RESTORING SUSTAINABILITY FOR WHITE OAK AND UPLAND OAK COMMUNITIES:

AN ASSESSMENT AND CONSERVATION PLAN

WHITE OAK INITIATIVE

WWW.WHITEOAKINITIATIVE.ORG

"The White Oak Initiative is unique because it brings together end users of the product with private landowners, researchers, industry, state and federal agencies, and conservation groups to help sustain white oak into the future."

— MELISSA MOELLER, WHITE OAK INITIATIVE DIRECTOR

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The Assessment & Conservation Plan is a product of the White Oak Initiative. It is produced under the direction of the White Oak Initiative Steering Committee and written and produced by the American Forest Foundation and the University of Kentucky.

INTRODUCTION

This Assessment & Conservation Plan was developed by the American Forest Foundation and the University of Kentucky under the direction of the White Oak Initiative Steering Committee.

STEERING COMMITTEE MEMBERS DURING CREATION OF THE ASSESSMENT AND CONSERVATION PLAN

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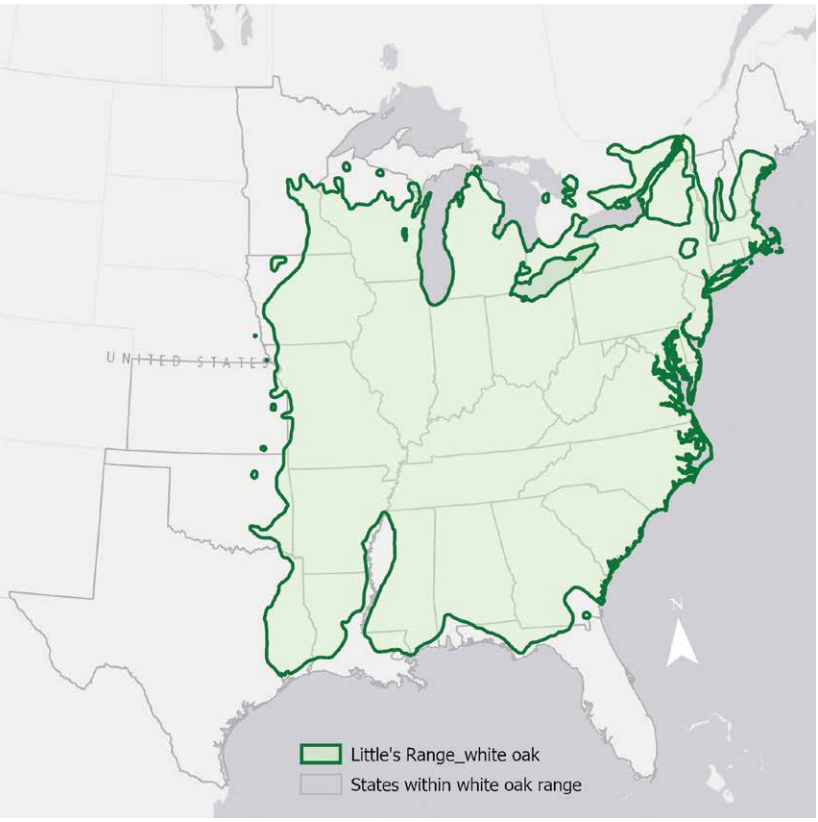
Elizabeth Wise, Sazerac

ABOUT THE WHITE OAK INITIATIVE

The White Oak Initiative is addressing needs for awareness, research, technical and financial assistance, education, communication, policy, and locally customized on-the-ground implementation.

White oak is a dominant tree species across the Central, Northern and Appalachian hardwood regions. Its range spans more than 20 states, covering much of the eastern United States. Not only is it important ecologically and economically, white oak is critical to many wildlife and pollinator species and a foundation for many upland hardwood forests. Sustaining significant white oak resources is vitally important to a variety of environmental and social values, including the long-term survival and growth of important economic sectors responsible for contributing to local economies throughout the white oak region.

WHITE OAK (QUERCUS ALBA) RANGE



Source: USDA Forest Service, Northern Research Station Forest Inventory Analysis

While white oak growing stocks are currently sufficient to meet demand for uses in an array of forest products, forest monitoring and long-term projections show significant problems in maintaining high-quality white oak regeneration. Areas where these trees grow have been subjected to changes in land-use and forest management practices that have contributed to an increasing number of competing species establishing themselves in the understories of our oak forests. These species are shading out oaks, preventing the regeneration needed to conserve our oak forests and our white oak resource. There are still plenty of healthy oak trees in our nation's eastern woods, but they are not being replaced by a meaningful number of younger trees. If current management trends continue, white oak populations will decline significantly in the coming decades. This means there is a sustainability problem looming for industries and wildlife species that rely on white oak and other upland oak species.

The White Oak Initiative was formed in 2017 by a group of organizations that all rely on or care about white or upland oak for a variety of reasons. Their goals are to raise awareness of the looming predicament and to incorporate more stakeholders to address the challenge most effectively, thereby fostering long-term sustainability of upland oak forests. To accomplish this, the White Oak Initiative is addressing needs for research, technical and financial assistance, education, communication, policy, and locally customized on-the-ground implementation. The Initiative's partners include universities, state and federal agencies, private landowners, conservation organizations, trade associations, businesses, and forest industries — all committed to the long-term sustainability of upland and white oak forests and their economic, social, and environmental benefits for centuries to come.

Matthew Vandersande

ABOUT THE WHITE OAK INITIATIVE ASSESSMENT & CONSERVATION PLAN

The *White Oak Initiative Assessment & Conservation Plan* was developed with review and input from hundreds of resource professionals and stakeholders who are affected by and interested in the goals of the White Oak Initiative. It represents a first-ever effort to frame forest-management activities across the entire range of eastern oak forests in a way that supports, improves, and accelerates the cumulative success and effectiveness of oak sustainability. It particularly applies to white oak, which has the broadest distribution of all the eastern upland oak species. Practices that focus on this keystone species provide benefits across all oaks, the upland forests they inhabit, and the wildlife and water resources they provide. However, upland oaks in general face many of the same challenges that affect white oak.

The *Assessment & Conservation Plan* is written for resource professionals, policymakers, landowners, and other individuals and organizations that are involved in and affected by decision-making related to forests in the region. Their active participation is essential for further refining and delivering the recommendations of the *Assessment & Conservation Plan* via strategies that are customized for different sectors and audiences. The *Assessment & Conservation Plan* and the White Oak Initiative are founded on the premise that effective efforts to restore sustainability of white oak-dominated forests will require a multitude of partners working collaboratively in a strategic, coordinated, and sustained fashion. This first-time, comprehensive approach is expected to be more effective than previous individual efforts because of the opportunity to coordinate resources, to share what has been learned, and to leverage the momentum of a range-wide effort.

The *Assessment & Conservation Plan*'s Assessment section describes the current state of declining upland oak forests with an emphasis on white oak. It also summarizes results from completed research, including a technical introduction, a landowner survey and a spatial analysis. This sets the stage for future long-term management actions, which are summarized in the Conservation section. The details that are specified in the *Assessment & Conservation Plan* will continue to evolve and be refined as we gain knowledge and experience in the coming years.

Please go to **www.whiteoakinitiative.org** for additional information, contact information, and new developments on white oak. We appreciate the contributions of all involved to date and are eager to have your input, advice, and help to achieve our vision of ensuring a future for oak ecosystems and the many benefits they provide.

CURRENT AND PAST STEERING COMMITTEE MEMBERS

Alabama Forestry Commission

American Forest Foundation

American Forests

Appalachian Hardwood

Beam Suntory

Brown-Forman

Central Kentucky Forest Management Inc.

Columbia Forest Products

Cumberland Springs Land Company

dendrofund

The Forestland Group

Independent Stave Company

Kentucky Forest Industries Association

Missouri Conservation Department

NHLA

NRCS

nwtf

The Ohio State University College of Food, Agricultural, and Environmental Sciences

Sazerac New Orleans

Tennessee Forestry Association

Eastern & Southern Regions

Virginia Department of Forestry

WestRock

A LETTER FROM THE WOI EXECUTIVE COMMITTEE 2/3/2021

The first time the three of us were in a room together was in the summer of 2017. We had come together in Louisville, Kentucky, to outline how our organizations might work together to establish an initiative to ensure that our future forests included white oak at a level commensurate with its current composition.

There was a clear call for action among industry stakeholders, conservation groups, state and federal agencies, and universities for sustaining white oak resources. The stage had been set for developing a regional effort to promote white oak resources and the decision to establish a "white oak initiative" had been made. However, the details on what this would look like, how it would be structured, and how it would function were unknown. We recognized that without intervention at a grand scale, several decades in the future there would begin a precipitous decline in the extent of mature white oak and other upland oaks in the forests of the Central hardwood region of the United States. Further, given how long it takes to grow a mature oak, any decline would take decades to even begin to reverse. This reality clashed with the respective missions of our organizations. We recognized that any delay in acting would only exacerbate the already difficult challenge we face. This was the challenge that faced us the first time we met to get the ball rolling.

From those early discussions emerged the White Oak Initiative. Through the hard work, dedication, persistence, and resolve of many individuals and organizations, we have now completed an *White Oak Initiative Assessment & Conservation Plan*. This plan is not a finished work; rather, it reflects what we now know and understand about white oak and other upland oaks, and what it will take to ensure that our grandchildren and their grandchildren can enjoy the same array of economic, ecological, and social benefits that we enjoy from oak forests today. This is a living document and one that will be updated through the White Oak Initiative as we continue to act, learn, and adapt in our work to achieve our desired future.

The challenges and the opportunities that are outlined in this document show us a path forward. We are thankful for the array of talent that has served on the White Oak Initiative Steering Committee, which has guided this work and will guide the work that lies ahead. We also are thankful for the talented staff at the American Forest Foundation and the University of Kentucky who have done the heavy lifting on this assessment and plan.

We welcome your involvement going forward. If you have not already done so, please connect with the White Oak Initiative. It will take all of us working in alignment across this expansive region to return balance to our oak forests.

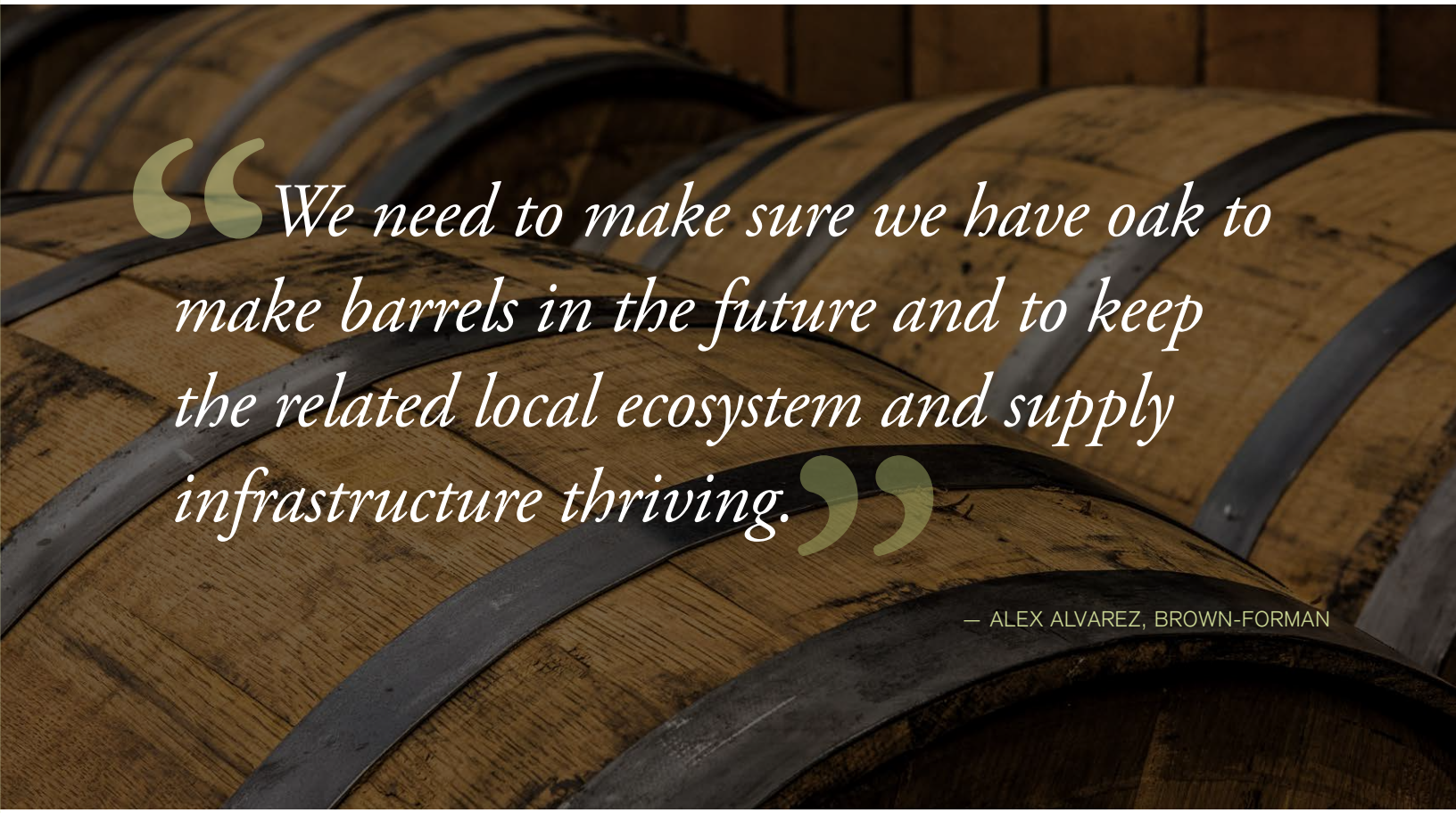
Thank you,

Paul DeLong
American Forest Foundation

Barbara Hurt
DendriFund

Dr. Jeff Stringer
University of Kentucky

EXECUTIVE SUMMARY



"We need to make sure we have oak to make barrels in the future and to keep the related local ecosystem and supply infrastructure thriving."

— ALEX ALVAREZ, BROWN-FORMAN

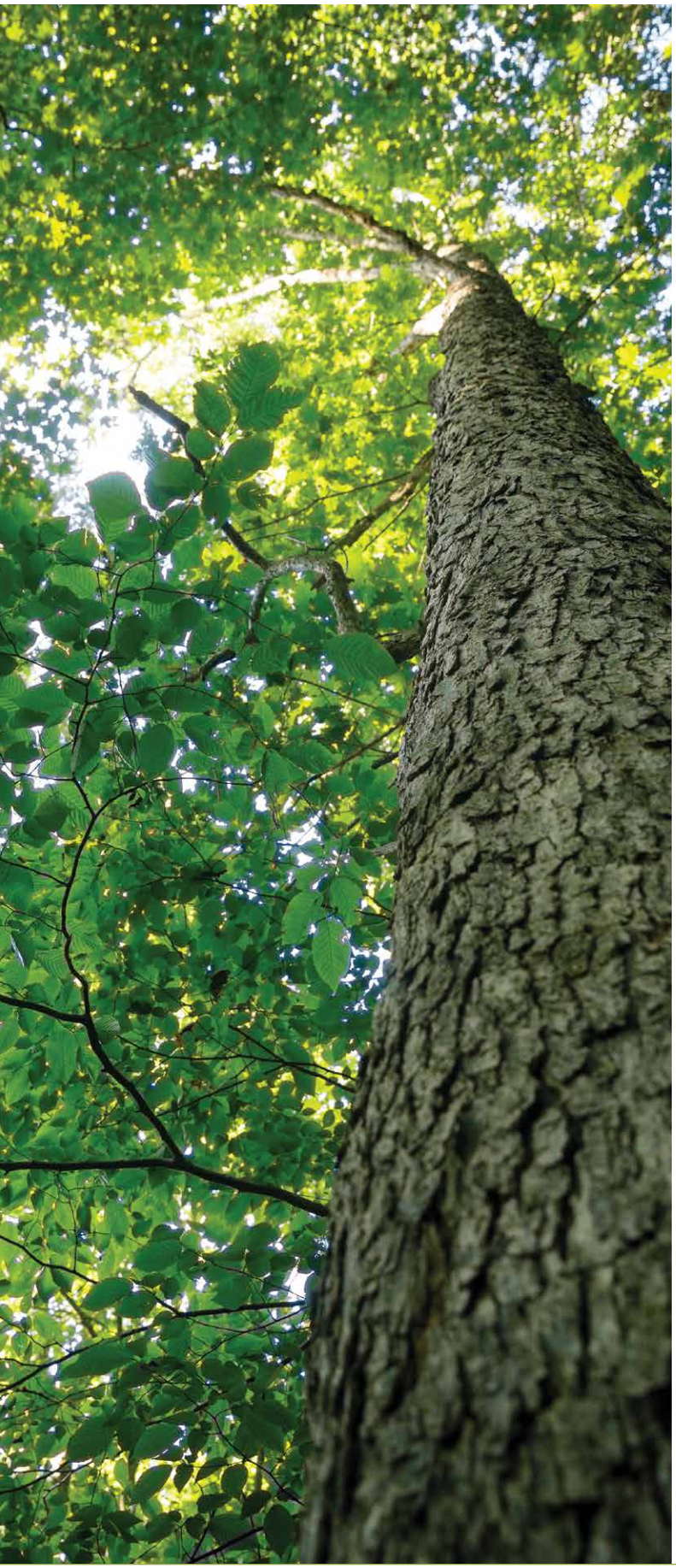
A BRIEF DESCRIPTION OF WHITE OAK

White oak (*Quercus alba*) is a cornerstone species of the forests of the eastern United States. From east Texas to Florida in the South, north to Maine and then west again to Minnesota, more than 100 million acres of white oak, a foundational species of upland oak forests, can be found. While the species occurs over a wide range of environments from rich-soil coves to dry ridges, it is most prevalent on well-drained, moderately productive upland sites.

White oaks are relatively long-lived compared to many of the tree species it lives with, capable of living more than 300 years. Mature white oaks can be taller than 100 feet, with trunks two to four feet in diameter. Their bark is light grey; however, the bark pattern can vary from tree to tree, with some trees having shallow ridges while some develop large gray plates. Their twigs are slender and smooth and their deeply rounded, lobed leaves are smooth and light green, transitioning to yellow, orange, and fiery red in the fall. Yellow male and red female flowers occur on the same tree; as with all oaks, they are pollinated by the wind. White oak wood is heavy, strong and water-resistant, with some of the highest commercial value of any tree species in the eastern and midwestern United States.

White oaks often grow alongside many other species. While white oaks tolerate shade better than most other oak species, they cannot tolerate deep shade; but neither are they the fastest-growing in full sunlight, instead competing best in moderate shade. In the North, white oaks often grow alongside white pine, sugar maple, and hemlock trees, while loblolly and shortleaf pine trees typically share white oak forests in the South.

But white and upland oaks are not simply important because they are attractive trees, or even because there are a lot of them across a wide area of the eastern United States. Oaks are a foundational species, with significant impacts on their ecosystem. Because of their high canopy and crown architecture, upland oaks allow a relatively high amount of light to reach the forest floor.



Historically, these forests tend to have open midstories and dense groundcover. This supports extensive plant and animal biodiversity, especially relative to forests dominated by other regional tree species, such as maple and beech, that darken forest floors and reduce species diversity.

Upland oaks also produce acorns — an important food resource for wildlife, especially with the widespread loss of American chestnut trees in the first half of the 20th century. While all oaks produce acorns, white oak has some of the most nutritious acorns, which are a preferred food for many wildlife species, including white-tailed deer and wild turkey. White and upland oaks also provide or support important habitat for a diverse range of insects and game and non-game birds and mammals. For example, large crowns of mature white oaks are preferred by cerulean warblers, while large hollow oaks are often used as black bear dens. Even forest-dwelling bats, including some species such as the Indiana bat that are threatened and endangered, are known to roost beneath white oak bark.

A CONSEQUENTIAL SHIFT

Because oaks, including white oak, are currently so abundant and widespread in some age classes, it is difficult to comprehend a problem with their sustainability. Comprehension of the problem is also difficult because changes in forests are relatively slow by human standards; it can be difficult for us to recognize long-term changes in our upland oak forests. However, the changes are real, and action must be taken now to avoid a significant reduction in oaks and white oak in many forests in the eastern United States. Currently there are enough oak trees, including white oak, to meet industrial demands and to support wildlife, but most of these trees are mature. About 75% of all white oak acres across the eastern United States can be classified as mature from an economic and/or reproductive perspective while the populations of young white oak trees are limited, signaling a long-term issue with sustainability. While there are some regions, such as parts of Missouri and Arkansas, where oaks are relatively successful in producing young trees to replace the maturing overstory, there are extensive regions where this is not the case. In simple terms, this means that as mature white and upland oaks age and die or are harvested, their places are being taken by other species. As a result, without intervention, there will be a marked decline in the amount of oak in our eastern forests beginning in the middle part of this century.

FOCUS ON WHITE OAK CHALLENGES

The problems facing upland oaks are common to all oak species. White oak has the broadest distribution of all upland oaks, its range encompassing much of the eastern United States. These trees, which rely on fire to reproduce, generally take 60-80 years, under the best conditions, to reach the minimum size needed for

use in a broad mix of products and up to 120 years to reach full economic maturity. These facts, along with white oak's economic and ecological significance, have helped to drive development of a white oak conservation plan that covers much of the same ground — both figuratively and literally — as all upland oaks.

White oak and upland oak forests face a variety of challenges that must be addressed to stave off the long-term loss of oak dominance in many regions of the eastern United States, including:

- **Changes in land use and protection of our forests** that have led to a reduction in prescribed and natural wildfires. Other major disturbances, including excess deer browse in some areas, have also caused environmental declines and have allowed competing species to gain a larger foothold in our oak forests.
- **A lack of active forest management** to help counter the changes in land use and remove competing species and low-quality "stands" (contiguous communities of trees that are sufficiently uniform in characteristics or location to distinguish them from adjacent communities) that are blocking the growth of quality trees and the regeneration of new oak trees.
- **Decreased demand for products made from other tree species,** leading to selective harvesting of high-value species such as oak and allowing other tree species to dominate the ecosystem.
- **Widespread invasive insects such as cottony cushion scales, invasive plant species such as English ivy, and diseases such as oak wilt.**
- **Changing climate conditions** that are predicted to change forest composition and influence many factors impacting oak species and oak forests.

To address these challenges, the White Oak Initiative has enlisted universities, state and federal agencies, private landowners, conservation organizations, trade associations, and forest industries including wine/spirits, flooring, cooperage, and timber. The group is committed to the long-term sustainability of white oak forests — and their economic, social, and environmental benefits — for centuries, not just decades. Creating a sustainable plan for white oak can help to preserve existing industries and the jobs associated with them, as well as the ecosystems for which oaks are a keystone species.

To restore white oak, we need to think, plan, and act decades ahead to prevent a crisis situation. Action is critical in light of changes already occurring in our white oak forests and to address climate change and forest health issues anticipated to further degrade white oak. The key to addressing these challenges is growing healthy, resilient, and robust white oak forests that are capable of fending off insects, diseases, and competition from natural and exotic species, and of adapting to an ever-changing environment. To give our oak forests the best chance for a healthy future, we can begin to actively remove competing tree species, improve oak regeneration, treat invasive insects and disease, and create conditions that are conducive to growing oaks.

PUBLIC AND PRIVATE FORESTS

Upland oak forests extend across public and private lands, although most upland oak forest acreage can be found on relatively small private forest properties, as the vast majority of eastern U.S. forestland is privately owned, according to the USDA Forest Service's Forest Inventory and Analysis National Program. To achieve its goal of conserving our nation's oak forest resources, the White Oak Initiative seeks to coordinate efforts across public and private lands and to assist private landowners via the following supporting goals:

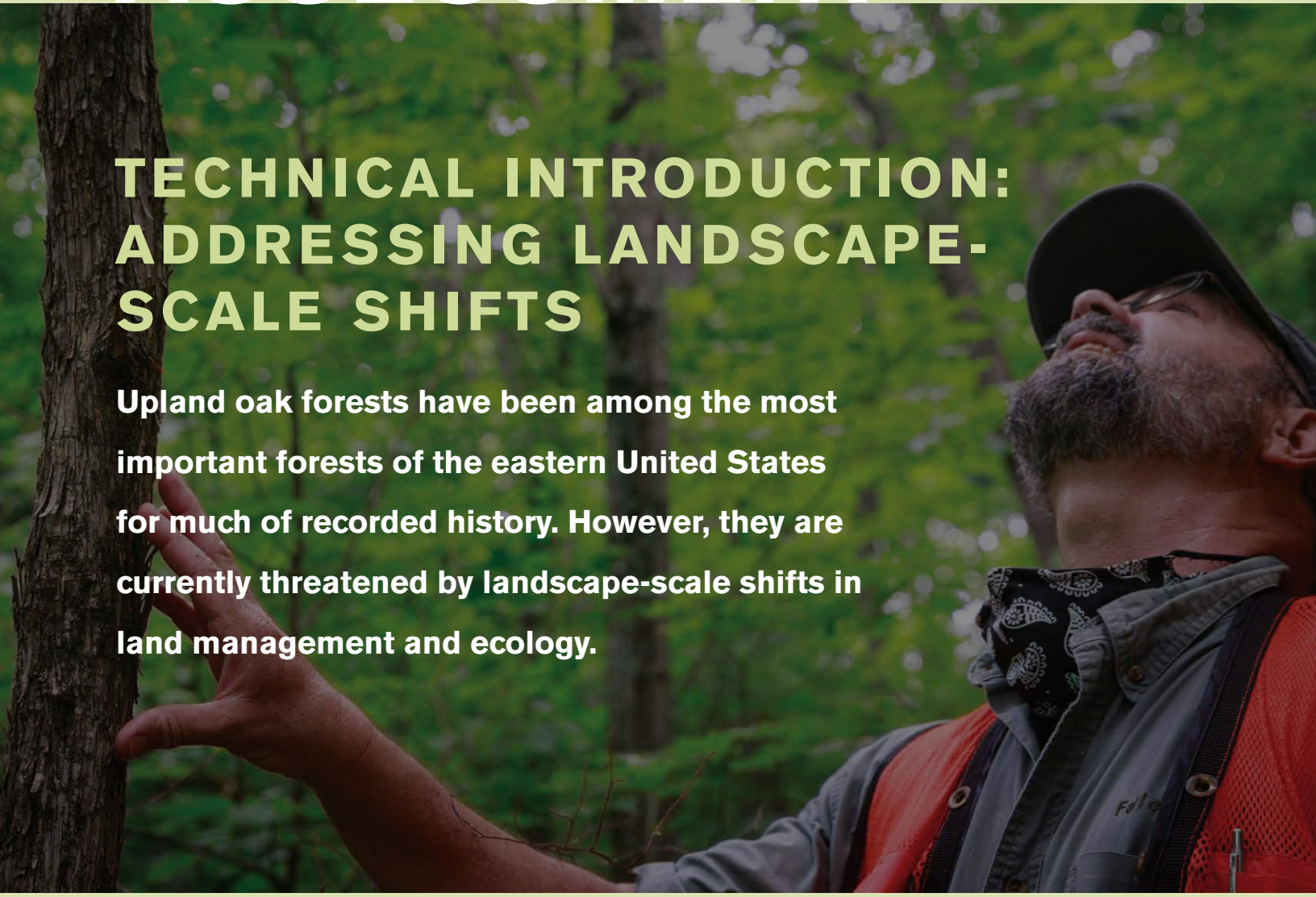
- **Providing technical assistance** to implement forest management plans.
- **Connecting landowners** with skilled loggers and knowledgeable foresters.
- **Identifying markets** for smaller trees and other species, defraying the cost of oak management.
- **Developing implementation strategies** that are customized for different geographies, sectors, or audiences.

While efforts to conserve and restore oak forests are underway, the future of oak forests is uncertain and much more can be done. This is why, starting in 2018, the White Oak Initiative began working with key partners to prepare a framework for white oak conservation work. With the support of USDA Forest Service Landscape Scale Restoration program grants and key public and private partners, the White Oak Initiative has developed this range-wide *Assessment & Conservation Plan*.

In general terms, the *Assessment & Conservation Plan* describes long-term recommendations to improve upland oak forest sustainability and to guide actions to support our upland and white oak forests. More specifically, the Plan is intended to help White Oak Initiative members, partners, and other stakeholders to answer the questions:

- What do we need to do?
- Where do we need to focus?
- How are we going to get things done?

ASSESSMENT



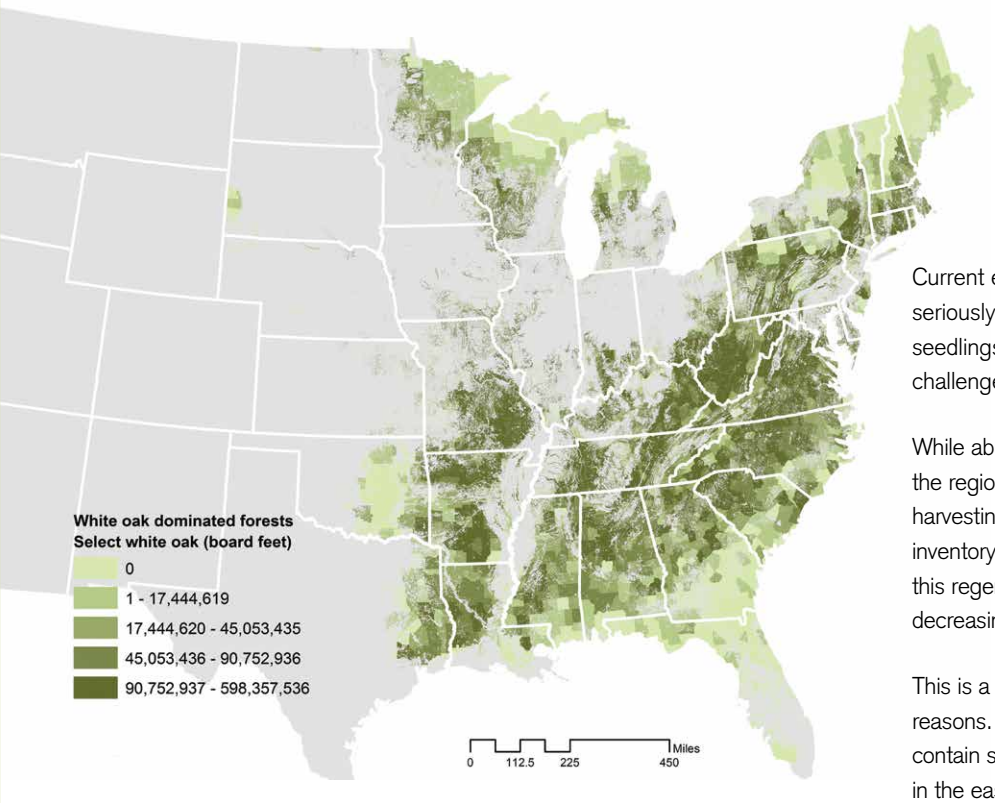
TECHNICAL INTRODUCTION: ADDRESSING LANDSCAPE-SCALE SHIFTS

Upland oak forests have been among the most important forests of the eastern United States for much of recorded history. However, they are currently threatened by landscape-scale shifts in land management and ecology.

Oak trees in the eastern United States increased in importance and occurrence due to a historical legacy of disturbance, the most prevalent being frequent fire throughout the region, including prescribed burns by indigenous people. After European settlement, fires became even more widespread a result of land-clearing, industrial activity such as railroads and iron production, and other activities that resulted in uncontrolled fires across the landscape. Uncontrolled wildfires were far different in intensity and occurrence from the controlled burns used for conservation practices today. Regardless, fire preferentially killed several tree species that competed with oak and reduced competition during the seedling-sapling stage of oak regeneration development. This maintained canopy openness that allowed enough filtered sunlight for oak to establish and become competitive. In addition, the American chestnut blight created space for oaks. In recent decades, declining oak regeneration — in harvested and non-harvested oak forests alike — has been attributed to widespread fire suppression and other factors that have facilitated the invasion of oak forests by competing plant species.

Throughout the eastern United States, upland oak forests are transitioning to forests that are increasingly dominated by shade-tolerant, fire-intolerant species such as maple and beech. These and other tree and plant species generate understory conditions that increase shade, increase the likelihood of high-severity fire, and limit oak regeneration. Other present and possible future threats include excessive deer browsing, invasive pests, invasive plants, pathogens, and stressors related to climate change.

WHITE OAK-DOMINATED FORESTS ARE FOUND ACROSS THE EASTERN UNITED STATES

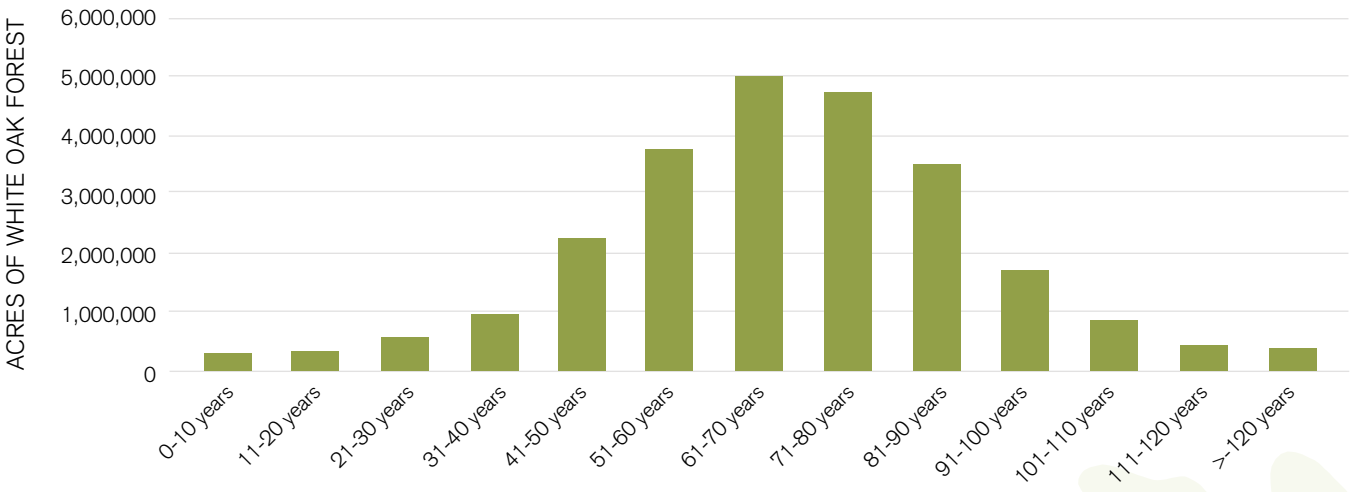


Source: USDA Forest Service
Southern Research Station, Forest Inventory & Analysis Program. Christopher M. Oswalt, March 2015.

Current estimates suggest that the upland oak resource is seriously threatened, as a decreasing percentage of oak seedlings and saplings presents a significant regeneration challenge.

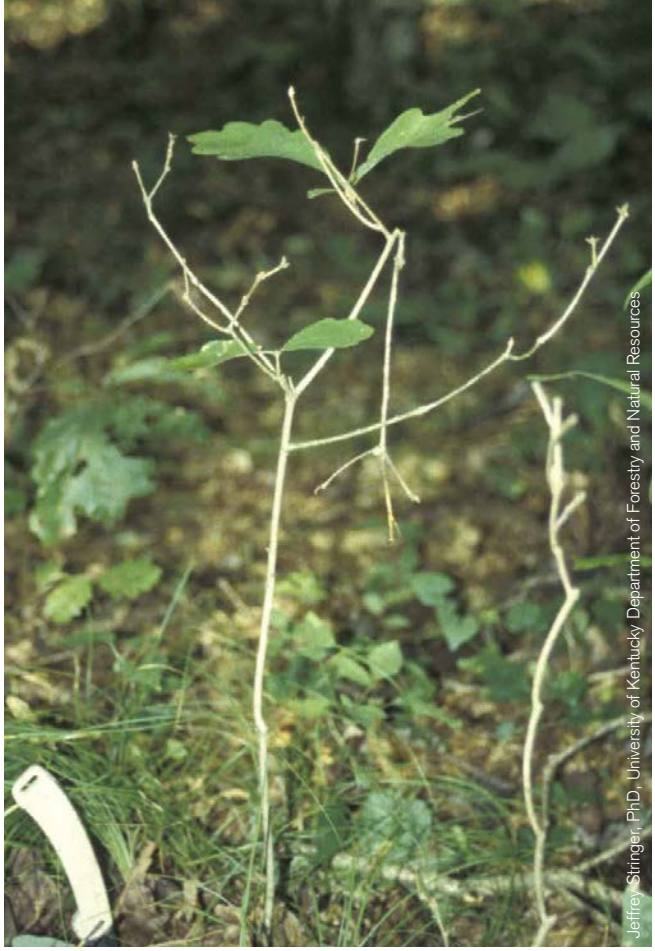
While abundant white oak timber volume is present across the region, these changes in regeneration and accelerated harvesting of high-quality white oak are observable in forest inventory data. In the coming decades or potentially sooner, this regeneration issue may become more apparent with the decreasing availability of white oak timber resources.

This is a concern for several economic and ecological reasons. For example, oak forests and white oak in particular contain some of the most valuable hardwood resources in the eastern United States. Forest sector economic reports from Central hardwood region states, where white oak predominates, clearly indicate the importance of oak



The age class distribution of white oak across Illinois, Indiana, Kentucky, Missouri, Ohio, and Tennessee shows the number of acres of white oak-dominated forests in different age classes. The curve shape indicates a lack of younger age classes needed for replacement over time.

Source: EVALIDator, version 1.7.2.00

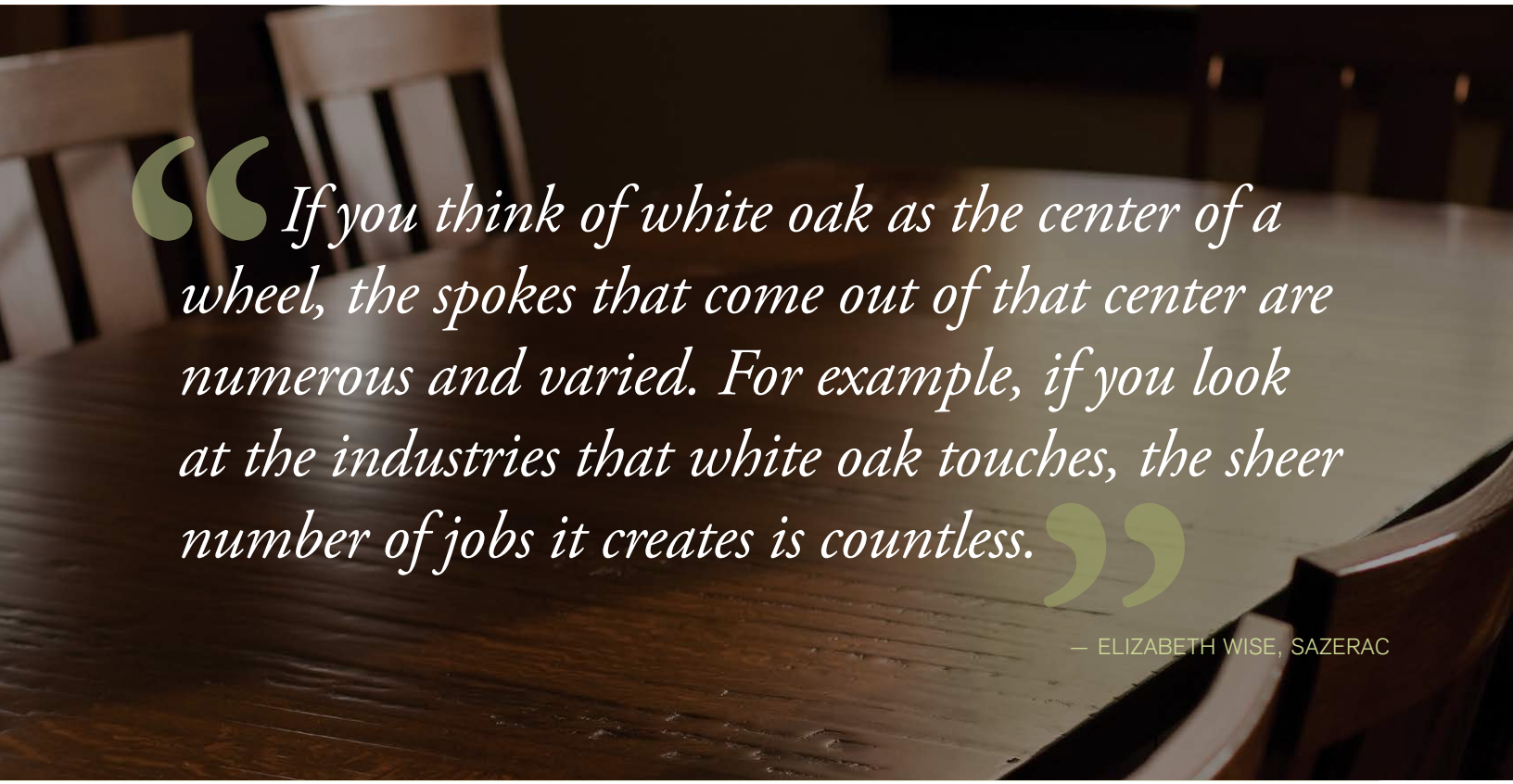


Dense understory and midstory shading, often by maple(s) and beech trees, tends to suppress white oak seedling growth, as shown by this 14-year-old low-vigor seedling.

resources, which generate billions of dollars annually to individual states. One example is Kentucky, where white oak has an estimated $2 billion annual impact on the wood products sector and a $6 billion annual impact on the distilling industry. While the distilling industry is particularly strong in Kentucky, the wood products industry's economic importance in other states in the region is similar and contributions from white oak are similar in magnitude. Regional oaks supply a timber industry that supports furniture, flooring, cabinetry, barrels, and other wood products.

Oak forests also provide a critical food source for a variety of wildlife species and serve keystone roles in maintaining diverse forest ecosystems. White oak hosts more than 100 moth and butterfly species that are essential for pollination and are food sources for breeding birds. They supply food and shelter for a large number of important non-game and game species such as squirrels, foxes, white-tailed deer, ruffed grouse, and wild turkey. They also provide habitat for species of concern such as the cerulean warbler and federally threatened and endangered forest dwelling bats, such as the Indiana and northern long-eared bat.

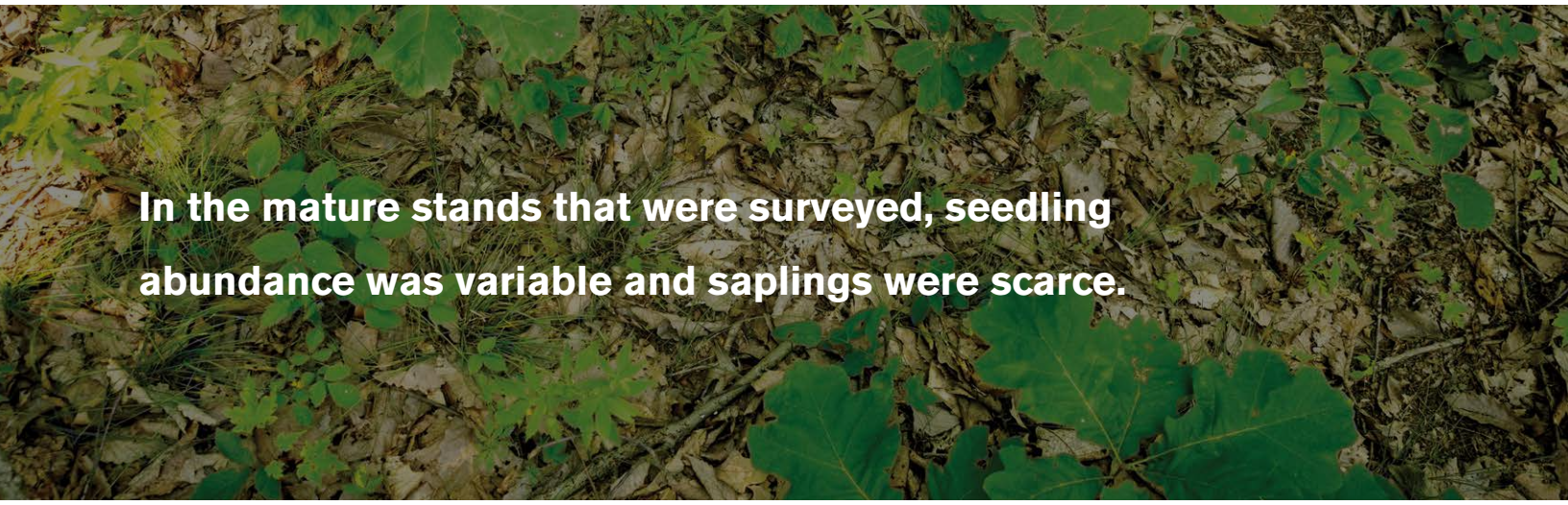
While efforts to conserve and restore oak forests are underway, the future of oak forests is uncertain and much more can be done. Upland oak conservation efforts have major implications for the eastern United States' ecology and economy, and thus should represent a major conservation and management priority.



"If you think of white oak as the center of a wheel, the spokes that come out of that center are numerous and varied. For example, if you look at the industries that white oak touches, the sheer number of jobs it creates is countless."

— ELIZABETH WISE, SAZERAC

SPATIAL ASSESSMENT



In the mature stands that were surveyed, seedling abundance was variable and saplings were scarce.

INTRODUCTION: PRIORITIZING CONSERVATION EFFORTS

To help evaluate upland and white oak conditions and set local priorities to restore conservation priorities, the White Oak Initiative commissioned a regional spatial analysis project. Conducted by scientists at the University of Missouri and engineering, design, and technology experts at Timmons Group, the analysis provided regional overviews from ecological, economic, social, and wildlife perspectives. The project boundary for the White Oak Initiative Spatial Assessment was based on USDA Forest Service Forest Inventory and Analysis (FIA) data, USDA Forest Service Region 8 and 9 states (Alabama, Arkansas, Illinois, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Missouri, Pennsylvania, North Carolina, Ohio, Tennessee, Virginia, West Virginia, Wisconsin) engaged with the White Oak Initiative Landscape Scale Restoration project, as well as additional southern states to ensure contiguous coverage. Datasets, parameters, and analysis limitations are described in the full University of Missouri *White Oak Regeneration Spatial Analysis* Final Report, found at www.whiteoakinitiative.org/reports, and the full Timmons Group report, *Using GIS To Determine Where to Invest in White Oak Growth*, found at www.whiteoakinitiative.org/reports.

This work was conducted in three separate phases:

1. Ecological assessment
2. Economic, social, and wildlife assessments
3. Spatial assessment that converted phases 1 and 2 into a mapped format

Following are details for each phase.

PHASE 1 — ECOLOGICAL ASSESSMENT

To evaluate forest conditions and evaluate the ecological challenges to white oak sustainability, University of Missouri researchers analyzed FIA data from 59 forested areas in 33 states, spanning nearly the entire U.S. white oak range. The FIA national inventory is a grid of sample locations, each usually representing about 6,000 acres. The data represented forest conditions circa 2017, which was the most recent data year available across the entire region.[1] Results were generally divided into two categories — one for upland oak in general (including white oak) and the other for only white oak. Detailed findings are described in the *White Oak Regeneration Spatial Analysis Final Report*. Following are report highlights.

- **White oak is widespread,** with a range of more than 104 million forestland acres. It reaches its highest concentrations (in percent of acres present) in the Northern Cumberland Plateau, the Boston Mountains of Arkansas and Oklahoma, the Ozark Highlands in and near Missouri, and the Central Appalachian Piedmont.

- **White oak forestland is largely mature.** About 75% of all surveyed white oak acres can be classified as at least mature (approximately 75 years or older) from an economic and/or reproductive perspective and as is defined in the *White Oak Regeneration Spatial Analysis Final Report*.

[1] Population and other attribute estimates were derived using the rFIA package for R software, while all geospatial manipulations were conducted using the raster and sf packages in R software.

Healthy, well-developed white oak seedlings grow after a midstory removal management practice.

- **In mature stands[2], white oaks become increasingly prevalent as large trees,** while seedling abundance is variable and saplings are scarce. In many places, the next generation of white oak in mature stands is not clearly established. An estimated 60% of surveyed mature white oak acres have no white oak seedlings present and about 87% have no white oak saplings present.

- **No section is immune to regeneration concerns.** For example, the Ozark Highlands has the second-highest proportion of mature white oak acres with seedlings (63%) but saplings are overwhelmingly absent (missing from 81% of acres). The presence of seedlings indicates that acorns are successfully germinating and that oaks are becoming established. However, seedlings are failing to grow into saplings, indicating a problem with recruitment of small oak regeneration into larger size classes needed to successfully regenerate oaks, including white oak.

- **Limited canopy recruitment of saplings is a concern across the range.** White oak saplings were absent from 72% of mature white oak acres in all ecological sections.

- **A lack of white oak reestablishment was particularly noticeable in locations that had a least one million mature acres** with white oak trees present but white oak seedlings absent on 75% or more of those acres. These areas included the Driftless and Escarpment area of Wisconsin, Minnesota, and northeastern Iowa, the Gulf Coastal plains and flatwoods, and the Central Appalachians.

- **Establishment concerns were relatively lower** (up to 50% seedling-less acres) in certain areas: the Ozark Highlands, the Shawnee Hills in southern Illinois, the Central Appalachian Piedmont, the Ouachita Mountains of western Arkansas and southeastern Oklahoma, and Michigan's Northern Lower Peninsula.

- **While white oak "sprouting" (new stems growing from dormant buds on the stump or base of a tree after the trunk was harvested, damaged, or otherwise in poor health) can make up some deficit in seedlings and sapling populations in a regeneration event, not all stems will sprout.** Moreover, saplings and small trees are more reliable sprouters than large-diameter trees. Therefore, sole reliance on stump sprouting for regeneration will result in a net loss of white oak in the next generation.

- **Locale, physiography, forest type, and disturbance history** appear to be among the more important variables that contribute to inconsistency in seedling abundance.

- **Seedling and sapling presence and abundance are often spatially variable,** even within an ecological section. This suggests that localized, stand-level drivers and adaptive silviculture (the practice of controlling the growth, composition/structure, health, and quality of forests to meet diverse values and needs, including timber production) will be highly important to stand development and regeneration outcomes.

PHASE 2 — ECONOMIC, SOCIAL, AND WILDLIFE ASSESSMENTS

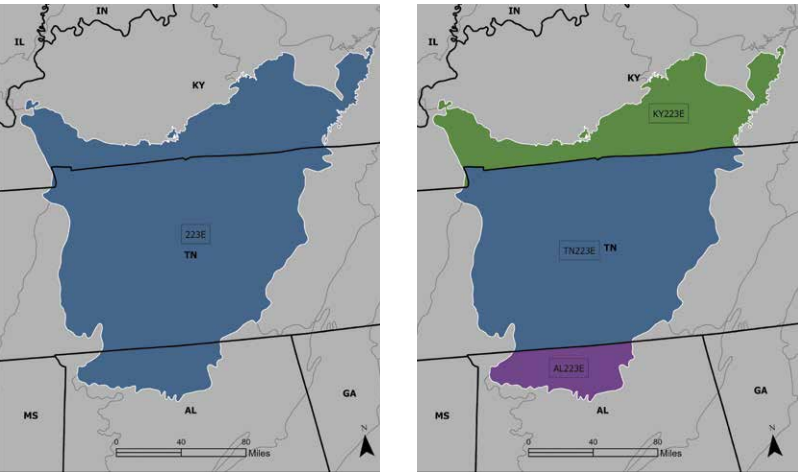
For phase two, the Timmons Group worked with the American Forest Foundation to cross-reference phase 1 data against social and economic factors such as land-ownership data, along with industrial and biological factors. This allowed the Timmons Group

[2] Mature stage plots have at least 67% of their basal area in mature and large diameter classes, with more basal area in the mature class or at least 67% of their basal area in mature and pole diameter classes (diameter at breast height: 4-9 in.) but more basal area in the mature class.

to identify locations across the 20-state study area where efforts to restore oak sustainability would be most likely to succeed. For other areas in the study, the results can be useful in identifying potential areas of improvement that can help efforts to succeed.

One hundred and forty-six different geographical areas called "EcoStates," incorporating state boundaries as well as "ecosections" (an area that was fairly similar in topography, geology, climate, and forest composition), were scored from 0 to 50 for white oak and/or upland oak, in terms of the six data themes listed below. As different themes are considered to have different levels of importance, they were weighted differently as part of the evaluation process. Based on parameters and factors chosen for phase 2 of the analysis, higher ratings indicate superior suitability for potential efforts.

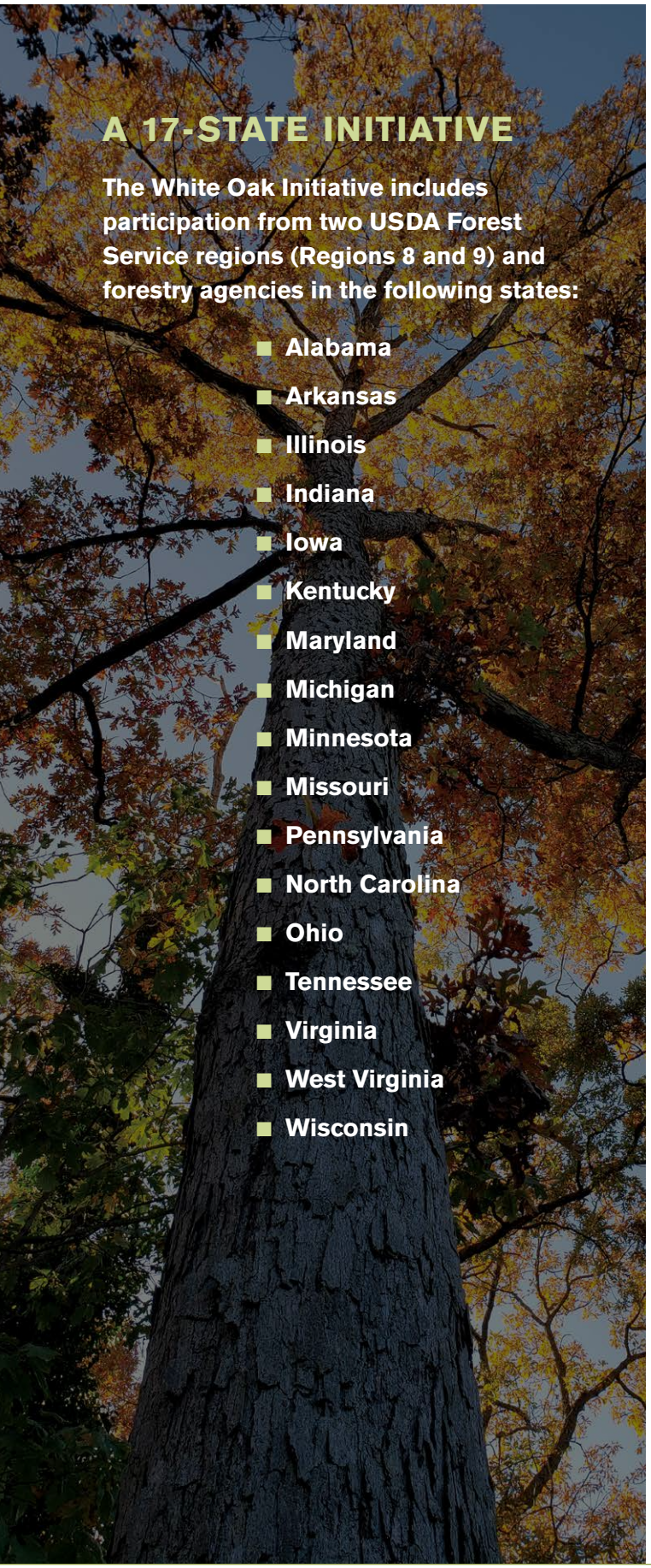
Detailed explanations of phase 2 methodology, limitations, and findings are described in the Timmons Group report, *Using GIS to Determine Where to Invest in White Oak Growth*, which can be found at www.whiteoakinitiative.org/reports.



Phase 2 ecosections typically span state lines, such as Kentucky, Tennessee, and Alabama. These ecosections were also split into units to show state-specific ecosystem portions, or "EcoStates." The image above shows an ecosection (223E) on the left, in blue. This ecosection spans across Kentucky, Tennessee, and Alabama. The right shows the same ecosection cut along state lines, showing the resulting EcoState units (KY223E - green, TN223E - blue, and AL223E - purple). See a map of all ecosections in the full spatial report at www.whiteoakinitiative.org/reports.

CLIMATE CHANGE DATA

One challenge encountered when determining what data to use for the spatial analysis was addressing how a changing climate will affect white oak regeneration. Under guidance from Dr. Jacob Muller, assistant professor at the University of Kentucky's Hardwood Silviculture and Forest Operations Extension, the intention was to investigate potential challenges associated with species range shifts and interspecific competition that could occur with climate change projections across the white oak range, using USDA Forest Service Tree Atlas data along with The Nature Conservancy's Resilient and Connected Landscapes modeling tool. The complex and intricate nature of these tools required resources beyond the team's capacity, which led to a decision not to incorporate climate change data into the spatial analysis. The White Oak Initiative recognizes the importance of incorporating climate change modeling in future analyses and recommends further research on this topic in the near future.



A 17-STATE INITIATIVE

The White Oak Initiative includes participation from two USDA Forest Service regions (Regions 8 and 9) and forestry agencies in the following states:

- **Alabama**
- **Arkansas**
- **Illinois**
- **Indiana**
- **Iowa**
- **Kentucky**
- **Maryland**
- **Michigan**
- **Minnesota**
- **Missouri**
- **Pennsylvania**
- **North Carolina**
- **Ohio**
- **Tennessee**
- **Virginia**
- **West Virginia**
- **Wisconsin**

DATA THEMES

- **Probability of regeneration success.** This data theme, which was based on ecological conditions and derived from phase 1 analysis, included analysis of stand maturity, seedling frequency, and site productivity (weighting: 60%).

- **Enabling conditions of management.** This theme refers to capacity for managing forests and processing timber as represented by the number of foresters and jobs across various relevant industries and the presence of timber mills (weighting: 12%).

- **Forest product demand.** Timber Product Output data were used to quantify recent extraction/demand for white oak in the 20 study states (weighting: 8%).

- **Conservation impact.** This theme is based on whether a particular area has critical habitat for one or more threatened or endangered species (weighting: 6%).

- **Landowner efficacy.** This theme was based on the White Oak Initiative's state-specific survey to gauge landowner sentiment and experience regarding their management history, methods and plans (weighting: 6%).

- **Barriers to success.** This theme was based on pests, pathogens, and deer density, as these factors can be a significant pressure on vegetation growth (weighting: 6%).

Based on phase 1 and 2 analysis, the 146 EcoStates received the following ratings in terms of suitability for efforts to restore oak sustainability. Although all 146 EcoStates can be considered to have potential for success, a higher score indicates more suitability for work to restore sustainability. Specific EcoState scores ranged from approximately 40 (high suitability) to approximately 20 (lower suitability), with an average score of 31.91.

It is important to recognize that the model used in this analysis was configured to support the landscape scale of the analysis and to use data that were readily available across all landscapes. The model used scores and composite scores; in many instances, the reality might not be as simple as the output the model portrays. There is opportunity for further exploration of the data beyond the broad landscape level that was assessed in this analysis. Additional information on ratings, data used, and scoring can be found in full Timmons Group report, *Using GIS to Determine Where to Invest in White Oak Growth*, at www.whiteoakinitiative.org/reports.

WHITE/UPLAND OAK SUITABILITY FOR RESTORING SUSTAINABILITY BY STATE AND ECOSTATE

(A higher score indicates greater suitability for work to restore sustainability)

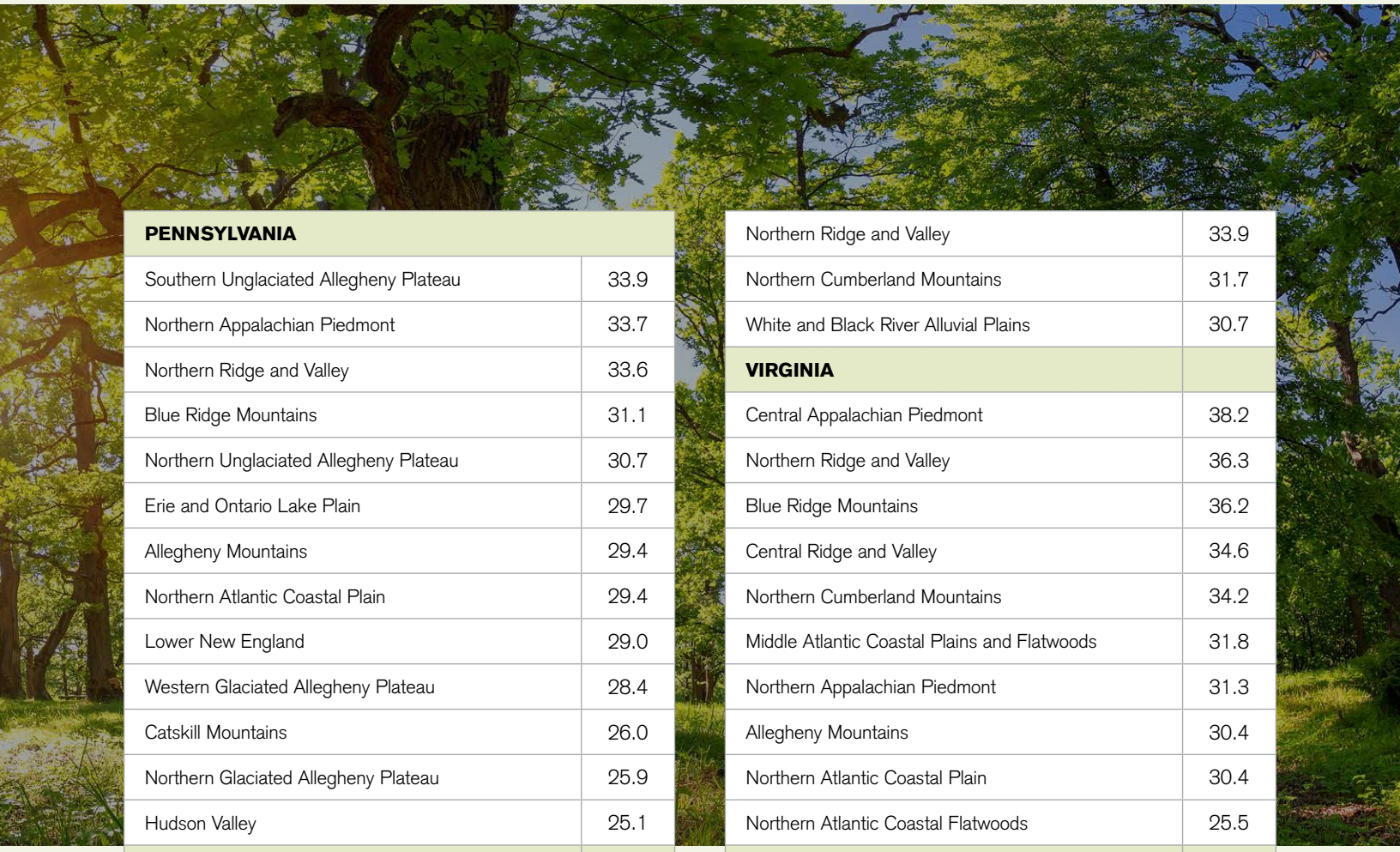
STATE/ECOSTATE NAME	FINAL SCORE
ALABAMA	
Southern Ridge and Valley	40.4
Southern Cumberland Plateau	38.8
Southern Appalachian Piedmont	38.5
Coastal Plains-Middle	37.3
Interior Low Plateau-Highland Rim	36.2
Gulf Coastal Plains and Flatwoods	34.3
Gulf Coastal Lowlands	29.6
ARKANSAS	
Ouachita Mountains	40.6
Arkansas Valley	37.4
White and Black River Alluvial Plains	36.2
Mid Coastal Plains-Western	33.8
Ozark Highlands	33.7
Boston Mountains	33.6
Arkansas Alluvial Plains	29.2
Southern Mississippi Alluvial Plain	20.9
GEORGIA	
Southern Ridge and Valley	42.1
Southern Cumberland Plateau	40.1
Southern Appalachian Piedmont	39.4
Blue Ridge Mountains	36.7
Southern Atlantic Coastal Plains and Flatwoods	33.7
Coastal Plains-Middle	33.2
Gulf Coastal Plains and Flatwoods	32.0
Atlantic Coastal Flatwoods	29.9

ILLINOIS	
Central Dissected Till Plains	32.7
Interior Low Plateau-Shawnee Hills	32.1
Ozark Highlands	31.1
Central Till Plains and Grand Prairies	31.0
Southwestern Great Lakes Morainal	29.3
Coastal Plains-Loess	29.0
Central Till Plains-Oak Hickory	28.4
White and Black River Alluvial Plains	26.8
North Central U.S. Driftless and Escarpment	26.3
Central Till Plains-Beech-Maple	24.5
South Central Great Lakes	23.6
INDIANA	
Interior Low Plateau-Shawnee Hills	30.8
South Central Great Lakes	30.5
Southwestern Great Lakes Morainal	29.7
Central Till Plains and Grand Prairies	27.0
Interior Low Plateau-Bluegrass	26.8
Interior Low Plateau-Transition Hills	26.8
Central Till Plains-Beech-Maple	24.4
Central Till Plains-Oak Hickory	24.2
Lake Whittlesey Glaciolacustrine Plain	24.1
IOWA	
Central Dissected Till Plains	35.7
North Central U.S. Driftless and Escarpment	28.3
Minnesota and Northeast Iowa Morainal-Oak Savannah	23.9

WHITE/UPLAND OAK SUITABILITY FOR RESTORING SUSTAINABILITY BY STATE AND ECOSTATE (continued)

KENTUCKY	
Interior Low Plateau-Shawnee Hills	40.8
Northern Cumberland Plateau	40.7
Interior Low Plateau-Highland Rim	38.9
Coastal Plains-Loess	36.6
Southern Unglaciated Allegheny Plateau	36.4
Northern Cumberland Mountains	35.0
Interior Low Plateau-Transition Hills	34.9
Interior Low Plateau-Bluegrass	34.8
White and Black River Alluvial Plains	34.0
MARYLAND	
Middle Atlantic Coastal Plains and Flatwoods	32.3
Northern Appalachian Piedmont	28.9
Northern Ridge and Valley	28.8
Northern Atlantic Coastal Plain	28.5
Blue Ridge Mountains	26.6
Allegheny Mountains	26.6
MICHIGAN	
Northern Lower Peninsula	39.8
South Central Great Lakes	34.2
Northern Green Bay Lobe	31.2
Northern Highlands	31.0
Lake Whittlesey Glaciolacustrine Plain	26.8
MINNESOTA	
Western Superior Uplands	29.9
North Central Wisconsin Uplands	26.8
North Central U.S. Driftless and Escarpment	26.4
Minnesota and Northeast Iowa Morainal-Oak Savannah	26.0

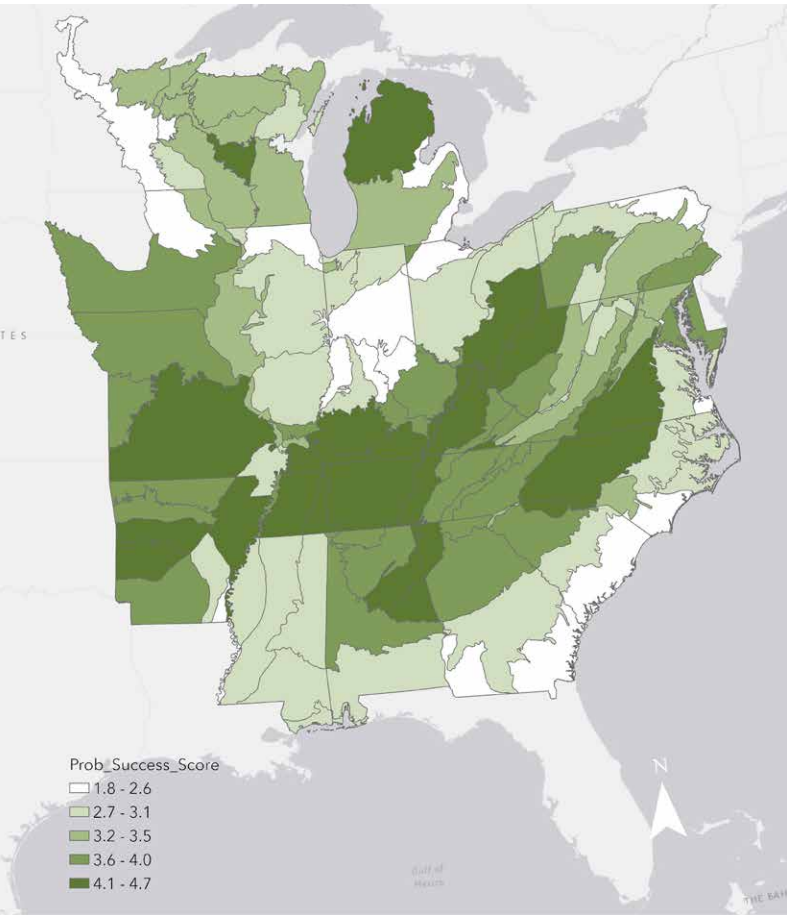
MISSISSIPPI	
Gulf Coastal Plains and Flatwoods	29.8
Coastal Plains-Middle	29.6
Gulf Coastal Lowlands	29.3
Coastal Plains-Loess	28.8
White and Black River Alluvial Plains	26.4
Southern Mississippi Alluvial Plain	20.2
MISSOURI	
Ozark Highlands	42.5
Osage Plains	33.1
Central Dissected Till Plains	33.1
White and Black River Alluvial Plains	27.7
NORTH CAROLINA	
Central Appalachian Piedmont	40.0
Blue Ridge Mountains	38.7
Southern Appalachian Piedmont	36.4
Southern Atlantic Coastal Plains and Flatwoods	34.5
Middle Atlantic Coastal Plains and Flatwoods	31.9
Northern Atlantic Coastal Flatwoods	30.7
Atlantic Coastal Flatwoods	30.1
OHIO	
Southern Unglaciated Allegheny Plateau	39.0
Interior Low Plateau-Bluegrass	35.9
South Central Great Lakes	33.0
Central Till Plains-Beech-Maple	29.6
Western Glaciated Allegheny Plateau	28.1
Lake Whittlesey Glaciolacustrine Plain	26.9
Erie and Ontario Lake Plain	26.8



PENNSYLVANIA	
Southern Unglaciated Allegheny Plateau	33.9
Northern Appalachian Piedmont	33.7
Northern Ridge and Valley	33.6
Blue Ridge Mountains	31.1
Northern Unglaciated Allegheny Plateau	30.7
Erie and Ontario Lake Plain	29.7
Allegheny Mountains	29.4
Northern Atlantic Coastal Plain	29.4
Lower New England	29.0
Western Glaciated Allegheny Plateau	28.4
Catskill Mountains	26.0
Northern Glaciated Allegheny Plateau	25.9
Hudson Valley	25.1
SOUTH CAROLINA	
Central Appalachian Piedmont	34.8
Southern Appalachian Piedmont	33.7
Southern Atlantic Coastal Plains and Flatwoods	31.4
Blue Ridge Mountains	29.1
Atlantic Coastal Flatwoods	27.2
TENNESSEE	
Northern Cumberland Plateau	38.8
Coastal Plains-Middle	38.1
Coastal Plains-Loess	37.7
Interior Low Plateau-Highland Rim	37.6
Southern Ridge and Valley	37.6
Blue Ridge Mountains	36.7
Central Ridge and Valley	36.1
Southern Cumberland Plateau	34.3

Northern Ridge and Valley	33.9
Northern Cumberland Mountains	31.7
White and Black River Alluvial Plains	30.7
VIRGINIA	
Central Appalachian Piedmont	38.2
Northern Ridge and Valley	36.3
Blue Ridge Mountains	36.2
Central Ridge and Valley	34.6
Northern Cumberland Mountains	34.2
Middle Atlantic Coastal Plains and Flatwoods	31.8
Northern Appalachian Piedmont	31.3
Allegheny Mountains	30.4
Northern Atlantic Coastal Plain	30.4
Northern Atlantic Coastal Flatwoods	25.5
WEST VIRGINIA	
Northern Cumberland Mountains	33.0
Southern Unglaciated Allegheny Plateau	32.5
Allegheny Mountains	31.6
Northern Ridge and Valley	28.3
Blue Ridge Mountains	28.2
WISCONSIN	
Wisconsin Central Sands	36.2
Southwestern Great Lakes Morainal	33.8
Northern Highlands	31.6
Northern Green Bay Lobe	30.8
North Central U.S. Driftless and Escarpment	30.7
Western Superior Uplands	30.6
North Central Wisconsin Uplands	30.1
Minnesota and Northeast Iowa Morainal-Oak Savannah	24.9

DATA THEME EXAMPLE: PROBABILITY OF SUCCESS

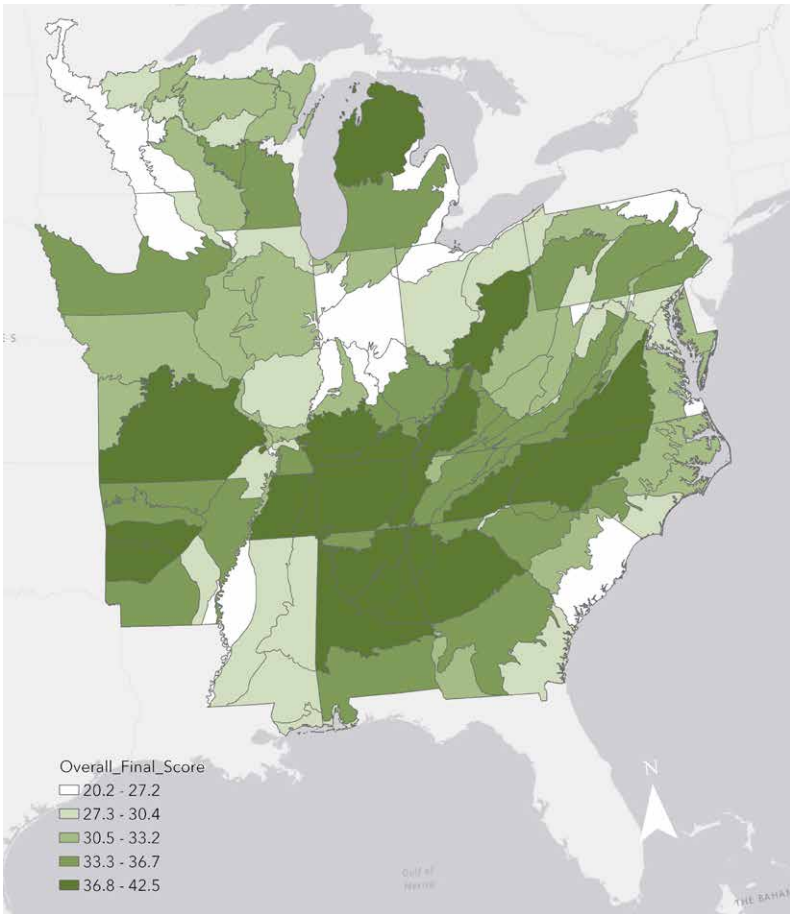


Based on phase 1 data and phase 2 analysis, the "probability of success" data theme was the most important factor in evaluating overall suitability for white and upland oak regeneration efforts because it considered key ecological conditions related to white and upland oak including key forestry/silvicultural factors, like site productivity. Other data theme maps can be found in the full Phase 2 spatial report at www.whiteoakinitiative.org/reports.

PHASE 3 — VISUAL REPRESENTATION

Phase 3 of the spatial analysis involved showing phase 1 and 2 data in a series of maps covering the 20 states that were included in the study. These maps can be found in the full Timmons Group report, *Using GIS to Determine Where to Invest in White Oak Growth*, found at www.whiteoakinitiative.org/reports. The analysis also resulted in the Overall Final Score map, which indicates EcoState scores across the entire region. The darker regions on the map show the areas with the highest-rated potential for successfully restoring sustainability, while the lighter regions show lower-rated potential. However, it is important to note that all regions on the map have opportunities for locally customized oak conservation. Across all EcoStates, a closer look at the data can provide foresters and land managers with important details about how to improve the chances of success of restoring sustainability in a given area.

PHASE 3 OVERALL FINAL SCORES



Based on a combination of six rated factors, the darker regions on the map show the areas with the highest-rated potential for successfully restoring oak sustainability, while the lighter regions show lower-rated potential. However, it is important to note that all regions on the map have opportunities to successfully restore oak sustainability based on the available resources and priorities in that area.

WHITE OAK MANAGEMENT: CHALLENGES AND RESOURCES

Missouri Department of Conservation

White oak is an important species for many landowners, but its management involves a few challenges. In the words of Chris Will, president of forestry consulting firm Central Kentucky Forest Management, "The number one challenge is that it takes at least a 75- to 80-year-old tree to make many white oak products, whether they're flooring or whiskey barrels. If you lay out a management plan for growing oak, it has to be multigenerational: the land ethic and the philosophy about growing timber have to be passed down and the next generation has to buy into it."

A second challenge is that white oak management is complicated, requiring attention and professional forestry assistance. "This expertise doesn't come for free," Will says, adding that landowners have ongoing costs such as gravel, taxes, and more. However, Will points out, "Taking a hands-off or an extractive approach is a recipe for disaster both financially and ecologically, in terms of sustainability." Will explains that if a landowner wants to plan for future oak harvests, there are many factors to consider. "Not only do you have pretty restrictive requirements in terms of sunlight needs, but there are a host of non-native invasive species and other forest health issues," he says. In most cases, oak regeneration will not succeed until the right conditions are achieved. "There's a lot of focus on white oak in the White Oak Initiative," Will observes, "but it's really a healthy forest management initiative."

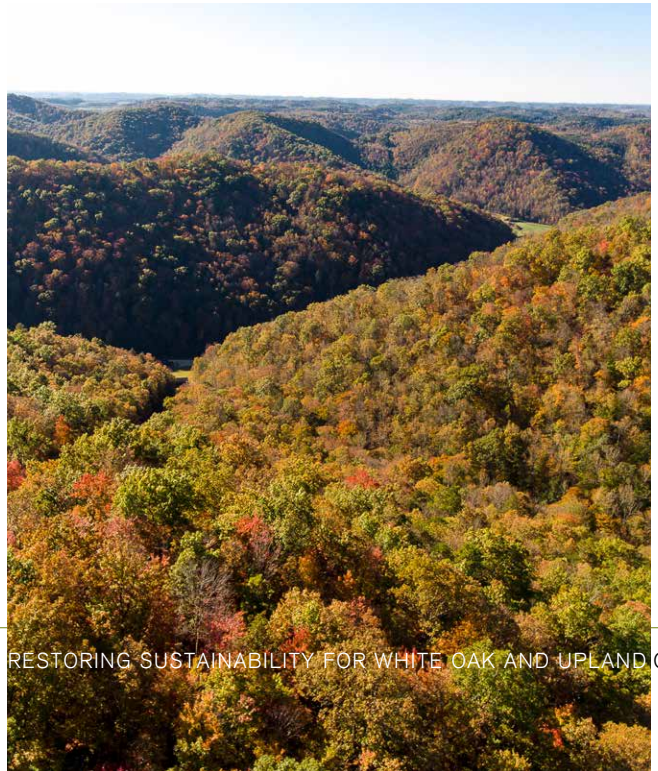
Thankfully, landowners have several resources available to help with managing for white oak. "The first step is to collect information on your land," Will says, adding, "This opens the door to funding opportunities and helps determine the best way to maintain your goals for the land." Will suggests that landowners contact Natural Resource Conservation Service (NRCS) regional offices for guidance, as well as university extensions and state and federal agencies for help in developing forest management plans. He also recommends a visit to the Association of Consulting Foresters website (www.acf-foresters.org) to find a local forestry consultant. Will explains, "A qualified consulting forester has a key role in the white oak harvesting process. You really need a technician who can apply local forestry knowledge to a property, highlight funding opportunities, and help the project to succeed."

SPATIAL ANALYSIS CASE STUDIES

To get a closer look at how the factors play out in various EcoStates, we contacted forestry representatives in Kentucky, Michigan, Missouri, Pennsylvania, Tennessee and Virginia. Our goals were to augment the quantitative data with qualitative information to describe white and upland oak importance and oak restoration opportunities in middle- and high-ranking EcoStates, as well as local perceived strengths and weaknesses related to current and future efforts to restore sustainability.

KENTUCKY — NORTHERN CUMBERLAND PLATEAU

The Northern Cumberland Plateau contains some of the largest stretches of contiguous forest in the eastern United States and is one of several areas in Kentucky that were historically and ecologically dominated by white oak forests. This area has deep cultural significance as well: known as the country's first major gateway to westward expansion, Cumberland Gap allowed colonial settlers to reach central and western Kentucky and Tennessee, including what is now the Cumberland Gap National Park, located in parts of Harlan and Bell counties. For this area and across Kentucky, the White Oak Initiative was highlighted in the Kentucky's 2020 Forest Action Plan.



Northern Cumberland Plateau in Kentucky by Chris Barton, University of Kentucky.

Today, Kentucky's white oak forests provide acorns and a forested ecosystem that is critical to many wildlife species, including many threatened and endangered species. These forests also support recreational activities such as biking, hiking, and hunting. White oak logs are an important commercial species used by many primary and secondary wood industries; an example is Somerset Hardwood Flooring, a privately owned, environmentally conscious company that uses Appalachian hardwood to make high-quality flooring. Kentucky white oak lumber and forest products generate about $61 million in annual revenue, while Kentucky barrel stave production generates $134 million in annual revenue. Kentucky bourbon, which is heavily reliant on white oak for production, generates about $8.6 billion in revenue every year.

According to the White Oak Initiative spatial analysis, Kentucky's Northern Cumberland Plateau scored well due to ecological and forestry conditions that can support white oak regeneration management. It also has significant white oak supply and a significant amount of White Oak Initiative partner priority lands and critical habitat. On the other hand, there is room for improvement in terms of invasive removal, pathogen prevention, and landowner understanding and participation. In terms of stakeholder support, a recent survey of three Kentucky-based white oak stakeholder groups indicated that the most-supported long-term white oak

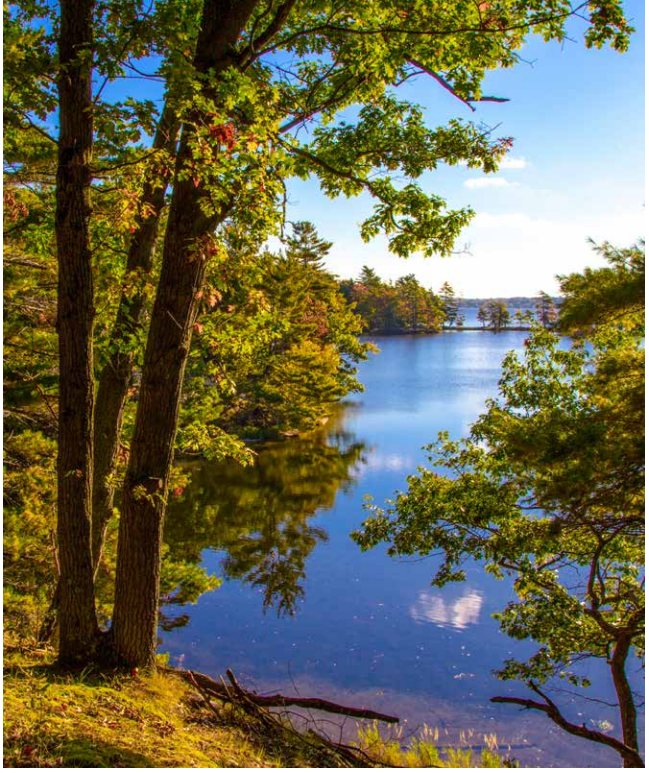
policy and management decisions are: 1) encouraging and incentivizing sustainable forest management and 2) addressing poor harvesting practices.

To address these issues and others, the Kentucky Division of Forestry is working with landowners to write forest stewardship plans that focus on growing high-quality white oak and making silvicultural recommendations to improve long-term sustainability for the species. The Division has developed demonstration sites and is administering a multistate southern region landscape-scale restoration grant, received though the USDA Forest Service, for upland hardwoods with an emphasis on white oak. In addition, the Daniel Boone National Forest has been identified as a primary resource area for sustainable white oak populations. The state's other partners in white oak restoration include the White Oak Initiative, the USDA Natural Resources Conservation Service (NRCS), the USDA Farm Service Agency, the Kentucky Woodland Owners Association, and the Kentucky Forest Industries Association. The University of Kentucky's Department of Forestry and Natural Resources is another key partner, with its research into seed genetics, its Center for Forest and Wood Certification, and leading woodland-management courses.

Yet while the Northern Cumberland Plateau and Kentucky in general are at the forefront of white oak restoration work, there is still room for improvement. Specifically, there is potential from the Kentucky Division of Forestry's efforts to obtain federal funding for cost-share assistance or via collaboration with similar and neighboring high-potential upland oak restoration areas such as the Northern Cumberland Plateau EcoState in Tennessee. The Kentucky Division of Forestry could also benefit from additional funding, particularly to add personnel to reach and educate more landowners. "Eastern Kentucky has a lot of absentee landowners and it can be a challenge to reach them," according to Pam Snyder, forest management chief for the Kentucky Division of Forestry. In addition, Snyder says, group ownership of properties can make it challenging to build consensus on how to manage those properties.

MICHIGAN — NORTHERN LOWER PENINSULA

Across Michigan, oak-hickory forests occupy about 12 percent of the state's forested areas, making oak-hickory the third-largest forest type in the state. Michigan has a variety of oak-dominated forest types, including oak savannahs, oak barrens, and oak-pine and oak-hickory forests. Most of the state's oak-hickory forests are located in the Lower Peninsula. Within oak-hickory forests, more than 60 percent of the volume is in oak or hickory species.



Ludington State Park in the Northern Lower Peninsula, Michigan from Shutterstock.

Oak trees and woods are culturally, economically, and environmentally important to Michigan. According to Jesse Bramer, a forester with the Michigan Department of Natural Resources, "In places like the Baldwin, Hastings, and Brighton areas and across the state, decreased oak-dominated habitats would lead to a decrease in overall biodiversity, including available food and habitat for charismatic species such as cerulean warblers, red headed woodpeckers, black bear, and turkey populations. This would definitely have an impact on hunting and outdoor recreation."

Michigan's oak forests are transitioning away from oak-dominated communities to shade-loving tree species such as red maple and black cherry due to competition and a lack of established oak seedlings and saplings in the understory. Other challenges include lack of prescribed or controlled fire on the landscape, oak wilt, older maturing stands lacking abilities to stump sprout, lack of forest management in general, and a lack of targeted oak regeneration forest practices where management does take place.

In terms of spatial analysis for the White Oak Initiative study, Michigan's Northern Lower Peninsula EcoState scored highest for its strong ecological and forestry conditions, its significant white oak supply, and the presence of White Oak Initiative partner priority lands and critical habitat. However, this area could benefit from improved landowner understanding and participation, along with better invasive species removal, oak wilt pathogen prevention, and controlled fire.

Bramer says Michigan has been proactive in improving sustainability of other tree species, but oak forests could use more attention. “To me,” he says, “it’s clear that oak is important, from ecotourism for nature viewing and hunting to the timber industry for floor trim, cabinetry, furniture, veneer, whiskey barrels, hobby wood crafts such as woodturning, and even boat-building and repair.”

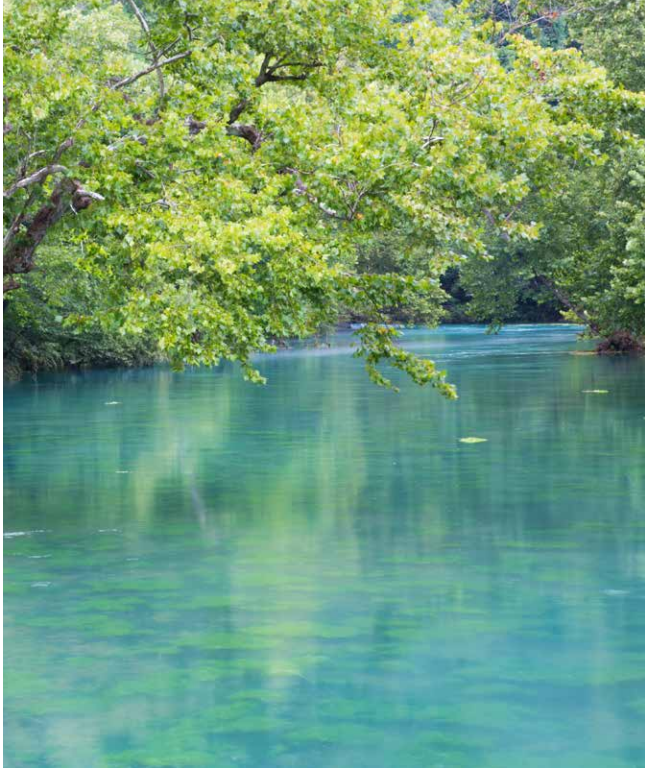
Bramer explains that while Michigan places strong importance on forestry and forest habitat, many oak-specific issues are just now becoming more widely understood. “This is new ground for Michigan,” he says, adding, “People are becoming more aware of how important this resource is, but we need to make it a top-down and bottom-up priority to raise public awareness and support for oak forest management.”

MISSOURI — OZARK HIGHLANDS

As with many other heartland states, Missouri heavily relies on white and upland oak for wildlife habitat and cultural and economic value. But the Ozark Highlands area has a particular connection to this forest type. According to Rich Blatz, forestry field program supervisor for the Missouri Department of Conservation, “That area is where the majority of the Ozark forests that are held in public trust are located in Missouri. It’s the heart of the Ozarks, a timber breadbasket, and a recreation hub for outdoor activities.”

This area includes a significant amount of public land, including Mark Twain National Forest and various federal and state parks and large private landowners. The city of Eminence, which Blatz considers to be one of the communities that’s most associated with the state’s oak forests, is known for its hunting, fishing, and trail-riding in the Ozark National Scenic Riverways recreational area. Winona and Van Buren are among the many other towns in this area that have similar connections to oak-dominated forests. According to Blatz, “The folks that live there are really tied to the land. Whether they live in the towns or the woods, they love their outdoors … and they love to tell you about it, whether it’s riding, hunting, or fishing.”

There are also many small farms and timber and cattle businesses in this area. Across many regional parks and properties, oak-dominated forests are changing due to insect pests, armillaria fungus, hypoxylon cankers (sores), drought, and competition from other species. There’s also an overabundance of black oak trees, which were among the first trees to sprout following widespread



Ozark National Scenic Riverways in Big Spring near Van Buren Missouri.

deforestation in the late 19th and early 20th centuries. According to Blatz, “We’re not doing enough disturbance across that landscape to fully sustain it. For the next 50 years we should be all right, but most of those forests are more than 80 years old and we’re just not seeing enough saplings. Unless we act, there’s going to be a decline that moves through the system.”

According to the White Oak Initiative spatial analysis, the Ozark Highlands EcoState has ideal or optimal ecological and forestry conditions to support white oak regeneration, as well as significant white oak supply and a significant amount of White Oak Initiative partner priority lands and critical habitat. Areas of improvement include invasive removal, pathogen prevention, and landowner understanding and participation.

Blatz says the state’s biggest challenge may be in overcoming local residents’ often wary attitudes toward working with government agencies. Blatz sees a solution, but he admits that it will take time, effort, and money. He explains, “Typically in the Ozarks — and this applies somewhat to the whole state — the owners want to improve wildlife habitat, especially for deer and turkey. When we go to their property and tell them that white oak is the preferred acorn species for deer and turkey, we can start moving that needle. And then there’s the economics: if you manage these woods properly, there’s potential for a good return. These trees could become barrel staves, not just pallets and railroad ties.”

In addition to the White Oak Initiative, the Missouri Department of Conservation works closely with the NRCS, the National Wild Turkey Federation, the Audubon Society, and other groups to overcome these barriers. Also, the Mark Twain National Forest has shortleaf pine-oak woodlands restoration projects in the Eleven Point and Poplar Bluff ranger districts that can be used as teaching areas. But even with all these resources, it can be an uphill battle to convince landowners of the need for change. And, due to competition from higher-paying agencies, the department also faces challenges in retaining experienced foresters and wildlife biologists. According to Blatz, "As an agency we have a very large outreach program; we have nature centers, local classes for landowner training, newsletters and more. We also have our Missouri Conservationist magazine which is free to any Missouri resident. But it's hard to gain traction. We're struggling to determine what else we can do."

PENNSYLVANIA — NORTHERN UNGLACIATED ALLEGHENY PLATEAU

Upland oaks make up a significant portion of Pennsylvania's sprawling north-central forests, with benefits that include wildlife food and habitat, recreation, and timber for flooring, cabinetry, furniture, and barrels. "Pennsylvania is known for its world-class lumber, and the Allegheny plateau is where our best timber comes from," according to Benjamin Livelsberger, a wood utilization specialist at Pennsylvania's Department of Conservation and Natural Resources. "It represents a significant portion of our forest product industry, which is a $37 billion industry annually," he says.

These forests are also crucial to the identity of communities such as the borough of Emporium, which is nestled between Moshannon State Forest, Allegheny National Forest, and Elk State Forest. Nearby areas that rely heavily on oak-dominated forests include Elk, Forest, and Potter Counties. "A lot of their jobs come from the woods," Livelsberger says. "If those jobs were to go away, many small communities would have some real challenges." One notable forest industry company is Hickman Lumber. Founded in 1938 and based in the western Pennsylvania borough of Emlenton, this family-owned business specializes in high-end flooring, lumber, and timber management services.

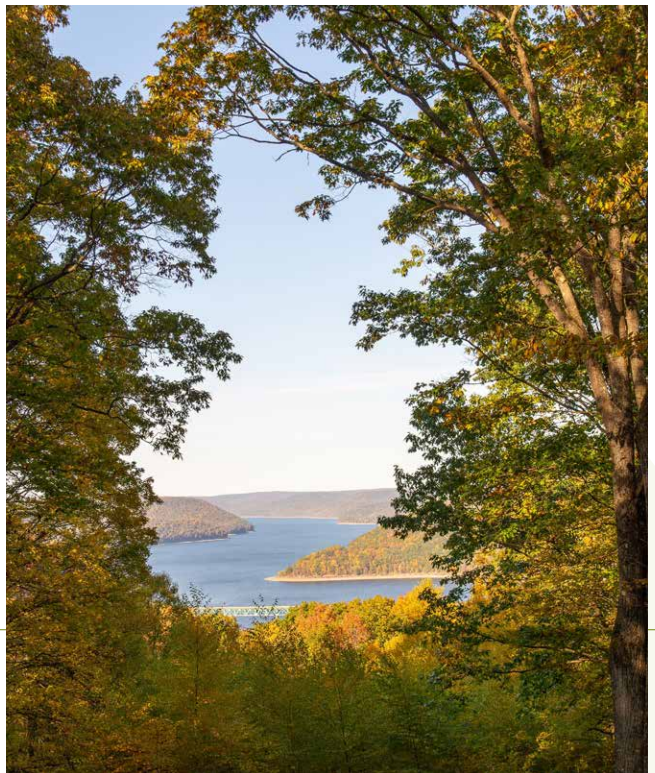
But oak populations here and across Pennsylvania are declining. Challenges include excessive deer browsing and increased populations of striped, red, and sugar maple, American beech, blackgum, and black birch. These midstory trees can prevent oak seedlings and saplings from surviving and maturing.

Livelsberger explains that the state typically uses Silviculture of Allegheny Hardwoods (SILVAH) software to help determine restoration approaches. "A good 30% of those forests are upland oak," he explains, "but regenerating white oak is becoming more difficult. The silviculture practices we're using allow the white oak to regenerate seedlings, but those seedlings are not making it to the sapling or pole-wood stage."

In response, organizations, universities, and agencies such as the NRCS, Penn State University, and the USDA Forest Service's Northern Research Station have funded or conducted oak forest research for decades. This research, conducted in the Allegheny National Forest and elsewhere, has found that, in addition to using fire and herbicides to remove undesirable midstory trees, shelterwood harvests and deer reduction can help improve oak establishment rates. Similar findings by the University of Kentucky are highlighted in this report.

In terms of the White Oak Initiative spatial analysis, this region scored well for supply, forestry jobs, forester capacity, and mill capacity. Challenges include invasive removal, pathogen prevention, deer density, and landowner sentiment and experience. According to Livelsberger, "Landowner education is definitely important. As in many places, there tends to be an attitude that all timber harvesting is bad and that any green is good." With better-funded public outreach and federal cost-share programs, Pennsylvania may have increased success in implementing white and upland oak management guidance.

Allegheny National Forest by Chris Warner, U.S. Forest Service.



TENNESSEE — NORTHERN CUMBERLAND PLATEAU

Oak-hickory forests cover an estimated 70% — almost 10 million acres — of Tennessee's forestlands. These forests support a variety of forestry and forest product industries that contribute more than $24 billion to Tennessee's economy, employ about 100,000 individuals, and generate labor income of about $6.2 billion annually. "Forest products are a bigger business than our dairy and wheat industries combined," says Nathan Hoover, forest health specialist for Tennessee's Department of Agriculture. Local companies that are associated directly or indirectly with white oak include Brown-Forman, one of the country's largest American-owned spirits and wine companies. In addition, much of white oak's economic impact is felt in Tennessee's rural and economically distressed counties.

However, oak-hickory forest resiliency is an increasingly thorny issue, often characterized by what Hoover describes as a failure of recruitment. As with other parts of the country, root diseases, bark beetles, and general oak decline are leading causes of oak mortality here. And in the coming years, climate change is expected to worsen the severity of forest pest outbreaks.

In the White Oak Initiative spatial review, the Northern Cumberland Plateau rated highly in terms of having ideal or optimal ecological and forestry conditions to support white oak regeneration and significant white oak supply. According to Hoover, "It doesn't surprise me that the Northern Cumberland Plateau rated so highly in the study — it's got the right kind of soil, for one thing. It also has beautiful scenery and topography." However, the spatial review also found that this area faces challenges related to invasive plant removal, pathogen prevention, and landowner sentiment and land management experience.

Along with shortleaf pine, the state has targeted white oak for species maintenance and reestablishment, with the White Oak Initiative highlighted in the Tennessee Department of Agriculture report, *Tennessee Forest Action Plan 2020-2030*. Other partners include the NRCS, the Tennessee Division of Forestry, The Nature Conservancy, the University of Tennessee, the Oak Woodlands and Forests Fire Consortium, and the Consortium of Appalachian Fire Managers and Scientists.

Despite public-facing websites such as protecttnforests.org, demonstration areas in places such as Pickett State Forest, and potential inter-state synergies with neighboring high-potential upland oak restoration areas such as the Northern Cumberland Plateau EcoState in Kentucky, Hoover says that more could be done to promote the need for oak-hickory forest restoration in Tennessee. "For this kind of work you need a lot of foresters to provide technical assistance to landowners as well as guidance for obtaining financial assistance, because some landowners can't afford to manage for white oak on their own. You need foresters for that, and there's just not a lot of us," he says.

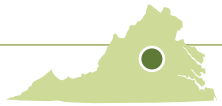
This effort is especially important in Tennessee because so much of the state is made up of privately owned land. According to Hoover, "Parcel sizes are getting smaller and landowners don't know how to manage their forests. They look at their woods, they see green, and they think it's good. But the green might be privet or honeysuckle, not healthy trees."

Tennessee landowners are often unaware of white oak's economic importance, with often less understanding of the biodiversity that oak-hickory forests support. "There are stories to be told about staves, the whiskey industry, and oak exports," Hoover says, "but there's also this unique ecosystem involved. Landowners need to know that this ecosystem relies on disturbance, which it's no longer occurring because fire and grazing patterns have changed."

Looking forward, Hoover is hopeful for oak forest regeneration success. "Recruitment and regeneration have been talked about for a long time," he says, adding, "We know about light-penetration needs and midstory removal. Those documents and brochures exist; we just need to get the word out. The White Oak Initiative can help because it represents so many groups and can reach so many people."

Northern Cumberland Plateau in Tennessee from Adobe Stock.

Central Appalachian Piedmont in Virgina from Shutterstock.



VIRGINIA — CENTRAL APPALACHIAN PIEDMONT

In the book *Remarkable Trees of Virginia*, an arborist is quoted as saying, "White oaks are Virginia's finest tree, period." The authors go on to say that white oaks "live the longest and therefore have the longest connections to Virginia's people and landscapes," and with their often huge trunks and wide crowns, they "most often achieve the classic form, shape, and size people expect of a remarkable tree."

According to Dean Cumbia, director of the Virginia Department of Forestry's Forest Management Branch, "People love hardwoods throughout Virginia because of what they mean in terms of deer, turkey, bear, hunting, and forest products, including barrel staves." White oak is also highly important economically in Virginia. "It's one of those woods that's multi-purpose," Cumbia says, "From furniture to fence boards to pallet stock and barrel staves, there's a home for all of it."

White oak also has deep cultural connections in the state. According to Cumbia, "Forestry is a foundation for what built Virginia. Hardwood supported the state's growth. Thomas Jefferson and James Madison's homes were about 25 miles apart on small mountains that were heavily forested. Today we have heritage forests like Montpelier Landmark Forest that include huge white oak trees. And in addition to the Appalachian Piedmont, there are a lot of white oaks in the Blue Ridge Mountains, some of the Shenandoah Valley and places in western Virginia, where there are also a lot of mills."

However, as with all the other states in the White Oak Initiative analysis, white and upland oak face numerous challenges in Virginia. In addition to the insects, diseases, and midstory shade issues that plague this species across the eastern United States, about 80% of forested areas are privately owned. "Time and markets are factors that can work against oak restoration. And there's also a fairly steep learning curve," Cumbia says, adding, "Hardwood management is challenging because of the variety of species and the long-duration considerations. Since white oak financial return might take 80 years, landowners have to be pretty forward-thinking and accept the fact that their grandchildren might be the ones to benefit from their decisions."

According to the White Oak Initiative spatial study, Virginia's Central Appalachian Piedmont area has ideal or optimal ecological and forestry conditions to support white oak regeneration and significant white oak supply, but it could benefit from better invasive removal, pathogen prevention, and more White Oak Initiative partner priority lands.

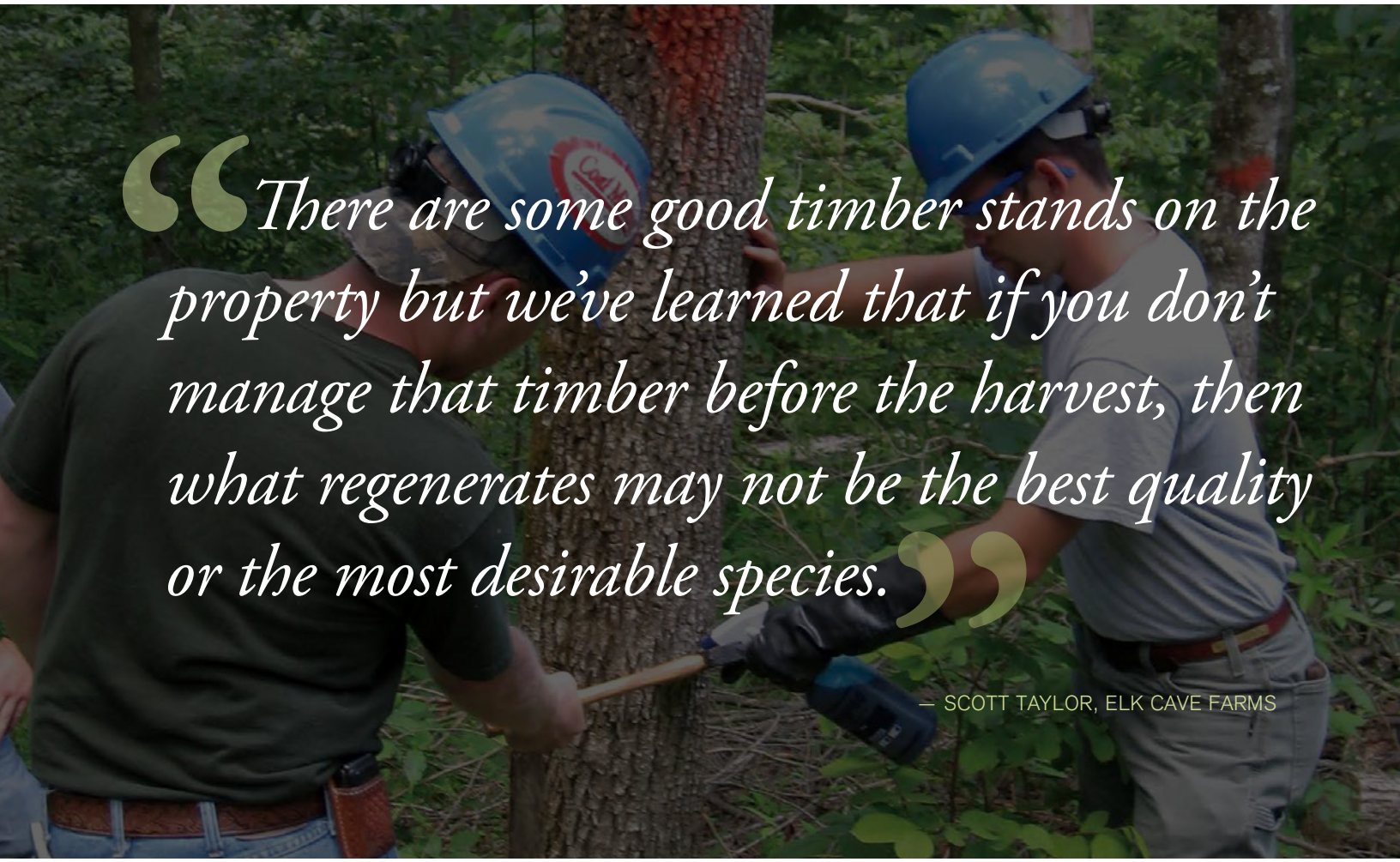
To address these issues and others, Virginia works closely with federal forest stewardship programs and local and regional organizations, including the White Oak Initiative. "The White Oak Initiative has provided excellent educational resources, as has Virginia Tech's Cooperative Extension Service. There are the Woods & Wildlife conferences, the weekly *15 Minutes in the Forest* videos, and white oak and crop tree release videos," Cumbia says.

Virginia has also created a statewide hardwood management stakeholders group, Cumbia says, adding, "The response has been overwhelming and diverse, with private, state, federal, sawmill, landowner, and consulting forester interest. The group is loosely organized but is working together to define species and ecosystem goals to obtain grants and prescribed burns, just as we've done for longleaf pine for a longer time. It's just a matter of organization and moving forward at this point."

UPLAND OAK SPECIES INCLUDED FOR THE SPATIAL ANALYSIS

- White oak
- Black oak
- Chestnut oak
- Chinkapin oak
- Northern red oak
- Post oak
- Scarlet oak
- Southern red oak

FAMILY FOREST OWNER SURVEY



"There are some good timber stands on the property but we've learned that if you don't manage that timber before the harvest, then what regenerates may not be the best quality or the most desirable species."

— SCOTT TAYLOR, ELK CAVE FARMS

PROJECT OVERVIEW

In June and July 2020, researchers from the USDA Forest Service and the Family Forest Research Center at the University of Massachusetts Amherst conducted a survey of almost 3,200 family forest owners/private landowners across the white oak range with at least 10 acres of land, including a subset who are members of the American Tree Farm System ("Tree Farmers"). The survey differentiated family forest landowners who are Tree Farmers from those family forest landowners who are not part of the American Tree Farm System (called "landowners" in this report). On average, surveyed landowners owned an average of 79 wooded acres while surveyed Tree Farmers owned an average of 110. These groups were targeted because a large part of the upland oaks' range is held by individuals and families. The project's goals were to understand respondents' opinions on oak trees and upland oak forests, their feelings about certain forest management practices and resources, and characteristics of themselves and their wooded land. Survey respondents gave their views on a variety of topics, including:

- Thoughts on oak trees/forests
- Perceptions of related programs and organizations
- Perceived benefits and challenges of specific oak management practices
- Willingness to consider management advice

MAIN FINDINGS

Family forest owners see many positive benefits of upland oak forest, and many have abundant oak trees and want more oak trees on their land. However, for most oak management practices, barriers for respondents include a lack of information and a perceived inconsistency with land goals.

One important takeaway from this is that outreach efforts that build on positive attitudes towards upland oak forests and connect relevant management practices to growing or increasing oak trees may increase landowners' interest in conducting those practices. The study also found that programs to support landowners that include cost-sharing to reduce the cost of managing for oak may increase program participation. Cooperation with state natural resources agencies and university/extension departments and other organizations may also increase respondents' participation in land management activities.

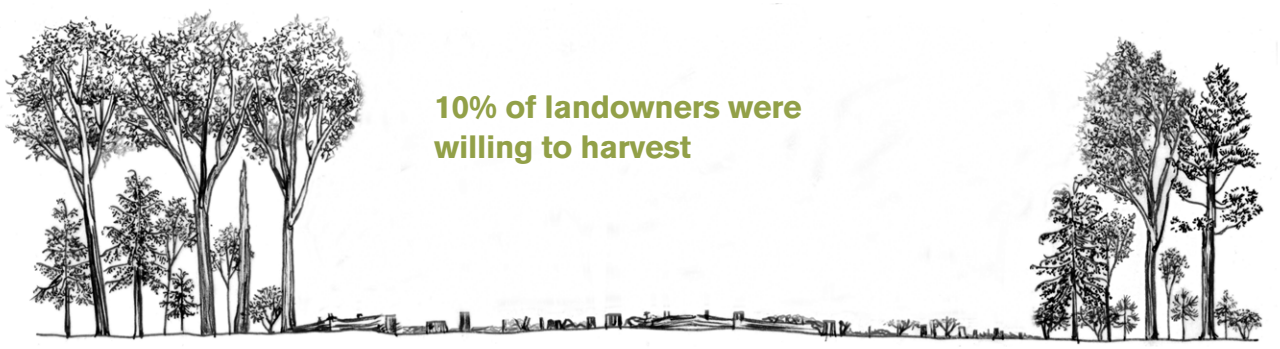
Following are additional details, organized by topic.

- **Thoughts on oak trees and forests.** Landowners and Tree Farmers who participated in the study tended to view upland oak forests positively, citing good scenery, wildlife habitat, timber, and recreational opportunities. When asked if they would like more oak on their land, about half — mainly concentrated in the center of the Central hardwood range — said yes while about 40% were neutral. However, possibly indicating a lack of awareness regarding the challenges that upland oak forests face, only about 31% of landowners and 35% of Tree Farmers think that upland oak forests are at risk of decline.

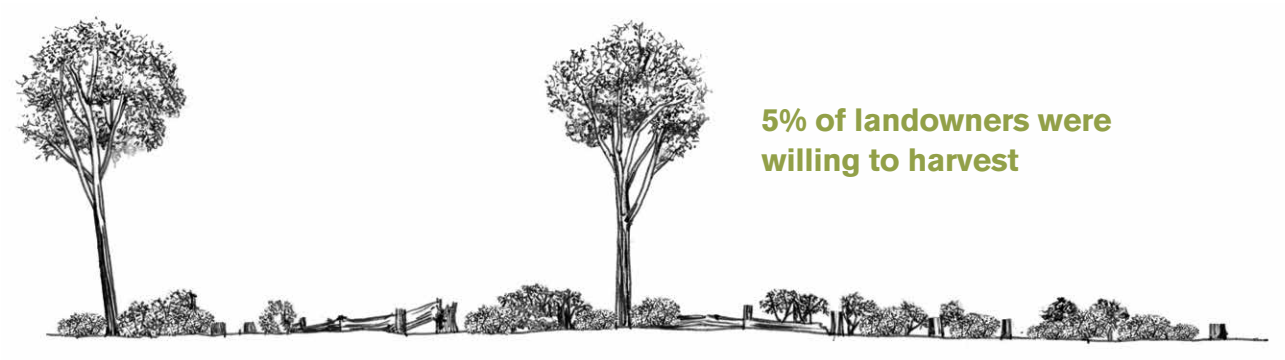
- **Experience with forest management.** Surveyed Tree Farmers were very likely to have conducted forest management practices: Between 50% and 75% of these sources said they had cut trees for sale or maintenance or used brush cutting, invasive plant removal or herbicides. Prescribed fire had only been used by about 25% of these sources. Landowners were less likely to have conducted similar practices. While brush cutting was a relatively common management practice for this group, fewer than 50% had conducted the other management practices named in the study and about 12% had conducted none of the management practices named in the study.

- **Willingness to get land management advice.** While surveyed landowners have often gone without management advice in the past, attitudes may be changing. Only 38% of surveyed landowners said they had received management advice in the past while 58% said they want advice in the future. Tree Farmers were relatively more proactive: more than 80% have received advice in the past and more than 80% want advice in the future.

CUTTING MANY TREES PER ACRE, CLUSTERED TOGETHER



CUTTING MOST TREES PER ACRE



- **Attitudes toward tree cutting and tree planting.** Reflecting a plethora of land management goals, survey respondents' plans and attitudes regarding tree cutting and tree planting varied widely, as did the related benefits and challenges. However, the perceived benefits included improved wildlife habitat, improvement of future timber, and the potential to earn money. Tree cutting challenges included difficulty finding trusted loggers, land and scenery damage, lack of information on how to proceed, and a lack of willingness to complete necessary harvest levels to regenerate white oak. Tree planting challenges included deer browse, time and money, and insects and disease. For both cutting and planting, Tree Farmers were more likely to see benefits while landowners were more likely to report challenges.

- **Attitudes toward herbicides.** Although responses again varied widely, Tree Farmers were much more likely to have considered herbicides: More than half of the Tree Farmers plan to use herbicides in the future, as opposed to just 22% of landowners. There was much uncertainty on this topic: almost 40% of landowners and more than 20% of Tree Farmers were either undecided on future herbicide use, hadn't considered it, or didn't respond. Herbicide benefits included invasive plant reduction, desired plant or timber encouragement, and wildlife habitat improvement. Herbicide challenges included high costs and damage to woodlands, wetlands, and desired plants. Landowners also cited a lack of information. Again, Tree Farmers were more likely to see benefits while landowners were more likely to report challenges.

- **Attitudes toward prescribed fire.** Among landowners and Tree Farmers alike, a wide majority of respondents fell into one of three categories: not planning to, never considered, or undecided. Only 27% of Tree Farmers

and 7% of landowners plan to conduct prescribed fire actions in the future. For these sources, prescribed fire benefits include reduction of undesired plants, habitat improvement, and promotion of desired trees. Challenges include risk, potential damage to desired plants, resistance from neighbors, a lack of information, or simply no need for this kind of forest management. Again, Tree Farmers were more likely to see benefits while landowners were more likely to report challenges.

- **Landowner values.** Landowners and Tree Farmers alike held strong feelings about land amenities. The most important values that respondents associated with their land included: protection of beauty and wildlife habitat, privacy, recreation and hunting, and timber. Similarly, landowners and timber growers were most likely to identify with the terms "wildlife viewer" and "conservationist," with more than half of all surveyed Tree Farmers also identifying with the term "environmentalist."

- **Organizational involvement.** Most surveyed landowners had low involvement in conservation/environmental organizations: About 12% said they were members of a local organization but 10% or fewer said they were members of The Nature Conservancy, the National Wild Turkey Federation, or other national conservation/environmental organizations. Tree Farmers were more likely to have an environmental organization affiliation; the organization most frequently mentioned in the survey was the American Forest Foundation, followed by the Forest Landowners Association, the National Woodland Owners Association, and local organizations.

- **Cooperative management plan preferences.** Given several hypothetical oak-management partnership scenarios, respondents preferred cost-share programs and price incentives per acre. Neither the intensity nor the purpose of the program (game, wildlife, wood products, stewardship, etc.) made a significant difference to respondents' interest levels. While only 37% of landowners expressed interest, 46% of Tree Farmers were interested in a hypothetical oak management partnership program.

- **Management cooperation preferences.** While some Tree Farmers and landowners expressed interest in working with agencies and forestry professionals in general, Tree Farmers were more likely than landowners to express interest in doing so. For both groups, state agencies and universities/extensions were most likely to be preferred. In addition, 25% or more of landowners and 40% or more of Tree Farmers expressed interest in working with federal or local agencies or private consulting professionals.

LANDOWNER SURVEY DEVELOPMENT PARTNERS

White Oak Initiative

American Forest Foundation

The Aldo Leopold Foundation

Family Forest Research Center

Tools for Engaging Landowners Effectively

University of Massachusetts Amherst

Extension
University of Wisconsin–Madison

Forest Service, U.S. Department of Agriculture

A TREE FARMER'S PERSPECTIVE: KEEPING OAK IN THE FAMILY

Clifton Taylor's tree farm, Elk Cave Farms in Gravel Switch, Kentucky, has grown from 287 acres in 1959 to more than 1,200 acres today. Much of its certified hardwood forestland is on steep, rugged terrain about 900 to 1,500 feet above sea level. Ever since the first tract was purchased, on land neighboring the farm where Clifton was born, the Taylor family has had a mission of establishing new forests, tending young timber stands, and harvesting sustainable forest products from mature trees. Today, three generations of Taylors manage the land and share their knowledge with other landowners.

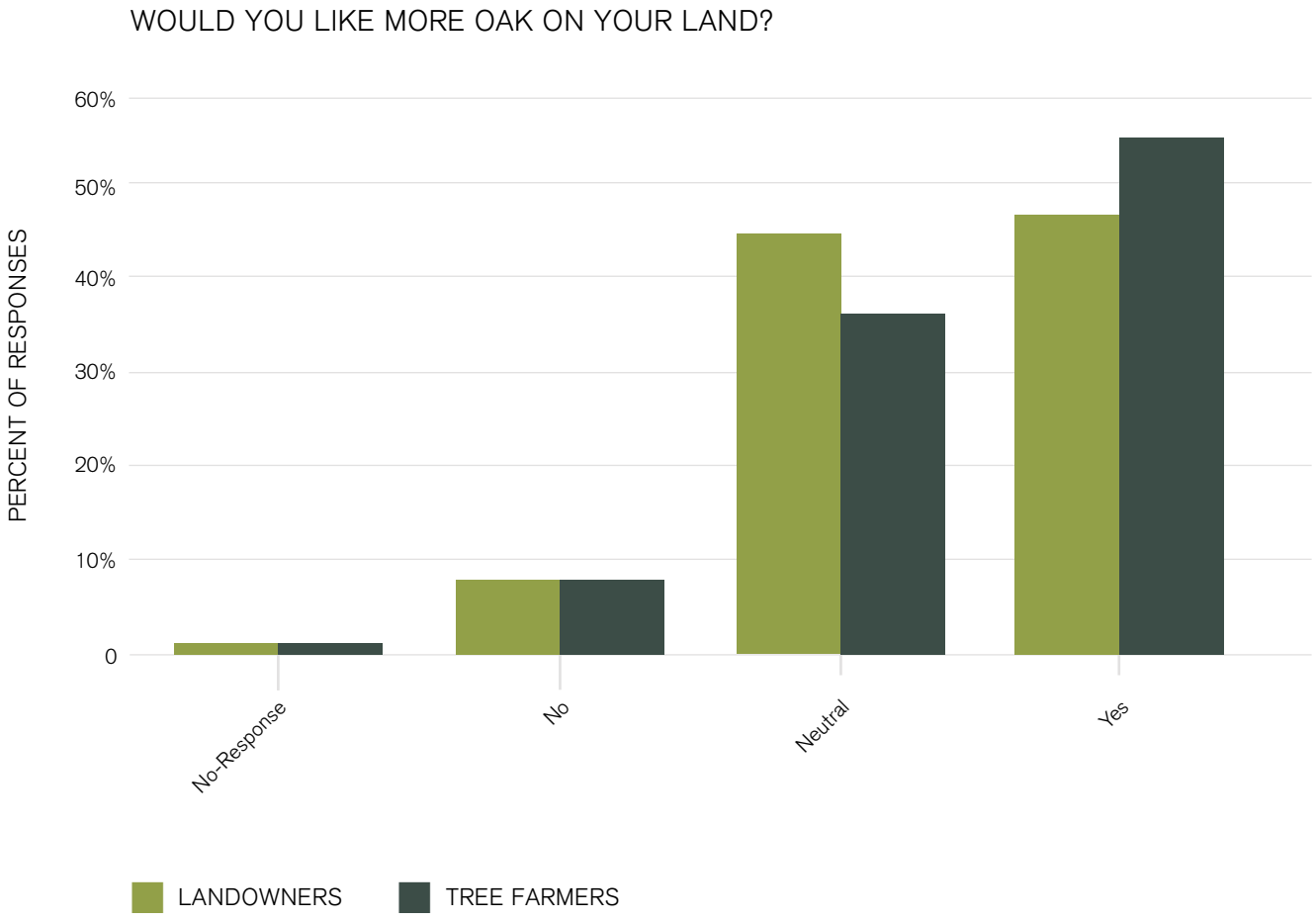
According to Clifton's son, Scott Taylor, "From early on, my father was doing improvements and learning about forestry, with a focus on commercial timber production. He was a county extension agent and had a high degree of respect for science and applying it to the real world."

Clifton was one of the first private landowners in Kentucky to obtain forest management certification from both the American Tree Farm System and the Forest Stewardship Council. His tree farm features impressive oak and hickory forests and one of the best examples of the oak shelterwood management method. According to Scott, "There are some good timber stands on the property but we've learned that if you don't manage that timber before the harvest, then what regenerates may not be the best quality or the most desirable species." Today, Elk Cave Farms is the exclusive white oak log supplier to Irish Distillers for the production of PEFC-certified whiskey barrels in the United States.

The Taylors worked closely with the Kentucky Division of Forestry, the Natural Resources Conservation Service, the University of Kentucky Department of Forestry and Natural Resources, and forestry consultant Chris Will, who is the president of a consulting firm called Central Kentucky Forest Management. According to Will, "On the Taylor farm, we've been working to regenerate oak since 2010 but we lacked practical experience. Through Clifton's encouragement and experimentation, we researched oak and perfected our techniques. By around 2014 we figured out the process and how to do it in an economical way. Now we're sharing that knowledge with others, including through the White Oak Initiative."

For Scott, it's all part of a long-term plan that will last long after he and his brother Steve are gone. "We try to look at the land and the watershed from a holistic perspective, not just for one big payday. We want a sustainable tree farm here — to treat it as a production system that we manage, not something that will grow wild and we'll worry about 60 years from now. It's more important to have a good, healthy forest. My father's first great-grandchild was just born a few months ago … we want something that will stay in the family for a long time, so that there's timber for my grandchildren to harvest."

FAMILY FOREST OWNER SURVEY: INTEREST IN MORE OAK



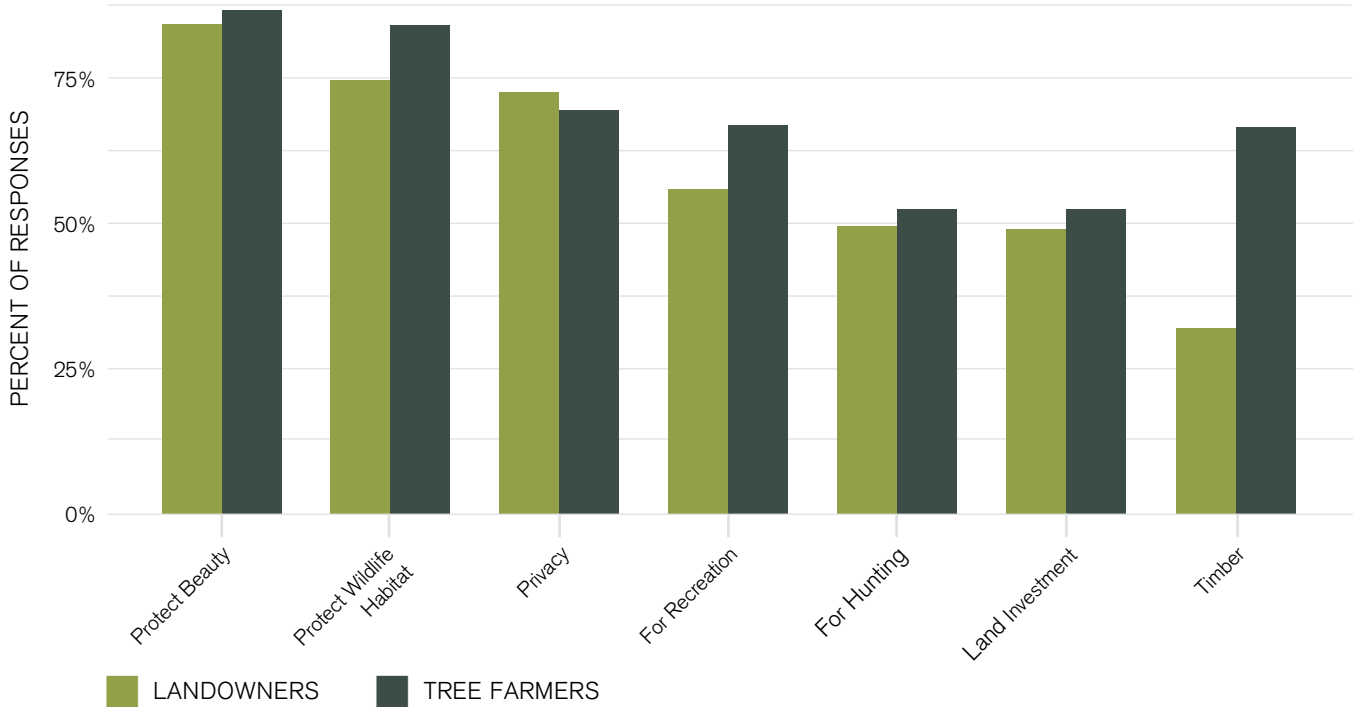
FAMILY FOREST OWNERS: ATTITUDES TOWARD FOREST MANAGEMENT ADVICE

RESULTS: PEOPLE WANT MORE ADVICE ABOUT THEIR LAND

	Landowners	Tree Farmers
Got advice in the **past**	38%	87%
Want advice in the **future**	**58%**	**81%**

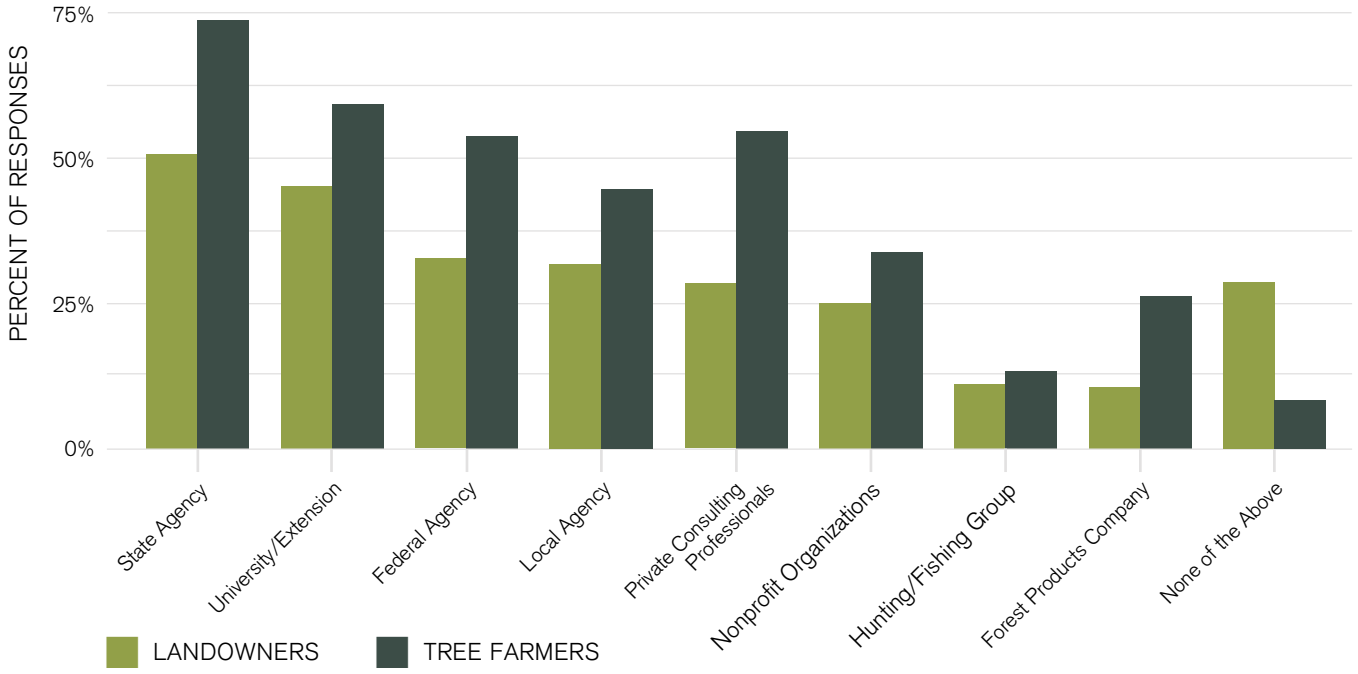
FAMILY FOREST OWNERS: REASONS FOR OWNING LAND

REASONS FOR OWNING LAND THAT ARE "IMPORTANT" OR "VERY IMPORTANT"



FAMILY FOREST OWNERS: PREFERRED LAND MANAGEMENT PARTNERS

WOULD YOU BE INTERESTED IN COOPERATING TO MANAGE YOUR WOODED LAND WITH...



DENDRIFUND:
ENVIRONMENT, ECONOMICS, AND SOCIAL EQUITY

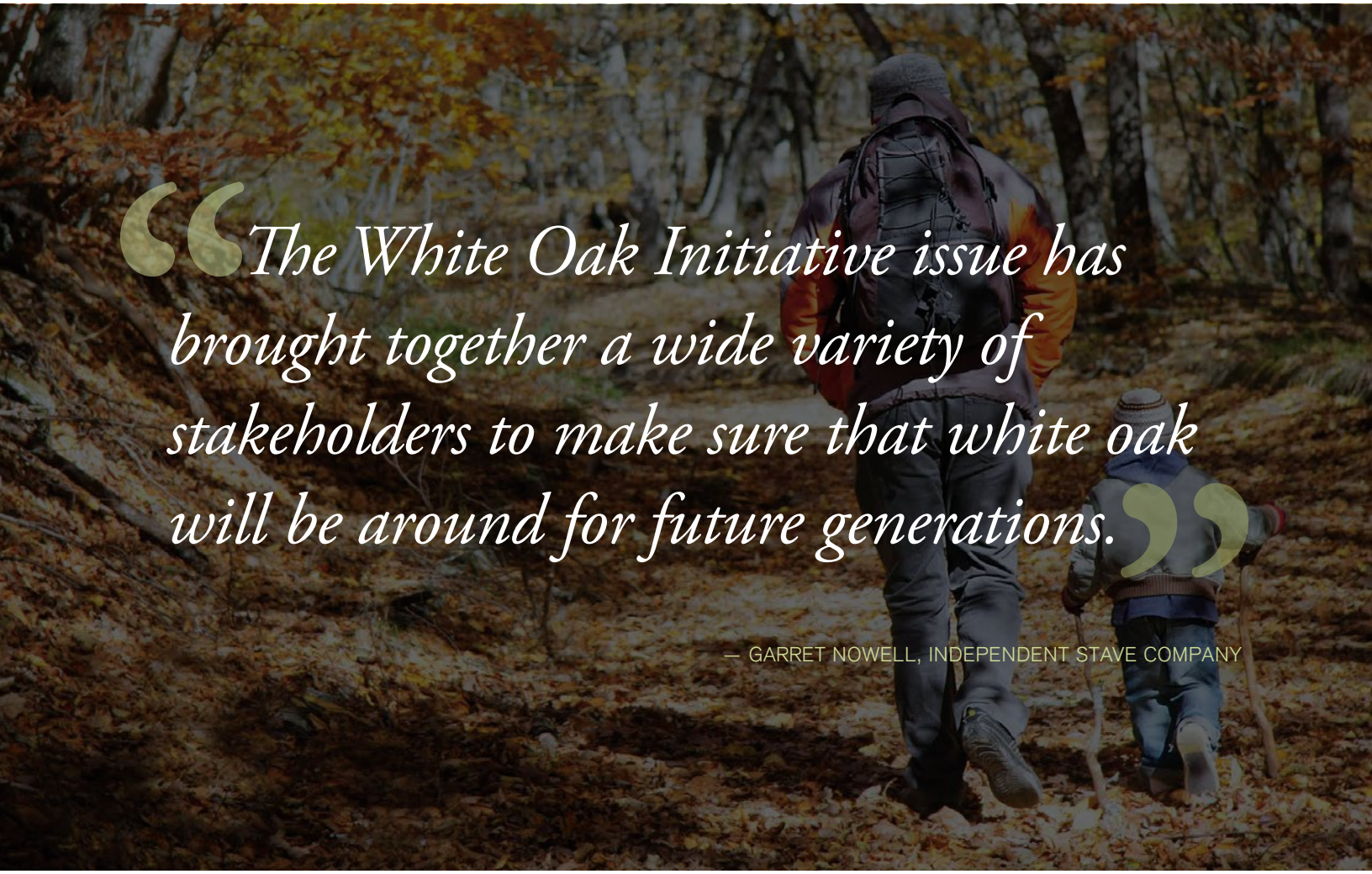
When the independent, nonprofit organization DendriFund was founded about 10 years ago, its purpose was to honor the long-term sustainability aspirations of its founding stakeholders: the Brown family and Brown-Forman, one of the largest American-owned companies in the spirits and wine business and the only spirits company in the world that makes its own barrels. Today, DendriFund's mission is to inspire joint action to improve the natural, social, and economic environment for future generations with programs focused on wood, water, and grain — the natural ingredients needed to make bourbon whiskey. As Brown-Forman is the manufacturer of Jack Daniel's and other spirits with distilling processes that rely on white oak, it's not surprising that DendriFund was a founding partner in the White Oak Initiative.

"This was exactly the kind of effort we were looking to help build," says DendriFund Executive Director Barbara Hurt. She explains, "Our approach is very community-centered and dependent on engagement with community members, environmental stakeholders, and industry all working together at the same table. In this case the effort requires support from business, nonprofits, academia, landowners, government organizations, and more. Given the multiple benefits of white oak, it isn't surprising that all these groups with seemingly differing agendas are able to find common ground."

The white oak story is a compelling one, Hurt says, and not just for the bourbon industry. "It's this incredible species," she notes, "that when you manage for its health, you manage for the whole forest."

Partly based on a wide variety of stakeholder support, Hurt is optimistic for the Initiative's success. She says, "When you have this many and varied stakeholders committed, you get a ripple effect that's much greater than what you could have accomplished alone."

CONCLUSION: LOOKING FORWARD



"The White Oak Initiative issue has brought together a wide variety of stakeholders to make sure that white oak will be around for future generations."

— GARRET NOWELL, INDEPENDENT STAVE COMPANY

The long-term sustainability of the eastern United States' upland oak forests is threatened. These forests are ecologically important, providing a critical food source for a variety of wildlife species and serving keystone roles in maintaining a diverse forest ecosystem. They are also economically valuable, representing billions of dollars in annual economic impacts across the region.

Historically maintained by frequent disturbance, especially fire, regeneration patterns in these forests have undergone significant change over the past several decades, with growing stock increasingly dominated by fire-intolerant species such as maples. This landscape-scale shift is expected to have significant detrimental effects on both the ecology and economy of the eastern United States, and thus represents a major conservation and management priority that we hope can be addressed using the processes described in this report.

The spatial analysis provided an understanding of areas within the region that provide the greatest opportunity and have the greatest need, based on ecological, social, economic, and conservation conditions. Here are a few key takeaways from the assessment:

- Within the 17-state region, no section of the range is without opportunity or need for restoring oak sustainability. (In fact, opportunities and needs extend beyond the 17 states involved in the study.)

- The 104 million acres of white oak forestland today are largely mature. About 75% of all white oak acres can be classified as mature or older from an economic and/or reproductive perspective.

- The next generation of white oak in mature stands is not clearly established. In mature stands, white oaks become increasingly prevalent as large trees, while seedling abundance is variable and limited, and saplings are scarce.

- Family forest owners want oak on their land and desire more information about oak management. However, regenerating and releasing young oak often takes considerable effort, and the cost for this work is a large barrier, especially as land ownership size decreases.

- From the analysis, we have an understanding, spatially, of ecological probability of success, landowner efficacy, barriers to success, forest product demand, enabling conditions of management, and conservation impact.

That said, we acknowledge that additional research may be needed to optimize and locally customize these processes and to answer additional questions as they arise. It's also worth noting that while private landowners are a key aspect of oak conservation efforts, there can be barriers to working with this group that can vary based on specific ecological, economic, and social factors. The White Oak Initiative intends to update this assessment periodically in order to provide up-to-date guidance and suggestions for improving the sustainability of America's upland oak forests.

WHITE OAK USES INCLUDE:

- **Barrel staves**
- **Cabinets**
- **Caskets**
- **Doors**
- **Flooring**
- **Furniture**
- **Interior trim**
- **Pallets**
- **Paneling**
- **Railroad cross ties**
- **Veneer**
- **Wood pulp**

INDEPENDENT STAVE COMPANY: RELIANT ON WHITE OAK

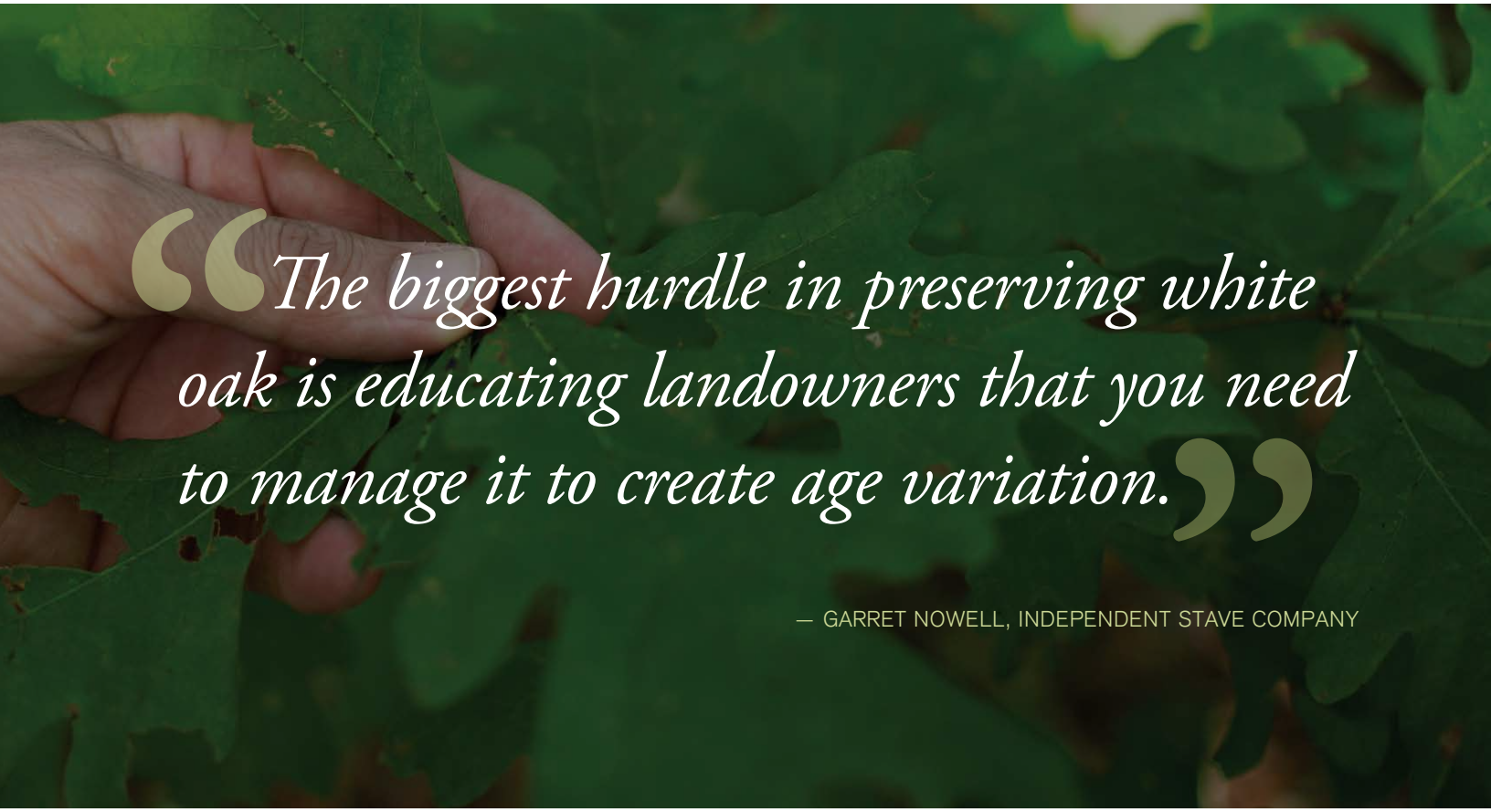
More than a century ago, when T.W. Boswell established a working stave mill in the white oak country of the Missouri Ozarks, he probably never could have imagined a time when white oak wood supply would be in danger. But as we look to the future, it's possible that the depletion of American white oak could be the biggest threat to the cooperage industry since Prohibition.

Today, Boswell's descendants run Independent Stave Company, which crafts oak barrels and other cooperage products. According to Garret Nowell, the company's director of log procurement, "Mr. Boswell started this business in 1912 with 10,000 acres of his own land. As a landowner and a businessman he would have known that white oak is a vital resource on many levels and that it's worthy of being taken care of."

Indeed, without white oak there would be no viable bourbon cooperage business — and not much bourbon, either. Nowell explains, "White oak wood contains something called tyloses, which are balloon-like cellular outgrowths that block water movement." These air pockets in the growth rings mean that liquid can't get out of the barrel. "Another important white oak characteristic is the lignins," Nowell says, which are the organic material that gives rigidity to wood and bark. In a cask, lignins can add flavors such as vanilla, caramel, chocolate, and more. It's why white oak barrels are used to make bourbon, as well as certain types of scotch, rum, wine, tequila, and even tabasco sauce.

While there's currently plenty of white oak available for its various uses, Nowell is very conscious of the need for improved oak regeneration. He explains, "You've got to remember that the average-age tree that we use is about 100 years old, about 13 or 14 inches in diameter, free of knots or imperfections, and the wood is taken from the bottom 12 feet of the tree. White oak makes up about 17% of the forests that we use and about 11% is cooperage stock, so we're talking about only 2% of the forest." In other words, it's a limited resource, which makes its lack of regeneration all the more urgent. "The lack of regeneration isn't a problem for white oak supplies today," Nowell says, "but it could be a concern in 40 to 50 years."

UPLAND OAK MANAGEMENT TECHNIQUES



"The biggest hurdle in preserving white oak is educating landowners that you need to manage it to create age variation."

— GARRET NOWELL, INDEPENDENT STAVE COMPANY

A look at historical land use provides evidence of many factors that likely benefited upland oaks, causing them to dominate much of the forests in the eastern United States. Many of these factors have now disappeared or have greatly diminished in frequency or impact. The most important of these may be forest fire, whether caused by lightning, indigenous peoples, or as an unintended consequence of early European settlement and industrialization of the eastern United States.

Evidence points to frequent prehistoric and historic fires and other disturbances that provided a competitive advantage to upland oaks, including white oak. These conditions resulted in a reduction in species that competed with oaks. The reduction in competitors, coupled with oaks' well-developed root systems and energy reserves that allow them to re-sprout vigorously if the top is killed, aided oak in developing dominance in many forests. Other historical factors undoubtedly also played a role in the significance of oaks in our upland forests. For example, the American chestnut blight created space for oaks in the Appalachians and surrounding regions. Farmers also maintained oaks to feed livestock, and grazing in the woods was common, helping to reduce competing species. These and other long-lost practices are considered to have played a part in creating the significant oak resource we now enjoy.

However, for more than a century, land-use practices have been changing. Highly effective wildfire suppression and exclusion have largely removed fire as a factor in eastern oak-hickory forests. As practices and conditions changed, so did the potential to maintain oak, including white oak, in its current abundance. Researchers have known for years that many upland oak species are not regenerating to the extent they once did across a wide range of sites. While some oak species such as white oak seem to be maintaining their presence on lower-quality sites where competition from co-occurring species is limited, on medium and high-quality sites, oaks are failing to adequately regenerate themselves. It is these more productive sites where changes are most widely felt.

MANAGEMENT PRACTICES TO SUSTAIN UPLAND OAK

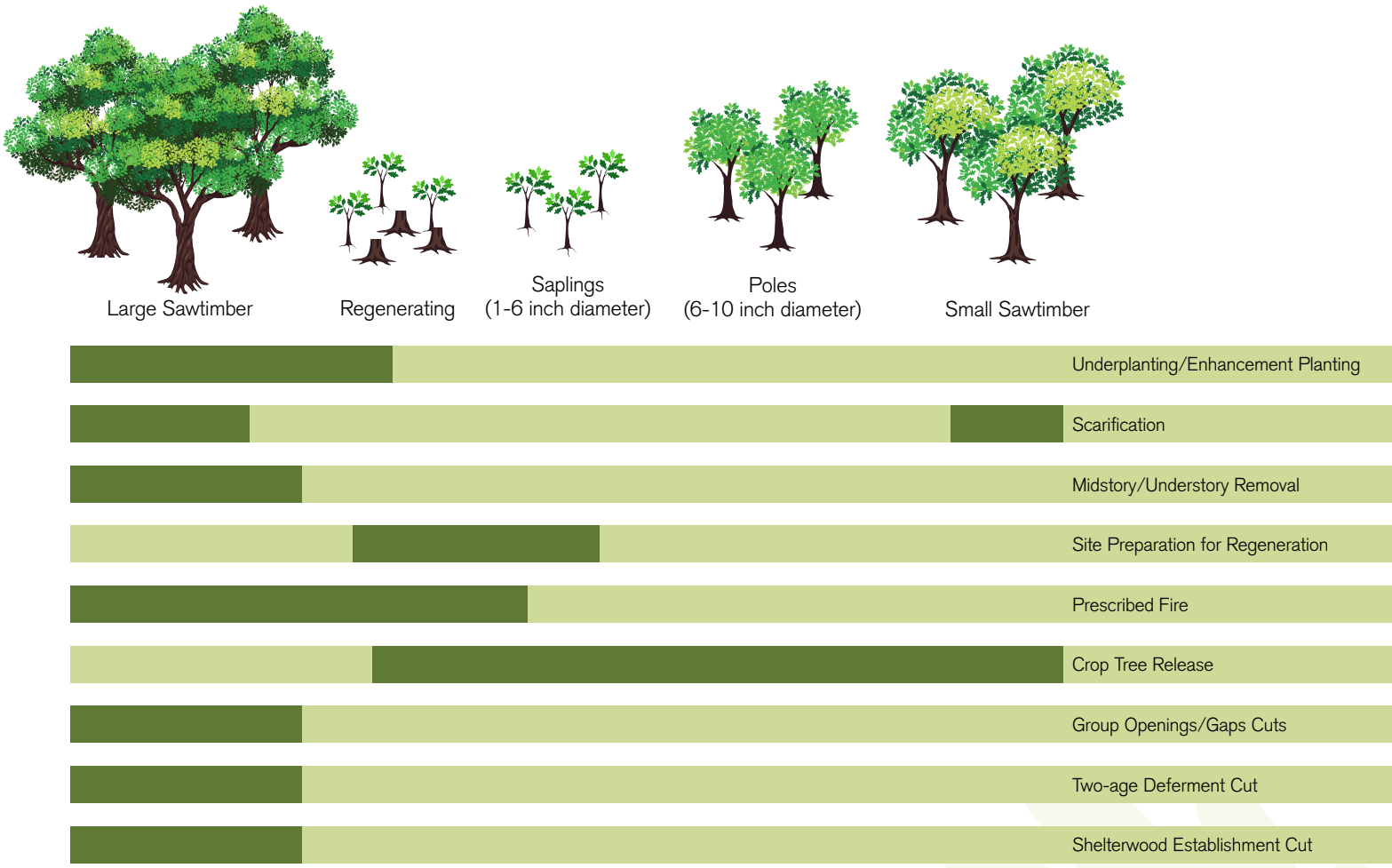
Unfortunately for oak, it is not possible to functionally re-establish repeated landscape-level burning or similar disturbance practices that historically reduced oak competitors and promoted oak prominence. To address this issue, it has become clear to scientists and researchers that management techniques will have to be widely employed that have the ability to establish oak regeneration, reduce competitors, and cultivate maturing oak trees. Because of the large number of forestry practitioners and landowners owning or managing white oak across a large geographic area, it was clear that a unified set of management recommendations had to be developed in order to facilitate effective, efficient utilization of appropriate practices to improve white oak success.

As a part of the White Oak Initiative, Dr. Jeff Stringer at the University of Kentucky coordinated leading oak researchers and practitioners in the development of a suite of 10 management practices to sustainably manage oak over the wide range of stand ages and conditions that occur across the region. Where appropriate, specific recommendations were provided for white oak.

The management guidelines that have been developed for each practice include specific information on when and under what conditions to apply the practice, and details of how to implement and monitor the practice to ensure oak success in upland hardwood stands. Because of white oak's importance, specific information on how to apply the practice to enhance white oak is also provided.

One of the practices — afforestation — was developed specifically to establish new forests on land that is currently non-forested. The other nine practices involve management of existing forests, to encourage the establishment and regeneration of oaks and to ensure they maintain robust growth and development.

MANAGEMENT PRACTICES BY STAGE OF STAND DEVELOPMENT



The use of management practices commonly used to help promote oak regeneration and growth are displayed in the stages of stand development where they are generally employed on private lands.

The practices can be used independently or in combination, simultaneously or sequentially. The image on page 41 shows when each of the nine practices is typically implemented across the range of stand ages and conditions associated with upland oak forests.

For oaks to naturally regenerate, large seedlings at least 3-4 feet tall and saplings need to be present in a forest prior to a regeneration event, such as an intensive timber harvest. The established seedlings and saplings are termed "advance regeneration" and must be present before a harvest. At times, smaller oaks (generally up to 8-10 inches in diameter and younger than 80 years old in the case of white oak) are also present and can aid in regenerating oak. The existing seedlings, saplings, or sprouts have the potential to maintain rapid height growth, giving oak regeneration a head start to maintain dominance in the regenerating age class. Without this advance regeneration of oak prior to a harvest, seedlings and saplings from competing tree species, like yellow poplar or maple grow more rapidly than slower growing oak seedlings regenerating from acorns. Therefore, establishing oak seedlings and saplings prior to a harvest is critical to restoring oak sustainability.

The nine oak management practices are designed to:

- initiate and develop advance regeneration,
- reduce competitors,
- ensure that harvesting is used properly to encourage oak regeneration, and
- cultivate established oak trees.

Detailed information on these practices is being developed and disseminated across the region. When considering these practices, it is important to understand that historical impacts leading to current oak abundance, such as repeated landscape-scale burning, cannot be re-established. It is also important to note that, while burning can be accomplished under controlled conditions such as prescribed fire, research has shown that it is difficult to use prescribed fire to quickly address oak regeneration issues, especially for small-ownership properties. The management practices developed recognize these issues and were designed to provide options that can be implemented easily, particularly on small, private-ownership properties commonly found throughout much of the eastern United States. On large public lands and as we become more sophisticated in managing small private ownerships, there may be more opportunity to use prescribed fire more often in oak management.

DEVELOPING ADVANCE REGENERATION

Two practices — underplanting and scarification — are designed to start new seedlings under an existing canopy several years prior to a harvest. Underplanting involves planting seedlings or acorns in large, sawtimber-sized stands prior to a regeneration harvest and is timed to provide the seedlings or acorns several years to develop before a harvest. Scarification is a practice where disks or rakes are used with tractors or bulldozers to incorporate or mix naturally occurring acorns into the leaf litter and the top 2-4 inches of soil. This greatly increases the number of acorns that successfully germinate and grow into small seedlings. Adding acorns to those that are naturally occurring may, in some instances, be possible. Both underplanting and scarification are designed to start new oak seedlings when not enough naturally occurring advance regeneration is present.

To ensure that these seedlings and naturally occurring oak seedlings have the proper environment to grow — namely, enough diffused light — a midstory/understory removal is often required to remove competing understory and midstory trees that are producing significant amount of shade to the forest floor where the small seedlings and saplings occur. Once they are large enough, other practices, such as a harvest, can be implemented and the larger advance regeneration has the opportunity to compete and grow into overstory trees.

HARVESTING

When significant numbers of advance regeneration or young trees that have the ability to sprout from stumps are present, a regeneration harvest can be used to jump-start a new age class of trees containing an abundance of oak. However, the harvest needs to be completed in a manner that helps the oak seedlings and saplings maintain growth and, if possible, reduce competition from other species. Several practices are designed to do this. A shelterwood harvest retains approximately 50 percent of the overstory, delivering an appropriate amount of reduced sunlight that favors the oaks while slowing competitors such as yellow poplar that grow quickly in full sunlight.

At times, group openings or gap cuts, one-half to two acres in size, can be harvested. The edge around the openings is partially shaded from the adjacent unharvested forest, encouraging oak growth while slowing shade-intolerant competitors.

A third type of harvest, called a two-age deferment harvest, can be used to help with long-term oak sustainability if a harvest is required when limited advance regeneration or stump sprouters are present. This practice retains scattered, long-lived overstory oaks (reserve trees) while all other overstory trees are removed.

A LOOK BACK: HOW THE WHITE OAK INITIATIVE BEGAN

The White Oak Initiative officially launched in the fall of 2017 but its roots go a few years deeper. According to Dr. Jeffrey Stringer at the University of Kentucky's Department of Forestry and Natural Resources and one of the Initiative's co-founders, the Initiative grew out of two meetings in 2015 and early 2017. These meetings, conducted by Stringer, were designed to share critical information with white oak-dependent industries and stakeholders on the species' region-wide regeneration problems. While the science behind this regeneration issue had been understood by those involved in forest science and forestry for more than 30 years, little of this information had been effectively communicated to the industries dependent upon white oak.

From the discussions among the experts and stakeholders in these meetings, it was clear that the regeneration problems would eventually threaten the long-term availability of white oak timber and cause a loss of the species in many forests across the eastern United States. Interest in white oak sustainability was also being fueled by rising interest in bourbon and whiskey. This was causing greater demand for barrels and higher-quality white oak, which provides 100% of bourbon's color and 70% of its flavor.

"We were looking at the amount of that resource that was available and the prices, and we came to the conclusion that although white oak is fairly common and there's good supply now, future availability was in question," Stringer says, due to the lack of white oak seedlings and saplings in many oak forests across the region. "That led to some conversations with distillers, forest industry organizations, and conservation groups about white oak sustainability."

Attendees of the 2017 meeting agreed that white oak supply was unsustainable in the long term and that something needed to be done. "Trees that are harvested to make distilling barrels can take up to 100 years to grow, so you have to think ahead," Stringer says.

Interest in this issue by the industry and other stakeholders spurred discussions between Stringer and AFF President Tom Martin, who was one of the presenters at the 2017 meeting. These discussions led to the concept of an initiative that would focus on white oak conservation. To further this concept, they gathered a team to formulate a plan for an initiative. DendriFund, a nonprofit organization focusing on developing collaboration to foster sustainability of water, grain, and wood — the three main components of bourbon whiskey — was one of the sponsors of the 2017 meeting and had shown significant interest in collaborating to help white oak. DendriFund Executive Director Barbara Hurt and Brown-Forman Communication & Brand History Manager McCauley Adams, along with AFF Vice President Paul DeLong, met with Martin and Stringer. Together, they developed the White Oak Initiative concept and identified potential steering committee members to represent the full range of white oak stakeholders across the species' geographic range. A fledgling steering committee met in the fall of 2017 and the White Oak Initiative was formally launched.

Despite its strong connection with bourbon, white oak's value goes far beyond the distilling industry and traditional wood products. According to Stringer, "White oak is hard, it has a nice grain and it's uniquely suited for barrels, but it's also really important for wildlife." For example, he says, "White oak acorns are one of the most-preferred acorns for many animals, and warblers and some bats prefer to nest in white oak trees." The White Oak Initiative addresses a lot of interests, Stringer says, including timber, wildlife, recreation, and overall forest health. This is why today, White Oak Initiative members include distillers, federal and state agency representatives, conservancy organizations, and traditional wood-use companies. Stringer notes, "The White Oak Initiative is one of the few examples where economic and conservation interests effectively align to address an issue that's critical to all stakeholders. The White Oak Initiative provides the mechanism that leads to action to address sustainability issues."

A regenerating age class will start to grow beneath them but without any oaks, due to the lack of advance regeneration or stump-sprouters. The oak reserve trees are kept to ensure that acorns continue to be produced in the stand. While the rapidly developing regenerating class will be devoid of dominant oaks, the reserve trees will continue to produce acorns. As the regenerating stand develops below the reserve trees, the acorns produced will start to establish seedlings that can be cultivated and initiate the development of advance regeneration that can be used to establish oak in the next generation 50-70 years in the future, when the forest will be harvested again. This practice is used to "life-boat" oaks in the stand. If the oak regeneration potential is low or nonexistent when a harvest occurs and the overstory oaks are removed, there is little chance of easily reintroducing oak back into the stand. The two-age deferment harvest ensures that long-lived oak species such as white oak can be maintained in the stand for future regeneration.

ORGANIZATIONS REPRESENTED IN THE UPLAND OAK SILVICULTURAL RESEARCH SURVEY

- **Auburn University**
- **Michigan State University**
- **Mississippi State University**
- **Missouri Department of Conservation**
- **Penn State University**
- **Purdue University**
- **Southern Illinois University**
- **University of Alabama**
- **University of Arkansas**
- **University of Kentucky**
- **University of Missouri**
- **University of Tennessee**
- **USDA Forest Service**
- **West Virginia University**

POST-HARVEST REGENERATION TREATMENTS

In association with a harvest, several treatments can be used to remove competing trees, including invasive species, that remain after a harvest, to provide unhindered growing space for oaks. A site preparation for regeneration treatment is used to kill competing trees left after a commercial harvest that can impede the growth of the oak seedlings, saplings, or sprouts. This treatment, normally using directed herbicides to kill competing trees, can be administered directly before, during, or after a harvest. Regardless, the aim is to reduce the post-harvest competition for the regenerating oaks.

Prescribed fire can also be used to top-kill competing species in association with a harvest; for example, directly burning before a harvest. Prescribed fire has been shown to provide positive results if implemented correctly. Researchers are also investigating the use of repeated prescribed fires to encourage oak advance regeneration to develop and reduce competing species over a long period of time. This can be helpful in developing forests with good oak regeneration potential, but widespread use of this practice will require more research.

Enhancement/enrichment planting can be used directly before or after harvesting to establish oaks. This practice requires planting oak seedlings and using appropriate competition control measures to "enhance or enrich" the naturally regenerating age class that is deficient in oaks. While this practice of planting oak seedlings directly before or after a harvest seems like a direct means of regenerating oaks, it has significant hurdles. Browsing by wildlife of the planting seedlings is common and is exacerbated by the high level of nutrients in seedlings from tree nurseries. Protection for the seedlings can be required, adding cost to the practice. Also, practices needed to adequately control competing species can be significant and costly. Plastic mulch, tree shelters, herbicides, or mechanical controls of competing species may be required. The high cost and degree of risk involved in planting oak seedlings in natural forests currently precludes the widespread use of this practice.

IMPROVING THE GROWTH AND DEVELOPMENT OF EXISTING OAKS

Once oaks have been successfully regenerated, making sure that existing oaks in older stands have room to grow with vigor is the objective of crop tree release. This practice releases the crowns of individual oak crop trees, providing room to expand their crowns. This practice ensures that oaks are not overtopped and that they maintain good growth rates. This release can be accomplished in natural stands and plantations that range in size from large saplings to small and medium-sized sawtimber.

When trees are sapling-sized or small pole-sized, the practice is often non-commercial, where competing trees are removed with herbicides or chainsaws. When trees are larger, a commercial harvest can be used to release crop trees, retaining them to continue to grow in value and size. Crop tree release has been well-studied and researchers have determined specifics as to the amount of crown release needed and when to apply the practice to benefit the specific species being grown. Oaks respond well to this practice, from the time of a regeneration harvest until they are 70-90 years old and possibly older.

In total, these practices provide all those interested in oak sustainability with management options aimed at sustaining the presence of upland oaks. Selecting which practice to use, by itself or in combination, and when and how to implement them, requires the expertise of a forester experienced in upland oak management.

WHITE OAK-SPECIFIC GUIDELINES

The practice-management guidelines have information that is provided to specifically enhance white oak regeneration, growth, and development. This is useful because white oak has a few unique or unusual characteristics relative to other upland oaks. For example, white oak is the most shade-tolerant of all upland oaks, allowing white oak to live longer in the shade than other oaks. This provides time to employ corrective practices such as midstory removal to improve the light condition in stands, which helps seedlings before they succumb to the shade. Another factor, along with this relative shade-tolerance is the relatively slow growth of white oak relative to many other upland oaks and competing species. This must be considered when implementing practices: white oak may need longer periods than other oaks to respond to treatments, such as midstory removal.

Slow growth and shade-tolerance also indicate the utility of shelterwood harvests for promoting white oak. White oak is long-lived and highly responsive to practices such as crop tree release, even when trees are 90 or more years old. This longevity also makes white oak a perfect candidate for a two-age deferment harvest that requires reserve trees to be retained for 150 to 300 years.

CONSERVATION – JASON LUPARDUS

CONNECTING WITH NATURE: THE NATIONAL WILD TURKEY FEDERATION

With a focus on science-based conservation and hunters' rights, the National Wild Turkey Federation is a dedicated stakeholder in the White Oak Initiative. In the words of Jason Lupardus, the Federation's director of development for the Central East region, "We work closely with the White Oak Initiative to support active forest management for forest health in terms of both flora and wildlife."

Lupardus notes that white oak is the most ecologically important tree in the eastern United States and that oak regeneration is a priority. "In 40 years or so, we may be missing a cohort of trees," he says, adding, "That's why we emphasize the need for forested landowners to incorporate active forest management as part of their long-term plan, and to work with a forestry professional to help manage those lands for long-term use that addresses management goals."

Lupardus explains that white oak is the most easily recognized tree species for Federation members, partly due to its acorns and the wide variety of wildlife it supports. As an example, he describes an oak savannah in northeastern Tennessee — the North Cumberland Wildlife Management Area: "It's got these large oak tree patches with native grasses. The wildlife diversity there — including eastern elk, grouse, and wild turkey — is just astounding. It's an incredible place to connect with nature."

Marie Read

PRIORITIZATION OR OPPORTUNITIES FOR PRACTICE

While all 10 practices are important and provide solutions to address most stand conditions found in upland hardwood stands, some have more widespread utility and greater potential for use than others. Based on this generalized assessment, the following table provides an opportunity ranking of each practice. However, it is important to note that all practices can have value in specific circumstances.

TEN SUGGESTED UPLAND AND WHITE OAK MANAGEMENT PRACTICES

HIGHEST OPPORTUNITY LEVEL

- **Midstory/understory removal.** Due to the lack of adequate advance regeneration in a significant number of medium- and high-quality upland oak stands, this practice — aimed at improving the vigor of advance regeneration — is one of the most useful to enhance oak regeneration.
- **Crop tree release.** This practice is the primary technique used to ensure that oaks continue to maintain vigorous growth. It can be applied in sapling-sized to sawtimber-sized stands. The practice has been shown to be successful across the region on all site types. The range of age classes on which this approach can be used makes this one of the most-used and most effective practices to grow oak.
- **Shelterwood establishment cut.** Mature, larger sawtimber-sized upland oak stands dominate the forest; a shelterwood harvest allows landowners to capitalize on their timber value and provides a semi-shaded light regime favorable to oaks and less so to competitors. It requires adequate oak regeneration potential for success. Practices to enhance oak advance regeneration prior to implementing a shelterwood establishment cut as well as practices to control competition impacting oak regeneration are likely needed in conjunction with a shelterwood establishment cut.

HIGH OPPORTUNITY LEVEL

- **Group openings/gaps cuts.** As is the case with the shelterwood practice, a group opening allows for harvesting of older stands that dominate the region. It provides a semi-shaded area around the opening edge that is conducive to oak regeneration.
- **Two-aged deferment cut.** A significant number of mature upland oaks forests have limited oak regeneration potential. This practice is a technique of last resort for these stands, sacrificing immediate oak regeneration but maintaining future oak regeneration potential. This practice requires the presence of long-lived oaks species in the overstory.
- **Site preparation for regeneration.** Often harvests that initiate regeneration such as shelterwood and group openings need a practice that removes trees that are or will compete with oak regeneration, making this practice useful throughout the region over a wide range of site conditions.

MODERATE OR SELECTIVE OPPORTUNITY LEVEL

A number of practices can effectively establish seedlings but are costly and are best used in combination with other practices. These include:

- **Afforestation.** The establishment of new forests with seedlings or seeds, competition control, and, at times, control of deer and other wildlife.
- **Underplanting/enhancement planting.** This approach uses artificial regeneration to establish oak that is limited or nonexistent in upland hardwood stands and requires the use of other practices to ensure success.
- **Scarification.** Scarification is used to help ensure adequate acorn germination and seedling establishment. It must be used only in years with abundant acorn crops and can be limited in use due to terrain constraints.
- **Prescribed fire.** Prescribed fire can be used as a phase in a shelterwood establishment cut or after a harvest as a liberation/cleaning tool such as the site preparation for regeneration treatment. However, the need for appropriate environmental conditions and correct timing, potential liability concerns, and, in some areas, a lack of technical expertise can make this practice a less desirable option. It should be noted that the use of prescribed fire to encourage oak regeneration, as a stand-alone practice or in combination with other practices, is currently being investigated for use on both small private holdings and large public-ownership properties. Results have been mixed and further investigation to fine-tune prescribed fire prescriptions is underway.

APPLYING FEDERAL RESOURCES: MAKING PROGRESS IN OHIO

White oak currently dominates much of Ohio's eight million acres of forestland, but its future is far from certain. A USDA report that's published every five years reported that, from 2011 to 2016, Ohio's white oak supply decreased almost 10% in net volume, with nearly a 15% decrease in the number of white oak trees measuring five inches or greater in diameter. Stated another way, Ohio's white oaks are being removed faster than they're regenerating. It's an issue that will affect many private landowners, as the USDA estimates that families and individuals own 70% of Ohio's forestland, 63% of which are oak/hickory forests.

One such landowner is Jim Savage, a Tree Farmer with about 450 acres in southeastern Ohio. During a harvest operation six years ago, he removed about three-fourths of the tall trees from a five-acre oak-dominated stand that was in decline. The few white oak trees that remained after this shelterwood harvest provided acorns for regeneration, while the newly opened canopy partially allowed light to hit the ground and promote new growth.

With funding partly provided through NRCS Environmental Quality Incentives Program (EQIP), his land was the site of Ohio's first prescribed burn aimed at oak regeneration on private land. According to Savage, a semi-retired commercial litigation attorney, "Oak is highly resistant to fire and other trees are not, so you basically run a fire through the area to kill all the seedlings that are outcompeting the oak. The little oak trees aren't harmed at all, and then they're free to shoot up and dominate the stand as you had intended."

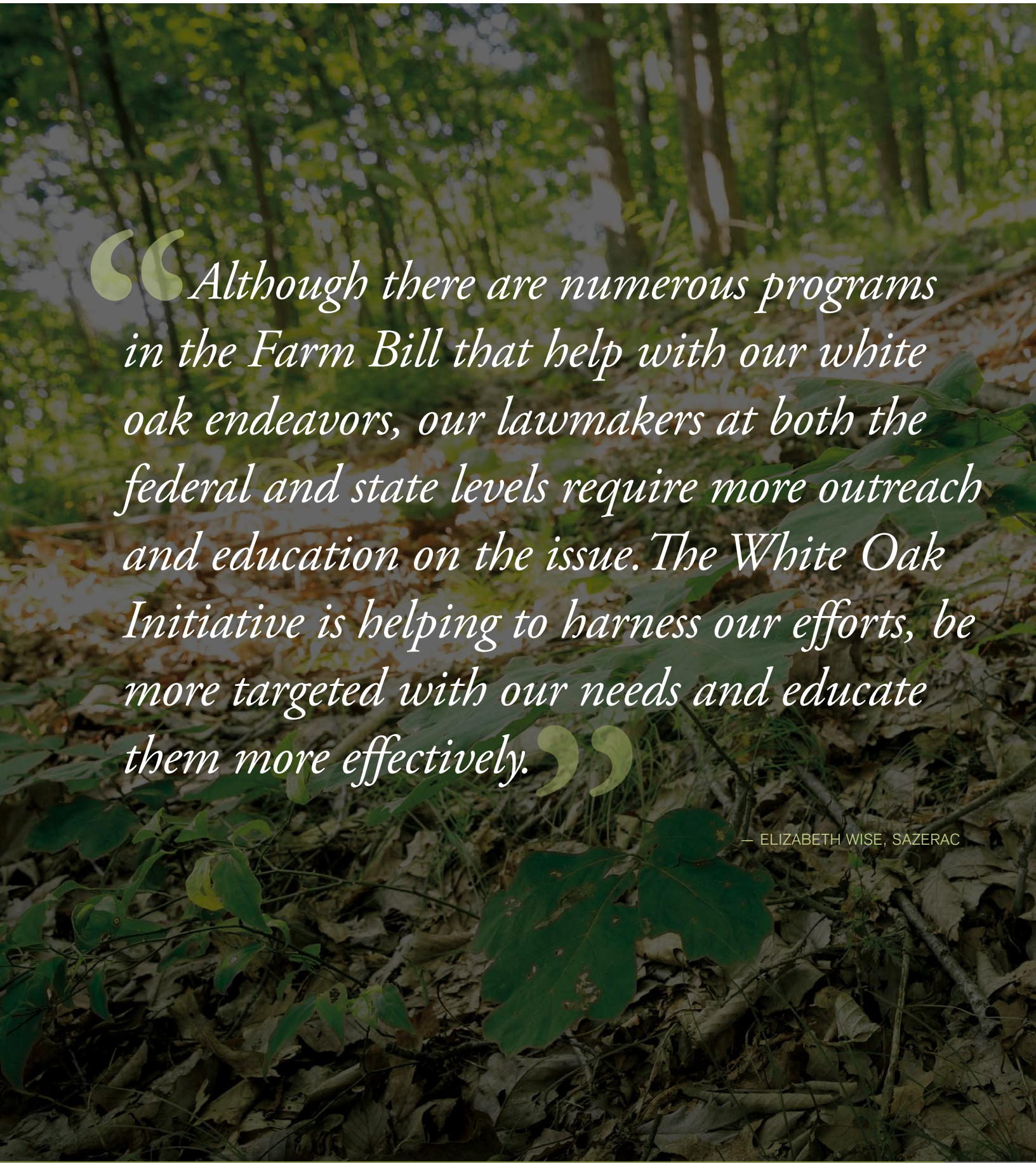
The fire was conducted in November 2020 with only one hitch: the cost. "With the hilly terrain of southern Ohio, the creation of fire breaks and the labor necessary to safely accomplish the burn and watch it overnight before putting out the hot patches the next day is very expensive," Savage said. With an increase in the use of prescribed fire in the region, more research, training, and coordination of practices to evaluate and reduce costs will be needed.

Fortunately, the Ohio Department of Natural Resources' Division of Forestry is addressing this issue in the hope of significantly increasing the EQIP pay item to make this practice feasible by 2022. "It's been recommended that I repeat the burn several more times every two to three years. I'd like to do so in 2022 if the pay item is increased to a realistic level," Savage said.

Mitch Farley, a Tree Farmer with 82 acres in southeastern Ohio who recently retired from the Ohio Department of Natural Resources, is on a similar mission to regenerate white oak. He hopes to have a controlled burn on his property in 2022 in conjunction with the Wayne National Forest, which borders his land on two sides. With help from EQIP in 2016, Farley removed red maple and other shade-tolerant trees from the midstory and understory of an aging white oak stand. Once he sees established white oak regeneration on those acres, he says he likely will perform a shelterwood harvest, removing about 80% of the old oak trees so the seedlings can get enough sunlight. "There's a lot of pressure on our remaining white oak," Farley says, "and we want to grow as much of it as possible so we can have it both for wildlife and economic purposes."

In both cases, White Oak Initiative partners worked closely with these landowners and took careful notes to help other forest owners to better manage their lands. By helping them connect with foresters and to access resources such as EQIP, the White Oak Initiative is seeking to empower forest owners to take action.

Note: Partly adapted from an article written by Nick Fortuna for the summer 2020 Woodland *magazine.*



"Although there are numerous programs in the Farm Bill that help with our white oak endeavors, our lawmakers at both the federal and state levels require more outreach and education on the issue. The White Oak Initiative is helping to harness our efforts, be more targeted with our needs and educate them more effectively."

— ELIZABETH WISE, SAZERAC

THE 2018 FARM BILL: POTENTIAL WHITE OAK RESOURCES

The White Oak Initiative emphasizes current and prospective resources highlighted in the 2018 Farm Bill, which includes many recommendations that can help restore white oak forests in the midwestern United States. These recommendations include:

- **Supporting forest owner participation and funding for the Environmental Quality Incentives Program (EQIP),** the Conservation Stewardship Program (CSP), and the Conservation Technical Assistance (CTA) program, which assist farmers in improving environmental quality, particularly water quality and soil conservation. Additional information on EQIP can be found at www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip. Additional information on CSP can be found at www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/#. Additional information on CTA can be found at www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/technical.

- **Maintaining authority for the Regional Conservation Partnership Program (RCPP),** which promotes coordination of NRCS activities with partners to address on-farm, watershed, and regional natural resource concerns in the Midwest. Additional information on RCPP can be found at www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/rcpp.

- **Codifying a new Collaborative Forest Landscape Restoration Program (CFLRP)** in the USDA Forest Service that allows landscape-level restoration of white oak trees and work across property lines, as opposed to parcel-by-parcel work. Additional information on CFLRPs can be found at www.fs.fed.us/restoration/CFLRP.

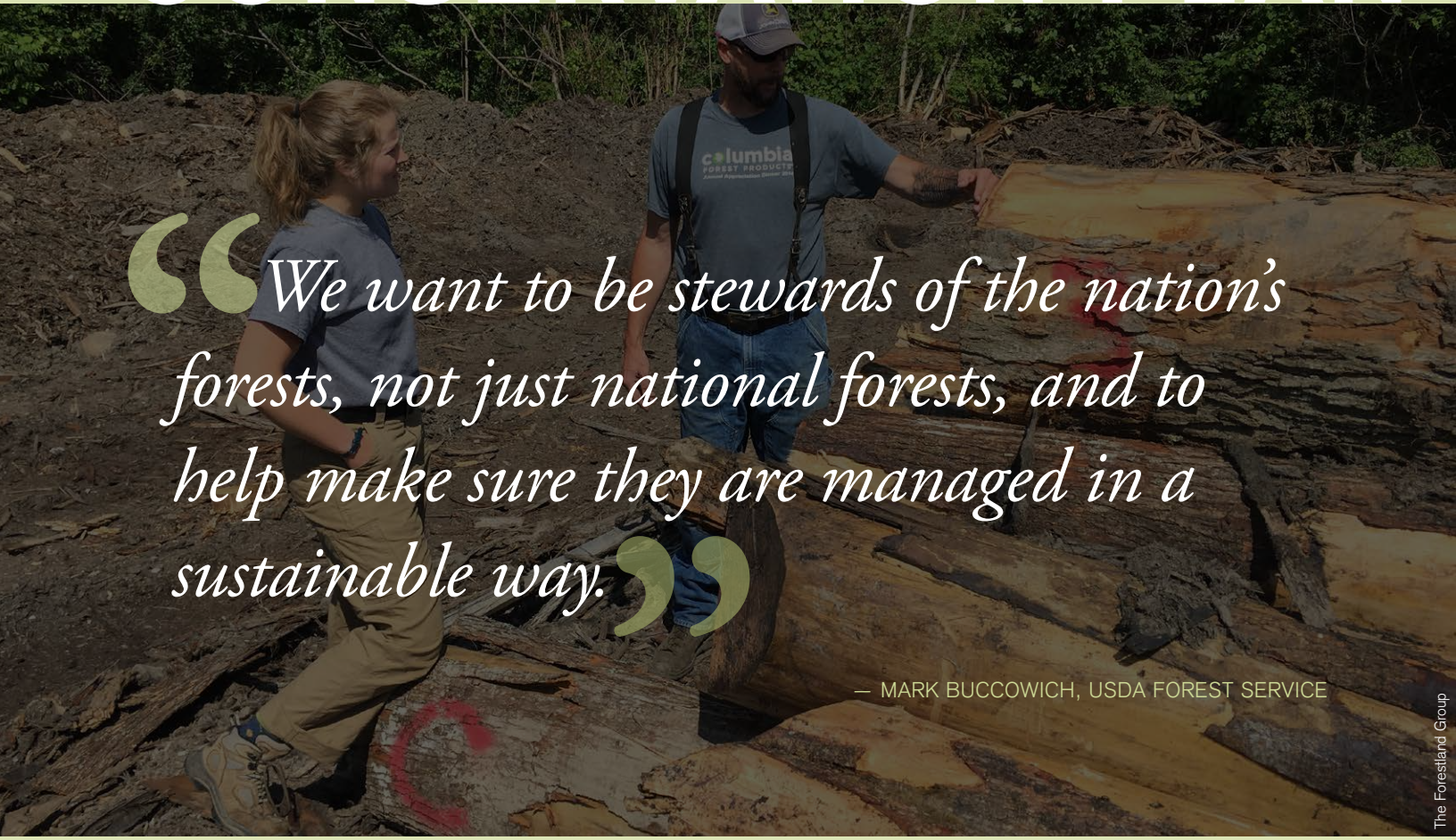
- **Improving management on public lands,** including improving USDA Forest Service Good Neighbor and Stewardship Agreements, to allow for road reconstruction, restoration, and repair that are necessary to manage oak stands. Additional information on Good Neighbor Authority can be found at www.fs.usda.gov/managing-land/farm-bill/gna.

- **Enacting the Timber Innovation Act,** which promotes new and innovative uses for wood. Additional information on the Timber Innovation Act can be found at www.congress.gov/bill/115th-congress/senate-bill/538.

- **Revising the Community Wood Energy and Wood Innovation Program,** which provides grants to install high-efficiency wood-heating systems in hospitals, schools, community centers, and entire towns and to support increased markets for wood, including low-value trees that need to be removed to make room for healthy white oak. Additional information on Community Wood Energy and Wood Innovation Program grants can be found at www.fs.usda.gov/science-technology/energy-forest-products/wood-innovation.

- **Broaden USDA Rural Development programs** to allow loggers to secure loans for equipment and other business needs. Additional information on USDA Rural Development programs can be found at www.rd.usda.gov/about-rd/farm-bill.

CONSERVATION PLAN



"We want to be stewards of the nation's forests, not just national forests, and to help make sure they are managed in a sustainable way."

— MARK BUCCOWICH, USDA FOREST SERVICE

The Forestland Group

INTRODUCTION: LEARN, PLAN AND ACT — TOGETHER

A cornerstone species of the eastern United States, white oak provides ecological, social, and economic value to numerous stakeholders. Not only does it provide vital habitat and food for wildlife, it also plays an essential role in rural economies and supports a wide variety of important and growing industries including furniture, flooring, cabinetry, barrels for spirits and wine, and more.

To ensure sustainable and healthy white oak forests for the future, we need to think, plan, and act today to prevent a crisis situation decades in the future. From the spatial assessment, we are armed with valuable knowledge and analysis to inform a collective plan of action. While we acknowledge that the problem is complex and likely requires a solution of relative complexity, the assessment provided insights into the factors that influence success, both from the perspectives of key stakeholders and from a spatial perspective.

Grounded in the findings from the *White Oak Assessment*, the White Oak Initiative presents our vision for the future of upland oak forests and ways to remove critical barriers to success. It represents the first time that such a vision for oak forests has been created via a widespread, coordinated effort. On the following pages, we lay out our own guiding principles for collective action, a long-term vision for the future, goals, implementation strategies, and recommended management practices.

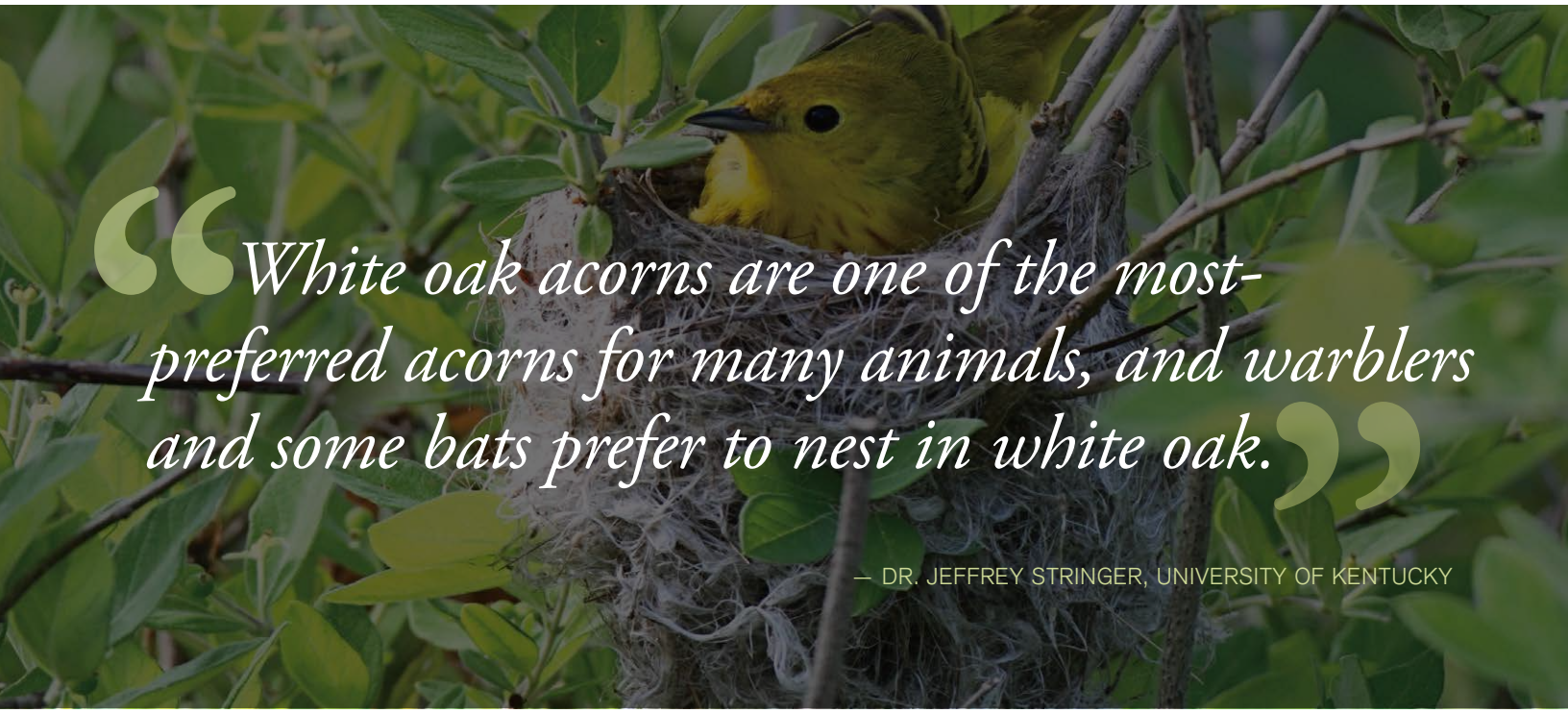
As we acknowledge in the *Assessment*'s concluding remarks, additional research will be needed to continually refine our strategy and practices. As a group, we are committed to a continual process of learning, planning, and acting as we work together toward our vision.

GUIDING PRINCIPLES

There's no quick fix or simple solution to restoring sustainability to America's eastern upland oak forests. The outcomes sought by the White Oak Initiative will take a comprehensive effort by many stakeholders. To develop a strategy for action, White Oak Initiative members have established several guiding principles. These principles are summarized below.

- **A science-based approach.** The plan is based on the best available science and a research-backed approach.
- **Strategic and outcome-oriented.** The White Oak Initiative has identified and employed the most significant actions to achieve measurable, meaningful outcomes, acting with an understanding of the markets available to support desired outcomes.
- **Collaboration.** Cross-boundary communication and coordination are necessary to achieve success. The White Oak Initiative is designed to actively develop and facilitate the implementation of practices specifically designed to conserve and sustainably manage white oak dominated forests. The White Oak Initiative is founded on principles for effective collaboration such as effective governance and transparency.
- **Site and stand-level decisions.** White and upland oak forest lands cover diverse and variable ecosystems. Site and stand-level variables, practicality, and landowner values and objectives should all be considered.
- **Public and private lands involvement.** Private landowners own a significant percentage of the United States' upload oak forests. Restoring oak sustainability on these lands is critical to the Initiative's success. Work on public lands will also provide meaningful impacts and opportunities to demonstrate desired sustainability outcomes.
- **Sharing of knowledge.** The White Oak Initiative communicates findings and convenes stakeholders to serve as catalysts to advance conservation actions.
- **Stakeholder feedback.** The White Oak Initiative has a goal of involving as many stakeholders as possible to develop a collective vision and to shape implementation strategies. As part of this effort, several assessment and conservation plan stakeholder feedback presentations have been conducted. These presentations have reached more than 300 individuals, including White Oak Initiative partners and email-newsletter subscribers.

GOALS — SHORT-TERM GOALS; LONG-TERM VISION



"White oak acorns are one of the most-preferred acorns for many animals, and warblers and some bats prefer to nest in white oak."

— DR. JEFFREY STRINGER, UNIVERSITY OF KENTUCKY

When considering the White Oak Initiative's purpose, it can be helpful to remember two things. The first is that upland oak trees can live for hundreds of years, so our actions today and in the coming years will have effects that will last for many human generations. The second is that there's a need to act soon, so that white oak supplies and benefits can continue in the coming decades.

In some cases, where we have a complete absence of oak seedlings, we need to take steps to establish seedlings and regenerate oak in the understory. Where we have seedlings established, we want to ensure that they can grow to become the next generation of mature oak forests. The same treatments that regenerate and release white oak will also produce favorable conditions for other upland oak.

With a significant percentage of targeted forest land owned by families and individuals, we will need to work with thousands of landowners to complete treatments for oak regeneration and release and to develop longer-term management plans or commitments focused on desired white oak outcomes, in addition to working with public land managers and landowners owning larger acreages.

To support longer-term desired outcomes, we will also need to ensure that we have a strong supply chain, including foresters, logging operators, and markets in priority areas. Where appropriate, public lands across the region should be managed to create large core areas of healthy, upland oak. In addition to sustaining core areas of healthy forest, these areas can serve as management demonstration areas, as seed sources for reforestation efforts, and as research sites.

With these thoughts in mind, the White Oak Initiative has devised a long-term vision that reflects decades-long challenges and shorter-term goals to articulate progress toward attaining that vision. During the next 50 years, we will set goals in 10-year increments that move us closer to our long-term vision of sustainable and balanced oak resources by 2070.

LONG-TERM VISION

By 2070, we envision that at least 100 million acres of forest within the central hardwood regions will have a healthy balance of young and mature white and upland oak trees. The balance will be reflected in a normal distribution of age classes, seedlings, and saplings through poles and mature stands, for white oak across the region to ensure a sustainable supply of forest products, habitat for a diverse array of wildlife species, and the long-term sustainability of healthy oak forests for the many benefits they provide. Without the collective and intentional efforts outlined in the Conservation Plan, we will see a significant reduction in white and

upland oaks in many forests in the eastern United States, with a transition to competing species. Through collective action, we will restore sustainability to the 100 million acres of white and upland oak forests, ensuring that they will continue to support the health of our natural, social, and economic environment into the future.

SHORT-TERM GOALS

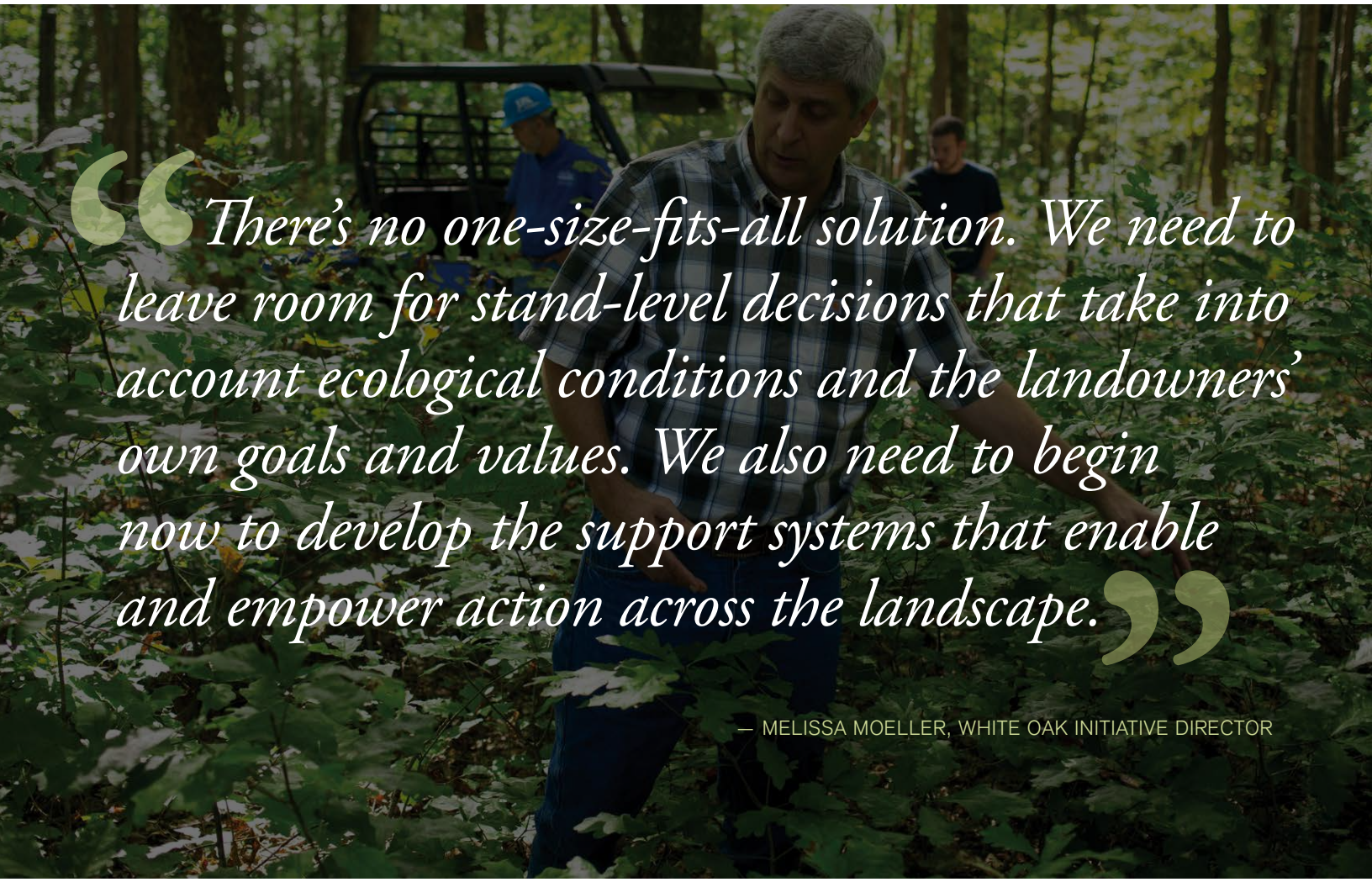
By 2032, it is our goal that three million forested acres in the Central hardwood region will have been treated to establish white oak seedlings or to release white oak saplings, increasing the current number of white oak acres in younger age classes and supporting the long-term economic, social, and environmental benefits derived from white oak dominated forests for future generations. To accomplish this, the White Oak Initiative will align knowledge and resources behind efforts to increase the number of forested acres in seedling and sapling stages and ensure that infrastructure is in place to support a sustainable cycle in the future.

To continue our cycle of learning, planning, and working together, we have set targets for the first three years (2022-2024) as we continue to refine strategies that will allow us to have an impact at scale. The near-term targets include acres treated and targets for connecting with stakeholders:

1. **4,000 forest practitioners and logging operators** receiving forest management guidelines for oak management
2. **500-1,000 practitioners** trained on management guidelines
3. **50,000 landowners** reached with information about oak sustainability
4. **5,000 landowners** connected with practitioners or plans for restoring oak sustainability
5. **1,500 landowners** managing their property for upland oak, with an emphasis on white oak
6. **100,000 acres** treated to establish oak seedlings or to release saplings
7. **Increase the number** of demonstration areas on public or private lands that highlight quality oak forests by nine or more.

With an eye toward scaling our impact, the actions in the initial four years help to inform our strategy for greater impacts on more acres in subsequent years, and we also intend to use initial actions to spur actions by more stakeholders.

IMPLEMENTATION STRATEGIES



"There's no one-size-fits-all solution. We need to leave room for stand-level decisions that take into account ecological conditions and the landowners' own goals and values. We also need to begin now to develop the support systems that enable and empower action across the landscape."

— MELISSA MOELLER, WHITE OAK INITIATIVE DIRECTOR

Early on, White Oak Initiative members identified a need to spur action by creating the right conditions to support decisions that regenerate oak, and to ensure that the proper supports — including markets, policy, and research — are in place. This is why one of the most important efforts by the White Oak Initiative has been developing implementation strategies that are customized for different sectors or audiences. Listed below, these recommendations and guidelines can help guide actions on the ground to help the Initiative reach its goal of ensuring long-term sustainability of upland and white oak forests.

PRIVATE AND FAMILY-OWNED LANDS

Because of the significant percentage of private ownership in the white oak range, ensuring that private landowners have the knowledge, opportunities, and resources to conduct treatments to restore oak sustainability will be a key to success. With an eye toward our long-term vision, we also want to ensure that private landowners have the support and resources needed to steward the next generation of oak forests. Our recommendations include:

- **Provide information to landowners** to better understand oak benefits relative to their own values (aesthetics, wildlife, etc.) and the actions they can take to lead to desired outcomes.
- **Ensure that landowners have management plans** that support stewardship of the next generation of oak forests.
- **Connect landowners interested in taking actions within priority landscapes to practitioners** (foresters, loggers, etc.) who have been trained on the Initiative's suggested management activities for oak regeneration.

- **Prepare landowners for action** on their land by connecting them with resources to offset the upfront cost of management, including financial and technical assistance through NRCS, their state agency, or other groups.

- **Ensure strong practitioner support** to support actions on the ground that will lead to desired outcomes for oak.

- **When practical, aggregate landowners** to encourage them to manage together, increasing the efficiency of resources and technical service to increase economic returns and achieve desired outcomes.

- **Monitor and track outcomes** through a network of partners working with landowners in priority landscapes.

STATE AND FEDERAL PUBLIC LANDS

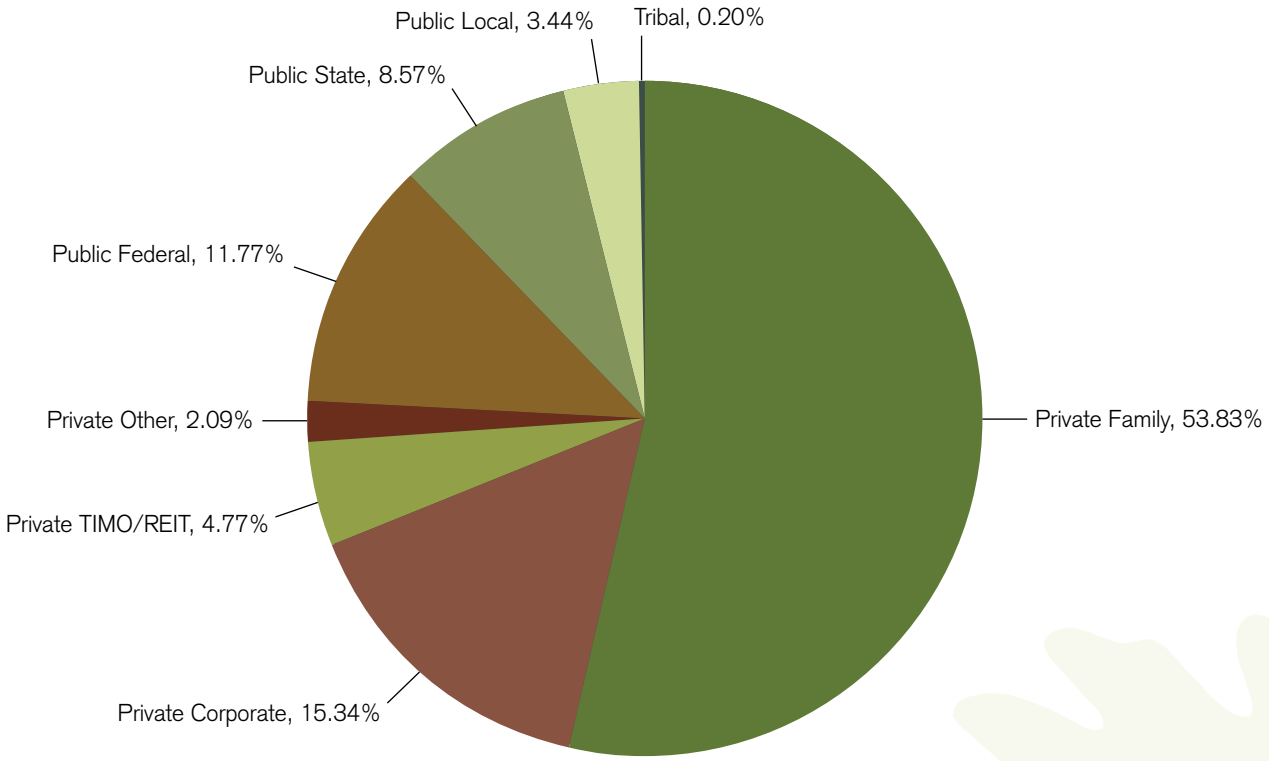
While state and federal public lands make up less of the white oak range, actions to increase the white oak forested acres in younger age classes on these lands can add to the Initiative's success because of the ability to treat large acres in blocks. Actions on public lands can also provide demonstration areas for private landowners to learn about specific management techniques and allow larger areas for testing innovative treatments that can be applied more broadly. Our recommendations include:

- **Work with the USDA Forest Service, other federal land-management agencies and state agencies** to develop demonstration areas on government-managed lands, providing educational opportunities for private landowners.

- **Work with public land managers to incorporate management recommendations or expand efforts** in management plans and implement management treatments to establish white oak seedlings or to release white oak saplings, helping to increase the number of white oak acres in younger age classes.

- **Look for opportunities to work with public land managers to test innovative management treatment strategies and share findings** with the broader community to inform future work.

TOTAL % OF FOREST BY OWNERSHIP TYPE (ACROSS ALL ECOSTATES)



SPOTLIGHT ON KENTUCKY BOURBON:

According to the Kentucky Distillers' Association, Kentucky accounts for 95% of global bourbon supply. As of 2019, according to the association, Kentucky had 68 distilleries, up 250% in the past decade. At 1.7 million barrels in 2019, Kentucky's bourbon production has increased more than 115% over the past five years, driven largely by premium small-batch and single-barrel brands that mainly rely on charred white oak barrels to give bourbon its color and flavor.

RESEARCH

To further understand the challenges and solutions surrounding establishment and development of the next generation of white oak forests, additional research is needed to help support improved outcomes on private and public lands. Our recommendations include:

- **Develop models of recommended forest management practices** to improve predictions of growth under varying circumstances, and in turn inform availability of supply to meet economic demand.
- **Monitor and evaluate efficacy of practices** intended to regenerate white oak.
- **Further refine measures to encompass product types in Forest Inventory Analysis tracking** that are important for white oak industries and increase economic understanding of the factors influencing successful efforts to restore oak sustainability.

MARKET-BASED SOLUTIONS

Strong markets for wood, especially smaller, lower-value trees and other ecosystem services, will help to support establishment of the next generation of white oak forests, ensuring the establishment and viability of younger forests. Our recommendations include:

- **Convene a diverse set of knowledgeable stakeholders** to further analyze existing market challenges and opportunities, leading to collective problem-solving.
- **Explore opportunities with new and emerging markets** to support desired outcomes.
- **Develop and enhance existing local and state initiatives** to support markets needed to support oak sustainability.
- **Explore innovative and outcome-based financing solutions** to support work to restore sustainability, aligning with or creating markets as needed.

FEDERAL AND STATE POLICY

Improved federal and state policies and programs can enable success on private lands, public lands, research, and market-based solutions. Our recommendations include:

- **Support for state and federal programs** that provide landowners with cost-sharing and technical assistance for management practices to support the next generation of white oak forests.

INVASIVE SPECIES AND OTHER FACTORS

That Can Interfere With White Oak's Ability to Regenerate and Thrive (Partial List)

- **Autumn olive**
- **Bacterial leaf scorch**
- **Bush honeysuckle**
- **Cattle grazing**
- **Common buckthorn**
- **Excessive deer browse**
- **Fire exclusion**
- **Gypsy moth**
- **Hypoxylon canker**
- **Japanese honeysuckle**
- **Japanese stiltgrass**
- **Kudzu**
- **Multiflora rose**
- **Nepalese browntop**
- **Oak anthracnose**
- **Oak wilt**
- **Privet shrubs and trees**
- **Reed canarygrass**
- **Tree of heaven**
- **Wintercreeper**

- **Support for management treatments on public lands** that lead to the establishment of the next generation of oak forests.

- **Improve policies to allow for landscape-level work** across public and private land.

- **Support policies and programs that increase markets for wood,** especially low-value trees that need to be removed to allow for the next generation of white oak saplings and trees.

- **Support policies and programs that support a skilled logger workforce and foresters** knowledgeable in white oak management to restore sustainability.

COMMUNICATION, EDUCATION AND OUTREACH

Much like the adage, "It takes a village…" the White Oak Initiative's success depends on coordinated efforts by diverse stakeholders. To improve communication, education, and outreach to these stakeholders, our recommendations include:

- **Provide training for foresters and loggers** related to management for oak regeneration and recommended practices.

- **Provide outreach and education to landowners** around oak benefits relative to their own values and the actions they can take to lead to desired outcomes.

- **Provide outreach and education to key stakeholders and decision-makers** who can support market solutions and policy solutions that enable work on private and public lands.

- **Provide clear messages and outreach to the broader public** around oak benefits and actions needed to support long-term desired outcomes, with an eye toward empowering public land managers and private landowners.

- **Use demonstration sites** on state and federal public lands as educational opportunities for resource managers, forestry professionals, and private landowners.

WHITE OAK IN OHIO: A STATE-LEVEL LOOK

Like many states, Ohio is serious about its forests. Back in 2008, the Ohio Department of Natural Resources' Division of Forestry joined with the USDA Forest Service and the NRCS to create the Ohio Interagency Forestry Team, which is dedicated to the concept of shared stewardship and a goal of enhancing resilience in the state's forests.

But very few of the state's forests are state forests … or national forests, either. About 86% of Ohio's woodlands are privately owned, with 72% controlled by family forest owners. According to Cotton Randall, the cooperative forest management administrator for the Ohio Department of Natural Resources' Division of Forestry, these forests drive about $26 billion in annual economic activity. "Oak-dominated forests are definitely Ohio's dominant forest type," Randall says, adding, "For veneer and cooperages, white oak is economically huge in Ohio, to say nothing of its ecological, aesthetic, and emotional value."

The Ohio Interagency Forestry Team has been doing collaborative oak management for longer than the White Oak Initiative has been around, and it has core projects around the state to show for it. Randall explains, "By connecting forest owners with the EQIP program through NRCS, we've helped landowners to get funding for thinning and crop tree release to make sure oak is part of future forests. We're doing this work on federal and private lands alike, including a prescribed burn in Wayne National Forest."

Randall's involvement in the local Forestry Team has highlighted the power of collaboration. "There's such a patchwork of ownership here, you can't have a shotgun approach. You need collaboration." This is why Randall is so excited about the White Oak Initiative. "There's a lot of potential from a 17-state initiative," he says, adding, "Having such a wide and measurable impact allows us to think about common data to collect, common terminology … we can all share our challenges, mistakes and breakthroughs. And it helps get a wider message across that you can't take white oak for granted."

SUPPORTING LITERATURE

Abrams, M. D. (1992). Fire and the development of oak forests. BioScience, 42(5), 346-353.

Abrams, M. D. (2000). Fire and the ecological history of oak forests in the eastern United States. In Proceedings: Workshop on Fire, People, and the Central Hardwoods Landscape. USDA Forest Service. Richmond, Kentucky (pp. 46-55).

Abrams, M. D. (2003). Where has all the white oak gone? BioScience, 53(10), 927-939.

Conrad, A. O., Crocker, E. V., Li, X., Thomas, W. R., Ochuodho, T. O., Holmes, T. P., & Nelson, C. D. (2020). Threats to Oaks in the Eastern United States: Perceptions and Expectations of Experts. Journal of Forestry, 118(1), 14-27.

Dickson, J. G. (2004). Wildlife and upland oak forests. Gen. Tech. Rep. SRS-73. Asheville, NC: US Department of Agriculture, Forest Service, Southern Research Station, 106-115.

Ellsworth, J. W., & McComb, B. C. (2003). Potential effects of passenger pigeon flocks on the structure and composition of presettlement forests of eastern North America. Conservation Biology, 17(6), 1548-1558.

Jedlicka, J., Vandermeer, J., Aviles-Vazquez, K., Barros, O., & Perfecto, I. (2004). Gypsy moth defoliation of oak trees and a positive response of red maple and black cherry: an example of indirect interaction. The American midland naturalist, 152(2), 231-236.

Knoot, Tricia & Schulte, Lisa & Rickenbach, Mark. (2009). Oak Conservation and Restoration on Private Forestlands: Negotiating a Social-Ecological Landscape. Environmental management. 45. 155-64. 10.1007/s00267-009-9404-7.

Luppold, W., & Bumgardner, M. (2008). US hardwood lumber production: 1963 to 2003. In In: Jacobs, Douglass F.; Michler, Charles H., eds. 2008. Proceedings, 16th Central Hardwood Forest Conference; 2008 April 8-9; West Lafayette, IN. Gen. Tech. Rep. NRS-P-24. Newtown Square, PA: US Department of Agriculture, Forest Service, Northern Research Station: 157-165. (Vol. 24).

Luppold, W. G., & Bumgardner, M. S. (2013). Factors influencing changes in US hardwood log and lumber exports from 1990 to 2011. BioResources, 8(2), 1615-1624.

Luppold, W. G., & Bumgardner, M. S. (2018). Structural changes in the growing stock of important tree species groups in the Central hardwood region. Journal of Forestry, 116(5), 405-411.

Luppold, W. G., & Bumgardner, M. S. (2019). Changes in the Quality of the Northern US Hardwood Timber Resource from 2008 to 2017. BioResources, 14(3), 6304-6315.

Nowacki, G. J., & Abrams, M. D. (2008). The demise of fire and “mesophication” of forests in the eastern United States. BioScience, 58(2), 123-138.

Rooney, T. P., & Waller, D. M. (2003). Direct and indirect effects of white-tailed deer in forest ecosystems. Forest ecology and management, 181(1-2), 165-176.

Spetich, M. A. (2004). Upland oak ecology symposium: history, current conditions, and sustainability. Gen. Tech. Rep. SRS-73. Asheville, NC: US Department of Agriculture, Forest Service, Southern Research Station. 311 p., 73.

W.R. Thomas, T.O. Ochuodho, C.F. Niman, M.T. Springer, D.A. Agyeman, L.R. Lhotka. 2020. Stakeholder Perceptions of White Oak Supply in Kentucky: A SWOT-AHP Analysis. Small-scale Forestry.

ADDITIONAL RESOURCES

Links to the *White Oak Initiative Assessment & Conservation Plan* and supporting documentation can be found at www.whiteoakinitiative.org/assessment-conservation-plan. Supporting documents on this webpage include:

- *White Oak Initiative Entry Principles for Membership*
- *White Oak Initiative Fact Sheet*
- *White Oak Initiative Landowner Survey Report*
- *White Oak Initiative Management Practices*
- *White Oak Initiative Partner Preview Webinar Presentation*
- *White Oak Initiative Regeneration Spatial Analysis Presentation*
- *White Oak Initiative Spatial Regeneration Report*
- *White Oak Initiative Technical Introduction*
- *Using GIS To Determine Where to Invest in White Oak Growth*

A REPORT BY THE AMERICAN FOREST FOUNDATION AND THE WHITE OAK INITIATIVE STEERING COMMITTEE

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