OAK SILVAH IN OHIO AT THE LANDSCAPE SCALE

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Insights for Managers

- **State and federal land management agencies are using this approach to establish short- and long-term priorities for even-age management treatments of oak-hickory stands.**
- **The Ohio Interagency Forestry Team is applying the model across the 17-county project area to align agency programs of work with family forest landowner interest in managing oak across the region.**
- **Managers can use these tools to assess public and private land opportunities to prioritize investments in oak management in southeastern Ohio by estimating the cost of oak treatment based on site productivity and oak regeneration.**
- **Managers and scientists can apply this modeling approach to other species of interest such as the nonnative invasive tree, Ailanthus.**

INTRODUCTION TO OHIO FORESTS

Forests cover 8.2 million acres in Ohio, encompassing 31 percent of the state's land area (Widmann 2014). Eighty-three percent is privately owned; 17 percent is publicly owned. Most forest land is in the unglaciated southeastern area of Ohio and is dominated by oak-hickory forests (Fig. 1). These provide critical habitat for more than 100 wildlife species, which include at-risk animals such as wood thrush (*Hylocichla mustelina*), cerulean warbler (*Setophaga cerulea*), and timber rattlesnake (*Crotalus horridus*). The topography of these landscapes is highly dissected and creates spatially heterogeneous microenvironments that influence oak-hickory advance regeneration stocking (Iverson et al. 2017). Mature mixed-oak forests grow on a variety of aspects and slope positions with site indices of 55-80. These overstories are dominated by white oak (*Quercus alba*), chestnut oak (*Q. prinus*), and black oak (*Q. velutina*). Midstory and sapling layers are dominated by red maples (*Acer rubrum*) and sugar maples (*A. saccharum*); however, numerous species including blackgum (*Nyssa sylvatica*), yellow-poplar (*Liriodendron tulipifera*), beech (*Fagus grandifolia*), and sourwood (*Oxydendrum arboreum*) are present. Deer pressure is generally lower in Ohio than in Pennsylvania and other eastern U.S. states. Nonnative plant species such as Ailanthus (*Ailanthus altissima*), autumn olive (*Elaeagnus umbellata*), multiflora rose (*Rosa multiflora*), twinberry honeysuckle (*Lonicera involucrata*), and stiltgrass (*Microstegium vimineum*) are problematic and continue to expand within these forests.

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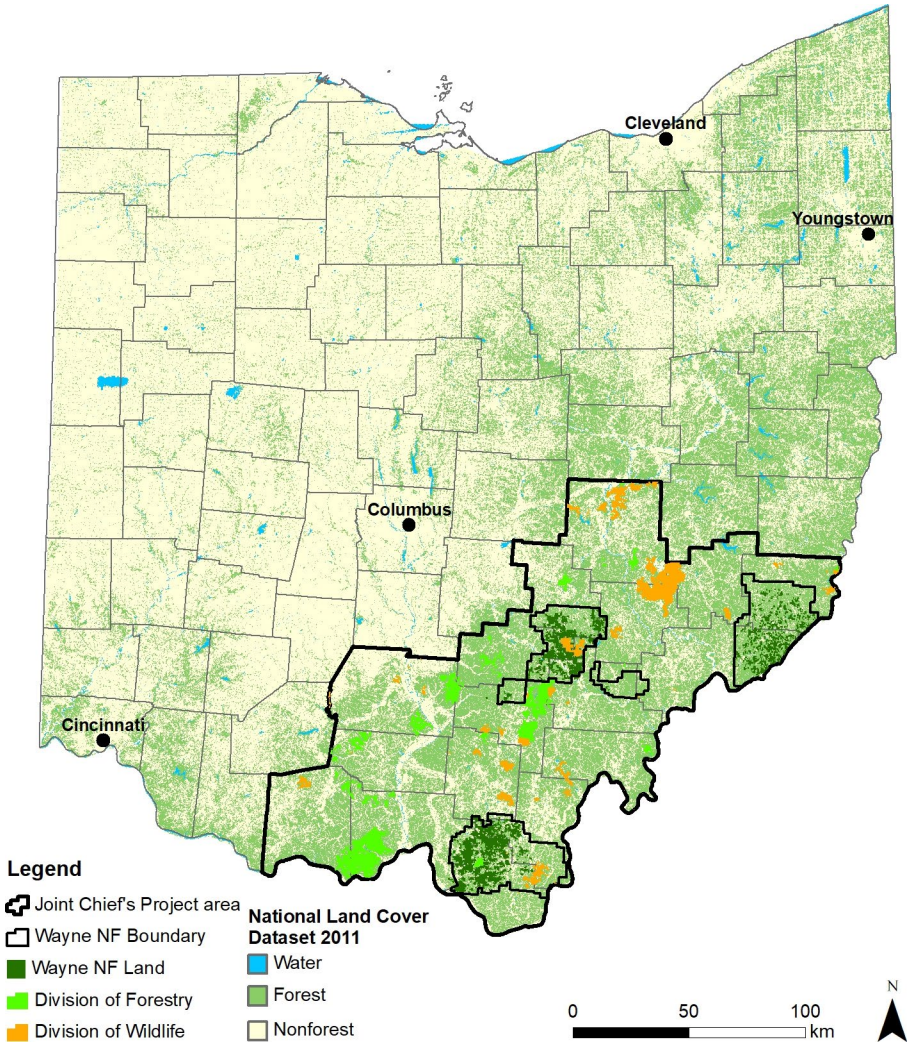

Figure 1.—Regional map of USDA Joint Chiefs' Landscape Restoration Partnership Project, Collaborative Oak Landscape Management in Ohio's Appalachian Mountains project area, including boundaries of WNF and Ohio Divisions of Forestry and Wildlife lands. Land cover data indicate the distribution of forested land in Ohio.

As in other parts of the eastern United States, removal of high-quality white oak from Ohio forests is exceeding recruitment. From 1991 through 2011 select white oak sawlog recruitment equaled removal, and pole-sized recruitment declined 11.8 percent, from 32.6 to 20.8 million trees (Widmann 2014). Management to sustain Ohio's mixed-oak forest to support wildlife habitat and timber production is a priority for the region. The recent boom in bourbon production increases the need for high-quality white oak stave logs, which production facilities are stockpiling. Speyside Bourbon Cooperage in Jackson, OH, began production in May 2016. It produces 1500 barrels and consumes 53,000 board feet of quarter-sawn white oak staves each day.[2] The Amish-based furniture manufacturing cluster in Holmes and surrounding counties in northeastern Ohio is a growing sector of the domestic furniture industry, which also uses Ohio's oak resource (Bumgardner et al. 2011).

[2] A. Ramirez, production manager, Speyside Bourbon Cooperage, 960 E. Main St., Jackson, OH 45640. Personal communication, October 13, 2017.

BRINGING OAK SILVAH TO OHIO

The first Oak SILVAH training session in Ohio was held in 2009. To date, more than 110 alumni represent a mix of private, county, state, and federal land management agencies, private consulting foresters, service foresters, and academics. The 4-day training sessions, typically held biannually at the Vinton Furnace State Experimental Forest (https://www.nrs.fs.fed.us/ef/locations/oh/vinton-furnace/) in Vinton County, Ohio, have become so popular that wait lists develop several months before an event.

Shortly after the first Ohio SILVAH training session, the Ohio Department of Natural Resources Division of Forestry (ODOF) piloted SILVAH (2010-11), which coincided with certification through the Forest Stewardship Council and the Sustainable Forestry Initiative. The SILVAH decision support system complemented the sustainable certification principles and standards for timber management of the Forest Stewardship Council and Sustainable Forestry Initiative. In 2015, Ohio Division of Wildlife (ODOW) partnered with the National Wild Turkey Federation by contracting SILVAH inventories in 13 wildlife management areas (42,526 acres), which were stratified by forest type, slope position, and tree height classes. Managers and technical staff from ODOW and ODOF attend biennial Oak SILVAH training sessions in Ohio and use SILVAH for forest inventories and management activities across Ohio.

The SILVAH system is addressing the forest management needs of Ohio's public and private landowners, and its use by private consulting foresters in Ohio continues to increase. The USDA Joint Chiefs' Landscape Restoration Partnership Project, Collaborative Oak Landscape Management in Ohio's Appalachian Mountains, incorporated Oak SILVAH training as a cornerstone for staff development. It includes the Wayne National Forest (WNF), Natural Resource Conservation Service (NRCS), Ohio Division of Soil and Water Conservation Districts, and ODOF service foresters.

JOINT CHIEFS' LANDSCAPE RESTORATION PARTNERSHIP PROJECT, COLLABORATIVE OAK LANDSCAPE MANAGEMENT IN OHIO'S APPALACHIAN MOUNTAINS

The USDA Forest Service and NRCS received Joint Chiefs' Landscape Restoration Partnership Project funding from 2015 through 2017 to work with state agencies such as ODOF and nongovernmental organizations with a goal to coordinate inventorying, management, and monitoring of oak-hickory forests in a 17-county area of southeastern Ohio (Figure 1) to improve the efficiency and effectiveness of landscape-scale management. The main goal is to identify and prioritize areas of investment to maintain or restore oak-hickory. The agencies developed data-sharing technologies, created a regional SILVAH inventory database, and modeled ecological landtypes (LTs) that favor oak habitat to achieve this goal and create an effective multiagency partnership. A major outcome has been the formation of a chartered working group, the Ohio Interagency Forestry Team, which operates under a new business model:

- A team charter outlines processes and expectations.
- A regional science framework includes data, tools, and training.
- Landscape-scale conservation strategies enhance government services and programs.

Data Sharing

Data-sharing technologies archive and provide access to datasets that are relevant to the project objectives that may otherwise be difficult to distribute among collaborators. Examples include Data Basin (https://databasin.org/) and Esri's ArcGIS Online (https://www.esri.com/en-us/arcgis/products/arcgis-online/overview), both of which allow geospatial data to be shared and mapped on a website that allows users to visually analyze data. Some data-sharing technologies can incorporate data provided as a map service, digital dynamic map layers, to reduce maintenance requirements by updating shared files in real time as hosting agencies edit and manage records. An interactive map viewer is also integrated with some basic tools for analyzing data. It enables users who might not use a full suite of geographic information system (GIS) functions to visualize, query, and extract pertinent records. Information sharing will support coordinated treatments and the development of landscape-scale strategies.

SILVAH Regional Database

The regional SILVAH database incorporates more than 5 years of data records collected by ODOF and ODOW, WNF, and Forest Service Forest Inventory and Analysis (FIA). FIA inventories are not collected using the SILVAH protocol and required some additional processing to derive information related to the status of oak in the overstory and understory layers. The FIA records do, however, provide representation of the species compositions that private forest landowners might be managing. FIA sampling protocols were revised in 2012 to collect SILVAH regeneration information in 24 northeastern states. This fills an information gap for smaller size classes of hardwood (12 inches tall) and conifer (6 inches tall) seedlings up to saplings (1 inch diameter at breast height [d.b.h.]). Data from Forest Service National Forest Common Stand Exams, as well as other formats such as T-Cruise, can also be pulled into the SILVAH software and analyzed; however, because SILVAH operates at the stand level and does not have a spatial component, locations of individual inventory plots are unknown. The additional refined spatial information would be useful, but access to other inventory formats can increase the ability of the database to provide current forest composition and structure information.

We calculated a metric of "oakiness" for each SILVAH and FIA inventory plot in the 17-county region. This represents the percentage of oak species in the overstory canopy by basal area and a weighted oak index that indicates the stocking of oaks in the understory layer. We used the following definitions: (1) competitive, >3 feet in height or ¾-inch root collar diameter; (2) established, 1-3 feet in height or ¼- to ¾-inch root collar diameter; and (3) new, <1 foot in height (Brose et al. 2008). We then weighted and summed counts of oak species within each class by 25, 12, and 1, respectively. Oak index values >24 can be considered stocked with advanced oak regeneration when deer browsing pressures are low.

Modeling Ecological Landtypes

Maintaining or restoring oak-hickory in these forests requires knowing the locations where these species would have suitable habitat. We used the research of Hix and Pearcy (1997) and Pearcy et al. (1999) to model six ecological landtype phases (LTPs) across 17 southeastern Ohio counties derived from 33-foot elevation and terrain variables. We then aggregated these LTPs, which define ridgetops, northeastern and southwestern upper and lower hillslopes, and valley bottomlands, into three LTs that represent favorable habitat for oak-hickory forests. We evaluated LTs and LTPs across this region by examining corresponding SILVAH inventory records: (1) where oak was not present at the site; (2) present in either the overstory or understory; or (3) present in both the overstory and understory canopies.

APPLYING LANDTYPE MODEL OUTPUTS AND SILVAH TO PRIORITIZE MANAGEMENT INVESTMENTS

Based on the modeled ecological LTs, the 17-county region (5,425,198 acres) comprises 39.7 percent dry oak forest, 29.3 percent dry-mesic mixed-oak hardwood forest, and 31.1 percent rolling bottomland mixed-hardwood forest (Iverson et al. 2018). Oak and hickory species have the potential for favorable habitats within the dry oak and portions of the dry-mesic mixed-oak hardwood forests, indicating that at least one-third of the region is unfavorable for oak-hickory forests. However, even though two-thirds of this region can likely support oak-hickory forests, past land-use and management practices may hinder the natural establishment and recruitment of oak into the canopy (Brose et al. 2008, Iverson et al. 2017). SILVAH inventories and recommended silvicultural prescriptions would inform forest managers of current conditions and the possible actions to reach an intended goal or condition.

Development of a Geographic Information Systems Tool

We developed a GIS tool that computes areal summary statistics of ecological LTs or LTPs and identifies any corresponding SILVAH inventories and land cover data within one or more areas of interest (e.g., stand or property) to help forest managers assess the investment of either maintaining or restoring oak-hickory to the landscape. Forest stands can vary in size and shape, species composition, and land-use history, and contain multiple morphological landscape components. This tool's main feature, therefore, is to help compare information that represents current or potential conditions of species composition and begin the process of determining which silvicultural practices may be required to maintain or restore oak-hickory stands. Identifying these "investment zones" can help to prioritize and align management practices with a broader objective for private and public landowners.

Forest Management Examples

1. Wayne National Forest

The WNF used information from the 17-county SILVAH database and modeled ecological LTs (Fig. 2) to identify stands where oak-hickory restoration could create early successional habitat to benefit wildlife in the short term while working toward the long-term goal of maintaining or restoring oak-hickory forest. Knowing how much of the WNF has been modeled as favorable habitat for oak-hickory forest, and the potential status of oak-hickory stands on neighboring landscapes, can help develop scenarios of management objectives that could aid in long-term decisionmaking.

2. Ohio Division of Wildlife

SILVAH has become an integral part of ODOW's tactical plan to manage wildlife habitat to sustain viable populations of native forest wildlife species that require large forested landscapes. After completing georeferenced forest stand mapping in 2014, ODOW partnered with the National Wild Turkey Federation to contract a SILVAH forest inventory of 13 state wildlife areas (approximately 43,000 acres) in eastern Ohio. The forest inventory employed a stratified design in forest stands with two forest types (mesic hardwood and xeric hardwood/mixed hardwood-pine), three slope positions (low, mid, and high) and two tree height classes (60-80 feet tall and >80 feet tall, based on LiDAR). Georeferenced overstory and understory SILVAH plot data are stored in an Esri ArcGIS geodatabase. These data are being used to support the development of long-range wildlife area management plans, to use SILVAH's decision support software to identify appropriate silvicultural prescriptions, and to support forest wildlife habitat management planning and wildlife habitat suitability index modeling.

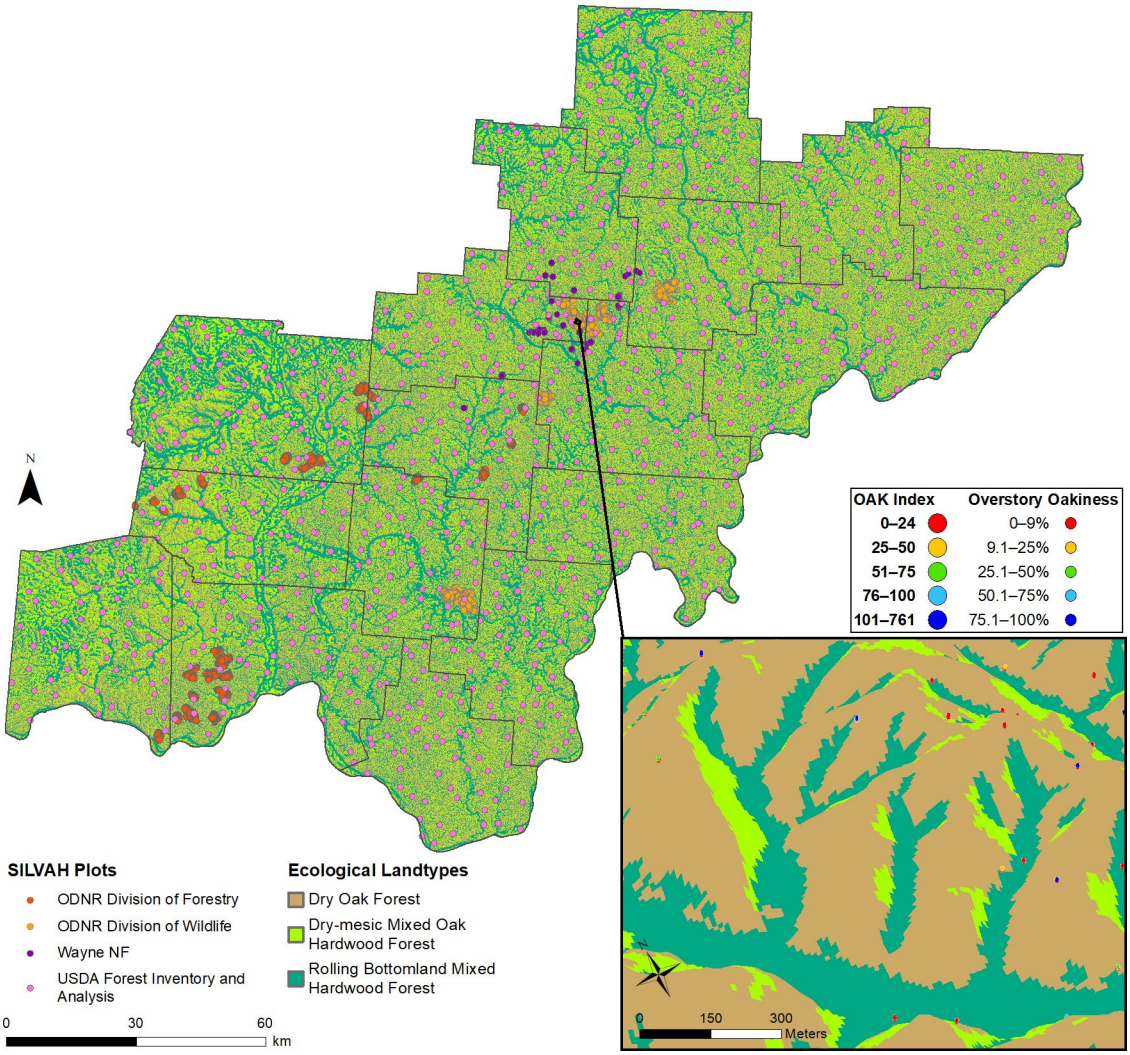

Figure 2.—Distribution of SILVAH inventory plots and modeled ecological landtypes (LTs) within the Joint Chiefs' project area in southeastern Ohio. Inset of 3-dimensional terrain with LTs and overstory percent "oakiness" and understory oak index values from SILVAH plots. Oak Index values >24 can be considered stocked for oak advanced regeneration when deer browsing is low.

CONCLUSION

In the 8 years since the first Ohio Oak SILVAH training session was first held, the Ohio forestry community has embraced the SILVAH Community of Practice. Input from its members led to the incorporation of a nonnative invasive plants module into the SILVAH software. Private consulting foresters eagerly serve as beta testers for software updates and provide constructive feedback. Wait lists months in advance of training sessions are now the norm. The WNF, NRCS OH, and the ODOF and ODOW have conducted numerous SILVAH inventories and contributed these to a regional database that is now being combined with new FIA understory data to extend SILVAH science to the landscape scale (Fig. 3). These same public agency managers have increased their effectiveness in collaborating to sustain oak forests and wildlife habitats across large landscapes and ownership boundaries. The Ohio Interagency Forestry Team is using the ecological LTs to align agency programs of work with family forest landowner interests in managing for oak across the 17-county Joint Chiefs' Landscape Restoration Partnership Project, Collaborative Oak Landscape Management area. The SILVAH community of practice has taken root in Ohio, and collaboration among diverse partners continues to strengthen.

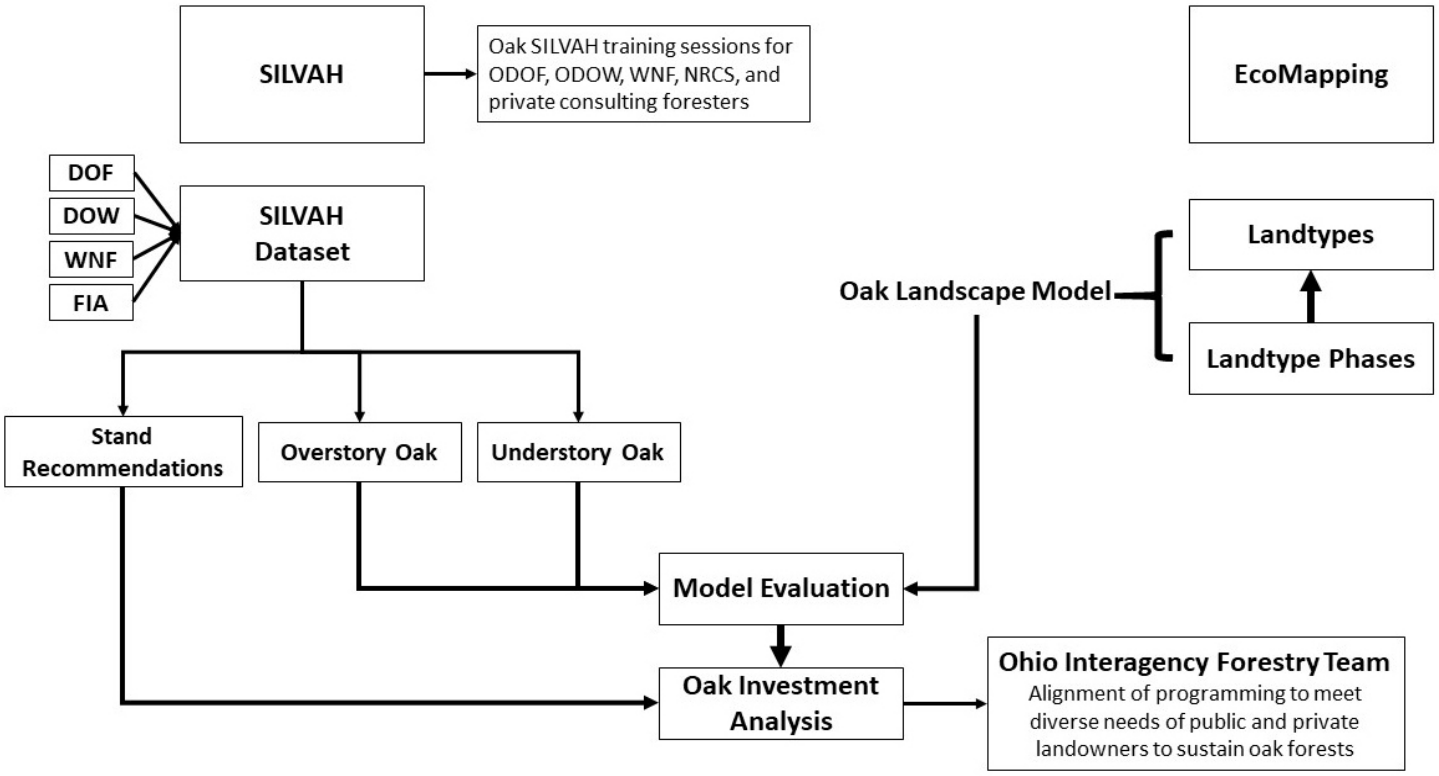

Figure 3.—Linkages of SILVAH to the oak landscape model, oak investment analysis, and incorporation into the business model for the Ohio Interagency Forestry Team.

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