Typically accomplished using lethal deer removal methods (hunting/culling) or implementation of physical barriers such as fencing and tree tubes. Fences exclude deer from areas of tree regeneration; tree tubes protect seedlings from deer browse. Excessive deer populations remove their preferred browse species such as oak, while leaving non-preferred species (e.g., spicebush, pawpaw, and American beech) to proliferate and dominate the understory and impede oak regeneration.

Forest Stewardship Practices for Oak-Hickory Ecosystems in Indiana



LSSI, in cooperation with Indiana NRCS and Purdue Extension, created the *Forest Stewardship Practices for Oak-Hickory Ecosystems in Indiana* publication as a resource for landowners and managers interested in learning more about science-based management practices they can utilize on their property. This publication is available at all IDNR District Forester's offices, and is also available on-line at https://www.letthesunshinein-indiana.com.

Management Strategies

Strategy 1. Increase cross-boundary collaborative forest management.

1.1 Utilize strategies specific to FSC 1,3,4,5,10, and 12, as described above.

1.2 Actively work with public and private foresters across Southern Indiana to raise awareness of LSSI principles, and encourage collaboration to increase cross property line management strategies.

1.3 Working with public and private foresters, identify and develop opportunities for neighbors to collaborate on regeneration treatments, forest stand improvement, invasive species management, and similar practices, resulting in larger areas of contiguous healthy forest ecosystems and wildlife habitats.

1.4 Professional foresters organize neighboring landowners' forest management and regeneration projects into "bundles." Contractors can bid on the bundles, as opposed to single projects. This makes the work more attractive to contractors and enables landowners with smaller parcel sizes to implement their forest management projects.

1.5 Utilize USFS Good Neighbor Agreements (GNA) to expand and increase forest ecosystems and wildlife habitats on and adjacent to National Forest lands. The GNA allows USFS to collaborate with state, county, and Tribal agencies, to implement forest restoration on or adjacent to National Forest lands.

1.6 Utilize USFS Wyden Agreements, which allow the Forest Service to enter into cooperative agreements with willing partners and landowners for the protection, restoration, and enhancement of fish and wildlife habitat and other resources on non-Forest Service lands. Wyden Agreements are utilized on small inholdings within burn areas or areas where private property adjoins a prescribed burn unit.

1.7 Engage private owners of public forest land inholdings.

- Review ownership maps to locate private inholdings on public lands.
- Conduct targeted outreach to inholding owners to elevate their interest in participating in cross-boundary forest management.

Strategy 2. Continue LSSI outreach and education campaign throughout southern Indiana; promote value of oak-hickory ecosystems and the benefits of active management. Encourage landowners to strongly value forest land resources and the oak-hickory ecosystem.

2.1 Develop and utilize demonstration areas in all FSCs, with interpretive signage to enhance landowner and public awareness and understanding of science-based forest management. Continue to utilize existing Demonstration Areas in FSC 4 and 12.

2.2 Develop annual strategy to actively use field days, workshops, press releases, and other methods of outreach to inform the public about the loss of the oak-hickory ecosystem, and the impacts of this loss.

2.3 Develop and maintain a network of like-minded forest management partners to increase capacity for landowner outreach; seek additional resources and utilize partnerships to effectively deliver outreach to landowners.

2.4 Work with conservation partners to create innovative products and tools to inform landowners and the public about science-based forest management.

2.5 Cooperate with State Park and State Forest managers: place informational signage in strategic locations to provide outreach opportunities to visitors.

2.6 Seek outreach methods for urban landowners. Provide forestry knowledge and technical information to all residents to raise public awareness, understanding, and acceptance of the need for science-based forest management.

2.7 Encourage landowners to value and maintain forest tracts and not to convert to agricultural land or other development.

2.8 Develop methods to effectively reach absentee landowners.

2.9 Incorporate oak-hickory management into Future Farmers of America curriculum, Envirothon, and other high school curricula.

2.10 Provide signage to landowners who manage their forest for oak-hickory systems to promote the program and engage additional landowners.

Strategy 3. Increase use of prescribed fire for forest management.

3.1 Conduct aggressive public education campaign about the uses and benefits of prescribed fire. Education should be directed to the general public and private landowners to help mitigate public opposition to prescribed fire and increase support for the use of fire as a management tool.

3.2 Plan and hold workshops, trainings about the use of prescribed fire for forestry professionals and private landowners.

3.3 Utilize existing campaigns such as #goodfire and other campaigns already used by collaborators.

3.4 Support passage of State of Indiana prescribed fire legislation detailing the responsibilities and liabilities of private landowners, burn bosses, and associated prescribed fire crew members and planners when conducting prescribed fires.

3.5 Connect private landowners who wish to burn with USFS fire resources. USFS collaborates with private landowners and supports their efforts to utilize prescribed fire by providing technical expertise in developing burn plans, assessing conditions, and ensuring safe and effective implementation of prescribed burns on private land.

3.6 Connect private landowners interested in prescribed burns on land adjacent to TNC or USFS properties with appropriate TNC or USDA Forest Service fire resources to discuss cross-boundary burn agreements.

3.7 Connect private landowners who wish to burn their properties with IDNR Division of Fish and Wildlife. IDNR will develop and write burn plans for private landowners and supply them with prescribed fire tools. https://www.in.gov/dnr/fish-and-wildlife/files/HMFSPrescribedBurn.pdf

3.8 Utilize *Ready-Set-Fire in White Oak Woodlands* Joint Chief's funding (2024-2028) to implement prescribed burns.

3.9 Central Hardwoods Joint Venture, American Bird Conservancy, IDNR, and Sam Shine Foundation continue work with Indiana NRCS to fund and deploy additional partner foresters who will assist with prescribed fire implementation, among other duties.

Strategy 4. Expand private landowner awareness of, and access to, technical and financial assistance to help implement forest management.

4.1 Utilize strategies specific to FSC 1,3,4,5,10, and 12, as described above.

4.2 Connect private landowners with technical and financial assistance available through USDA NRCS Farm Bill programs such as the Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP), as well as federal easement programs.

4.3 Utilize technical and financial assistance to accelerate management of forests, counter increased mesophication, and mitigate the impacts of climate change.

4.4 Connect private landowners with technical and financial assistance programs through the Southern Indiana Sentinel Landscape (SISL). The SISL Regional Conservation Partnership Program (RCPP) covers the 3.5-million-acre SISL area and provides technical and financial assistance for oak-hickory restoration and management and permanent forest easements.

4.5 Connect private landowners with technical and financial assistance programs through the Southern Indiana Sentinel Landscape (SISL). The SISL America the Beautiful grant provides funding for outreach

and engagement events targeting invasive species removal in specific counties within the SISL boundary.

4.6 Work to ensure long-term conservation of private forests. Connect landowners with technical assistance on land trusts, conservation agreements and generational transfer of forests to ensure long-term retention of private forests.

4.7 Central Hardwoods Joint Venture, American Bird Conservancy, IDNR, and Sam Shine Foundation continue to work with Indiana NRCS to fund and deploy additional partner foresters who will conduct oak-hickory ecosystem management and riparian forest/early-successional forest management trainings for professionals and landowners, assist less-tenured foresters and biologists with FMP development, and conduct targeted outreach to groups of private landowners.

Financial Assistance Opportunities

- USDA Farm Bill Programs: Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP), Conservation Reserve Program (CRP), Agricultural Conservation Easement Program (ACEP), and Conservation Reserve Enhancement Program (CREP), among others. Contact your local USDA Service Center for more information.
- Southern Indiana Sentinel Landscape:
  - *Regional Conservation Partnership Program* for forest management practices, forestry easements, agriculture conservation practices. Visit sisl.org to learn more.
  - *America the Beautiful* grant for Invasive Species Management. Visit sisl.org to learn more.
- Lake Monroe Water Fund: Landscape Scale Restoration Grant for restoring crucial watersheds through control of non-native invasive plants, restoring native vegetation on public and private land to enhance watershed function, restoring important forest ecosystems, and improving wildlife habitat on land in Lake Monroe Watershed. Contact Lake Monroe Water Fund https://www.lakemonroewaterfund.org; info@lakemonroewaterfund.org for application information.
- Joint Chiefs *Ready-Set-Fire in White Oak Woodlands* (USDA NRCS and USDA USFS): Increase amount of forest stand improvement, non-native invasive species control, and prescribed fire implementation in Brown, Crawford, Dubois, Floyd, Greene, Harrison, Jackson, Lawrence, Martin, Monroe, Morgan, Orange, Owen, Perry, Putnam, and Washington Counties in Indiana. Private landowners from these counties that are interested in forest conservation and management on their land should reach out to their local USDA Service Center to submit applications for funding.

Landowner Management Resources

- Indiana DNR Division of Forestry District Foresters: https://www.in.gov/dnr/forestry/private-forestland-management/district-foresters/.
- Indiana DNR Division of Fish & Wildlife Biologists: https://www.in.gov/dnr/fish-and-wildlife/wildlife-resources/wildlife-biologists/.
- Professional Consulting Foresters: https://www.findindianaforester.org/.
- Purdue Extension County Office: https://extension.purdue.edu/about/county-office.html.
- USDA Service Centers: https://www.nrcs.usda.gov/conservation-basics/conservation-by-state/indiana.
- *Forest Stewardship Practices for Oak-Hickory Ecosystems in Indiana*: https://www.letthesunshinein-indiana.com.
- Indiana DNR Division of Forestry: https://www.in.gov/dnr/forestry/private-forestland-management/.
- Hardwood Ecosystem Experiment: https://heeforeststudy.org/.
- Purdue University Department of Forestry and Natural Resources: https://www.purdue.edu/fnr/extension/resources/publications/.

- US Forest Service: https://www.fs.usda.gov/managing-land/forest-management.
- University of Kentucky Department of Forestry & Natural Resources: https://forestry.ca.uky.edu/white_oak_publications.
- *Silviculture Guide to Forestry for the Birds in Indiana and the Central Hardwoods Bird Conservation Region*: https://www.chjv.org/forestry-for-the-birds/#silviculture-guide.
- White Oak Initiative: https://www.whiteoakinitiative.org/landowners-for-oaks.

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LSSI Participating partners

American Bird Conservancy
Central Hardwoods Joint Venture
Hoosier National Forest – USDA Forest Service
Indiana Forestry Educational Foundation
Indiana Forestry & Woodland Owners Association
Indiana Prescribed Fire Council
Indiana DNR – Division of Forestry
Indiana DNR – Division of Fish & Wildlife
National Wild Turkey Federation
Purdue University
Purdue Cooperative Extension Service
Ruffed Grouse Society – Indiana Chapter
Sam Shine Foundation
Southern Indiana Sentinel Landscape
State of Indiana Cooperative Invasives Management
The Nature Conservancy
USDA Fish and Wildlife Service
USDA Natural Resources Conservation Service – Indiana
Women4TheLand

Appendix 1

2021 National Land Cover Database Class Legend and Description

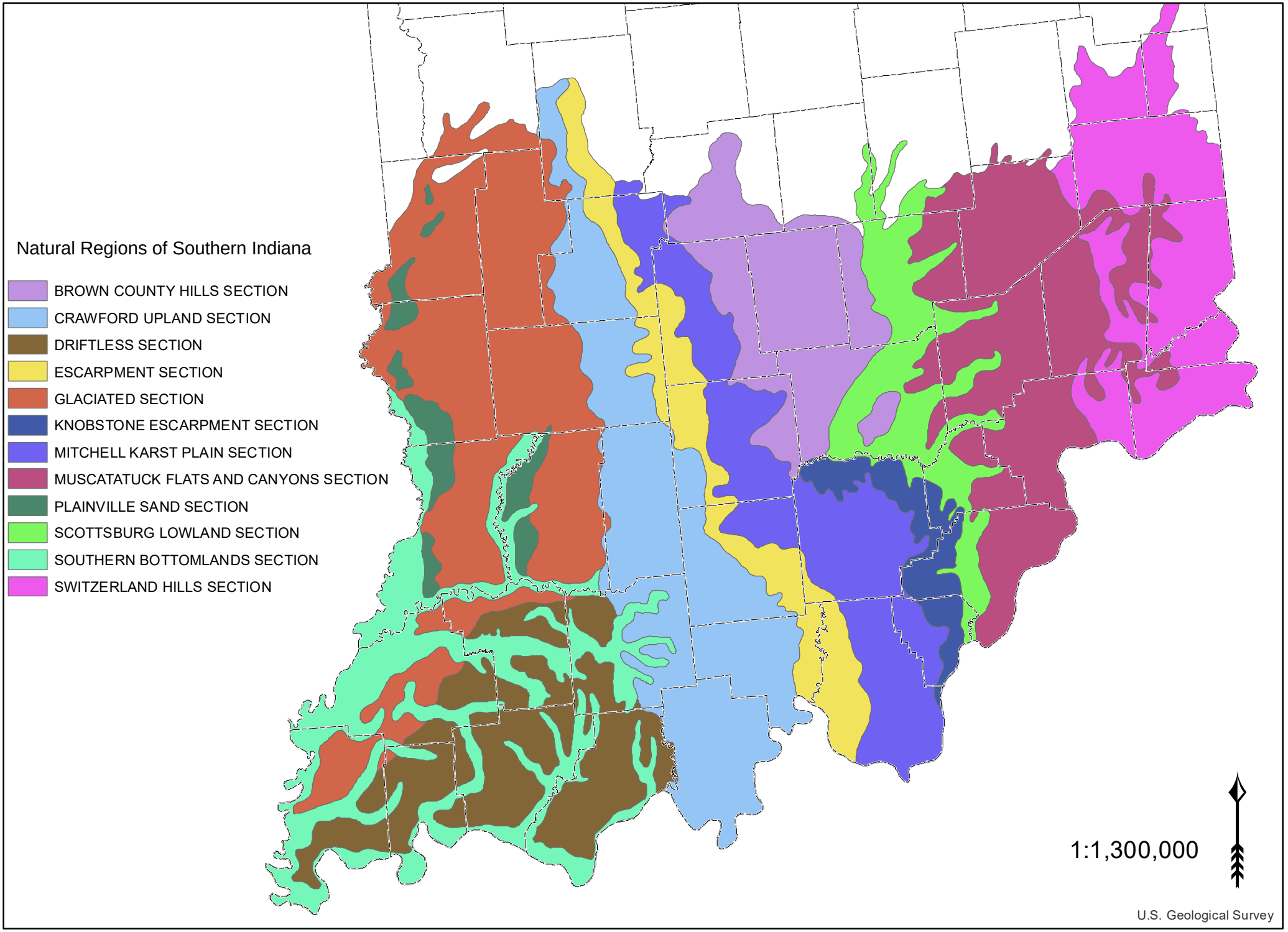
Class\ Value	Classification Description
Water	
11	**Open Water**- areas of open water, generally with less than 25% cover of vegetation or soil.
12	**Perennial Ice/Snow**- areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
Developed	
21	**Developed, Open Space**- areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
22	**Developed, Low Intensity**- areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.
23	**Developed, Medium Intensity** -areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.
24	**Developed High Intensity**-highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.
Barren	
31	**Barren Land (Rock/Sand/Clay)** - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Forest	
41	**Deciduous Forest**- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
42	**Evergreen Forest**- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.

43	**Mixed Forest**- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
Shrubland	
51	**Dwarf Scrub**- Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.
52	**Shrub/Scrub**- areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Herbaceous	
71	**Grassland/Herbaceous**- areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
72	**Sedge/Herbaceous**- Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.
73	**Lichens**- Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.
74	**Moss**- Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.
Planted/Cultivated	
81	**Pasture/Hay**-areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
82	**Cultivated Crops** -areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
Wetlands	
90	**Woody Wetlands**- areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

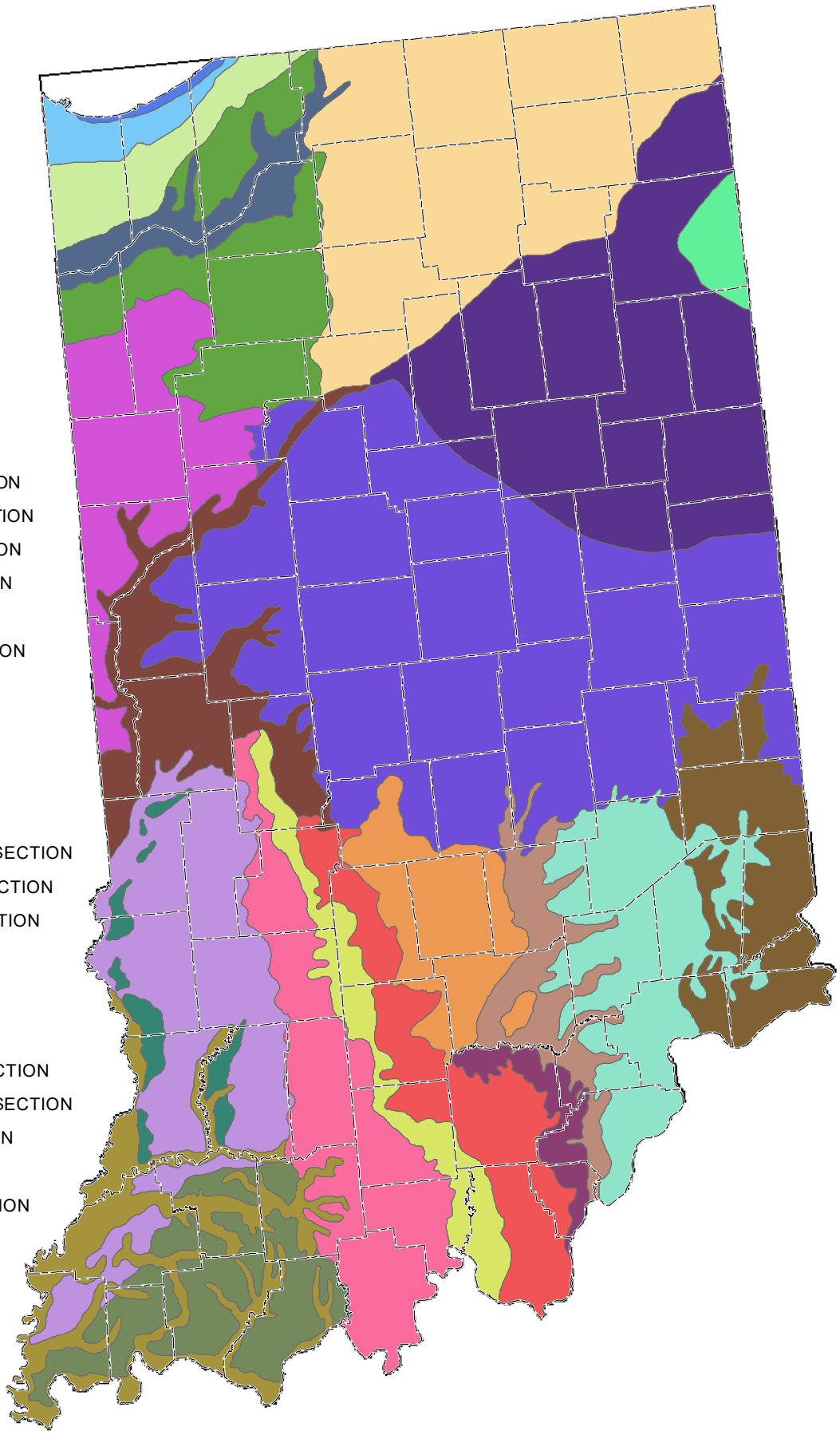
95	**Emergent Herbaceous Wetlands**- Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

USGS National Land Cover Database
https://www.usgs.gov/centers/eros/science/national-land-cover-database

Appendix 2 Natural Regions of Indiana



Natural Regions of Indiana



Subsections

- BLACK SWAMP SECTION
- BLUFFTON TILL PLAIN SECTION
- BROWN COUNTY HILLS SECTION
- CHICAGO LAKE PLAIN SECTION
- CRAWFORD UPLAND SECTION
- DRIFTLESS SECTION
- ENTRENCHED VALLEY SECTION
- ESCARPMENT SECTION
- GLACIATED SECTION
- GRAND PRAIRIE SECTION
- KANKAKEE MARSH SECTION
- KANKAKEE SAND SECTION
- KNOBSTONE ESCARPMENT SECTION
- LAKE MICHIGAN BORDER SECTION
- MITCHELL KARST PLAIN SECTION
- MUSCATATUCK FLATS AND CANYONS SECTION
- NORTHERN LAKES SECTION
- PLAINVILLE SAND SECTION
- SCOTTSBURG LOWLAND SECTION
- SOUTHERN BOTTOMLANDS SECTION
- SWITZERLAND HILLS SECTION
- TIPTON TILL PLAIN SECTION
- VALPARAISO MORAINE SECTION

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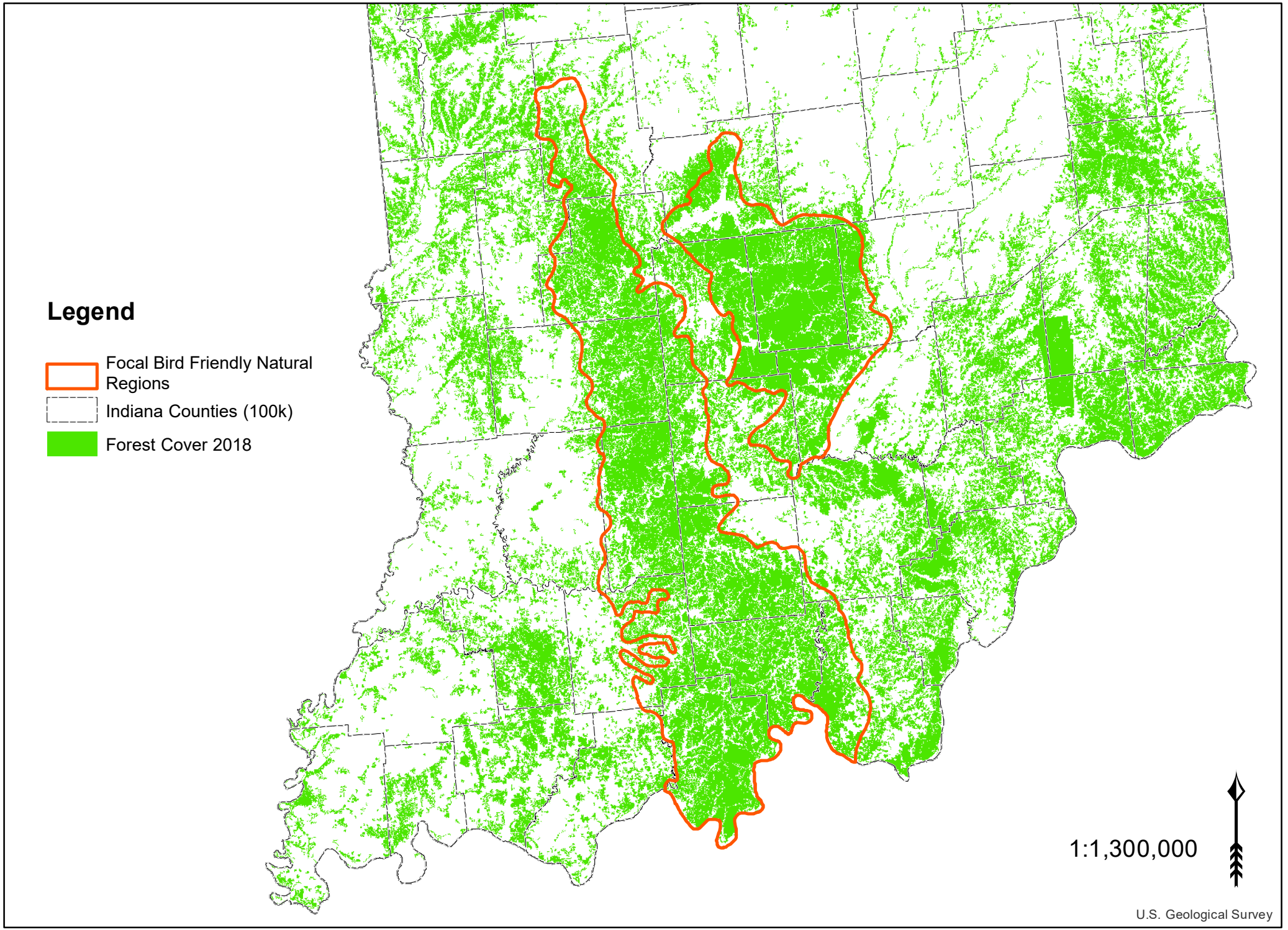
U.S. Geological Survey

Forest Cover



Appendix 3

The IDNR Division of Forestry manages 15 state forests with a total of 160,251 acres.
Interactive map: https://www.in.gov/dnr/forestry/properties/