INDIANA FOREST MANAGEMENT HISTORY AND PRACTICES

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Abstract.—Indiana's landscape and forests today are largely the result of Ice Age glaciations, Native Americans' use of fire, and over-harvesting in the late 19th and early 20th centuries. Any intentional management of the forest was not generally apparent until the early 1900s. Early visionaries at that time recognized the future impact forest depletion would have on the state's well-being and enacted legislation providing tax incentives to maintain land in forest cover. Some even-aged management has been applied to Indiana's forests and continues to be to some extent, but uneven-aged management is more prevalent, particularly on public lands. Although Indiana has many tree species of economic and ecological significance, a major focus of forest management today is on the regeneration and perpetuation of the oak species.

FROM GLACIERS TOWARD STATEHOOD

More than 700,000 years ago Indiana's landscape was dominated by glaciers that began moving through the area during the Ice Age (Fleming 1997). Moving slowly from north to south, these massive sheets of ice scraped away all land forms that impeded their progress. These glaciers completely altered surface drainage, created lakes, diverted stream channels, and filled large valleys with sediment, leaving little record of their existence. Also swept away in their paths were coniferous forests that prospered in Indiana due to the colder climate.

Although archaeological records for Indiana date back as far as 14,000 years, the first evidence of human habitation appears about 10,000 B.C. with the Paleoindians. By the time European settlers arrived, Native Americans were socially well organized and dependent upon intensive agricultural production, growing crops such as corn, beans, and squash that are familiar today. Towns were developed and connected through trade routes both over land and through rivers (Justice 2006). Cultivation of trees as a crop was still centuries ahead, yet it is likely that the people of this period used the forest resource for dwellings and heat, and perhaps did primitive management to enhance hunting. Jenkins (this publication) provides a more detailed account of prehistoric and presettlement forest conditions in Indiana.

The first Europeans to discover and occupy Indiana were the French, some in search of wealth from beaver pelts and some serving as missionaries (Troyer 1975). They arrived during the 1670s and established their first permanent settlements around 1720 near present-day Fort Wayne, Lafayette, and Vincennes.

Native Americans had lived in this region for thousands of years but had limited interaction with Europeans; most of their encounters occurred in the few decades prior to the Revolutionary War (Sieber et al. 1992). European settlers and their descendants came to the area in far greater numbers after the Revolutionary War. The Land Act of 1800 made it easy for private individuals to acquire federal land, and the first land office in what is now Indiana was opened at Vincennes in 1807.

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INDIANA'S GROWING PAINS: 1810-1900

By 1810, the Indiana territorial population had increased to about 24,000. When peace with European countries prevailed after the War of 1812, Indiana became a state in 1816 and most of central Indiana was open for settlement. Early settlers to Indiana were primarily subsistence farmers who cleared land for crops and pasture much as their ancestors had done to shape the European landscape centuries earlier. Their introduction to this country of metal tools and farming implements along with draft animals enabled them to more easily overcome the perceived barrier to progress that the forest represented.

The new state's population had increased to more than 147,000 by 1820. Road building began in 1832 with the clearing of trees for the Old Michigan Road, a rugged, tree-stump-strewn travel lane connecting the town of Madison in southern Indiana and Michigan City on the state's northern border. Thus began two decades of intensive expansion of transportation routes. In addition to these primitive roads, Indiana transportation was enhanced by steamboats, canals, and railroads during this time. By 1840 settlements were appearing throughout northern Indiana, particularly along the route of the Wabash-Erie Canal. When the Civil War began in 1861, Indiana ranked 6th in population among the 34 United States, and ranked in the top 3 states for the production of wheat, corn, potatoes, hogs, cattle, and sheep (Troyer 1975).

As Indiana's population increased and settlements continued to grow, the demand for lumber during the early to mid-1800s escalated rapidly. Most homes were built of wood and required 20 to 40 cords of wood annually for heating and cooking, and as many as 8,000 fence rails were needed to enclose a 16-ha (40-acre) field (MacCleery 1992). Sawmills played a key role in communities and laid the foundation for the state's economic growth. It was not uncommon for entire communities to work together in constructing new mills. Sawmills were powered by a variety of sources. Water was the principal source of power through the 1840s (Clark 1987), but in the 1850s steam power began to allow mills to venture away from flowing water into the woodlands. Cleared land was generally considered more valuable than land in forest cover, but a territorial law to protect unauthorized timber cutting appeared as early as 1799, when an $8 fine was imposed "for felling or boring any walnut, oak, whitewood, poplar, cherry, ash, locust, chestnut, coffee or sugar tree on another person's land without permission" (Pease 1925: 362). After acquiring statehood, Indiana's legislature passed similar regulatory laws adding further penalties for unsanctioned timber harvesting.

Prior to the Civil War, demand for Indiana hardwoods was mainly for construction and infrastructure. While these demands for durable products continued after the war, consumer interest also turned to products with both functional and aesthetic appeal (Clark 1987). Many species of hardwoods were used, but oak (*Quercus*), walnut (*Juglans*), maple (*Acer*), poplar (*Liriodendron tulipifera*), hickory (*Carya*), cherry (*Prunus serotina*), elm (*Ulmus*), and ash (*Fraxinus*) were of principal commercial value. The early Reconstruction period following the Civil War was a time of widespread change. Industries were busy shifting to peacetime production, subsistence farmers were being drawn to jobs in logging and sawmills, and Indiana's network of railroads was expanding (Hicks 1997). The popularity of the steam tractor in the 1870s (White 2010), coupled with genetically improved plants and the availability of fertilizers, led to greatly increased crop production per hectare. Some rugged lands that were tillable with a team of draft animals were left to revert to forest cover because they were too steep to navigate with a tractor and were marginally productive. Forest land was consequently regenerated in some areas, but those gains were offset by other factors. The building of more factories and homes not only increased the demand for construction lumber, but meant a greater demand for coal, oil, natural gas, and later gasoline to fuel the machines and vehicles. Forest land was lost to mining, pipelines, road construction, and other infrastructure (Hicks 1997).

Few people were concerned at the time that Indiana's forest resource might be in jeopardy. It wasn't until 1874 that the idea of a tax incentive related to forestry was first mentioned by M.B. Kerr in the Indiana Agricultural Report. Kerr noted that soil erosion and timber depletion were serious problems in many areas of southern Indiana and recommended that black locust (*Robinia pseudoacacia*) be planted in steep and eroded areas. He went further to recommend that tax exemptions be granted on lands that were planted to forest, at least for the first 10 years of the plantation. By 1880 Indiana's timbered area had shrunk to about 1.7 million ha (4.3 million ac), and by the end of that decade it would be depleted even further to about 607,000 ha (1.5 million ac).[2]

Indiana led the nation by the turn of the 20th century in the production of oak and walnut, with nearly 700 million board feet and 11 million board feet, respectively, produced annually. Due to the slow rate of secondary growth, this intense demand predictably led to a steady decline in hardwood availability. Government-funded research brought about more efficient milling and manufacturing techniques, which sustained the hardwood industry, but pressure on Indiana's forest resource took its toll. Indiana was able to maintain a sizable portion of the walnut market nationally, but production of other species declined rapidly. By 1900, Indiana's overall forest resource was reduced to a mere shadow of what it once was (Table 1).

[2] Data on file with the Indiana Department of Natural Resources-Division of Forestry, Indianapolis, IN.

Table 1.—Forest land area in Indiana, 1800-2008.

Year	Hectares	Acres
1800	7,891,650	19,500,000
1860	4,047,000	10,000,000
1900	607,050	1,500,000
1950	1,675,458	4,140,000
1967	1,604,352	3,964,300
1986	1,796,544	4,439,200
1998	1,821,676	4,501,300
2008	1,932,523	4,775,200

Near the end of the 19th century, several key developments would positively affect the early recovery of Indiana's forests. The Organic Administration Act of 1897 was federal legislation that made possible the formation of most of our National Forests. This law states, "No national forest shall be established, except to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States". These stipulations clearly set National Forests apart from National Parks, which were created to preserve the beauty of those properties and provide for recreational opportunities.

In 1898 a resolution was drafted by the Indiana Horticultural Society and forwarded to the Indiana General Assembly recommending a tax exemption for lands maintained strictly as forests, or at least tax adjustments to be made with appraisals for tax purposes based on the annual income accrued by the forest lands. Even though this resolution did not result in immediate legislative action, it undoubtedly had an impact on legislators as sentiment for support of forestry continued to mount.

The next piece of relevant state legislation came in 1899. At the urging of the Indiana Academy of Science and others, Indiana's state legislature passed "An Act for the Encouragement of Forestry" (Kriebel 1987), a more limited forerunner of today's Classified Forest program. Landowners were given a substantial tax reduction if they agreed to cut no more than 20 percent of their timber, plant a tree for every tree cut, and limit the grazing of livestock in their woods. This incentive could be applied to only one-eighth of the forested land they owned. This year also marked the formation of the Indiana Hardwood Lumbermen's Association, a group that would influence forest management and policy for decades to come.

With guidance from the National Committee on Wood Utilization and research from the U.S. Forest Service's Forest Products Laboratory, advances in milling

efficiency and forest management began to take shape. Cutting lumber to exact dimensions at the primary mill, for example, allowed the product to be received at the secondary mill ready to use, thus eliminating the inherent waste involved in remanufacture at the factory. This practice also enhanced utility of the material harvested and therefore increased the use of smaller logs. These efficiencies led to lower mill costs, less waste, and the development of new markets for lesser-quality lumber. It also demonstrated that the physical properties of second-growth timber were not inferior to those of virgin timber, refuting a commonly held belief.

INDIANA FOREST MANAGEMENT: 1901-2000

In 1901 the Indiana Board of Forestry was signed into law by Governor Winfield Durbin with the charge "to collect, digest and classify information on forestry and recommend plans and methods for the better practice of forestry and for the establishment of state forest reserves" (Clark 1987). At that point in time, there was not much forest land left to manage. Severely eroded lands needed to be reforested and habitat for wildlife restored. Early forest management focused on these efforts as well as public education. Private forest landowners were provided publications about tree planting, keeping livestock out of the woods, and growing trees for fence posts. On-site landowner assistance was also offered on a very limited basis.

Committing land to the public trust began in 1903 with passage of Indiana Code 14-23-4-1, allowing for the establishment and management of State Forests (Indiana Code 2011):

> It is the public policy of Indiana to protect and conserve the timber, water resources, wildlife, and topsoil in the forests owned and operated by the division of forestry for the equal enjoyment and guaranteed use of future generations. However, by the employment of good husbandry, timber that has a substantial commercial value may be removed in a manner that benefits the growth of saplings and other trees by thinnings, improvement cuttings, and harvest processes and at the same time provides a source of revenue to the state and counties and provides local markets with a further source of building material.

With this legislation came authorization for the state to purchase 809 ha (2,000 ac) of land in Clark County to serve as a forest laboratory, demonstration area, and tree seedling nursery. This property would later come to be known as Clark State Forest. Its condition upon purchase bore little resemblance to its beauty today. Having been heavily logged and scarred by fires that had occurred there almost yearly, Indiana's first State Forest had few large trees. Initial work focused on erosion control, tree planting, pruning, and establishment of roads and other infrastructure. A seedling nursery was established by 1907 to provide trees mainly for the property, with the intent of eventually making trees available to the public. This "Forest Reservation and Experiment Station," as it was known then, would remain Indiana's only State Forest for 26 years (Indiana Department of Natural Resources-Division of Forestry 2006).

Bluffton, IN, native Charles Deam was appointed as the first state forester in 1909. Deam was a druggist by trade but had a passion for studying plants. His achievements in botany are legendary. His botanical collection numbered some 78,000 specimens, of which 25 species were discovered by Deam. He also has 48 species that bear his name (Kriebel 1987). In the forestry arena, one of Deam's lasting legacies was writing a revised Forest Tax Classification Act, which the Indiana state legislature passed in 1921. Among other restrictions, this revised law eliminated the percentage limit on how much forest land could be classified, allowing for thousands more acres to be assessed at only $1 per acre in exchange for a written forestry management agreement. In 1925 a property tax increase of one-half mil on each $100 of taxable valuation was passed, which resulted in funding for

more forest management, including the employment of professional foresters. This legislation was known as the LaFuze Act, named after its sponsor, State Senator Oliver LaFuze. Its impact would prove to be enormous for the state Division of Forestry's operations (Bramble 1965).

Two important pieces of legislation at the federal level were passage of the Weeks Act of 1911 and the Clark-McNary Act of 1924. The Weeks Act authorized the Federal government's purchase of land in the eastern United States. Although the intent of these purchases was to protect the headwaters of navigable streams, much of the land purchased eventually became the core of what are now National Forests. The importance of the Clark-McNary Act of 1924 was to establish the groundwork for federal–state forestry cooperation, particularly in areas of fire control and working with private landowners. It also mandated the production of timber for National Forests (Hicks 1997).

A major effort was begun in the late 1920s by federal, state, and private forestry entities and by Purdue University to encourage sustained yield forest management, limit or eliminate livestock grazing in woodlands, and protect forest resources from fire. Improved forestry and logging practices were demonstrated to landowners and clearcutting practices were discouraged in favor of single-tree selection.

Increased funding from the mil tax allowed the state to hire additional professionally trained foresters. Financial hardships of the 1930s accentuated the depleted condition of Indiana's natural environment. Many farmers were unable to meet expenses, and those trying to make a living from the poorer land in hilly southern Indiana were not even able to pay taxes. Mortgaged lands were repossessed by banks, and other abandoned lands reverted to county ownership, much of it later to be converted to state and national forests (Troyer 1975). By 1932 the number of State Forests had increased to five (Table 2). Included in the State Forests' 10,120 ha (25,000 acres) was Morgan-Monroe State Forest, established in 1929. Much development of those properties took place at the hands of the federally funded Civilian Conservation Corps (CCC) during the 1930s. Land acquisition also began during this decade for the development of what would later become the Hoosier National Forest in 1951.

Any history of Indiana's forest resource would be incomplete without mention of the role of the CCC. Authorized by Congress in 1933 as one of President Franklin D. Roosevelt's New Deal programs, the CCC had two intended purposes: to provide employment for thousands who were out of work, and to improve and restore the country's natural resources, which were badly degraded. CCC projects included forest fire control, building construction, erosion control, dam construction, and trail building (Otis et al. 1986). Of

Table 2.—Establishment dates of Indiana State Forests (Booneville Enquirer 1933; Indiana Department of Conservation 1934, 1935, 1936, 1938).

Establishment Date	State Forest Name
1903	Clark
1929	Morgan-Monroe
1931	Jackson-Washington[a]
1932	Harrison-Crawford[b]
1932	Martin
1933	Scales Lake[c]
1934	Ferdinand[d]
1935	Pike
1935	Wells County[e]
1935	Salamonie River[f]
1936	Green-Sullivan
1939	Frances Slocum
1942	Selmier
1947	Yellowwood[g]
1948	Owen-Putnam

[a] Originally known as Jackson County State Forest.
[b] Originally known as Harrison County State Forest.
[c] Became a Warrick County park in 1967.
[d] Originally known as Dubois County State Forest.
[e] Became a State Recreation Area in 1962 and a State Park in 1983.
[f] Originally known as Wabash County State Forest.
[g] Previously leased from the U.S. Department of Agriculture since 1940.

particular note in Indiana, aside from the planting of millions of trees, was the timber stand improvement (TSI) and logging on State Forests. The CCC operated sawmills and planing mills that processed the lumber used to build the many barns, service buildings, and residences on state properties, many of which are still in use. When the CCC program came to an end in 1942, the United States was in the midst of World War II. The combination of a lack of manpower due to the war and the sudden loss of CCC labor resulted in a critical shortage of foresters, fire personnel, and property workers.

In 1944 a long-range forest management plan was developed for Indiana, and implementation of this plan received a boost a year later with an increase in the forestry tax to 5 mils. State Forester Ralph Wilcox expanded the number of forestry districts throughout the state to 10 and hired additional staff to meet the public demand for forest management assistance (Bramble 1965).

As soldiers from World War II returned home to a stimulated economy and began working in factories and raising families, a marked shift in forest landowner objectives occurred. Land that for decades had been "working forests," managed for production because it was considered essential for earning a living, now became places primarily held for recreation and aesthetic enjoyment (Hicks 1997). This characteristic of land ownership has carried through to the present day, as will be discussed later.

Moving into the 1950s, Indiana still suffered from a diminished supply of hardwood lumber. That, in combination with advances in metals and plastics technology, resulted in an overall depressed timber industry. More than 1,000 sawmills still operated in the mid-1950s, but only 30 had an annual production exceeding 1 million board feet. Ten years later, 68 percent of Indiana's mills were sawing less than 350,000 board feet of lumber per year (Clark 1987).

The forestry effort in Indiana was dealt a devastating blow in 1953, when the state administration suddenly ordered the firing of four district foresters and two nursery foresters. Working conditions deteriorated to the point that three additional foresters resigned, leaving only two foresters to provide services to a 42-county area in southern Indiana. Extension foresters from Purdue University offered assistance when possible, and even conservation law enforcement officers were assigned to conduct classified forest inspections. Conditions did not improve until 1957, when a new administration began hiring back some of the foresters previously dismissed and recruiting new foresters. Even then, improvements were very slow as it took time to rebuild positive relationships between professionally trained foresters and state government. When Robert Raisch became State Forester in 1962 under the supportive Department of Conservation leadership of Director Don Foltz, a new era of professionalism and growth began, expanding personnel and programs beyond what they had ever been (Bramble 1965).

Reduction in timber harvesting on federal lands, loss of forest land due to development, and increased demand for wood fiber created mounting pressure on non-industrial private forest land to produce timber. This pressure provided impetus for even greater support for forest management, both at the state and federal levels. In 1973 the Forest Incentives Program was initiated. This program covered up to 65 percent of the cost for planting trees or doing TSI, to a maximum of $10,000 per year. To participate in the program, landowners were required to maintain the practices for at least 10 years (Jacobson et al. 2006).

Patterned after the 1950s Federal Soil Bank program, the Conservation Reserve Program of 1985 encouraged farmers to plant trees on what was previously cropland (Hicks 1997). Land was typically enrolled in the program for 10 to 15 years, during which time the Commodities Credit Corporation made

annual payments based on the land's agricultural rental value. Landowners were also reimbursed up to 50 percent of their cost of planting trees or implementing other approved conservation practices on the land (U.S. Department of Agriculture 2007).

Downturns in the economy led to diminished federal funding of forestry programs in the late 1980s and throughout the 1990s. Most state forestry positions added when federal funding was plentiful were retained, but no new positions could be added and attrition led to the loss of some positions. "Streamlining" became the norm for doing business in both the private and public sectors.

On public forest land, there was greatly increased emphasis during the 1990s on forest values other than timber. Management decisions increasingly took into consideration wildlife populations, recreation, historic preservation, and other aspects of the forest. A more holistic approach to forest management evolved throughout that decade and continues today. The focus of federal forestry incentive funding was reflective of this change in approach. The Forest Stewardship Act of 1990 provided for funding of the Stewardship Incentive Program and the Forest Stewardship Program. Both of these long-term management programs valued not only timber production, but also the creation and maintenance of wildlife habitat, watershed protection, recreation, and aesthetics. The Stewardship Incentive Program was replaced in 2002 by the Forest Land Enhancement Program, which continues to be one of the most highly regarded incentive programs by both landowners and foresters for enhancing forest management and helping landowners meet their objectives (Jacobson et al. 2006).

MODERN FOREST MANAGEMENT

The greatest threats to both public and private forest land in Indiana through the 19th and early 20th centuries were unregulated over-harvesting and clearing for agriculture. Today, Indiana's forests face a number of challenges, perhaps the greatest of which are invasive species and forest fragmentation.

Garlic mustard (*Alliaria petiolata*), tree of heaven (*Ailanthus altissima*), bush honeysuckle (*Lonicera maackii*, *L. tatarica*, *L. morrowii*), and kudzu (*Pueraria lobata*) are but a few of the many invading plants that are displacing native species from their natural habitats. Insects such as the gypsy moth (*Lymantria dispar*) and emerald ash borer (*Agrilus planipennis*) are putting some of our most economically valuable tree species in jeopardy. Invasive species not only threaten the biodiversity of Indiana's hardwood forests but cost an estimated $120 billion in damages and control efforts (Pimentel et al. 2005), which does not take into account losses from tourism and recreation.

To put in perspective the potential impact that one of these alien invaders might have on Indiana's landscape and economy, we do not have to look far back into our past. *Cryphonectria parasitica*, the fungus that caused the chestnut blight, was first introduced into New York in 1904. Within 10 years it had spread to most states east of the Mississippi River. By the late 1930s, few mature American chestnut (*Castanea dentata*) trees were still living anywhere in the eastern United States. Within one generation, a tree whose lumber was worth millions of dollars and whose value as a wildlife food source was immeasurable was virtually wiped out (Hicks 1997). A similar urban story can be told of the impact of Dutch elm disease on the American elm (*U. americana*). Once a mainstay of the neighborhood landscape, the beautiful and abundant American elm was reduced to firewood.

The conversion of forest land to development has resulted in thousands of hectares of forest land being eliminated or seriously compromised. The fragmentation of forest land continues to create

problems for the management of both timber and wildlife. Forest fragmentation has been identified as a probable cause for the decline of several migratory bird species. Because fragmented forests greatly increase the amount of edge, Brown-headed Cowbirds (*Molothrus ater*) are able to more readily parasitize migrants' nests (Robinson et al. 1995). Aside from wildlife concerns, fragmentation also affects the forest structure itself, leading to changing tree associations and forest composition. The additional edge of a fragmented forest favors an increase in shade-intolerant tree species.

Another phenomenon different from fragmentation but often related is forest parcelization, or the division of ownership of a particular area of contiguous forest. Although parcelization may result in forest fragmentation, even parcelized land that remains as contiguous forest may well be impacted. Smaller parcels of land having different owners are likely to have homes and other structures built within them, or to have the forest managed differently based on differing landowner values and objectives.

Although the most recent Indiana forest inventory shows an increase in timberland throughout the state (Indiana Department of Natural Resources [IDNR]-Division of Forestry 2010), landowners' interest in marketing their timber appears to be declining. In a study conducted by the Center for Nonprofit Strategies, forest landowners in six Midwestern states including Indiana were surveyed and grouped into four categories according to their objectives for owning forest land. Only 26 percent of those private landowners fell into the "Working the Land" group, compared with 34 percent (the highest for any individual group) who were categorized as "Woodland Resort Owners".[3] As recreational and aesthetic values of private forest land supersede production values, the availability of marketable timber could decrease in the coming years.

[3] Data on file with the Indiana Department of Natural Resources-Division of Forestry, Indianapolis, IN.

In many respects, the history of active forest management in Indiana has been synonymous with the management of the oak species. Although walnut, maple, cherry, ash, and many other hardwood species certainly have economic and environmental values, the oaks are considered the most important aggregate of hardwoods found in North America (Harlow et al. 1996 from IDNR-Division of Forestry 2008a).

Oaks have a low tolerance of shade, so are generally early- to mid-successional species. Most oak seedlings can survive under low light conditions if food reserves stored in the cotyledon of acorns are adequate; but once those reserves are depleted, light becomes the limiting factor (IDNR-Division of Forestry 2008a). As oak mortality occurs, competing species such as sugar maple (*Acer saccharum*) and yellow-poplar take their place. If advance regeneration can occur under a closed canopy, followed by a disturbance that removes overstory to increase light to the forest floor, the chances of oak seedlings' successfully competing are enhanced. Without large-scale disturbance, the oaks have difficulty maintaining their dominance.

Native Americans used fire to convert forest land to an earlier successional stage, thus encouraging the growth of forbs and herbaceous cover and increasing wildlife habitat for hunting. Early settlers cleared forest land for agriculture, grazing, and settlement. All of these practices created disturbance that favored the regeneration of oak species. As the human population increased, however, large-scale fires were suppressed, giving the competitive advantage to more mesophytic tree species.

Today's Indiana woodlands have been shaped by disturbances far different from those of presettlement times. A great deal of data suggests that mature and over-mature oak-hickory stands are shifting to other forest types due to diminishing regeneration (IDNR-Division of Forestry 2008a). Because oaks generally grow more slowly than their competitors and are shade- and flood-intolerant, oaks are at a distinct

disadvantage. Aside from the lack of landscape-altering fire, management practices on both public and private land over the past several decades have not been particularly conducive to oak regeneration. High-grading on private forest land and relatively low levels of harvesting on public lands using principally single-tree selection have resulted in conditions unfavorable to oak regeneration. High-grading on private land can remove canopies before advance regeneration of oak seedlings occurs. Selective harvesting on public land allows little or no additional light through the canopy. Without advance regeneration, faster growing, more shade-tolerant species will quickly outcompete the oaks. Although oak seedlings are still present in Indiana forests, competitors outnumber them 4 to 1 statewide (IDNR-Division of Forestry 2008a). It is highly unlikely that natural regeneration will result in the oaks' return to dominance in an undisturbed stand. Intentional management will be required if Indiana's forests are to have a dominant presence of mature oaks in the future.

In recent years, prescribed fire has increasingly been used to reduce competition with oak seedlings. One adaptation that oaks have in their favor is rapid root growth. Although shoot growth of oak seedlings is very slow, oaks' roots grow faster than those of most of their competitors. Dormant buds near the root collar allow oak seedlings to resprout after top kill from fire or deer browse (IDNR-Division of Forestry 2008a). Each resprouting strengthens the root system and adds mass to it so that when disturbance increases the level of light, the shoot responds with vigorous growth. Mechanical removal of competing vegetation, soil scarification, and the application of herbicides are additional practices being used to eliminate competing tree species. Perhaps the most effective means of re-establishing forests with an oak dominance is through silvicultural practices that allow for enough light to reach oak seedlings. Combining selective harvesting with creating openings, small group selections and shelterwoods are being used to create conditions of more light without completely opening up the canopy.

Of course, not all forest management is focused on perpetuating the oaks. Public lands are managed for a multitude of purposes, including recreation and aesthetics. An uninterrupted tree canopy is important to visitors, providing a "natural" look to the forest. The varied tree species composition and forest structure of an uneven-aged stand also enhance wildlife habitat diversity and aesthetic appeal of the forest. Single-tree selection is used predominantly to maintain the uneven-aged stand, with group selection harvests employed when the goal is to open an area for shade-intolerant species. Group selection openings of at least 0.10 ha (0.25 acre) in size on south-facing slopes and 0.20 ha (0.50 acre) in size on north-facing slopes are generally used, with east and west slope openings of about 0.13 ha (0.33 acre) (IDNR-Division of Forestry 2008b). Group selections are generally not applied in areas where trees exhibit good health and vigor, but rather where a thinning to release trees of good quality is no longer possible. After approximately 10 years, TSI is done to the area to release crop trees, and prescribed fire may also be used if the principal crop trees in the area are oaks.

Creating a shelterwood situation is another option, removing the lower canopy of shade-tolerant trees by using prescribed fire or killing the lower canopy trees using TSI along with herbicides. This approach is generally used when there is an adequate number of seed trees or where it is practical to underplant seedlings in openings. Once the planted or regenerated seedlings have reached sufficient size, competition from overstory trees can be eliminated by removal or TSI.

When the goal is to improve development of existing trees without focusing on new seedling establishment, intermediate cuttings may be used. The practice may be a commercial harvest, TSI operation, or a combination of both. In any case, defective or otherwise undesirable trees are removed from the stand to improve overall stand quality. Whether management is even- or uneven-aged, thinning is an

intermediate cutting practice used to decrease stand density. Selection thinning removes dominant or co-dominant trees to release desirable trees in the lower canopy. Geometric thinning, most often used in a plantation, removes trees in a predetermined pattern. Free thinning is the combination of more than one thinning method (IDNR-Division of Forestry 2008b).

Deciding what combination of the above choices to use requires evaluating trees for vigor, canopy position, relationship of species with the site, best use of site space, and desired future development of the site. The limitations and potential of each species must be considered. Evaluation of the impact of surrounding trees must also be done to prevent possible damage to a crop tree during harvest or TSI operations. Aspect as related to the position of the trees that are to remain must also be taken into account. Removing or killing a tree on the south side of a crop tree, particularly on a north-facing slope, will yield greater benefit to the remaining crop tree than removing a tree on the north side of that crop tree.

Although management for factors other than timber production certainly occurs on public land, examples of these practices are quite common on private lands. Management to maximize mast production for wildlife, or to enhance cover or nesting sites, might lead a landowner to favor certain tree species over others regardless of timber value. Aesthetics and recreation are often cited as reasons for owning forest land, so trees with a form that might otherwise be considered undesirable might be retained for these values. In these situations landowners still employ selection thinning, simply basing their tree selections on different criteria.

Because of the greater emphasis today on the aesthetic and recreational potential of forest land, citizens have become a much more active voice in formulating forest management policies. The technical expertise of a professionally trained forester is still a valuable component in forest planning, but the forester now serves as just one member of a team in determining policy. To better facilitate this process, the Indiana Forest Stewardship Coordinating Committee was established. This committee brings together a wide range of individuals, organizations and agencies who share a common interest in the health and vigor of our forests, but who may differ on how that should best be achieved. The Forest Stewardship Coordinating Committee meets regularly to keep the lines of communication open and promote better understanding of forest management issues. The guiding principles of the group are spelled out in the Indiana Statewide Forest Strategy, a document that reflects a consensus of opinions gathered from forest stakeholders, both public and private (IDNR-Division of Forestry 2011).

The history of Indiana's forest resources has been one of drastic and relatively abrupt changes over the past 200 years. Forests covered more than 8.4 million ha (21 million acres) of what was to be Indiana when settlers arrived, but accounted for only 607,000 ha (1.5 million acres) as recently as 100 years ago. Previous Indiana inhabitants may have viewed the forest as an endless resource to be exploited, but we have come to appreciate the forest for its many benefits, including watershed protection, wildlife habitat, recreation, air purification, and fiber production. We also recognize the importance of managing our forests with the best science at hand so their many benefits will be enjoyed for generations to come. The fact that there is more than three times the amount of forest land today than there was 100 years ago is testament to the effectiveness of management.

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