
Ohio's Statewide Forest Action Plan
Forest Resource Assessment
December 2020
Division of Forestry

OHIO STATEWIDE FOREST RESOURCE ASSESSMENT – 2020

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Nondiscrimination Notice

Section 1 – Introduction

In 2010, the Ohio Department of Natural Resources (ODNR) Division of Forestry completed Forest Resource Assessment and Strategy documents which represented the first statewide, comprehensive forest resource assessment in Ohio since 1983. The findings of the Forest Resource Assessment were integrated into an accompanying Forest Resource Strategy document. The Forest Resource Strategy considered and complemented other existing strategic plans including the Ohio Comprehensive Wildlife Conservation Strategy (released in 2005), the Statewide Comprehensive Outdoor Recreation Plan (SCORP 2008), and local Community Wildfire Protection Plans. These combined documents, called the Ohio Forest Action Plan (OFAP), were a pilot for this integrated approach to evaluating and managing Ohio's forest resources. Those documents were living documents that were to be amended and updated as new data became available. As such, they underwent a thorough review in 2015 and have now been completely updated in 2020. These updated documents provide an updated and current look at Ohio's forest resources and will again receive an update in 10 years.

Purpose

The purpose of the OFAP is to provide a basis upon which future strategic directions and actions can be evaluated and selected. It is to be used by the ODNR Division of Forestry as well as existing and potential partners to marshal limited resources towards addressing identified forest issues and threats.

The Food, Conservation, and Energy Act of 2008 (the 2008 Federal Farm Bill) requires each state to complete a Statewide Forest Resource Assessment and Statewide Forest Resource Strategy (together; the OFAP) to continue to receive funds under the Cooperative Forestry Assistance Act. The OFAP will help ensure that resources are being focused on important landscape areas with the greatest opportunity to address shared management priorities and achieve meaningful outcomes.

Scope

The Forest Resource Assessment will include:

- an analysis of present and future forest conditions and trends on all ownerships in the state, including analysis of market and non-market forces.
- identification of threats to forest lands and resources in the state consistent with national priorities (listed below).
- identification of forest related benefits and services.
- a delineation of priority forest landscape areas in the state across themes and programs, ownerships, and the urban to rural continuum, to be addressed by the Statewide Forest Resource Strategy.
- a delineation of any multi-state areas that are a regional priority.

The USDA Forest Service has identified three national priorities that are to be addressed through an assessment process. These priorities are: 1) conserve and manage working forest landscapes for multiple values and uses, 2) protect forests from threats, and 3) enhance public benefits from trees and forests.

Methods

Through a comprehensive analysis of forest resource conditions and trends across Ohio, key issues and threats to Ohio's forest resources are identified, as well as the benefits and services that they provide. A framework of criteria and indicators (C & I) was used for this critical component of the assessment. This framework uses seven criteria and 18 indicators to assess Ohio's forest resources. It was adopted by the Northeastern Area Association of State Foresters (NAASF), now called the Northeast-Midwest State Foresters Alliance (NMSFA), as a method to assess the sustainable management of forests at both the state and regional levels. The adopted framework is a direct offshoot of an international effort referred to as the Montreal Process that uses seven criteria and 54 indicators. The C & I framework adopted by NMSFA uses a subset of indicators that are appropriate at the state and regional scale as opposed to the global scale.

To supplement the results of the assessment of forest conditions and trends, a broad-based group of stakeholders were consulted to develop a draft list of key issues, threats, and opportunities. A public comment period for draft assessment and strategy documents also provided critical input. Key partner organizations and agencies, including all required stakeholder groups identified in the 2008 and 2014 Federal Farm Bills, were consulted at various stages of the process, including the formal periods of stakeholder input and individual meetings. Another critical component of the assessment process was the comprehensive geospatial analyses that were conducted to identify potential priority forests and priority landscapes across the state, using overlay analysis techniques with GIS software (ArcGIS version 10.7.1). Results from these various assessment components are reported in this report. They form the foundation for developing a comprehensive Statewide Forest Resource Strategy.

Section 2 – Forest Conditions and Trends

Forest conditions and trends for the state of Ohio were assessed using a framework of criteria and indicators that was developed to assess the sustainability of forests in the northeastern United States. The criteria and indicators used in this assessment were developed from the Montreal Process, which is a larger system of criteria and indicators that assesses forest sustainability of temperate and boreal forests at the global scale (The Montreal Process 2018). The following criteria and indicators are used in this assessment.

Criterion 1. Conservation of Biological Diversity

Indicator: 1. Area of total land, forest land, protected forest land, and forest ownership
2. Forest type, structure, and successional stage
3. Extent of forest land conversion, fragmentation, and parcelization
4. Status of forest/woodland communities and associated species of concern

Criterion 2. Maintenance of Productive Capacity of Forest Ecosystems

Indicator: 5. Area of timberland
6. Annual removal of merchantable wood volume compared with net growth

Criterion 3. Maintenance of Forest Ecosystem Health and Vitality

Indicator: 7. Area and percent of forest land affected by biotic and abiotic processes and agents

Criterion 4. Conservation and Maintenance of Soil and Water Resources

Indicator: 8. Soil quality on forest land
9. Area of forest land adjacent to surface water, and forest land by watershed
10. Water quality in forested areas

Criterion 5. Maintenance of Forest Contribution to Global Carbon Cycles

Indicator: 11. Forest ecosystem biomass and forest carbon pools

Criterion 6. Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies

Indicator: 12. Wood products and non-timber forest products production, consumption, and trade
13. Outdoor recreational participation and facilities
14. Investments in forest health, management, research, and wood processing
15. Forest certification
16. Employment and wages in forest-related sectors

Criterion 7. Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

Indicator: 17. Forest management standards/guidelines
18. Forest-related planning, assessment, policy, and law

In December 2018, the USDA Forest Service released its latest Forest Inventory and Analysis (FIA) report for the state of Ohio entitled *Ohio Forests: 2016* (Albright et al. 2018). For many of the criteria and indicators included in this assessment, the *Ohio Forests: 2016* publication contains the most current relevant published data. Therefore, the assessment document will not reproduce all of the data reported in the FIA publication; the assessment will reference the FIA data, discuss it in the context of the assessment, and supplement it when appropriate. Accordingly, the *Ohio Forests: 2016* publication is an important reference to have as a complement to this assessment document. A copy of the FIA report can be requested from the USDA Forest Service or downloaded from the internet (https://www.fs.fed.us/nrs/pubs/rb/rb_nrs118.pdf).

Criterion 1 – Conservation of Biological Diversity

Criterion 1 includes four indicators that evaluate the structure and biological diversity of Ohio's forest ecosystems. The conservation of biological diversity is a critical component of sustainable forest management; diverse ecosystems are better able to respond to external influences, recover from disturbances, and maintain core ecological functions and services (Robertson et al. 2011).

Indicator 1 – Area of total land, forest land, protected forest land, and forest ownership

Total land area and area and percent of forest and other land cover

Based on FIA data, the total area of forest land in Ohio is 7,996,702 acres, representing 30.0% of the state's land cover (Albright et al. 2018). Prior to settlement, Ohio was estimated to be 95% forested. The state experienced a steady decline in forest cover from settlement until ~1940, when forest cover in the state reached a low point of 12% (Diller 1944). Successive surveys from the FIA reported a steady increase in forest land from the 1940s to the 1991 survey (Figure 1). However, a survey from 2006 found no statistical difference in forest land from 1991 to 2006, indicating a change in the trend of increasing forest land in Ohio. More recently, a 2011 survey showed 8.1 million acres of forest land in Ohio and the most recent survey (2016) estimates 8.0 million acres of forest land. These figures seem to validate the change observed from 1991 to 2006 and forest land acreage has remained steady over a 25-year period. The primary driving force for the increase in forest land from 1940 to 1991 was the reversion of farmland to forest. That driver has all but ceased and any new forest land arising from reverting farmland is likely being offset by land being converted to non-forest land for development.

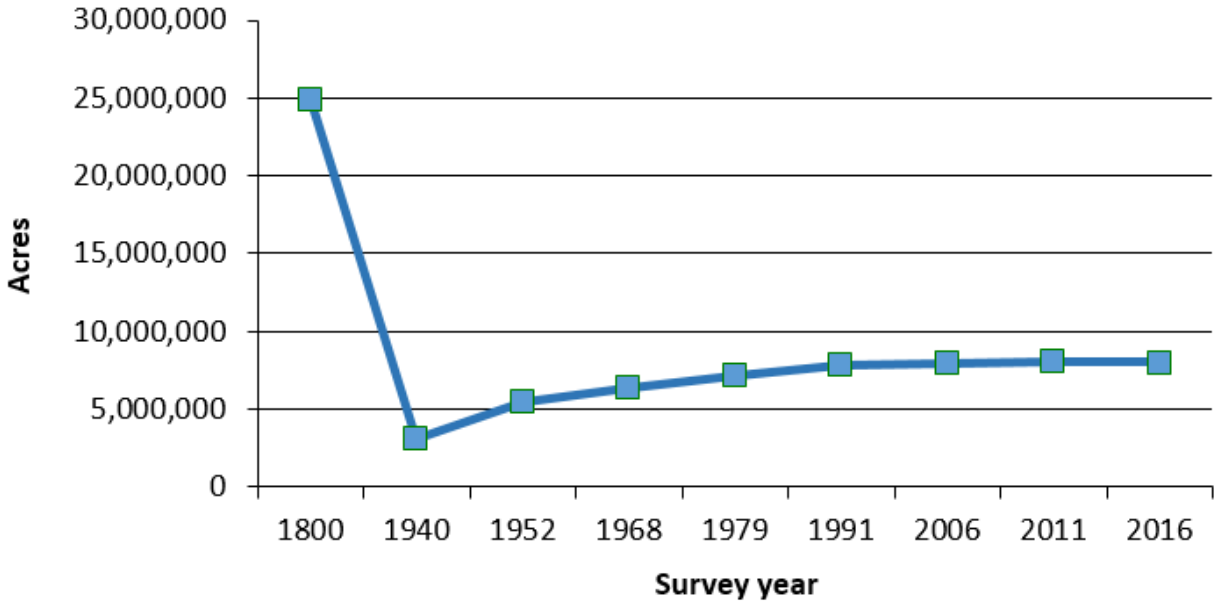

Figure 1. The change in total forest land acres in Ohio over time (Albright et al. 2018; Griffith et al. 1993).

Using 2016 satellite imagery, a nationwide land cover dataset was developed (Yang et al. 2018), and it will be referred to in this report as the National Land Cover Dataset (NLCD) 2016. A forest cover map for Ohio using NLCD 2016 data shows an uneven distribution of forest land across the state, with southeastern Ohio being the most heavily forested (Figure 2). The total area of forest land in the state using NLCD 2016 data (all green areas on the Figure 2 map) is 8.56 million acres, or 570,000 acres more than the 7.99 million acres reported by FIA. A likely explanation for this discrepancy is the difference in the scale of measurement. FIA defines forest land as being a minimum of 1.0 acre in size, while NLCD classifies land cover down to the 30 x 30 meter pixel (0.22 acre) size. Therefore, NLCD includes small patches of forest cover (0.22 to 1.0 acre in size) that are excluded from FIA. The total area of agricultural land (cultivated crops and hay/pasture) in the state using NLCD 2016 data is 13.06 million acres, covering 50% of Ohio and developed land covers 3.64 million acres; 13.9% of Ohio. By ecological sections (Cleland et al. 2007; Figure 3), the Southern Unglaciated Allegheny Plateau in southeast Ohio is the most heavily forested, followed by the Western Glaciated Allegheny Plateau in northeast Ohio. The Central Till Plains and lake plains of generally the western half of the state have low relief and are underlain by limestone and dolomite with some shale beds. The Allegheny Plateaus of eastern and southern Ohio are characterized by bedrock hills and are deeply incised by streams, forming narrow valleys and a landscape with up to 300 feet of relief. The Western Glaciated Allegheny Plateau has hills of lower relief and broader stream valleys relative to the unglaciated portion. Many hills are capped with erosion-resistant beds of sandstone. The Interior Low Plateau has high relief and is unglaciated or has thin, highly weathered deposits of early glaciations. Several areas of Ohio contain Karst landforms characterized by features such as sinkholes and caves. These mainly occur in the areas of Silurian- and Devonian-age carbonate bedrock of Adams, Brown, Erie, Highland, Sandusky, and Seneca counties. Most counties in the unglaciated Allegheny Plateau region have at least 50% forest land cover (Figure 4). The three most

heavily forested counties in Ohio are Hocking, Lawrence, and Vinton, which are 80%, 79%, and 79% forested, respectively. Most counties in northwest Ohio are less than 10% forested. From 2006 to 2016, the percent forest cover of most counties remained relatively stable at less than a 1% change, while several counties experienced greater change, with Lawrence County having the greatest gain in forest cover (2.6%) and Franklin having the greatest loss of forest cover (3.7%) over that time period (Figure 5).

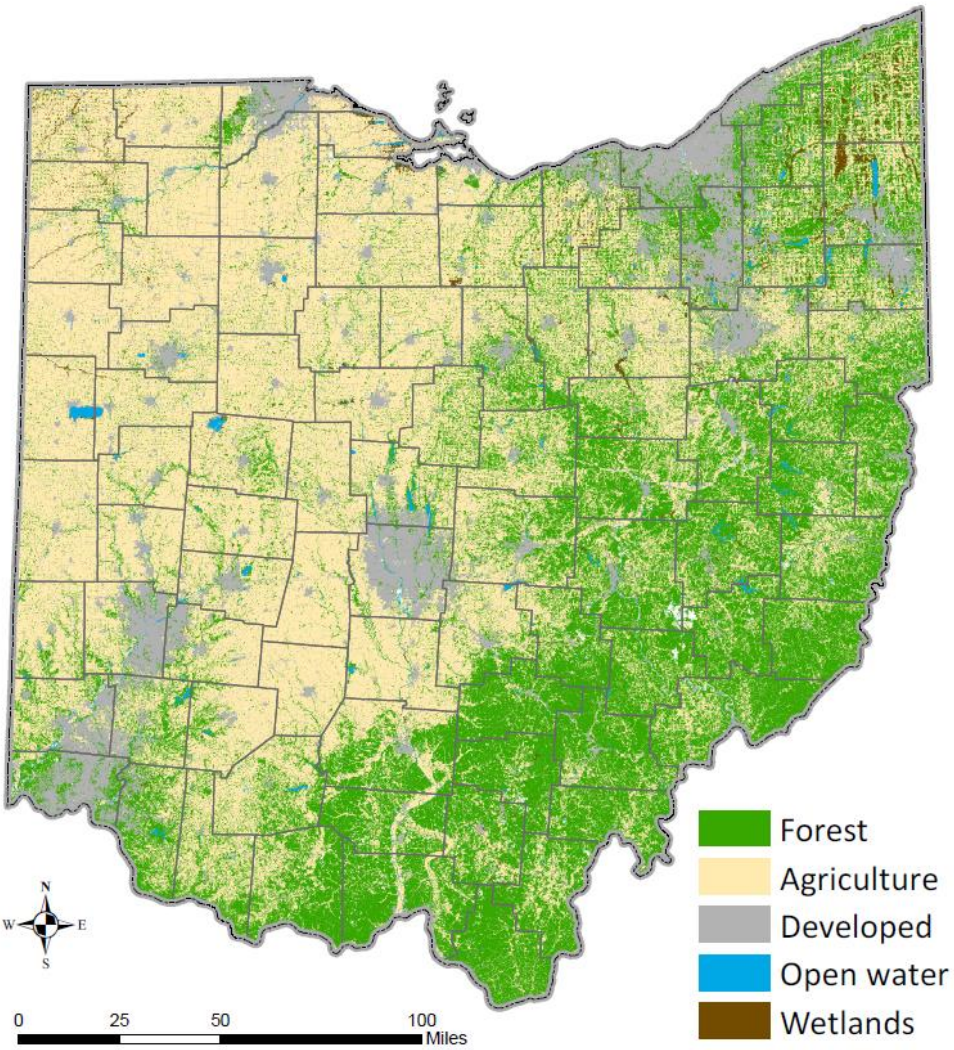

Figure 2. Map of land cover in Ohio based on NLCD 2016 satellite imagery.

Figure 3. Ecological Sections of Ohio (Cleland et al. 2007).

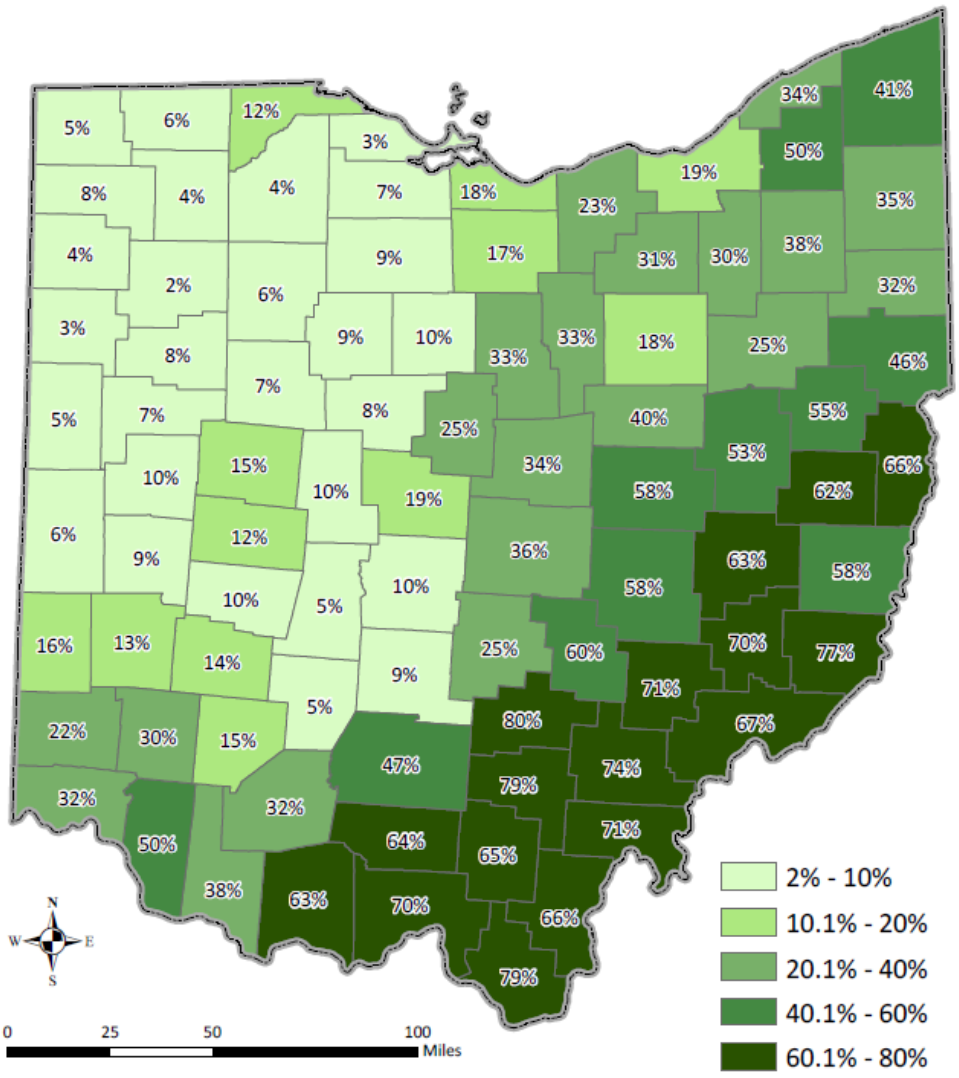

Figure 4. Percent forest cover by county (NLCD 2016).

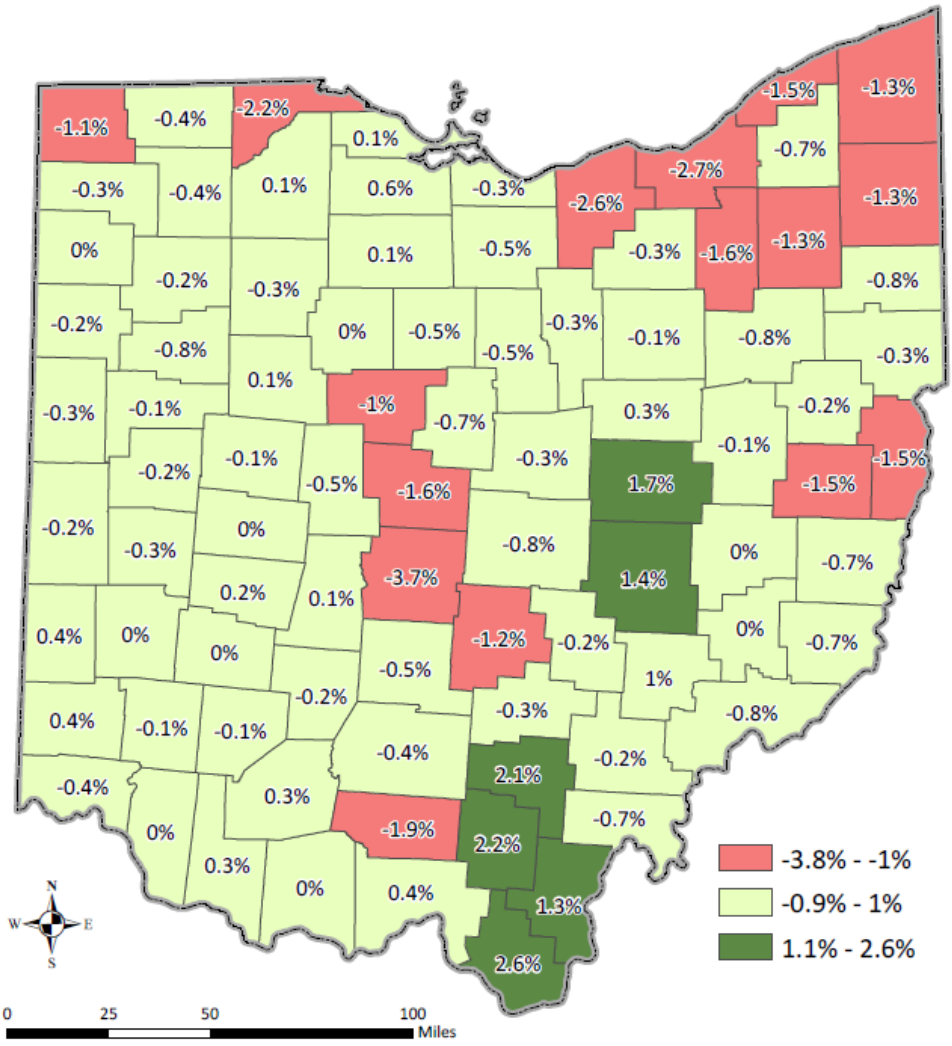

Figure 5. Percent forest cover change by county from 2006-2016 (NLCD 2006 and 2016).

Forest land ownership

The largest ownership group of forest land in Ohio is the family forest group, which owns 70% of the state's forests. Family forests are non-industrial private forests that are held by family groups. Other private landowners like forest industry, non-governmental organizations, clubs, and corporations hold another 15% of Ohio's forests, for a total of 85% of forest land under private ownership. Governments hold the remaining 15% of forests in the state, as shown in Figure 6. The National Woodland Owner Survey (Butler et al. 2020) reports on topics like forest landowner goals, sources of technical advice, and attitudes towards various forest management topics (i.e., timber harvesting). Some key findings of those surveys are: 1) the primary reasons for owning forest land are related to beauty, wildlife, and privacy; 2) the most common activities on their land are personal recreation, such as hunting and hiking, and cutting trees for personal use, such as firewood; and 3) most family forest ownerships have not participated in traditional forestry management and assistance programs in the past five years.

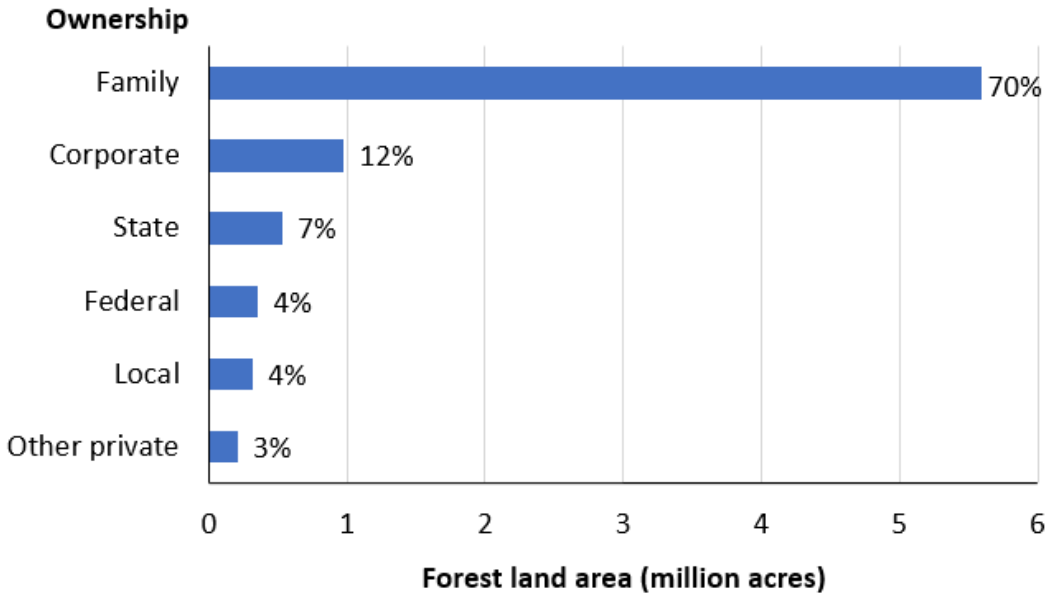

Figure 6. Area of forest land by ownership class (Albright et al. 2018).

State lands

The state of Ohio owns 572,843 forested acres, or 6.7% of forest land in Ohio. Table 1 shows the distribution of forest land managed by each division of the Ohio Department of Natural Resources (ODNR), which is the state agency that manages the majority of Ohio's state-owned forest land.

Table 1. State-owned forest land under management by the ODNR by managing Division. Data source: ODNR and NLCD 2016.

ODNR division	Acres of forest land
Division of Wildlife	224,591
Division of Forestry	201,673
Division of Parks & Watercraft	86,481
Division of Natural Areas & Preserves	24,734
Total owned by ODNR	**537,479**

Private forest land under conservation easements

Comprehensive statewide data have not been compiled on private forest lands in Ohio under conservation easements. The future development of such a dataset would be useful for monitoring and planning. Land trusts hold the majority of forest land conservation easements. The ODNR Division of Forestry holds an easement on 436 acres in Muskingum County (see Forest Legacy Program description that follows).

Ohio's Forest Legacy Program

The Ohio Forest Legacy Program (FLP), administered by the ODNR Division of Forestry, is a state-federal partnership that permanently protects important forest land through the purchase of

conservation easements and fee simple land purchases. To date, the ODNR Division of Forestry has acquired one 436-acre conservation easement and 8,032 acres through fee simple land purchases in Ohio using funding through the FLP. The fee simple purchases resulted in a new state forest, Vinton Furnace State Forest, and the purchase of strategic inholdings to expand Ohio's largest state forest, Shawnee State Forest.

As the state lead agency, the ODNR Division of Forestry in consultation with the Ohio Forest Stewardship Coordinating Committee, has concluded that Ohio's FLP will continue to be implemented following guidelines in the original assessment of need (AON) approved on August 5, 2005, which is hereby fully integrated into this 2020 version of Ohio's Forest Action Plan. The strategy section of Ohio's Forest Action Plan provides more details about Ohio's Forest Legacy Program. Ohio's Forest Resource Assessment provides updated data on forest conditions and trends that were reported in the original AON. Appendix A includes a crosswalk table identifying where FLP requirements are located in the assessment and strategy sections of Ohio's Forest Action Plan. No major changes in trends and threats were identified in this assessment that would warrant a major update to the state's FLP.

Population and per capita forest cover

Based on FIA data, there are 7,996,702 acres of forest land (Albright et al. 2018) for the 11,689,442 people (2018 census estimate) in Ohio. This represents 0.68 acres of forest land per person. Similar to total forest land in the state, the trend was an increasing amount of forest land per person as the percent of forest land cover grew from 1940 to 1991. However, with the stabilization of the statewide proportion of forest land (no growth from 1991 to 2016) and the continued population growth (Figure 7), the per capita forest acreage declined over the last two decades (Figure 8). The map in Figure 9 shows the distribution of major metropolitan areas across the state, and Figure 10 shows the per capita forest land by county in 2016. There was very little change in per capita forest land by county between 2006 and 2016.

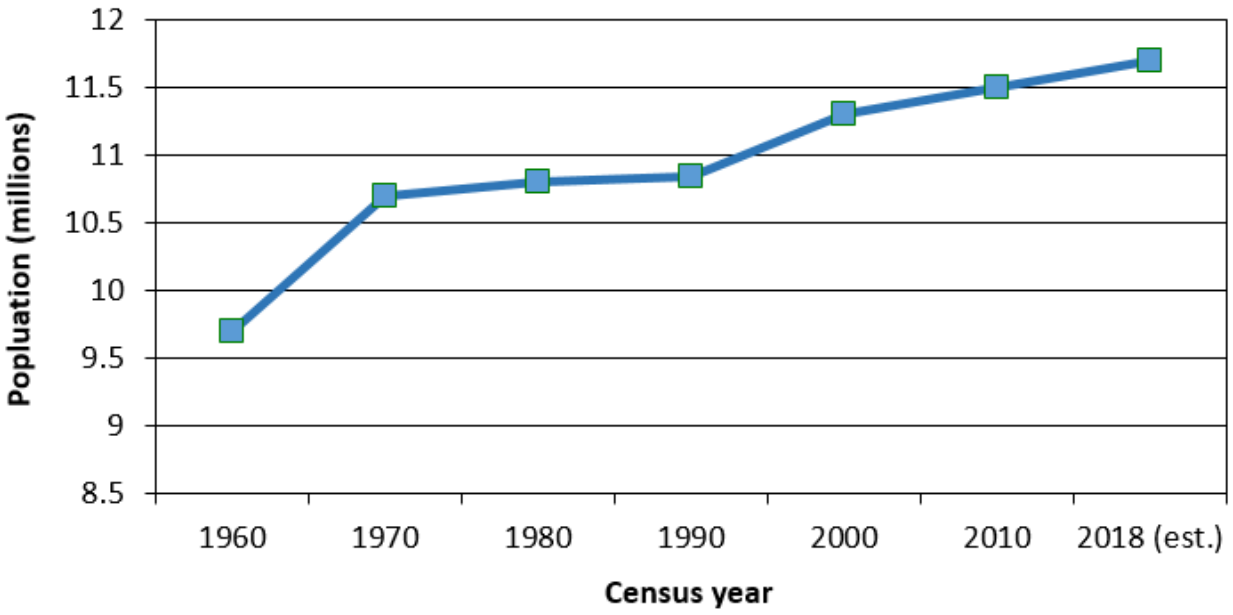

Figure 7. Human population of Ohio from 1960 to 2018. Data source: U.S. Census Bureau.

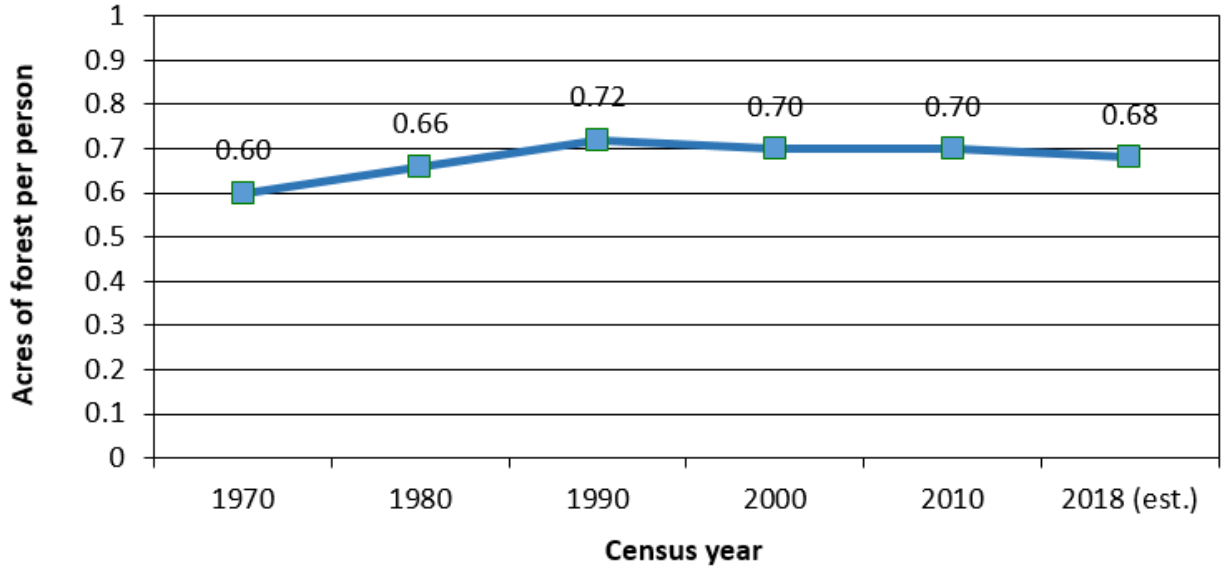

Figure 8. Change in the acres of forest per person over time. Data source: USDA Forest Service FIA and U.S. Census Bureau (note: 1968 FIA data are presented with 1970 census data, 1979 FIA data with 1980 census data, 1991 FIA data with 1990 census data, 2006 FIA data with 2000 census data, 2011 FIA data with 2010 census data, and 2016 FIA data with 2018 [estimated] census data).

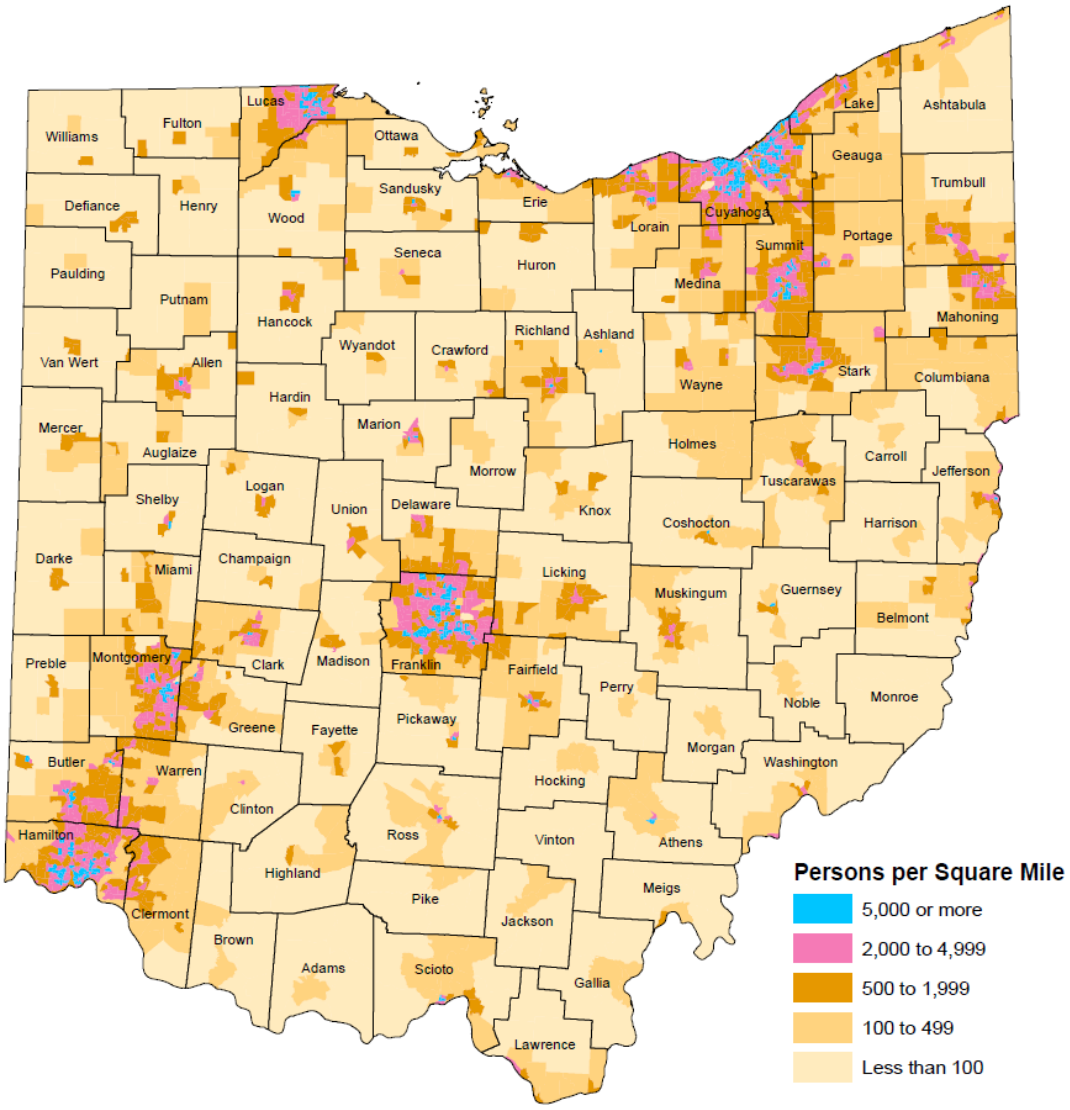

Figure 9. Population density of Ohio in 2010 by census tract. Map prepared by Ohio Development Services Agency using data from the U.S. Census Bureau.

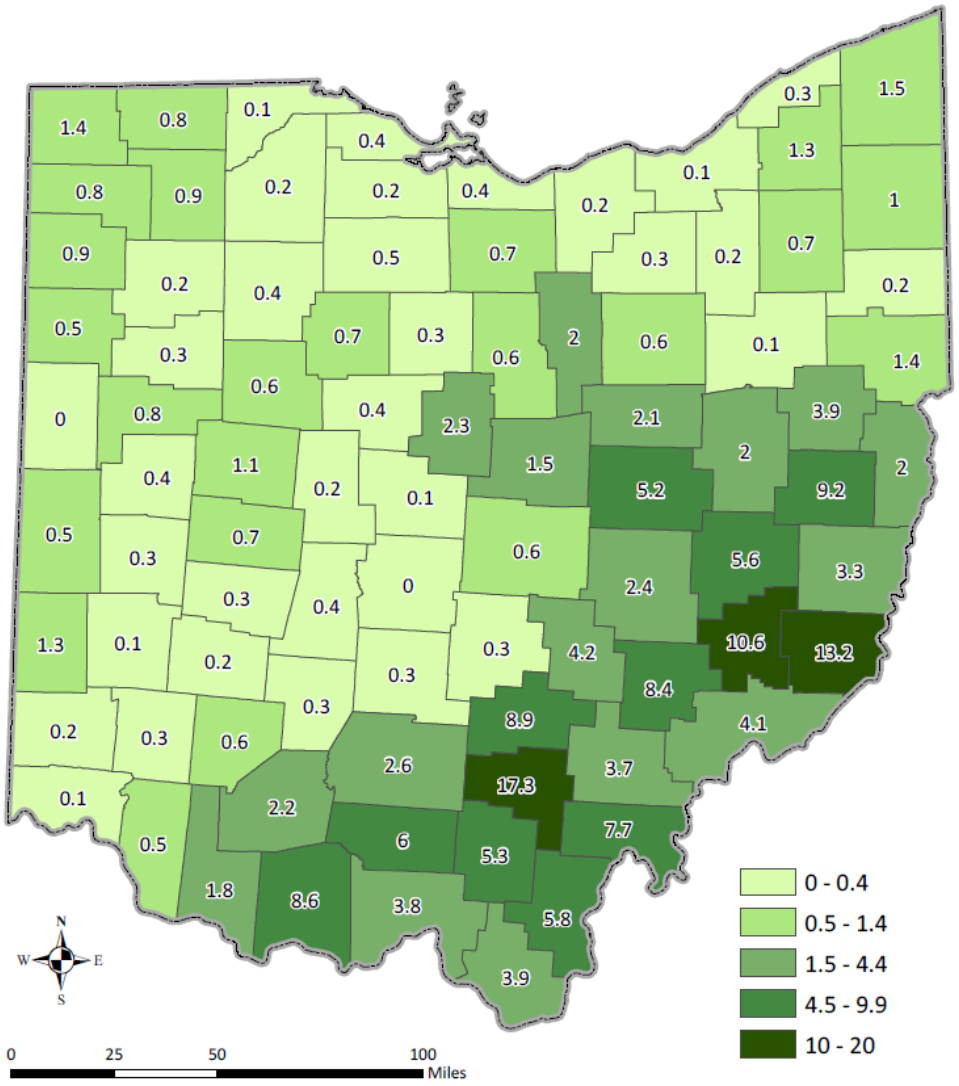

Figure 10. Forest acres per capita by county in 2016 (USDA Forest Service FIA and U.S. Census Bureau).

Protected forest land

The ODNR lands database and the Protected Areas Database of the United States, version 2.0 (PAD-US; USGS 2018) provide the best available data on protected natural areas in the state. To identify protected forest land in Ohio, the ODNR lands database and PAD-US data were overlaid with the NLCD 2016 forest cover data. The resulting forest area totaled approximately 946,944 acres (Figure 11). The ODNR and PAD-US databases include all ODNR lands (i.e., state forests, parks, wildlife areas, nature preserves), Wayne National Forest, National Park Service lands (i.e., Cuyahoga Valley NP), The Nature Conservancy lands, watershed conservancy districts, metroparks, and other community forests. While these databases include most lands in the state protected through

ownership by natural resource agencies or organizations, some lands, like private lands under conservation easements, may not be included.

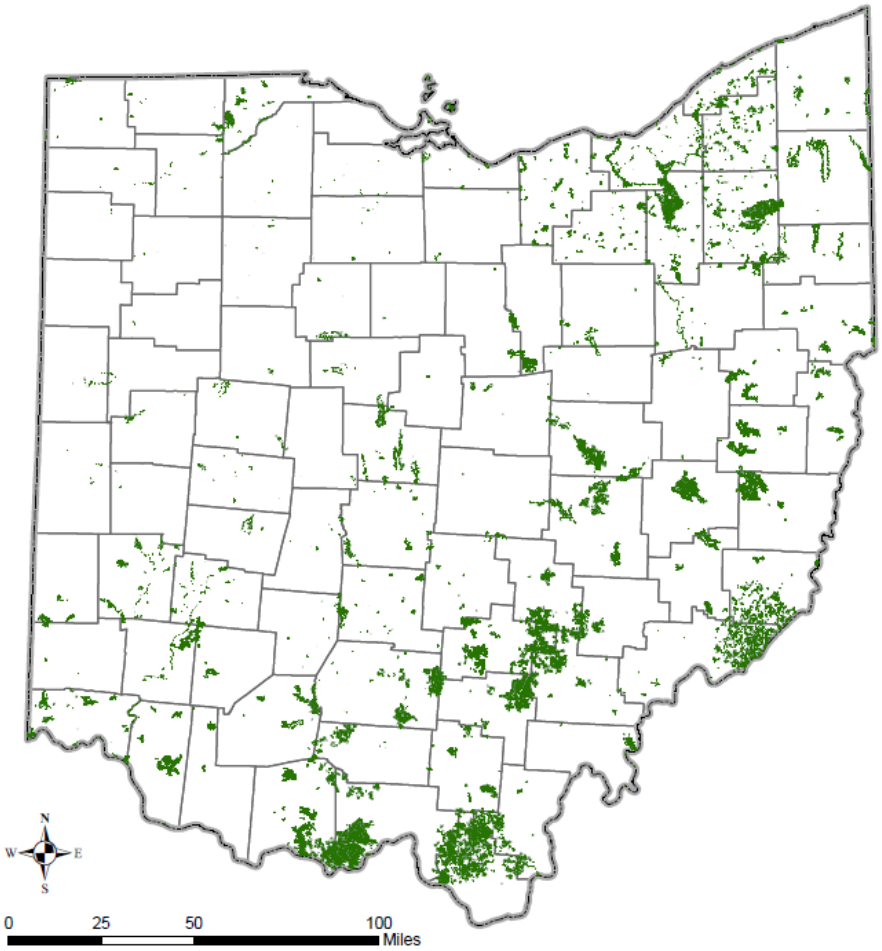

Figure 11. Protected forest lands in Ohio, identified by overlaying the ODNR lands and PAD-US data with NLCD 2016 forest cover data.

Reserved forest land includes forests that meet the FIA criteria for timberland but have statutes or administrative constraints that preclude timber utilization. This land potentially includes forests with conservation easements or parklands that prohibit timber harvest/utilization. In 2016, the reserved productive forest land was 288,518 acres. This represents 3.6% of the total forest land. The general trend is an increasing number of acres in the reserved productive forest land category (Figure 12). The trend is also for an increasing proportion of the total forest land to be in this category, increasing from about 1.2% in 1968 to the current 3.6%. All of the reserved forest land reported by the FIA is on public land, with county and municipal agencies holding the largest acreage (Figure 13). However, some private, non-governmental organizations, such as land trusts, may own private forest lands or hold conservation easements on private lands that meet the definition of reserved forests (i.e., prohibit timber utilization).

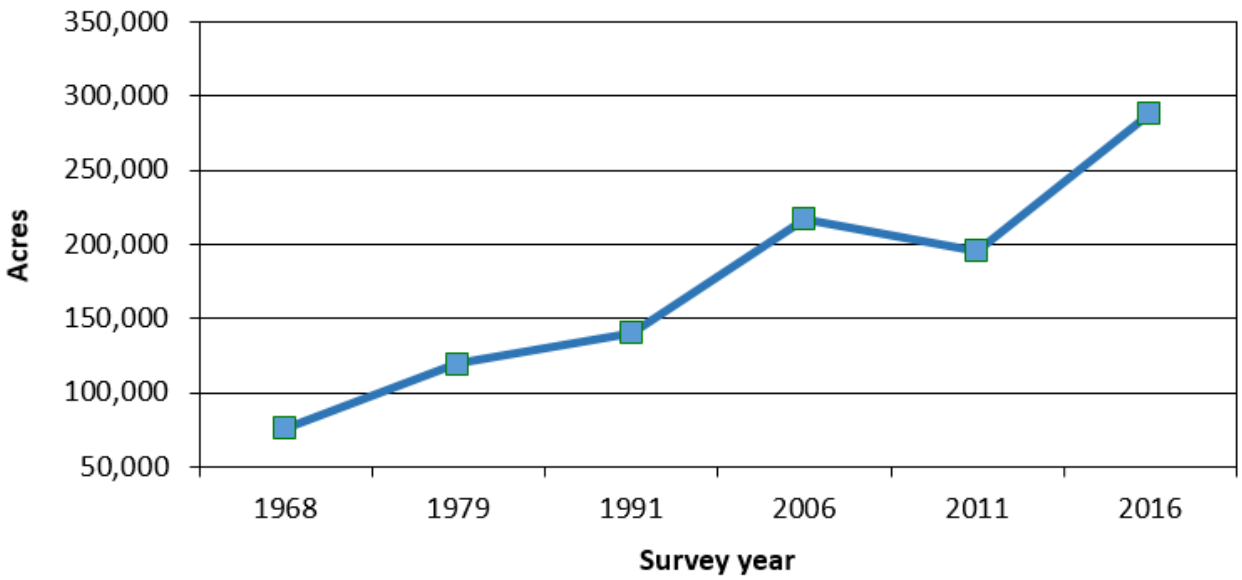

Figure 12. Change in reserved forest land over time, as reported in U.S. Forest Service FIA reports of 1968, 1979, 1991, 2006, 2011, and 2016. Data source: USDA Forest Service FIA.

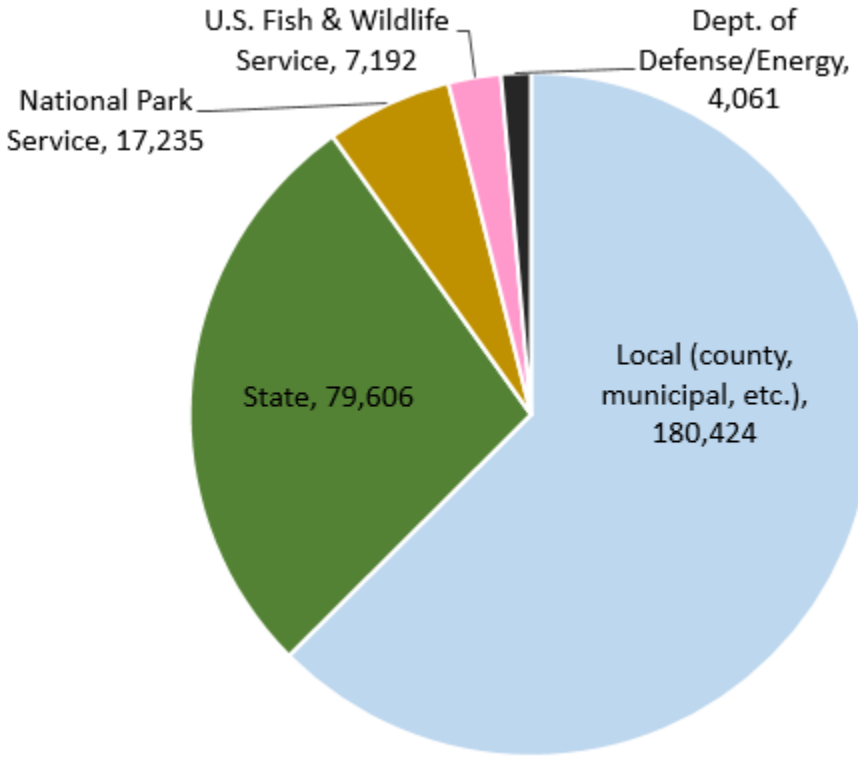

Figure 13. Total acres by ownership of reserved forest land in Ohio, 2016. Data source: USDA Forest Service FIA.

Urban and community forestry

Urban forests provide many benefits to society, including moderating climate, reducing building energy use and atmospheric carbon dioxide (CO_2), improving air and water quality, mitigating rainfall runoff and flooding, enhancing human health and social well-being and lowering noise impacts (Nowak et al. 2007). The annual benefits derived from U.S. urban forests due to air pollution removal, carbon sequestration, and lowered building energy use and consequent altered power plant emissions are estimated at $18.3 billion (Nowak et al. 2018a). Currently, tree cover in Ohio's urban areas (based on population density as defined in the 2010 Census data) is 37.6%, the tree cover in urban/community areas (based on jurisdictional or political boundaries delimited by U.S. Census Bureau definitions) is 38.2%, with a total of 220 million urban trees, 5 million acres of urban leaf area, and 36.5 million tons of carbon storage (Nowak et al. 2018a). However, various natural and anthropogenic forces are constantly altering the urban forest and consequently affecting the benefits and values derived from the forest (Nowak et al. 2018b) and in Ohio the projected urban land growth from 2010 to 2060 is estimated to be 3.3 million acres (Nowak et al. 2018a).

States with the greatest annual net percent increase in impervious cover in urban/community areas were Delaware (0.28%), Iowa (0.26%), and Colorado, Kansas, and Ohio (0.24% each) and states with the greatest annual net increase in impervious cover were Texas (17,590 ac/year), Florida (13,900 ac/year) and Ohio (8,670 ac/year) (Nowak et al. 2018b). Additionally, annual change in urban/community tree cover for Ohio resulted in a net percent loss of -0.20% which equates to 7,230 ac/year (Nowak et al. 2018b). Regarding urban areas, states with the greatest annual increase in impervious cover were Florida (14,570 ac/year), Texas (12,290 ac/year) and Ohio (10,180 ac/year) (Nowak et al. 2018b). To summarize, urban tree cover in Ohio has experienced an annual statistically significant percent loss in tree cover of -0.36%, an annual loss in tree cover of -10,180 ac/year, and a total net loss of benefits associated with air pollution removal, carbon sequestration, and altered building energy use and consequent altered power plant emissions estimated to be $9.3 million per year (Nowak et al. 2018b).

Several local studies confirm the statewide trends identified in Nowak et al. 2018b. The Cuyahoga County Planning Commission conducted urban tree canopy assessments in 2013 and 2019, and determined that nearly 6,600 acres, or 6.1%, of tree canopy was lost between 2011 and 2017 (Meany et al. 2019; Figure 14). Much of the decline in tree canopy can be attributed to development, emerald ash borer, and weather events. The assessments have summarized tree canopy metrics at detailed geographic levels and integrated them into GIS databases which can be particularly useful at the community and parcel level. The assessments have also positioned Cuyahoga County communities to better identify priority areas for tree plantings, increase educational opportunities for residents, and launch several initiatives to reverse these troubling trends. Within Cuyahoga County, the City of Cleveland developed The Cleveland Tree Plan in 2015 which identified that the city lost significant tree canopy every year and that immediate action was needed to correct the trend of loss (Davey Resource Group 2015). Cleveland has lost significant canopy over the last 70 years, dropping from 220,000 street trees in the 1940s to 120,000 street trees in 2015 with tree canopy cover measuring 19% and estimates showing that the canopy will continue to drop to 14% by 2040 (Davey Resource Group 2015). To curb the loss of tree canopy

cover, the Cleveland Tree Plan recommends the following steps: establish a unified voice, develop and implement an outreach and education strategy, develop and implement a funding plan, complete a comprehensive tree inventory, develop and implement a management plan for city-owned trees, undergo an operational review, establish a canopy goal, institute policy changes supportive of urban forestry, and plant with a purpose (Davey Resource Group 2015).

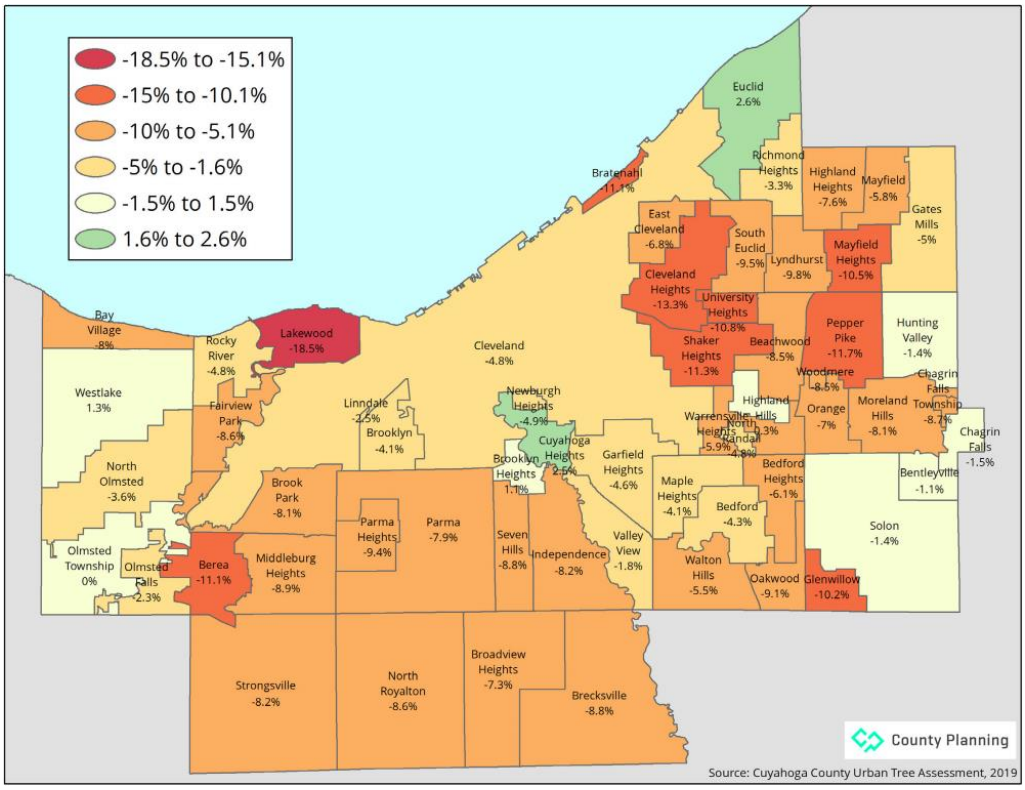

Figure 14. Cuyahoga County tree canopy change summarized by community (2011-2017). Data source: Cuyahoga County Urban Tree Assessment.

Like Cuyahoga County, Hamilton County and the Cincinnati Park Board have conducted multiple urban tree canopy assessments in 2000 and 2010, with a third assessment planned for 2020. According to their 2011 Urban Tree Canopy Assessment report, Cincinnati's tree canopy cover decreased by 1.2% (Figure 15) which can also be attributed to development, emerald ash borer, and weather events. The city's forest revitalization program over the past 20 years has helped the city achieve its relatively high tree canopy cover (38.8%) by planting 40,000 street trees, 30,000 highway trees, and thousands of park trees during that time. The city's 2004-2024 management plan calls for additional tree plantings to help the city reach its goal of 40% tree canopy in residential areas, 25% in mixed commercial/residential, and 10% in the central business districts (Cincinnati Park Board 2004).

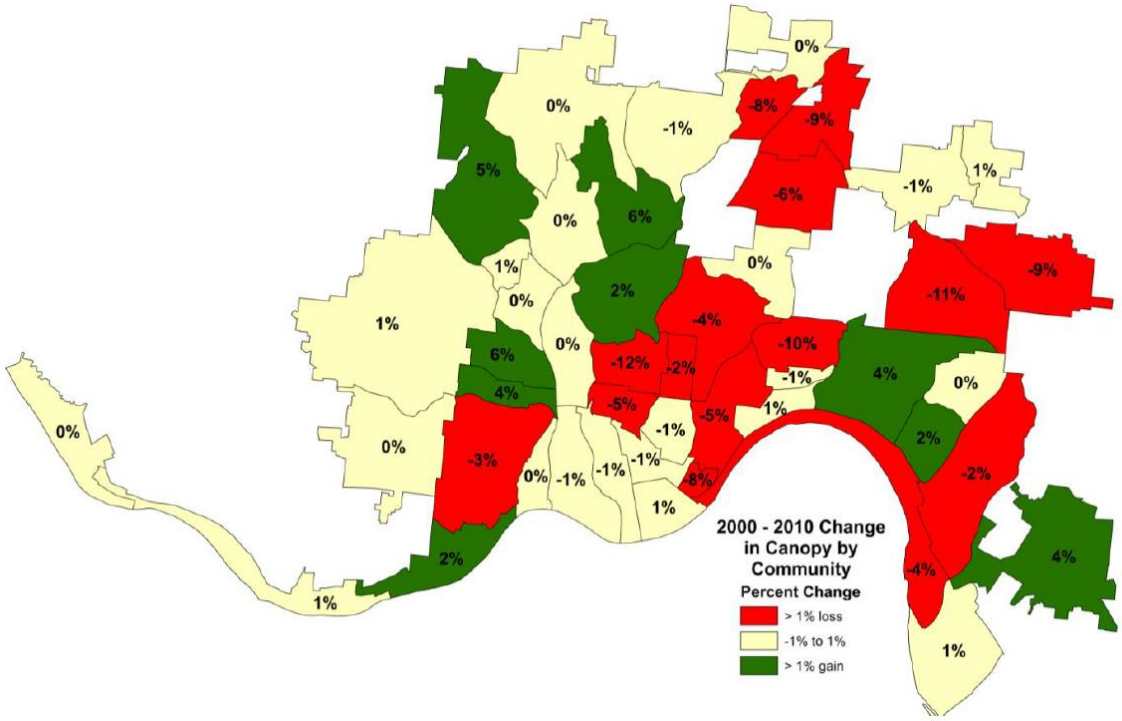

Figure 15. Cincinnati's urban tree canopy change by community. Data source: Cincinnati and Hamilton County, Ohio Urban Tree Canopy (UTC) Assessment, 2011.

The City of Columbus also conducted an urban tree canopy assessment in 2015. The urban tree canopy in Columbus covers 22% of the city, at a total of 31,171 acres, which results in a financial benefit of $12,151,446 (Plan-It Geo, LLC 2015). The assessment further determined that there is an additional 57,665 acres of land available for possible plantings (Plan-It Geo, LLC 2015). The report went on to evaluate three scenarios of future tree plantings. One scenario aimed to establish no net loss in 5 years, the second was to increase tree canopy at a minimum of 1% annually for five consecutive years, and the third reflected an urban tree canopy goal of 40% as recommended by American Forests (Plan-It Geo, LLC 2015). The assessment concluded with recommending that Columbus' forestry division take the lead in growing urban canopy, develop future canopy goals city-wide and by zoning class, target new plantings to address city priorities, develop an urban forest management plan, engage the community, and utilize the assessment and associated tools (Plan-It Geo, LLC 2015). Since the report was published, the City of Columbus has embarked on the development of an Urban Forest Master Plan in 2019, engaging stakeholders, reviewing current operations and policies, and recommending strategies for improvements.

While local and national trends and projections are showing a decline in urban tree canopy, the benefits of Ohio's urban forests for the nearly 80% of Ohioans that live in urban areas are still apparent. Ohio carbon sequestration is estimated to be 1.2 million tons of carbon/year (Nowak et al. 2018c). Additionally, Ohio ranks within the top five states for metrics such as greatest pollution removal values by urban forests ($266 million/year), greatest energy savings ($313 million/year), and greatest value in reduced emissions ($240 million/year; Nowak et al. 2018c). These ecosystem

services and other quantifiable social, economic, and environmental benefits are maximized and sustained when local governments implement comprehensive urban forestry programs that are integrated and commensurate with other community services.

The ODNR Division of Forestry's Urban Forestry Assistance Program maintains records of local urban forestry program development and state technical assistance through the USDA Forest Service's Community Assistance Reporting System (CARS). The system tracks program elements that are key indicators of communities developing and sustaining comprehensive urban forestry programs including codified and routinely enforced tree ordinances and/or policies, the employment professional urban forestry staff, possessing, using, and periodically updating an urban forestry management plan, and the establishment of advocacy/advisory organizations such as local tree commissions. Trends of these four indicators since 2005 show a leveling-off over the past decade after a significant increase in several of the elements following the infestation of emerald ash borer in Ohio. Figure 16 shows the number of communities with the four urban forestry program elements from 2005 to 2019.

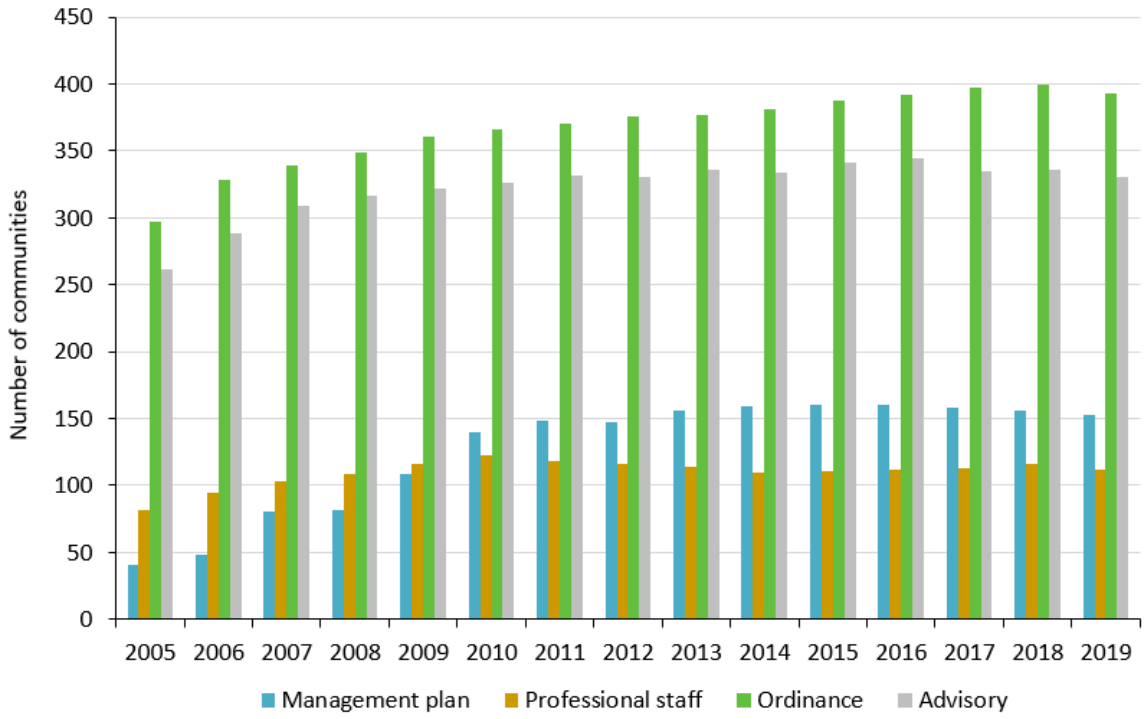

Figure 16. Number of Ohio communities with urban forestry management plans, professional staff, tree ordinances, and advisory organizations from 2005-2019. Data source: USDA Forest Service Community Accomplishment Reporting System (CARS).

While national, state, and local studies and metrics have shown declining urban tree canopy, increasing impervious cover, future expansion of urban land, and a leveling-off of urban forest management indicators in Ohio, this information has mobilized Ohio's government agencies, non-profit organizations, and industry partners to counteract these trends with actions necessary to

ensure an improved quality of urban life for all Ohio communities. More detailed urban forest resource assessments will help to further drive these actions including the USDA Forest Service's Urban Forest Inventory and Analysis (FIA) program which began collecting data in Ohio in 2016. The Cleveland metropolitan area will have a complete data set in 2022 (7-year cycle) with the Columbus, Cincinnati, and Toledo metropolitan areas in following years.

Indicator 2 – Forest type, structure, and successional stage

This indicator shows the general distribution of forests by type, size, age, and successional stage. An evaluation of these forest characteristics provides useful information about the current structure of the forests and the benefits they provide (i.e., wildlife habitat), as well as insight about how Ohio's future forests will look. A detailed evaluation of these forest attributes can be found in the USDA Forest Service report *Ohio Forests: 2016* (Albright et al. 2018). This section will highlight data from that report that illustrate overall trends for Ohio's forests, as well as those with direct applicability to the metrics under this indicator.

Ohio Forests: 2016 reports little change in the broad forest-type groups from since the 2006 survey, suggesting a stability in the forest resource in terms of community types (Albright et al. 2018). However, more significant changes were detected when evaluating individual species trends. Oak-dominated forest types (referred to by the FIA Program as "oak/hickory" forest types) remain a dominant forest type in Ohio's forests, but has decreased slightly since the 2011 survey. Also since 2011, Albright et al. (2018) reported that the relative dominance of the maple/beech/birch forest type has increased slightly and elm/ash/cottonwood has decreased slightly (Figure 17). Looking at total volume of tree species groups, oaks have generally been on a downward trend since the 1970s, while volume of maples has been increasing (Figure 18). An evaluation of tree species by size class suggests that this shift from oaks to maples will continue into the future, as oaks are lacking in the small diameter size classes (saplings), while maples are prominent (Figure 19).

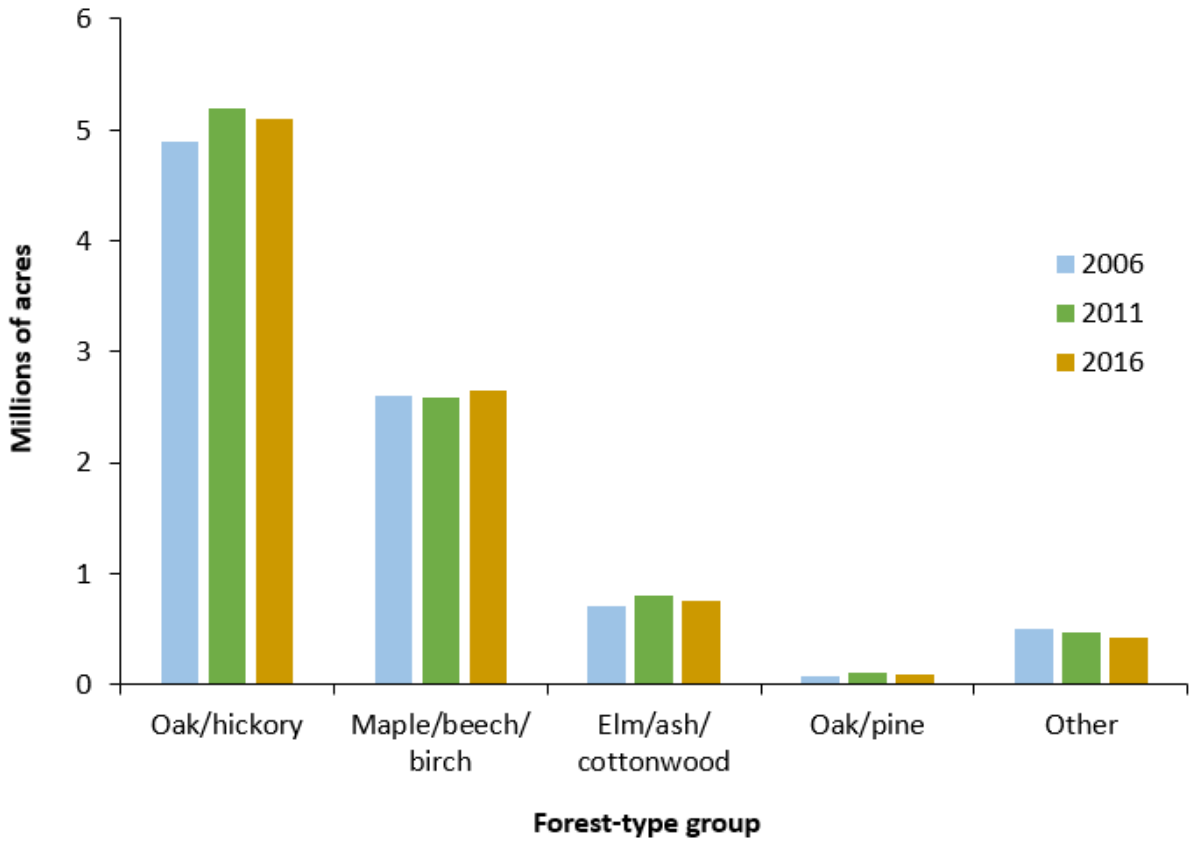

Figure 17. Forest land acreage by forest-type group and inventory year (Albright et al. 2018).

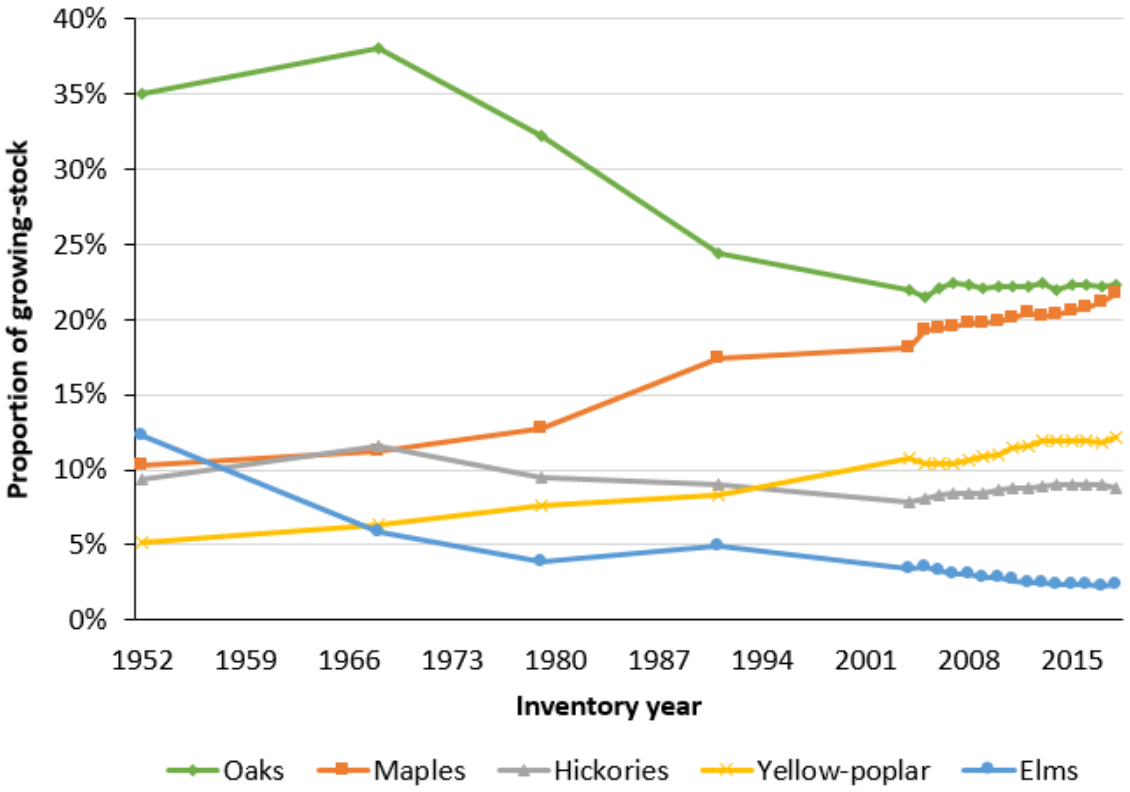

Figure 18. Change in proportion of total growing-stock volume on timberland of select species from 1952 to 2018 (USDA Forest Service FIA data).

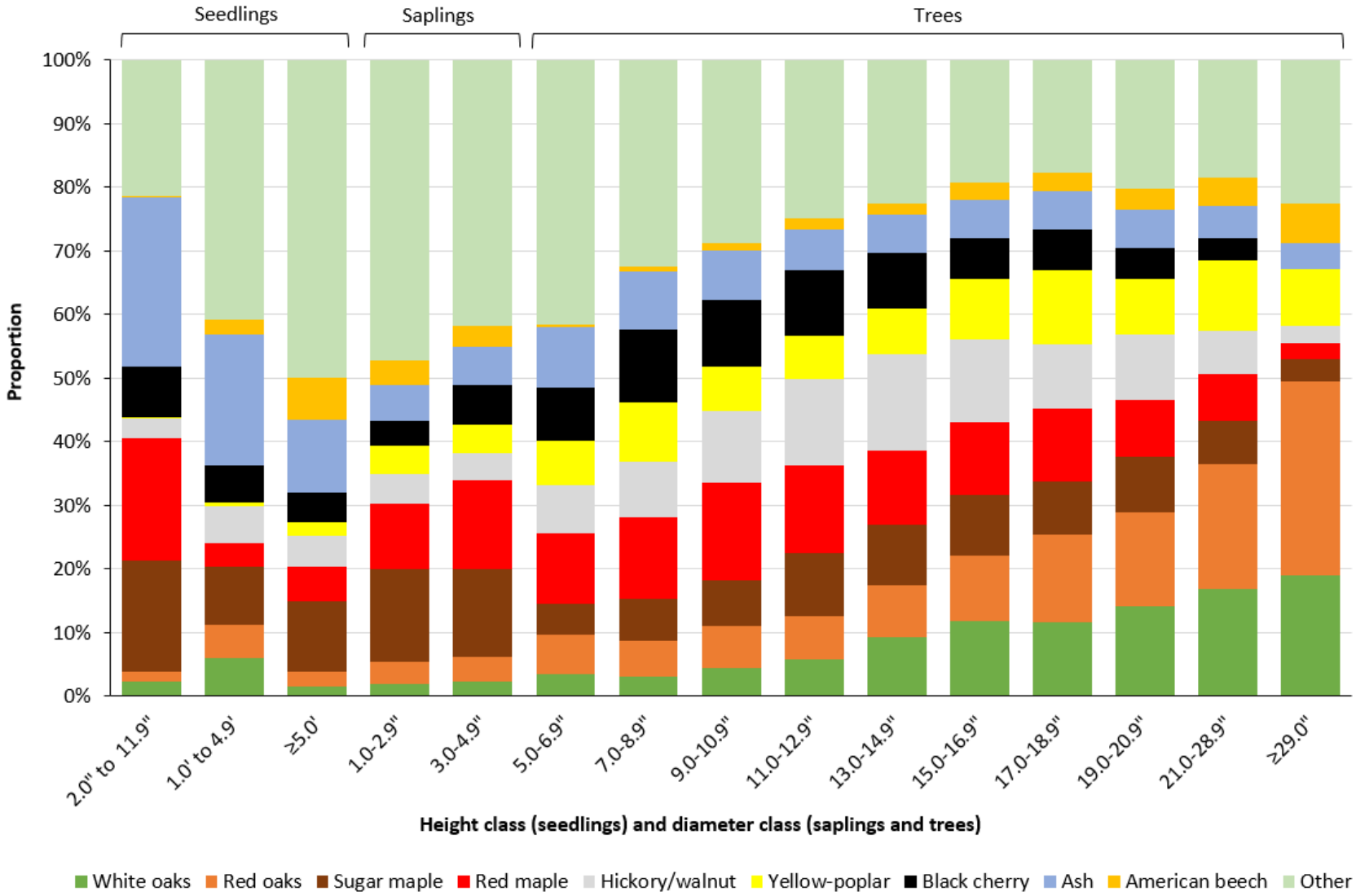

Figure 19. Species composition of seedlings, saplings, and dominant/codominant trees (Albright et al. 2018).

Across much of Ohio, particularly in the unglaciated portions of southern and eastern Ohio, oak-dominated forests have been the prevalent forest type for thousands of years (Hanberry and Nowacki, 2016). Oaks are generally warm-adapted species (Nowacki and Abrams 2015), which may be a key reason for their increase in abundance after the recession of the Wisconsinan Ice Sheet, during the early Holocene warming and throughout the Holocene thermal maximum, a period of climatic warming and drying approximately 9,000 to 5,000 years before present time. During the neoglacial cooling period (3,300 years before present), however, its continued persistence was likely due to fire. Oaks and associated species are highly adapted to fire (Abrams 1992 and 1996, Brose and Van Lear 2004, Hart and Buchanan 2012, Lorimer and White 2003, Varner et al. 2016). Fire during this time was likely human-caused, as it occurred outside of the normal "lightning season," had limited relation to drought, varied in frequency over cultural time periods, and generally increased over time with human population growth (Abrams et al. 2014, Abrams and Nowacki 2008, Brose et al. 2013, Guyette et al. 2003 and 2006, Nowacki and Abrams 2008, Stambaugh et al. 2018).

Fire became more prevalent with Euro-American settlement. Most forests in Ohio today regenerated either during the period of intense logging and burning of the late 1800s and early 1900s or thereafter, as farms and mines were abandoned (Brose et al. 2013, Gordon 1969, Hutchinson et al. 2008, McEwan et al. 2007). Oaks and light-seeded early-successional species (i.e., maples, yellow-poplar, black cherry, ash, bigtooth aspen) became established as a result of these disturbances, with oaks establishing on cutover forest areas through stump sprouting and light-seeded species colonizing abandoned fields (Dyer and Hutchinson 2019). However, with fire suppression efforts in the 20th century and natural succession, understories now principally consist of fire-sensitive, shade-tolerant tree species, partly due to mesophication (Hutchinson et al. 2008, Nowacki and Abrams 2008, Palus et al. 2018). The degree of mesophication depends upon site conditions, occurring mostly on mesic, lower slopes, and less so on xeric, south-facing upper slopes and ridges (Iverson et al. 2017 and 2018).

Ohio's forest composition today generally reflects land use, with more level and productive surfaces in agriculture and more rugged and less productive lands as forests. Forest overstories are still largely oak-dominated, as they were prior to Euro-American settlement. Oak dominance as it currently stands is primarily the result of major Euro-American land disturbances (cutting and fire), along with other interacting factors (Drury and Runkle 2006, McEwan et al. 2011). Because landscape-level burning is no longer a factor, and moisture levels have been generally increasing in recent decades (Hayhoe et al. 2018), forests are rapidly undergoing mesophication and shade-tolerant, fire-sensitive trees are greatly increasing at the expense of oaks and other fire-adapted species, though tree species diversity in Ohio does remain quite high.

Another factor that may be playing a role in the lack of regeneration of oak is nitrogen deposition (BassiriRad et al. 2015, Dyer and Hutchinson 2019). The amount of biologically available nitrogen produced by humans has greatly increased since the Industrial Revolution. Elevated levels of nitrogen have been shown to benefit tree species associated with arbuscular mycorrhizal (AM) fungi (like maple, yellow-poplar, and black cherry; Thomas et al. 2010) and inhibit growth of tree species associated with ectomycorrhizal (ECM) fungi, such as oaks, hickories, and American beech (BassirRad et al. 2015).

Forest density

For this assessment, forest density is described using stocking levels, which indicate the degree to which an area is being utilized by trees. Stocking is often expressed as the percent of total tree density required to fully utilize the growth potential of the land (Widmann et al. 2009). FIA surveys use the following categories for percent stocking: non-stocked (0 to 9%); poorly stocked (10 to 34%); moderately (medium) stocked (35 to 59%); fully stocked (60 to 100%); and overstocked (greater than 100%) (Albright et al. 2018). A comparison of stocking class distribution of the 2006, 2011, and 2016 forest inventories show relative stability of stocking classes in Ohio's forests (Figure 20). The 2016 FIA data shows a slight drop of forest land acres considered to be fully and overstocked. This change is likely because the USFS altered the stocking percentage rates from the 2011 survey to the 2016 survey and have become more restrictive (i.e., forest land that used to be considered fully stocked in 2011 may now be considered moderately stocked in 2016). Statewide, most forests in Ohio are moderately or fully stocked.

The significant increase in forests that are fully stocked since 2006 indicates that Ohio's forests are getting denser, more shaded, and generally maturing. The increasing stocking levels also suggest a decline in open, early-successional forest habitat, and that trend will be discussed later in this section. Finally, there is a growing proportion of Ohio timberland dominated by large diameter timber and the increasing percentage of timberland over 60 years old indicates a largely mature resource which provides opportunities for stand improvement activities to be funded by a removal of a portion of available sawtimber in fully and overstocked stands (Albright et al. 2018).

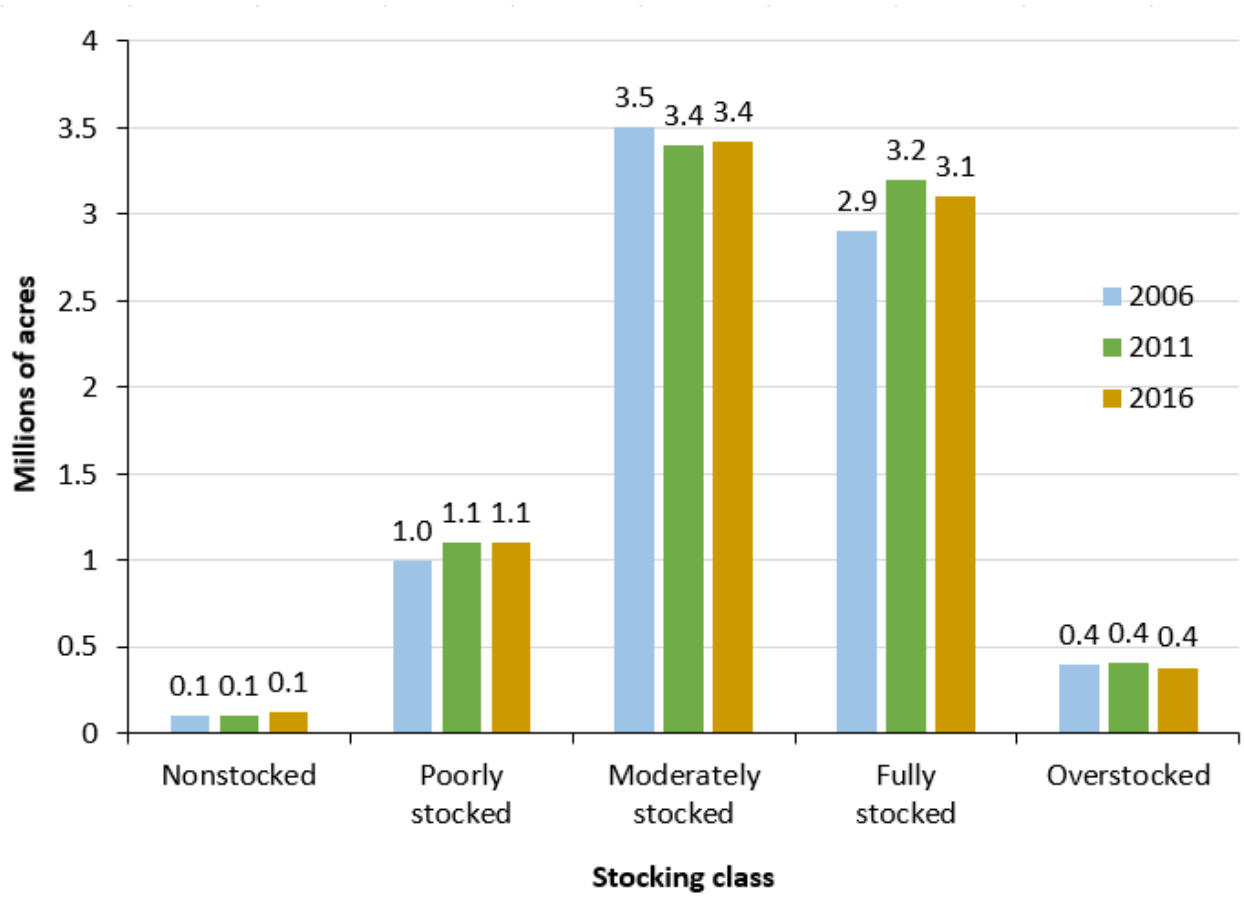

Figure 20. Area of timberland by stocking class of growing-stock trees in Ohio, 2006, 2011, and 2016. (Data source: USDA Forest Service FIA).

Stand structure: size & age class

Ohio's timberland continues to shift into larger size-classes. An estimated 5.2 million acres of timberland were classified as large diameter stands in 2016 (Figure 21), comprising 68% of total timberland area. This represents a substantial increase from the estimate of 53% in 1991 and 63% in 2006. Poletimber area decreased slightly from 23% in 1991 to 21% in 2016, covering 1.6 million acres. The small-diameter class saw a greater loss of acreage, dropping nearing 1 million acres of timberland from 1.8 million acres in 1991 (24% of timberland) to 821,000 acres in 2016 (11% of timberland) (Albright et al. 2018; Figure 21). FIA categorizes stand size based on the diameter at breast height (4.5 feet above ground level; dbh) of the trees occupying a majority of a stand and reports them as one of three classes; large diameter (minimum 11.0 inches dbh for hardwoods and 9.0 inches dbh for softwoods), medium diameter (5.0 inches to 10.9 inches dbh for hardwoods and 5.0 to 8.9 inches dbh for softwoods), and small diameter (less than 5.0 inches dbh). These classes can be referred to as sawtimber, poletimber, and seedling/sapling, respectively and are also indicative of the developmental stage of the forest (Albright et al. 2018).

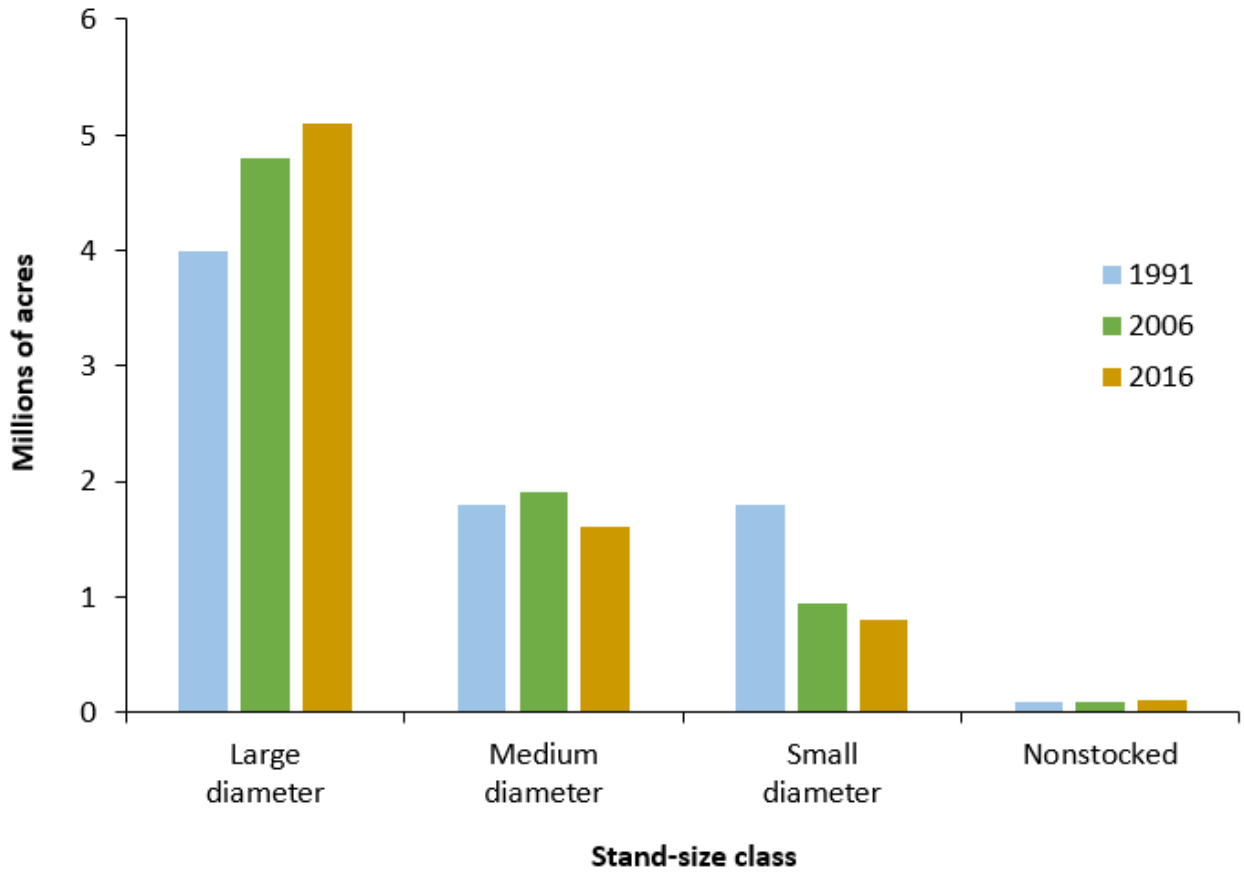

Figure 21. Percentage of timberland by stand-size classes in Ohio from 1991 to 2016 (Albright et al. 2018).

Ohio timberland has shown a clear trend of aging forests. In 2006, an estimated 65% of timberland was less than or equal to 60 years of age, with the bulk of that (36%) in the 41 to 60-year age class. This proportion dropped to 52% in 2016, with the largest drop occurring in the 21 to 40-year class, falling from 19% of timberland to just 11%; a loss of over 600,000 acres (Figure 22). Timberland aged 40 years or less dropped by over 650,000 acres from 28% of timberland in 2006 to 19% in 2016. Over the same time period, the proportion of timberland over 60 years old increased from 35% to 47%. Overall, these data support the conclusion that Ohio's forests are maturing, although most forests are still less than 100 years old.

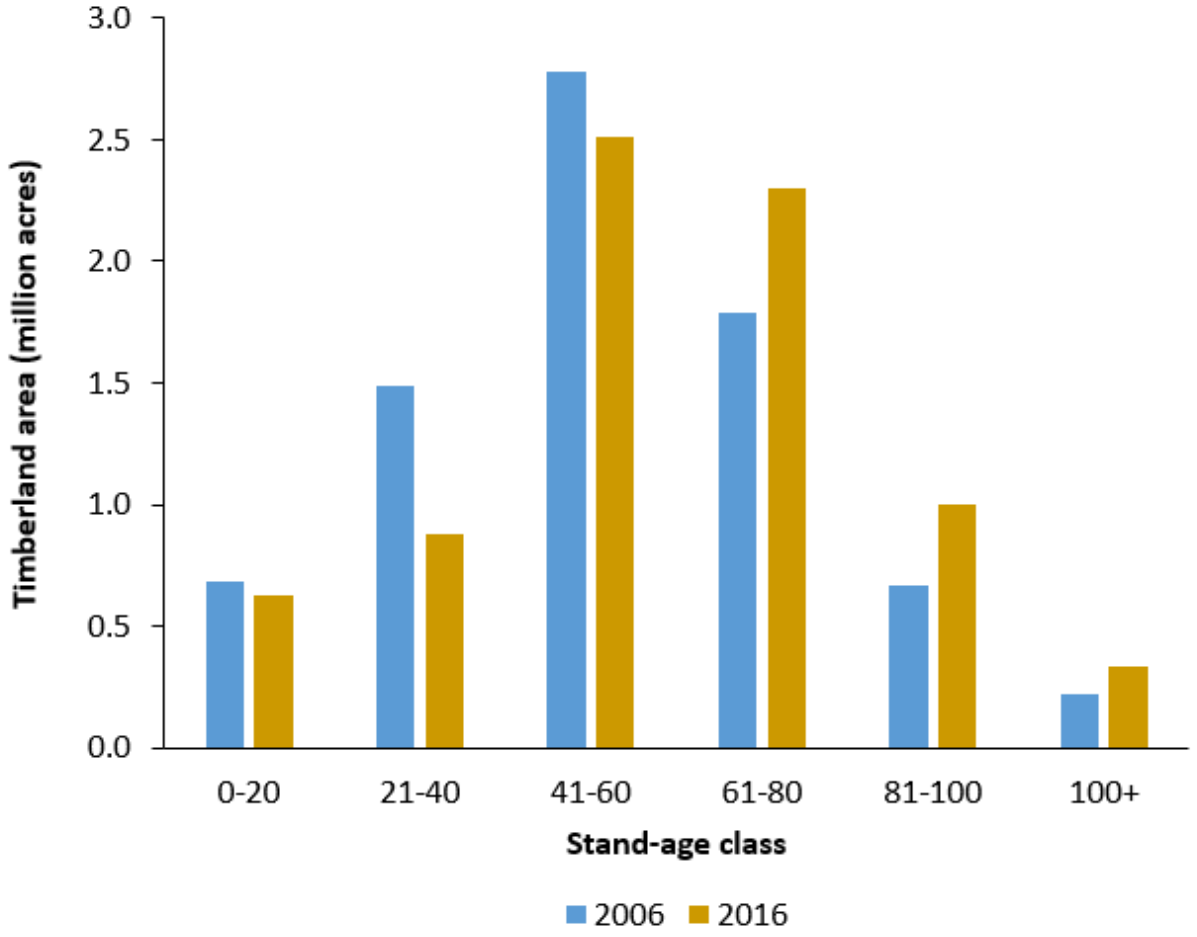

Figure 22. Timberland area by stand age class in 2006 and 2016 (Albright et al. 2018).

Successional stage

Ecological succession is defined as, "the gradual supplanting of one community of plants by another" (Helms 1998). The successional stage of forests is important to biological diversity, as each stage provides unique habitats for some plants and animals. The successional stages of forests are sometimes characterized using the following three broad categories: early-successional, mid-successional, and late-successional (sometimes referred to as "mature"). Another approach to characterizing forest succession, often used by forest ecologists and silviculturists, uses different milestones in forest development like "stem exclusion" and "canopy closure." To maximize biological diversity at a large scale, a range of different successional stages is desirable (ODOW 2015). On a more localized scale or when considering a single species or species group, a single successional stage may be desired (i.e., late-successional or mature forest for cerulean warblers). The general maturing of Ohio's forests that was described previously (i.e., Figure 21) suggests a shift towards later successional stages. The ODNR Division of Wildlife notes the importance of young forest habitat in their *Ohio's State Wildlife Action Plan 2015* (ODOW 2015):

> "Maintaining oak-hickory forest types and providing a sustainable balance of forest age classes, including early-successional habitats, on publicly-owned lands will be critical to provide habitat for diverse and abundant wildlife populations."

Additional data reflecting the impact of less area of early-successional forest on individual bird species are presented later in this report.

Indicator 3 – Extent of forest land conversion, fragmentation, and parcelization

For a 50-year period from 1940 to 1990, Ohio experienced a steady expansion of forestland and the single largest source of new forest land was old field reversion (abandoned agricultural land reverting back to forest). Ohio has now entered an era where the addition of forest land (i.e., from old field reversion) is being offset by the conversion of forest land to other uses. Much of this conversion of forest land is being driven by the parcelization of large contiguous tracts of forest land for home sites, urbanization, or other land development, which leads to fragmentation of contiguous forested tracts.

Forest fragmentation is "the process by which a landscape is broken into small islands of forest within a mosaic of other forms of land use or ownership" (Helms 1998). One measure of fragmentation is spatial integrity index (SII; Kapos et al. 2002). The SII integrates three facets of fragmentation affecting some aspect of forest ecosystem functioning – patch size, local forest density, and patch connectivity to core forest areas – to create a single metric ranging from 1 which indicates highly fragmented area to 10 which represents the highest forest spatial integrity (Albright et al. 2018). Spatial integrity index was calculated at two scales; the 2006 National Landcover Database at a 30 m scale (Fry at al. 2011) and 2009 USDA Forest Service FIA forest cover at a 250 m scale (Wilson et al. 2012). In Ohio, when considering SII at the 250m scale, 32% of the forest land in Ohio is core forest, 29% has high integrity, 11% has medium integrity, 1% has low spatial integrity, and 27% of the forest is in unconnected fragments (Figure 23). At the 30m scale, with 22 acres or greater considered core forest, 48% of the forest land in Ohio is core forest, 25% has high spatial integrity, 9% has medium or low integrity, and 18% of the forest is in unconnected fragments (Figure 24). Forest connectivity is highest in southeastern Ohio, and lowest in northwestern Ohio (Albright et al. 2018).

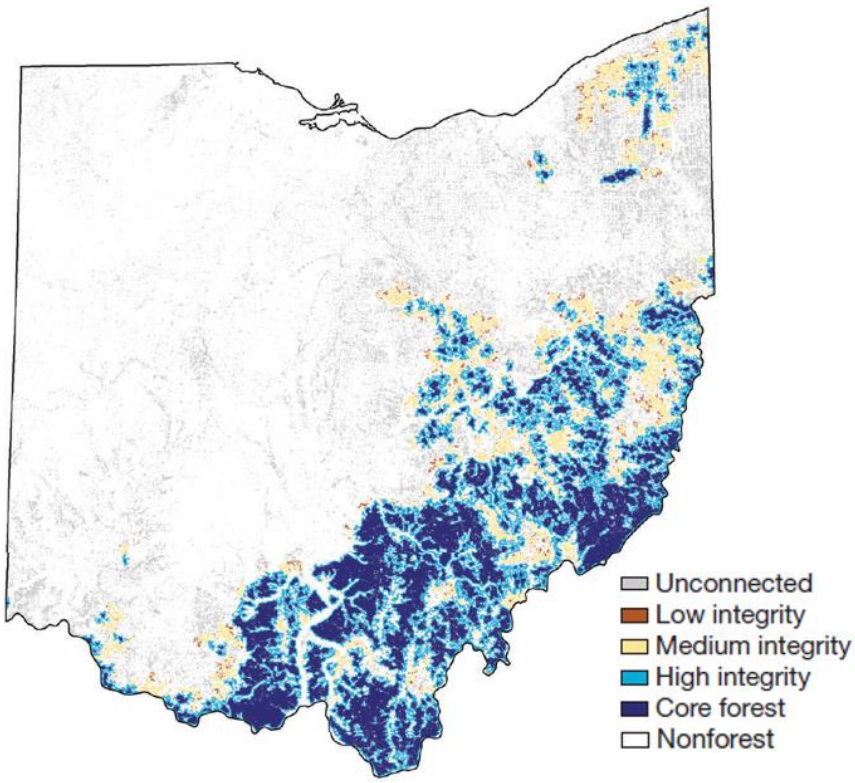

Figure 23. Forestland by spatial integrity index (SII) at the 250m scale (Albright et al. 2018).

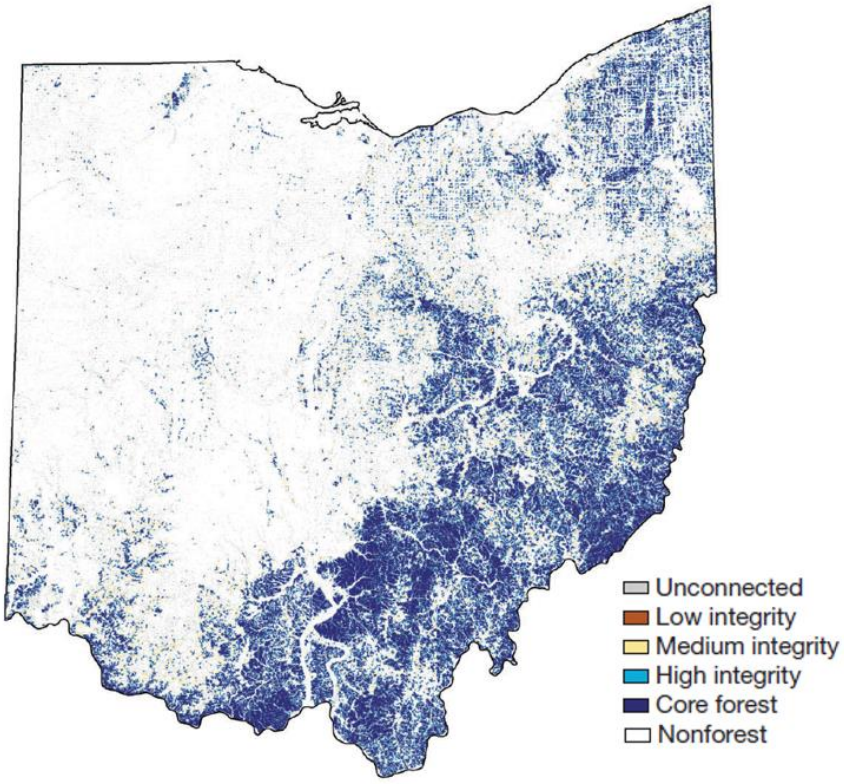

Figure 24. Forestland by spatial integrity index (SII) at the 30m scale (Albright et al. 2018).

Forest fragmentation is often linked to human activities, including road or pipeline construction, residential development, and land conversion for agricultural use (i.e., clearing forests for crop fields). Proximity to human population can be a good predictor of fragmentation in forested landscapes. The expansion of urban populations into rural, undeveloped natural areas (sometimes called wildlands) results in a suite of unique natural resource issues, including but not limited to forest fragmentation. Such areas are often referred to as the wildland-urban interface (WUI) (Radeloff et al. 2005). These areas are defined by housing density ("intermix" areas which have a minimum of 16 houses per square mile), proximity to developed areas ("interface" areas), and percentage of vegetation coverage (minimum 50%). Riemann (2019) intersected WUI areas (based on 2010 U.S. Census data) with forest land from the 2011 NLCD, using data from Radeloff et al. (2017) and Homer et al. (2015; Figure 25). Figure 26 shows the change in WUI in Ohio from 1990-2010 (Riemann and Mockrin 2019). From 1990-2010, Ohio experienced the highest rate of forest conversion to WUI of any state in USDA Forest Service Region 9 (20-state area of the Northeast and Midwest) – an average of 7.5% of forest land becoming WUI each decade (Riemann and Mockrin 2019).

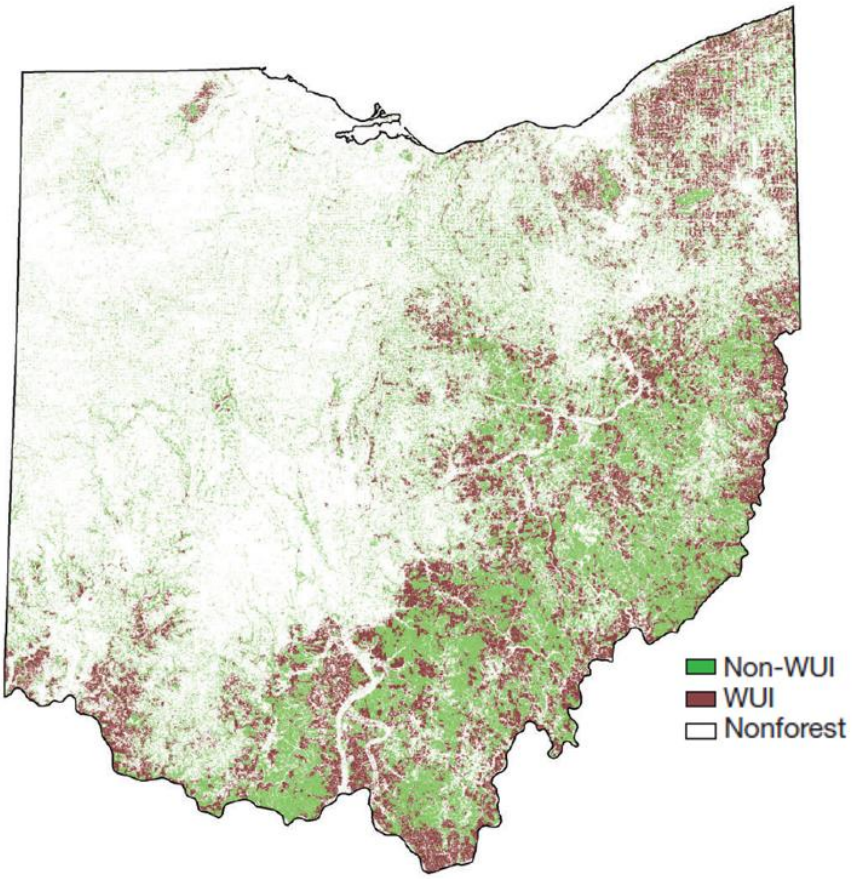

Figure 25. Distribution of forest land by wildland-urban interface status (based on 2010 U.S. Census data and 2011 NLCD data; Riemann 2019).

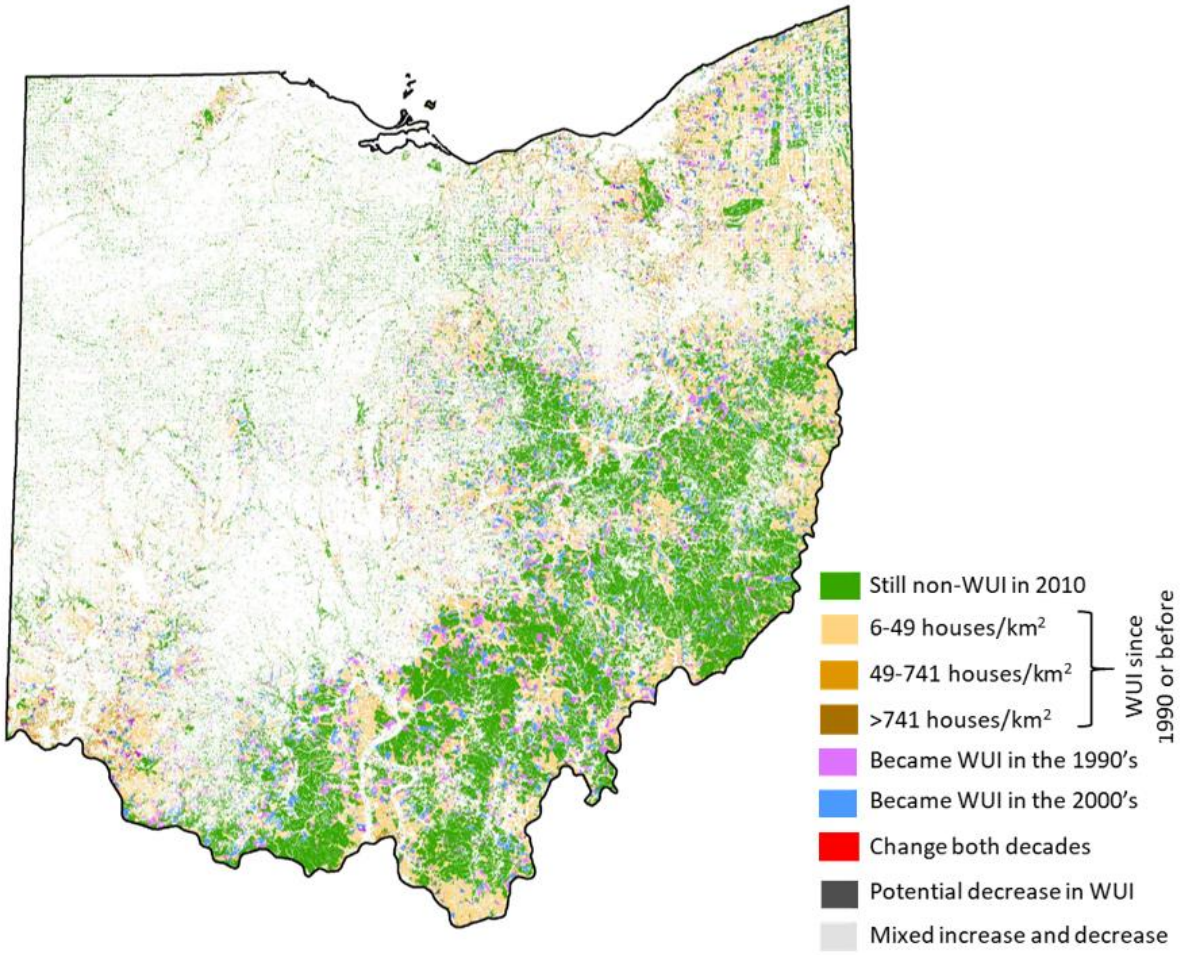

Figure 26. Wildland-urban interface (WUI) change from 1990-2010 (Riemann and Mockrin 2019).

Neither SII nor WUI captures the full impact of roads on forest land. Roads can have a variety of effects: direct hydrological, chemical, and sediment impacts; anthropogenic impacts; invasive species spread; habitat fragmentation; and wildlife mortality. Albright et al. (2018) identified the amount of forest land within 650 and 1,310 feet from a road (Figure 27). In general, when more than 60% of a region is within 1,310 feet of a road, cumulative ecological impacts from roads should be an important consideration (Riitters and Wickham 2003).

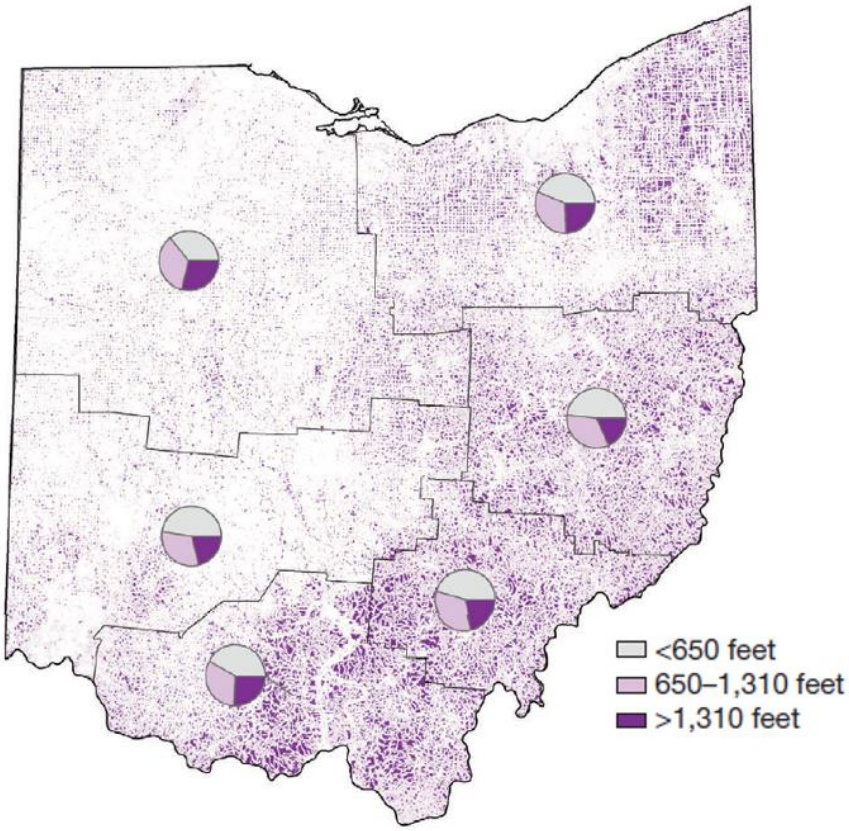

Figure 27. Forestland by distance from the nearest road (based on 2000 road data and 2001 NLCD data; Albright et al. 2018).

Oil, gas, and coal production

Ohio has a long history in the oil and gas industry, dating back to the mid-1800s. Ohio remains a leading producer of oil and gas, ranking in the top third of all producing states in the nation. In 2012, oil and gas production saw a major increase in Ohio with the advent of shale drilling in the Marcellus and Utica shale regions of Ohio (Figure 28). In Ohio, the Utica and Marcellus shale regions are located generally in the eastern half of the state, and the majority of shale drilling has occurred where the two regions overlap (Figure 29). Activities associated with shale drilling (hydraulic fracturing, or "fracking"), include well construction, access road construction, and above- or below-ground pipeline construction, which can contribute to forest loss and fragmentation of contiguous forest patches (Drohan et al. 2012; Johnson 2010; Langlois et al. 2017). Karns (2016) assessed several forest metrics before and after hydraulic fracturing shale gas development in a high-intensity development area of eastern Ohio (nine easternmost townships of Carroll County). Based on National Land Cover Database (NLCD) data from 2001-2006 and 2006-2011 (prior to major shale gas development), forest loss amounted to approximately 150 acres. However, from 2011-2015 (after major shale gas development had begun), forest loss in the same area amounted to approximately 1,500 acres. Karns (2016) also found the distribution of the footprint of shale gas development impacts (well pads, pipelines, and roads) fell 50% within forest land cover types, 39% within open lands (i.e., crops or pasture), and 11% within developed land, noting that impacts to open lands may

be more temporary (eventually re-vegetating to the original condition), among developed land the impacts will vary, and among forest land the impact is a permanent land cover change.

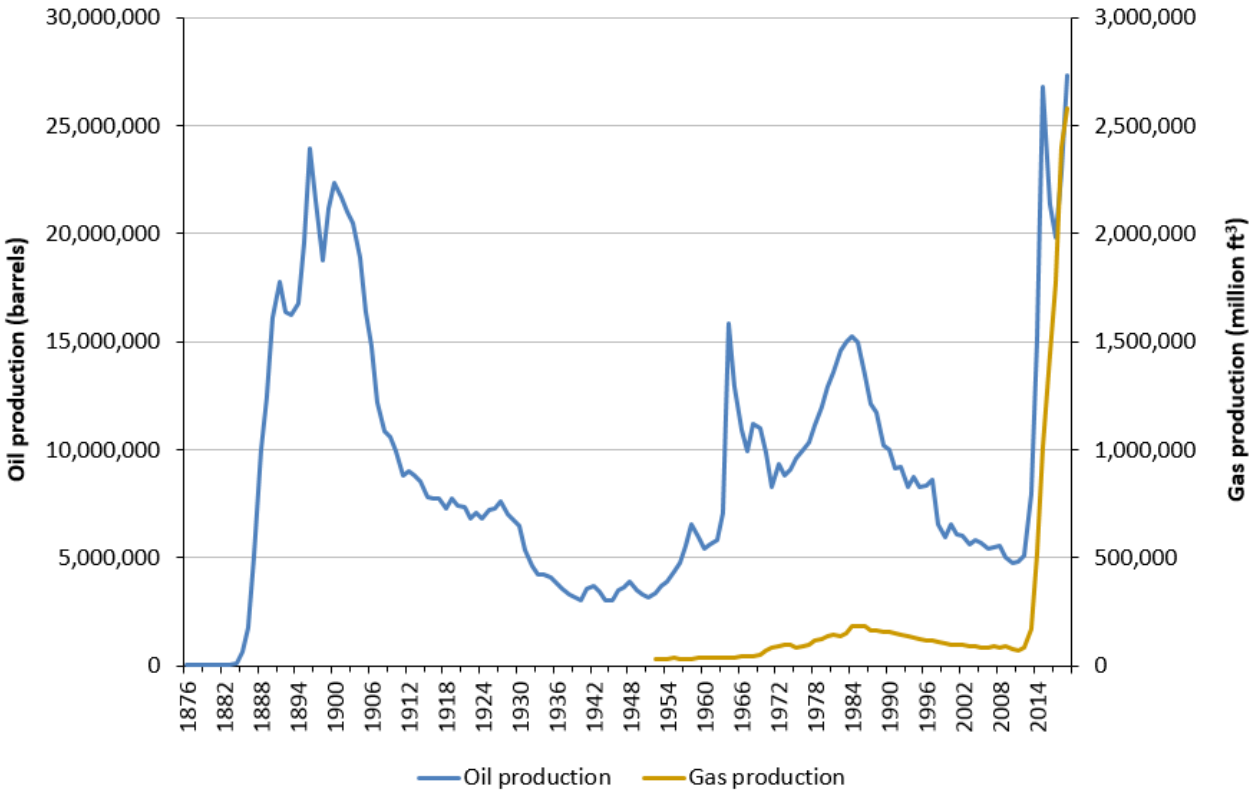

Figure 28. Oil and gas production in Ohio from 1876 to 2019. Data source: Ohio Department of Natural Resources, Division of Oil and Gas Resources.

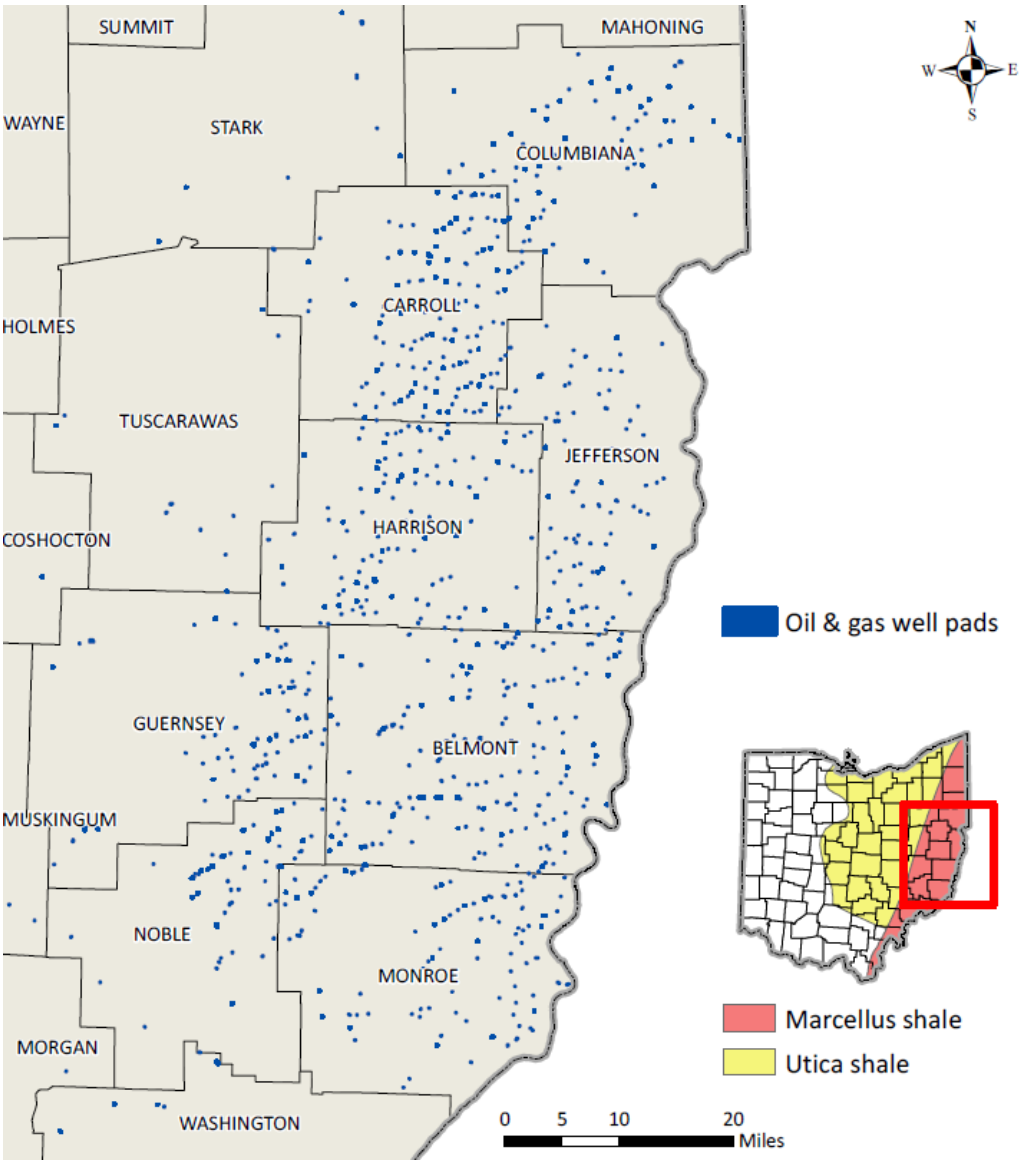

Figure 29. Oil and gas well pads and general location of the Marcellus and Utica shale regions in eastern Ohio, June 2018. Data source: Ohio Department of Natural Resources, Division of Oil and Gas Resources.

Like the oil and gas industry, Ohio has a long history with coal mining, dating back to the early 1800s and the state is a significant producer of coal nationally. Most of Ohio's coal mining activity has occurred in the eastern and southeastern portions of the state, with the top 3 coal-producing counties from 2008-2018 being Belmont, Harrison, and Perry (Figure 30). Early mining operations were almost exclusively underground and largely accomplished through manual labor. With more efficient excavating equipment, new drilling techniques, and explosives around the time of World War II, large earthmoving operations became possible. Surface mining can be a cause of forest loss and fragmentation. In 1972, Ohio established the abandoned mine land reclamation fund and in 1977 the federal Surface Mining Control and Reclamation Act (SMCRA) was enacted. Both of these created standards for reclaiming coal mined areas, including restoring topsoil, natural contours of

the land, and vegetation. Efforts to re-forest abandoned mine lands have occurred, and continue to occur, on many of Ohio's coal-mined lands. In 2018, Ohio ranked 15th out of 23 coal-producing states in the U.S. From 2010-2018, coal production in Ohio has been on a downward trend (Figure 31).

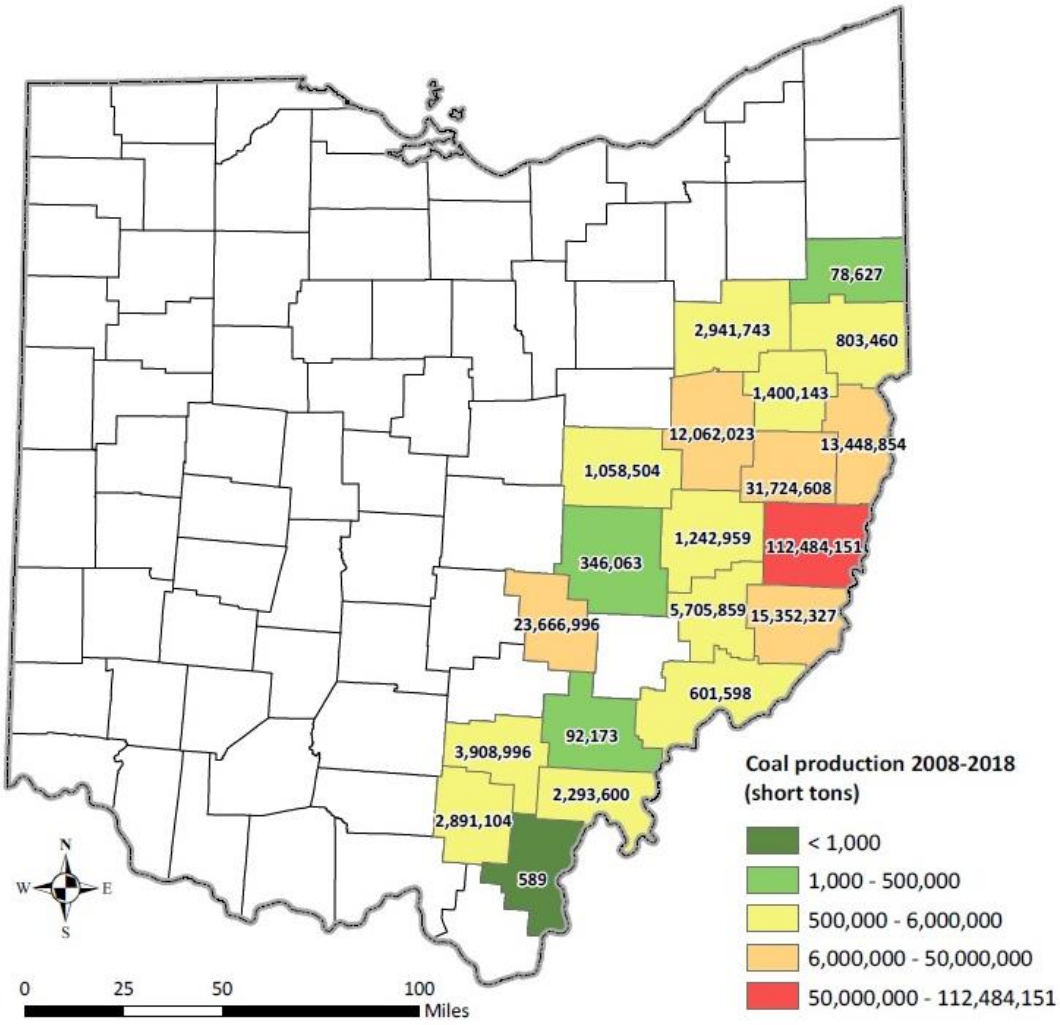

Figure 30. Total coal production in Ohio by county, 2008-2018. Data source: Ohio Department of Natural Resources, Division of Geological Survey.

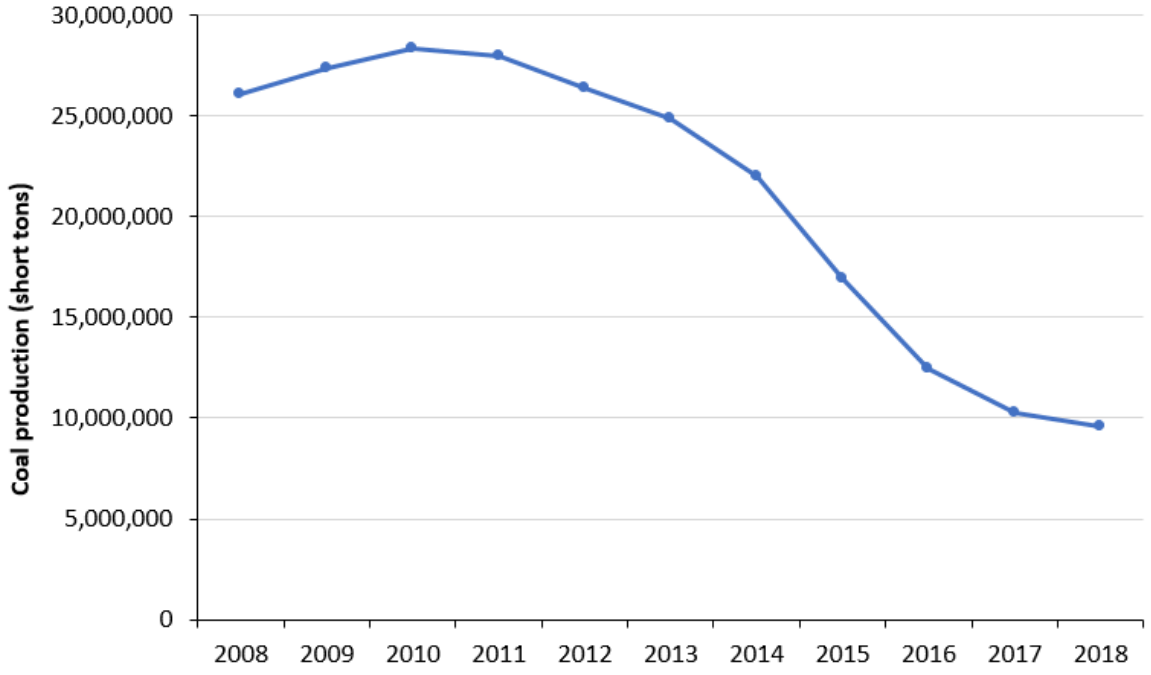

Figure 31. Production of coal in Ohio from 2008-2018. Data source: Ohio Department of Natural Resources, Division of Geological Survey.

Forest land development and parcelization

Of the 270 million cubic feet of removals in Ohio's growing-stock volume from 2011 to 2016, 16% was due to land use change to non-forest use (Albright et al. 2018). A significant portion of that land use change likely results from the development of forest land; however, the exact amount is unknown. The majority of forest land development occurs on private lands. An estimated 85% of the forest land of Ohio is privately owned. The majority of this land is owned by family forest owners. Ninety-three percent of family forest landowners own forests that are less than 50 acres in size (Figure 32). Fifty-three percent of family forest land is less than 50 acres in size. Between 2006 and 2013, the number of family forest owners increased by 28% (336,000 to 430,000) and acreage of family forests less than 50 acres in size decreased by 4% (3.19 million to 3.07 million acres), while the total statewide family forest acreage was essentially unchanged. The average size of family forests (with a minimum of one acre) is 13.5 acres (Butler et al. 2016), down from an average size of 19.0 acres in 1991 (Birch 1996) and 17.3 acres in 2006 (Butler et al. 2010). This reduction in size class of holdings reflects the increasing parcelization of Ohio's forests. Furthermore, newer data from Butler et al. (2020) show 90,000 landowners and 1.85 million acres in the 10-49 acre size class (a decrease of 34% and 49%, respectively from 2013-2018), 17,000 landowners and 1.12 million acres in the 50-99 acre size class (a decrease of 15% and 20%, respectively from 2013-2018), and 9,000 landowners and 1.45 million acres in the 100-499 acre size class (an increase of 12.5% and 21%, respectively from 2013-2018). This newer dataset does not contain information for landowners with less than 10 acres of forest land, however, it is likely that the decreases in both number of landowners and total acres in the 10-49 and 50-99 acre size classes from 2013-2018 was offset by significant increases in those metrics for the 1-9 acre size class.

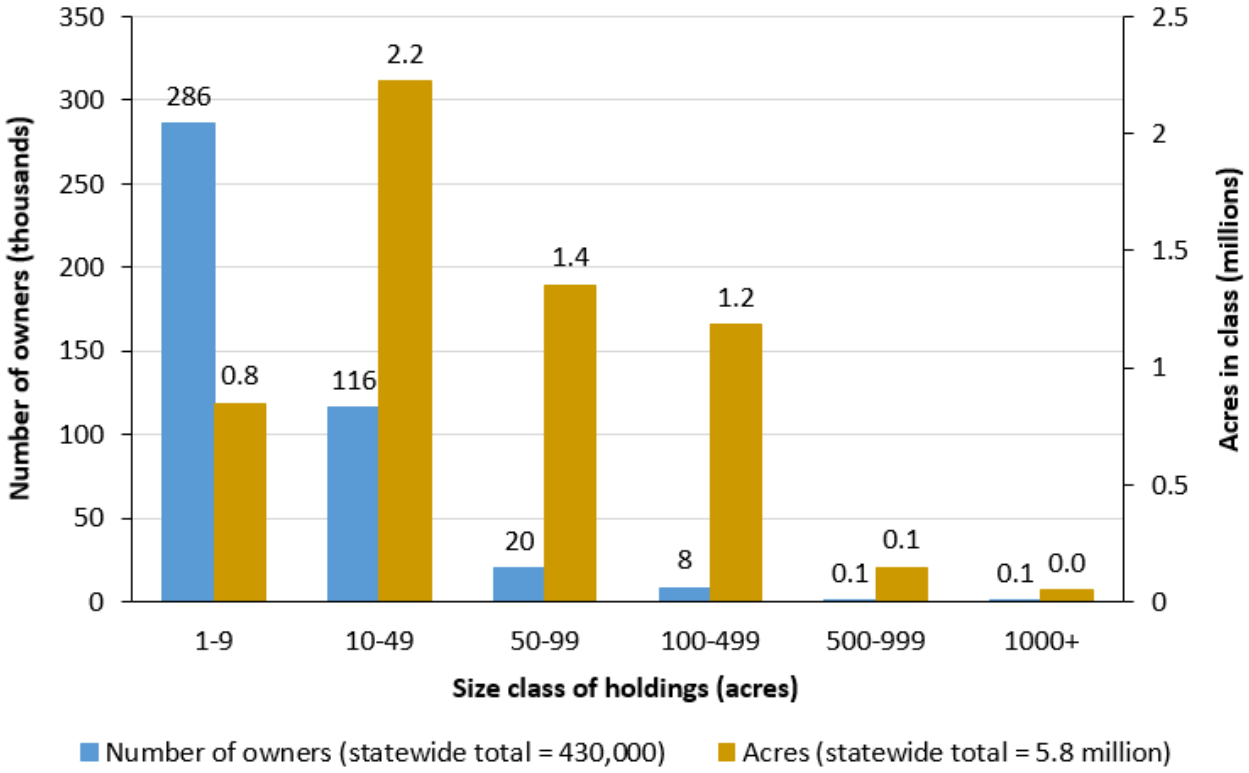

Figure 32. Percentage of family forest ownerships and acres of forest land by size of forest land holdings (Butler 2013).

Indicator 4 – Status of forest/woodland communities and associated species of concern

A core metric of the conservation of biological diversity is the variety of species and their population levels. This indicator describes forest communities and associated species in Ohio. It also reports the current condition and trends of forest-associated species of concern or species that can be used as indicators of community or ecosystem integrity. In 2012, the USDA Forest Service FIA Program began implementation of the Phase 2 Plus (P2+) protocol. The Phase 3 protocol, utilized in the 2006 FIA inventory, was dropped in favor of the P2+ method for the most recent FIA inventory in Ohio. As a result of the new inventory procedures, FIA only collects vegetation data on species they monitor. As such, the ability to draw all-inclusive conclusions about species diversity and richness has been lost. However, some large-scale observations can be made. The species composition of Ohio's forests is among the most diverse in the region with 103 tree species and 50 forest types identified on FIA plots. Invasive plant species were found on 96% of forested P2+ plots (Albright et al. 2018). Invasive plants are discussed in more detail under Indicator 7 of this report.

Discussions about biological diversity and species of concern can occur at multiple spatial scales, including biomes, ecoregions or ecological sections, ecological landscapes or subsections, ecosystems, biological communities, species populations, or individuals. For this indicator, the

discussion will start at the scale of Ohio's ecological sections, which are roughly equivalent to the Level III ecoregions developed by the U.S. EPA. Ohio's ecological sections from the USDA Forest Service's ECOMAP project are shown in Figure 3 (Cleland et al. 2007). Table 2 provides a summary of each section, including any unique or rare ecosystems, communities, or plant species of note.

Table 2. Summary of Ohio's ecological sections. Examples of rare ecosystems, plant communities, and plant species are listed (Brockman et al. unpublished). Animals are addressed later in this report. Common names are given for rare species.

Section name	General description	Dominant forest type	Rare ecosystems, communities, species
South Central Great Lakes	Relatively flat terrain with end moraines; abundant agricultural lands with generally small, isolated woods.	elm-ash-red maple; maple-beech	grasslands, wetlands
Erie and Ontario Lake Plain	Nearly level coastal strip of lacustrine deposits punctuated by beach ridges and swales; lake-modified climate that often has longer growing season; abundant urban and commercial development.	beech-maple	marshes, bogs
Lake Whittlesey Glaciolacustrine Plain	Much of area was the former Black Swamp; flat terrain with abundant agriculture; urban areas (Toledo); woods often occupy poorly drained areas or sandy, well-drained dunes and ridges.	elm-ash-red maple, maple-beech	oak savannas, sedge meadows, sand barrens, wet prairies, marshes, old forests/swamps, pumpkin ash, sweet fern, grove sandwort
Central Till Plains-Beech-Maple	Relatively flat terrain, with some rolling hills and end moraines; abundant agricultural lands with generally small, isolated woods.	elm-ash-red maple, oak-hickory, maple-beech-birch	remnant prairies, savannas, fens (i.e., Cedar Bog), old forests, spreading rock-cress, running buffalo clover, Wood's hellebore, three-birds orchid
Interior Low Plateau-Bluegrass	Rolling to deeply dissected, rugged terrain; mosaic of forests, agriculture, and urban areas (Cincinnati).	maple-beech-birch, oak-hickory, oak-gum	xeric limestone prairies, wall rue, glade spurge, cliff-green, Walter's violet
Western Glaciated Allegheny Plateau	Rolling to level terrain that is less fertile than other glaciated areas of Ohio; abundant urban, industrial, and agricultural development, and some heavily wooded areas.	maple-beech-birch, elm-ash-red maple, oak-hickory	bogs, fens, painted trillium, Northern monkshood, pumpkin ash, striped maple, bunchberry, Robin-run-away, triangle grape fern, speckled wood lily
Southern Unglaciated Allegheny Plateau	Hilly and wooded terrain (unglaciated); formerly extensive mixed-mesophytic forests; some isolated urban and agricultural areas, mostly in valleys and river bottoms.	oak-hickory, oak-pine, Virginia-pitch pine	old forest remnants, Northern monkshood, running buffalo clover, Virginia spiraea, small whorled pogonia, shale barren pussytoes, mountain-fringe, bigleaf magnolia

Forest and woodland communities

In general, statewide maps of distinct forest communities are lacking, and developing trend data is difficult. Data from the FIA provide good coverage of tree species and forest structure, but without corresponding data on understory species (i.e., shrubs and herbaceous plants), characterizations of complete plant communities cannot be made. The trends for overstory tree species and forest types were described under Indicator 2; the data indicate a general reduction in the relative dominance of oaks and hickories and an increase in other hardwood species, particularly maple and yellow-poplar. Figure 33 is a detailed map of existing vegetation (at the 30x30 meter pixel scale) developed using data from the LANDFIRE program (LANDFIRE 2016a). In the map, vegetation cover is described by ecological system (i.e., ecosystem) using NatureServe's Ecological System classification, alliances of the U.S. National Vegetation Classification (USNVC), the National Land Cover Database (NLCD), and LANDFIRE specific types. NatureServe also has global conservation status rankings of ecological associations (community level). Table 3 shows the forest associations in Ohio that are critically imperiled (G1 status), imperiled (G2 status), or vulnerable (G3 status) with the ecological system(s) in which they occur. Using the GIS map of vegetation types in Ohio (i.e., Figure 33), potential sites for these globally imperiled forest communities can be identified geospatially.

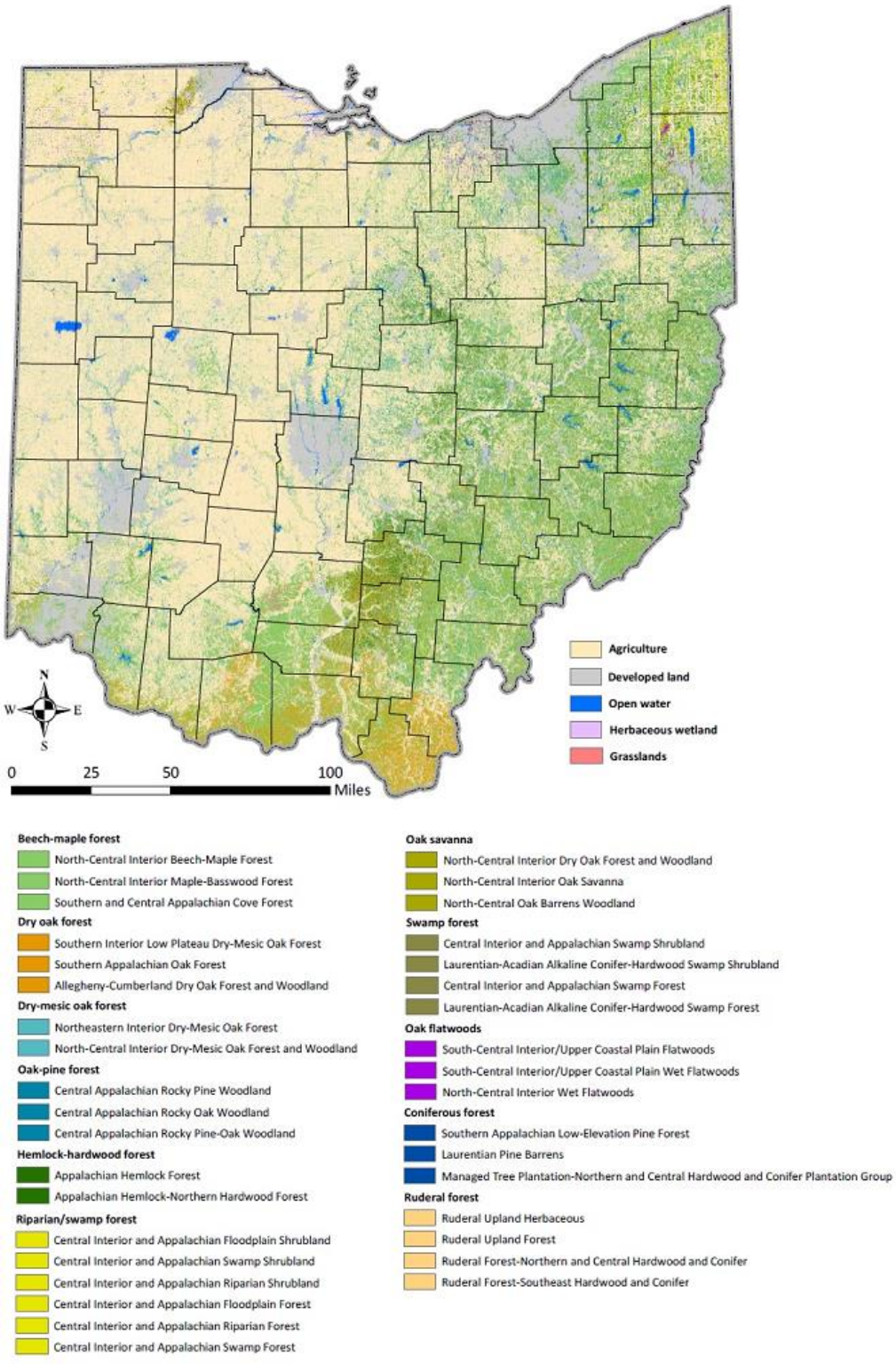

Figure 33. Existing vegetation types of Ohio (LANDFIRE 2016a). To simplify the legend, only select vegetation types are shown.

Table 3. Ecological associations in Ohio that have woody species and are critically imperiled (G1 status), imperiled (G2 status), or vulnerable (G3 status). "Q" denotes taxonomic distinctiveness at current level is questionable. Data source is NatureServe Explorer (NatureServe 2018) and from ODNR Natural Heritage Database.

Ecological association name	Global conservation status	Ecological systems placement	Acres
Cottonwood Dune Open Woodland	G1G2	Great Lakes Dune	110
Bluegrass Cat Prairie	G1Q	Central Interior Alkaline Open Glade & Barrens	70
Post Oak Chert Barrens	G1	Central Interior Acidic Open Glade & Barrens	70
Central Bur Oak Openings	G1	Central Midwest Oak Openings & Barrens	42
Central Limestone Glade	G2G3	Central Interior Alkaline Open Glade & Barrens	195
Central Mesic Tallgrass Prairie	G1G2	Central Tallgrass Prairie	324
Highland Rim Grass-of-Parnassus Seepage Fen	G1	Central Interior Seepage Fen	5

The Ohio Department of Natural Resources (ODNR) Division of Wildlife maintains a Natural Heritage Database (NHD) that contains records on the locations of Ohio's rare plants and animals, high quality plant communities, and other unique natural features (i.e., geologic features). Data from the NHD were used to identify priority landscapes in the geospatial analyses phase of this statewide assessment, but maps generated from that database cannot be shown due to data sensitivity. The ODNR Division of Wildlife maintains a separate statewide database called the Wildlife Diversity Database that includes geospatial data on documented state and federal listed wildlife species. Ohio's forest communities provide breeding or nesting habitat for thousands of terrestrial wildlife species, including 134 birds, 44 mammals, 79 herpetofauna (reptiles and amphibians), over 1,500 lepidopterans (butterflies and moths), and over 500 beetles (data source: ODNR Division of Wildlife). The ODNR Division of Wildlife identified unique terrestrial conservation opportunity areas in its State Wildlife Action Plan (SWAP; ODOW 2015), including the Appalachian foothills and Tecumseh forest. Other unique forest habitats that have high conservation value in Ohio include old forests and vernal pools. Known locations of state or federally listed rare species are also considered to be high conservation value areas. Ohio has 136 state nature preserves and natural areas that protect some of the state's most unique and important habitats or biological communities. The Nature Conservancy and other non-governmental organizations (i.e., land trusts) have also protected important natural areas through land acquisitions and conservation easement.

Status of forest-associated and all species of concern

While community-level data are limited in Ohio, quality data exist for individual species that are listed by the state or federal government. The U.S. Fish & Wildlife Service is the lead agency

administering the federal Endangered Species Act, and they enforce the protection of federally listed species (i.e., endangered or threatened). The ODNR Division of Wildlife administers the state's program for listing threatened and endangered wildlife species and the ODNR Division of Natural Areas and Preserves administers Ohio's listing of rare plants. Table 4 describes Ohio's federally listed plants. A comprehensive list of Ohio's rare plants (i.e., state listed species) can be accessed online at: http://naturepreserves.ohiodnr.gov/portals/dnap/pdf/Rare_Plant_Abstracts/2018-19%20Ohio%20Native%20Rare%20Plants%20Status%20List.pdf. The 2018 state list of rare native plants includes 84 presumed extirpated, 256 endangered, 158 threatened, and 106 potentially threatened taxa. Ohio has 20 federally threatened and endangered wildlife species (Table 5) and 175 state threatened and endangered wildlife species (Table 6).

A statewide strategic plan for wildlife species conservation is outlined in the SWAP developed by the ODNR Division of Wildlife in 2015 (ODOW 2015). A major trend for forest wildlife species with rebounding forest cover since 1940 has been increases in populations of forest-dependent species, like wild turkey, white-tailed deer, black bear, and bobcat. However, the SWAP notes that early-successional habitat important to many forest wildlife species is declining as Ohio's forests are maturing (ODOW 2015). In addition to the rare species data, the analysis of forest-associated wildlife species in this assessment uses trend data for forest bird populations as an indicator of the condition of all forest-associated wildlife. Correlations between birds and mammal species richness and composition are consistently positive and strong (Yong et al. 2016). The ODNR Division of Wildlife's approach for sustaining Ohio's forest wildlife species, as outlined in the SWAP, is to use two conservation opportunity areas–the Appalachian Foothills and Tecumseh Forest Conservation Opportunity Areas (Figure 34). Both of these focus areas are large, heavily forested blocks (>60,000 acres) that are capable of meeting the needs of all area-sensitive forest wildlife species and incorporate natural disturbances. The two forest focus areas are described in more detail in the SWAP. The plan describes how they will be managed to sustain a diversity of wildlife species by maintaining set distributions of different forest successional stages. Beyond the forest focus areas, the SWAP identifies other statewide strategies related to forest wildlife, including a public awareness program on viable forest management practices and the promotion of several specific management objectives including management for oak regeneration and the use of timber harvests to increase early successional forest habitat and maintain diversity (ODOW 2015).

The 2006 Forest Plan for the Wayne National Forest outlines its goals and objectives for sustaining favorable aquatic and terrestrial habitat conditions for wildlife and plant species and biological communities. The Wayne National Forest Plan also outlines goals and objectives for the recovery of endangered, threatened, and sensitive wildlife and plant species. A copy of the Wayne National Forest plan can be accessed from the "Land & Resources Management" page on the forest's website: http://www.fs.fed.us/r9/wayne/.

Table 4. Federally listed Ohio plant species. Listed status symbols are: endangered (E) and threatened (T).

U.S. status	OH status	Common name	Scientific name	Comments
T	E	Northern monkshood	*Aconitum noveboracense*	Habitat is shaded ravines with nearby running water; threats are loss of forest canopy, site/soil disturbance, invasive species, and herbivory. Currently restricted to 3 small, isolated populations.
T	E	Lakeside daisy	*Tetraneuris herbacea*	Require open habitat; expansion of forest cover threatens habitat.
T	E	Small whorled pogonia	*Isotria medeoloides*	Habitat is open, second-growth hardwood forests; rarest orchid in North America; restricted to Scioto and Hocking Counties in Ohio. Difficult to locate new populations.
T	T	Prairie fringed orchid	*Platanthera leucophaea*	Habitat is open, mesic to wet prairies, marshes, fens, and fields; threats are agricultural land use, encroaching forests, and invasive plants.
T	E	Appalachian spiraea	*Spiraea virginiana*	Habitat is gravelbars or streambanks of mid-sized streams; threats are change in stream morphology and invasive plants. Only found in Scioto County in Ohio.
E	E	Running buffalo clover	*Trifolium stoloniferum*	Prefers somewhat open, forested habitat with filtered sunlight; currently found in partially shaded woods, mowed areas, and along streams and trails.

Table 5. Federally listed endangered (E) and threatened (T) animal species in Ohio.

U.S. status	OH status	Scientific name	Common name	Comments
E	E	*Myotis sodalis*	Indiana bat	Found throughout Ohio. Roosts during warmer months in dead or live trees with peeling or exfoliating bark (i.e., some hickories and oaks), split tree trunks, branches or cavities (which may be used as maternity roost areas), stream corridors, riparian areas, and upland woodlots, which provide forage sites. Hibernates in caves and underground mines.
T	T	*Myotis septentrionalis*	Northern long-eared bat	Hibernates in caves and mines - swarming in surrounding wooded areas in autumn. During late spring and summer roosts and forages in upland forests.
E	E	*Charadrius melodus*	Piping Plover	Breeding habitat includes sand or pebble beaches with sparse vegetation along the shore of Lake Erie. Designated Critical Habitat exists in the vicinity of Sheldon Marsh State Nature Preserve, Huron, Erie County, Ohio.
T	T	*Calidris canutus rufa*	Red Knot	Present in Ohio during spring and fall migration.
T	E	*Nerodia erythrogaster neglecta*	Copperbelly water snake	Habitat includes lowland swamps or other warm, quiet waters (both seasonal and permanent), adjacent wooded migration corridors, adjacent upland slopes with underground hibernation sites below the frost line, and streams or rivers.
T	E	*Sistrurus catenatus*	Eastern massasauga	Inhabits wet areas including wet prairies, marshes and low areas along rivers and lakes.
E	E	*Noturus trautmani*	Scioto madtom	Known only from Big Darby Creek in Jackson Township of Pickaway County. Habitat for this species includes riffles where the water velocity decreases and the substrate is composed of sandy gravel with some small stones no larger than 4 inches in diameter. However, this species has not been seen since 1957.
E	E	*Cyprogenia stegaria*	Fanshell	Inhabits medium to large rivers with sand or gravel substrate and also prefer areas with riffles or moderate current.
E	E	*Epioblasma obliquata*	Purple catspaw	Inhabits large rivers in the Ohio River basin in areas with sand or gravel substrate, and prefers shallow areas with riffles and runs.
E	E	*Epioblasma perobliqua*	White catspaw	Found in the sand or gravel of small to medium streams and rivers with swift current.
E	E	*Epioblasma rangiana*	Northern riffleshell	Inhabits small to large streams with firmly packed sand or gravel.
E	E	*Lampsilis abrupta*	Pink mucket	Found in large rivers with strong currents in shallow to deep water with substrates composed of boulders, rubble, gravel, sand or silt.
E	E	*Pleurobema clava*	Clubshell	Occurs in small to large rivers with clean, loose sand and gravel in which they can bury themselves up to 4” deep.
T	E	*Theliderma cylindrica*	Rabbitsfoot	Fish Creek, Big Darby and Little Darby creeks, and the Ohio, Olentangy, Mohican, Muskingum, and Walhonding rivers.
E	E	*Villosa fabalis*	Rayed bean	Smaller, headwater creeks, but they are sometimes found in large rivers, and historically in Lake Erie.
E	E	*Plethobasus cyphus*	Sheepnose	Shallow areas in larger rivers and streams.
E	E	*Epioblasma triquetra*	Snuffbox	Small to medium-sized creeks in areas with a swift current and some larger rivers, and Lake Erie.
E	E	*Lycaeides melissa samuelis*	Karner blue	Found in the Oak Openings region of northwest Ohio due to the presence of wild lupine (*Lupinus perennie)* for the larval stage and nectar-producing flowers for the adult stage.
E	E	*Neonympha mitchellii*	Mitchell’s satyr	Found in fens with low nutrient, carbonate-rich ground water.
E	E	*Nicrophorus americanus*	American burying beetle	A generalist as far as habitat preference is concerned, meaning that it can be found in grasslands, open woodlands and brushlands. Requires available carrion to bury.

Table 6. Number of species by taxa classified as endangered, threatened, species of concern, special interest, extirpated, and extinct in Ohio, as of September 2019 (Data source: ODNR Division of Wildlife). List includes both state and federally listed species. A description of each listing category can be obtained from the ODNR Division of Wildlife (available online at: http://wildlife.ohiodnr.gov/portals/wildlife/pdfs/publications/information/pub356.pdf).

Taxon	Endangered	Threatened	Species of concern	Special interest	Extirpated	Extinct
Mammals	3	2	20	2	9	0
Birds	12	6	20	39	6	2
Reptiles	5	4	11	0	0	0
Amphibians	5	1	2	0	0	0
Fishes	22	11	8	0	9	2
Mollusks	24	4	8	0	11	6
Crayfishes	0	2	3	0	0	0
Isopods	2	1	0	0	0	0
Pseudoscorpions	1	0	0	0	0	0
Dragonflies	13	3	1	0	0	0
Damselflies	3	3	0	0	0	0
Caddisflies	3	6	3	0	0	0
Mayflies	2	0	1	0	0	0
Midges	1	3	1	0	0	0
Crickets	0	0	1	0	0	0
Butterflies	8	1	2	1	1	0
Moths	14	4	22	11	0	0
Beetles	3	2	7	0	0	0
Bees	1	0	0	0	0	0
Total	**122**	**53**	**108**	**53**	**36**	**10**

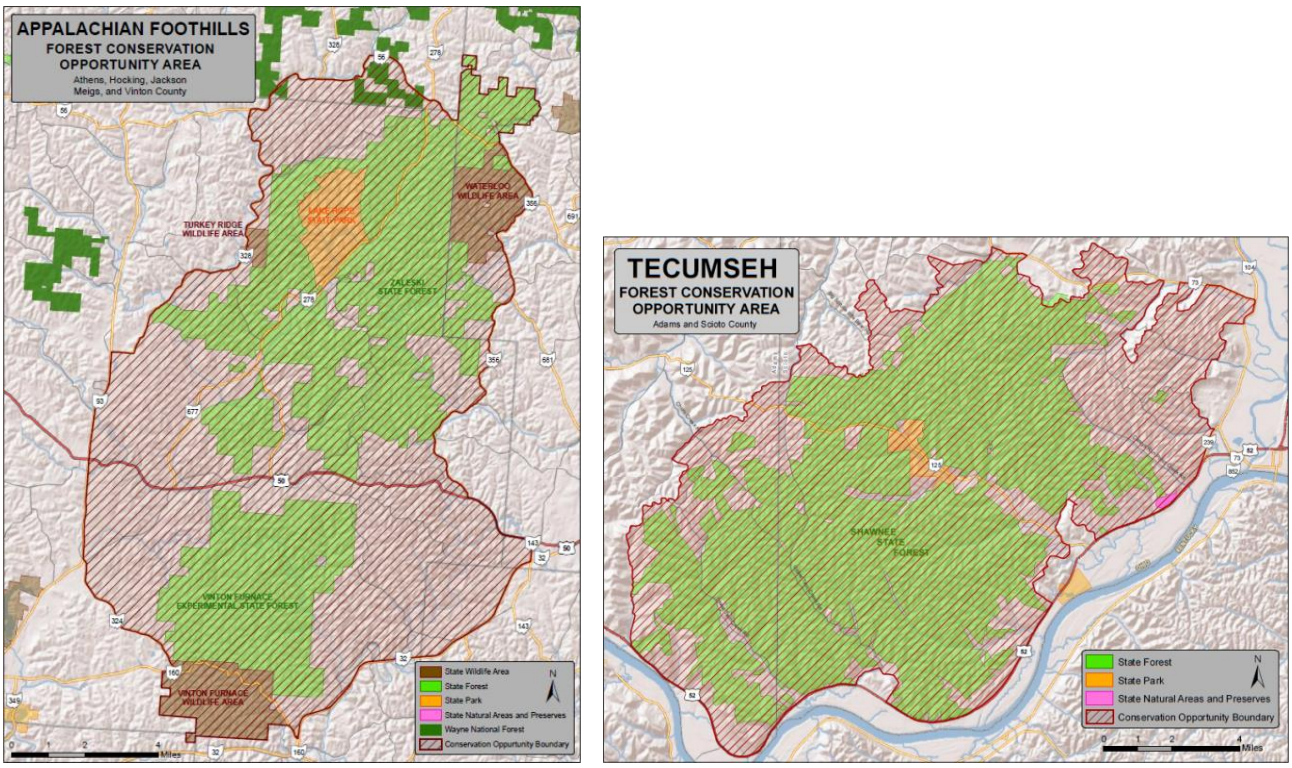

Figure 34. Appalachian Foothills and Tecumseh Forest Conservation Opportunity Areas from Ohio's State Wildlife Action Plan (ODOW 2015).

Status of forest-dependent bird populations

As mentioned in the previous section, forest bird populations provide a good indicator of overall forest wildlife communities. For this analysis, different indicator bird species were selected based on their habitat requirements related to forest age, structure, and successional stage, and their conservation status or importance as gamebirds. These habitat associations apply during the breeding season and are often different during other periods of each species' full lifecycle (many mature forest-breeding birds use early-successional forest during post-fledging and post-breeding periods as well as during migration). Table 7 shows the indicator bird species and their associated forest successional stage. The listed species are not directly linked to specific forest types, as many of them will utilize several different forest types. The majority of the mature and mid-successional forest bird species are increasing, although some exceptions exist (Figure 35 and Figure 36). For example, in mature forests, cerulean warblers and Kentucky warblers are declining. Both species are low-level disturbance specialists, with cerulean warblers relying on small canopy gaps and disturbance in an otherwise forested landscape, while Kentucky warblers use open canopy forests with dense understories. Disturbance suppression and canopy closure are key factors in the decline of Kentucky warbler populations. In mid-successional forests, eastern wood pewees are declining (Figure 36). Eastern whippoorwill and ruffed grouse require both early successional habitat and mature forest during the breeding season, and both species are in decline. Many early-successional forest bird species are showing population declines, including the American woodcock and blue-winged warbler (Figure 37). American woodcock is also closely monitored by the U.S. Fish and Wildlife Service and it was reported in 2017 that the population has had an overall trend of -1.65% growth from 1968 to 2017 (Seamans et al. 2017).

Table 8 shows the change value in abundance of select bird species from Ohio's first Breeding Bird Atlas (Peterjohn and Rice 1991) to Ohio's second Breeding Bird Atlas (Rodewald et al. 2016).

Table 7. Description of indicator forest bird species in Ohio. The fourth column identifies which group has indicated that bird species as a priority concern: Ohio Bird Conservation Initiative (OBCI), the Appalachian Mountains Joint Venture (AMJV), or the Upper Mississippi River/Great Lakes Region Joint Venture (UMRGLRJV; indicates "focal" species).

Bird species	Successional stage	Breeding season habitat preference	Priority species
Cerulean warbler	Mature forest	Upper slope canopy gaps	OBCI (highest priority), AMJV (highest priority), UMRGLRJV
Worm-eating warbler	Mature forest	Mesic coves	OBCI (highest priority), AMJV (highest priority)
Pileated woodpecker	Mature forest	Large trees/snags	
Yellow-throated warbler	Mature forest	Riparian zones	AMJV (moderate priority)
Wood thrush	Mid-successional	Mesic sites	OBCI (highest priority), AMJV (highest priority), UMRGLRJV
Eastern wood-pewee	Mid-successional	Large forest blocks	OBCI (moderate priority), AMJV (moderate priority)
Red-eyed vireo	Mid-successional	Deciduous forests	
American woodcock	Early successional	Shrub-riparian zones	OBCI (highest priority), AMJV (highest priority), UMRGLRJV
Eastern whip-poor-will	Early successional	Areas with mature forest adjacent to early-successional forest	OBCI (high priority), AMJV (high priority), UMRGLRJV
Blue-winged warbler	Early successional	Old fields reverting to woods; forest clearings and edges	OBCI (highest priority), AMJV (highest priority), UMRGLRJV
Wild turkey	Various: early-successional & mature forest	Food: hard mast from mature forest and fields or early successional forest for cover, soft mast, and invertebrates	AMJV (low priority)
Ruffed grouse	Combination of early-successional & mature forest	Food: hard mast from mature forests; young forest for cover and soft mast.	AMJV (moderate priority)

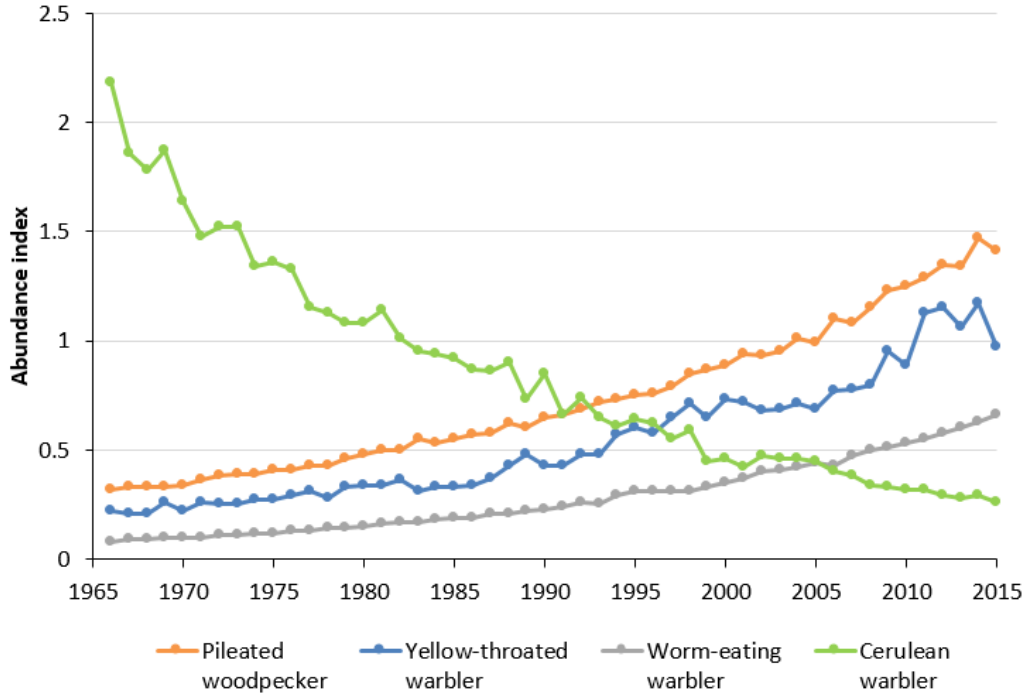

Figure 35. Trends in Ohio for select bird species associated with mature forest breeding habitat. Data source: USGS Breeding Bird Survey.

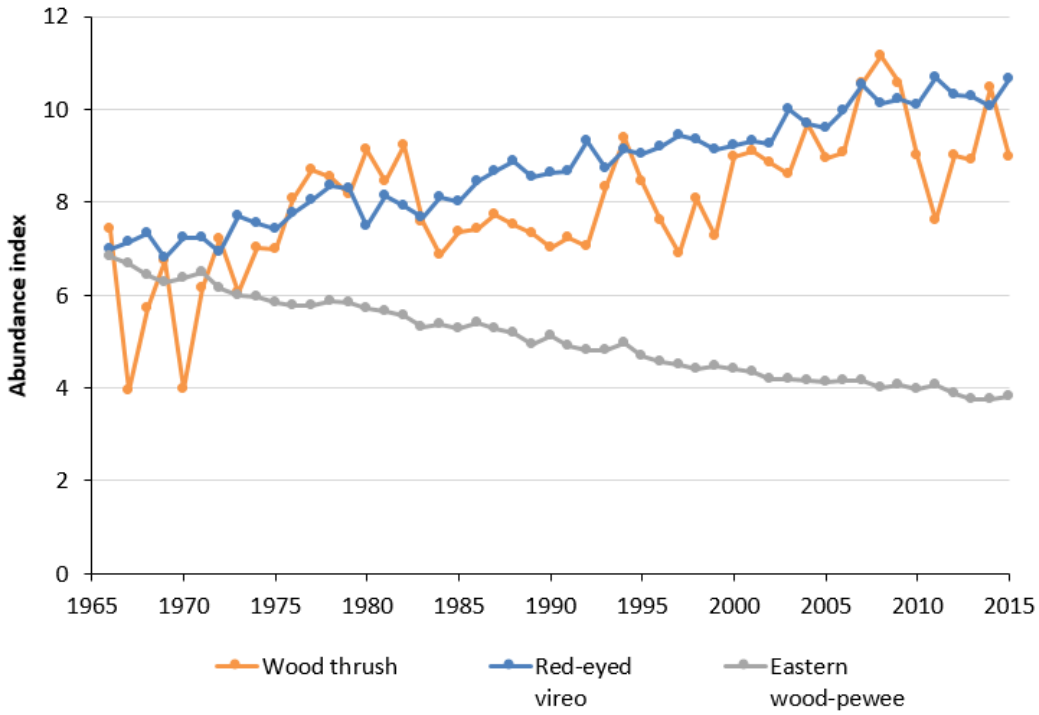

Figure 36. Trends in Ohio for select bird species associated with mid-successional forest breeding habitat. Data source: USGS Breeding Bird Survey.

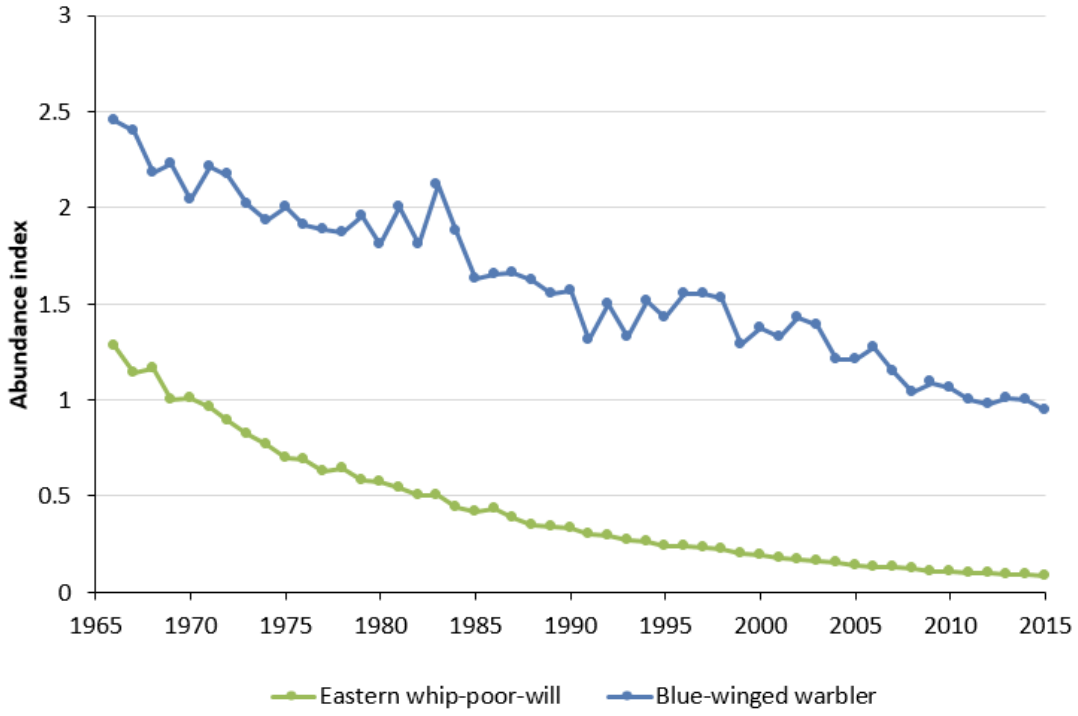

Figure 37. Trends in Ohio for select bird species associated with early-successional forest habitat. Data source: USGS Breeding Bird Survey.

Table 8. Percent change between atlas periods (1987–2011) species trend change value of select forest bird species using totals from priority blocks (n=764) along with the statistical significance of change (Rodewald et al. 2016). Includes possible, probable, and confirmed breeding records. Significance of percent change is calculated using a z-test: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ns = not significant.

Species	Change Value (%)	Significance
Wild turkey	283	***
Pileated woodpecker	17	***
Yellow-throated warbler	15	*
Eastern wood-pewee	-1	ns
Red-eyed vireo	-1	ns
Wood thrush	-4	***
Worm-eating warbler	-13	ns
American woodcock	-23	***
Kentucky warbler	-31	***
Blue-winged warbler	-33	***
Cerulean warbler	-45	***
Eastern whip-poor-will	-58	***
Ruffed grouse	-77	***

In its 2017 *State of Birds Report*, the U.S. North American Bird Conservation Initiative (NABCI) states that after two decades of declines, wetland bird populations have grown dramatically and forest and grassland birds have stabilized which is credited to the introduction of key Farm Bill conservation programs such as wetland easements, forestry title, conservation reserve program (CRP), and grassland easements (NABCI 2019). The report further states that conservation priorities for the next Farm Bill should include increasing funding for Farm Bill conservation, improve the impact of Farm Bill conservation programs on priority wildlife species as identified in State Wildlife Action Plans, enhance the capacity of Farm Bill public-private partnerships, and support the use of science to maximize Farm Bill conservation effectiveness. Ohio Audubon and the Appalachian Mountain Joint Venture (AMJV) have identified important bird areas across Ohio (Figure 38). Important bird areas provide essential habitat for at least one bird species and are often areas where groups of birds gather for critical habitat needs (i.e., nesting cover, wintering, or migration).

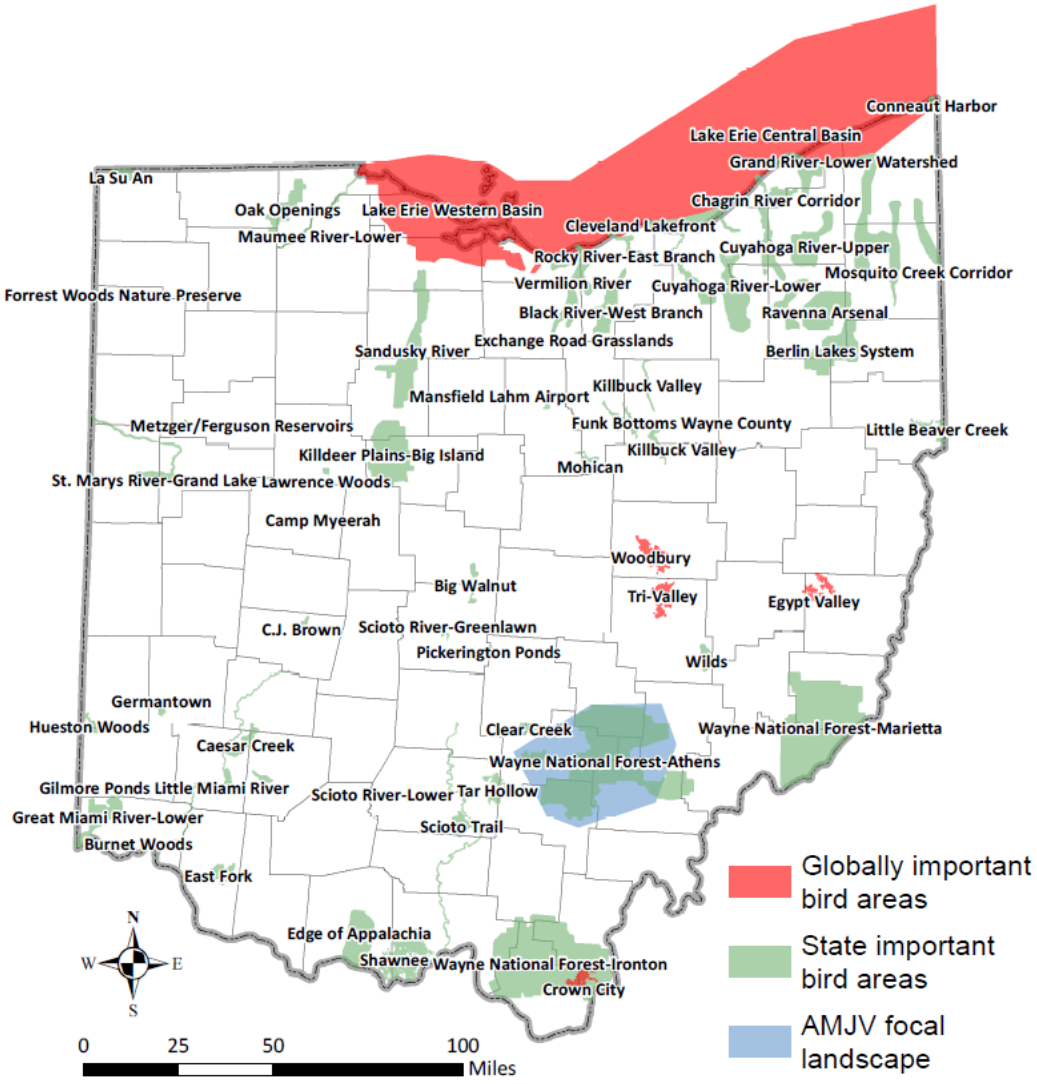

Figure 38. Ohio's important bird areas. Source: National and Ohio Audubon Society and Appalachian Mountain Joint Venture (AMJV).

Criterion 2 – Maintenance of Productive Capacity of Forest Ecosystems

"Forests, directly or indirectly, provide a wide range of extractive and non-extractive goods and services. The nature of these goods and services change over time as a consequence of changes in social and economic demands, technology, and actions taken in the forest to provide the goods and services. Changes in the productive capacity of forests could be a signal of unsound forest management or unforeseen agents affecting ecosystems." (Robertson et al. 2011)

Indicator 5 – Area of timberland

Timberland is the area from which wood is capable of being harvested for a myriad of uses, from wood for furniture to biomass for production of energy. Ohio's timberland supports a forestry industry that contributed over $27 billion to Ohio's economy and employed 132,400 people in 2017 (Mehmood 2019). Timberland is defined as forest land producing or capable of producing

crops of industrial wood (more than 20 cubic feet per acre per year) and not withdrawn from timber utilization (FIA definition). This is differentiated from forest land (described in Criterion 1, Indicator 1 of this document), which includes timberland and all noncommercial forest land. Currently there are almost 7.6 million acres of timberland in Ohio, which comprises 96% of the state's forest land (Albright et al. 2018). Trends for area of timberland show an increase that parallels forest land. However, the relative proportion of forest land that is timberland has decreased slightly since 1968 (Figure 39).

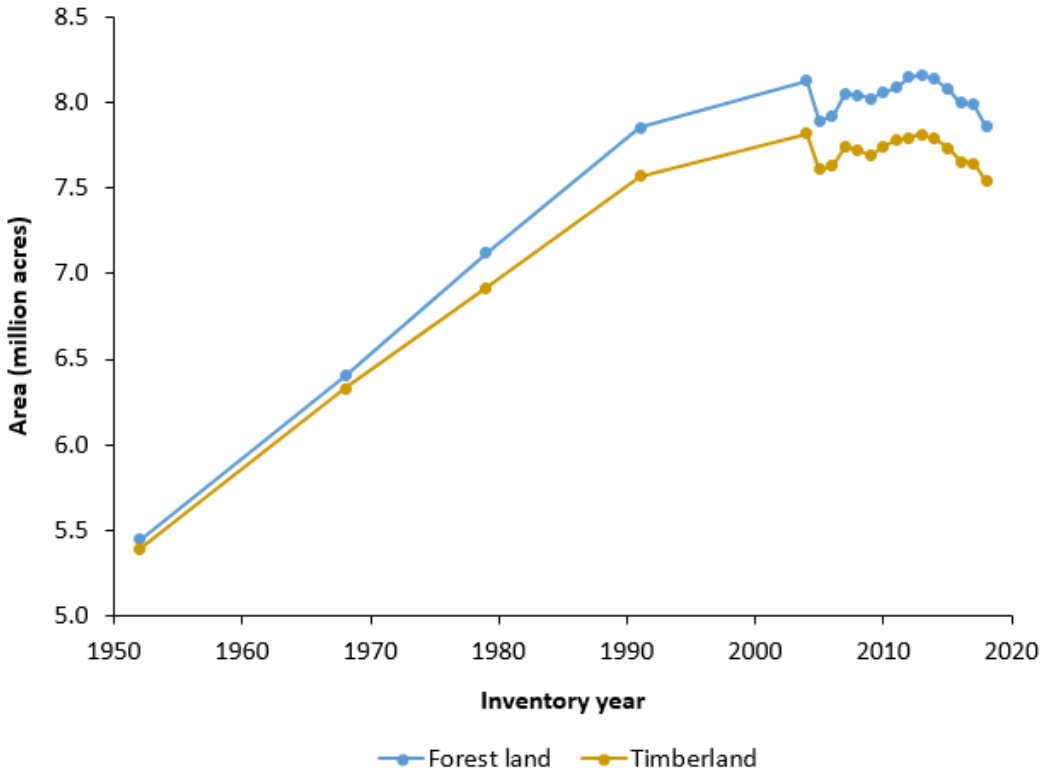

Figure 39. Trend in timberland area compared to forest land (USDA Forest Service FIA).

Indicator 6 – Annual removal of merchantable wood volume compared with net growth

This indicator shows the growth or loss of tree volume. Net growth is defined by FIA as the change, resulting from natural causes, in growing-stock volume during the period between surveys. Components of net growth are gross growth (including growth on existing trees and new trees growing into the sample), minus mortality. Removals are defined as the net growing-stock volume harvested or killed in logging, cultural operations (such as timber stand improvement), or land clearing, and the net growing-stock volume that was reclassified from timberland to noncommercial forest land during the period between surveys. In general, growth outpaces removals (Figure 40). Net growth saw an estimated 30% decrease from 2011 to 2018 (469 million ft^3 per year and 330 million ft^3 per year, respectively), largely driven by decreased growth in American beech, ash, yellow-poplar, and black cherry and an increase in mortality, up 33% between 2011 and 2018 (182 million ft^3 per year and 240 million ft^3 per year, respectively; USDA Forest Service FIA data). Annual removals from harvesting were 225 million ft^3 per year

and an additional 39 million ft^3 of removals per year were due to land-use change. Subtracting removals from net growth results in a surplus, or net change, of 65 million ft^3 per year, a 73% decrease from the 2011 net change estimate on timberland of 240 million ft^3 per year (USDA Forest Service FIA data). In 2018, annual net growth was 1.5 times the volume of annual harvests, less than the 2011 estimate of 2.3 times, due to decreased net growth and increased harvests between 2011 and 2018.

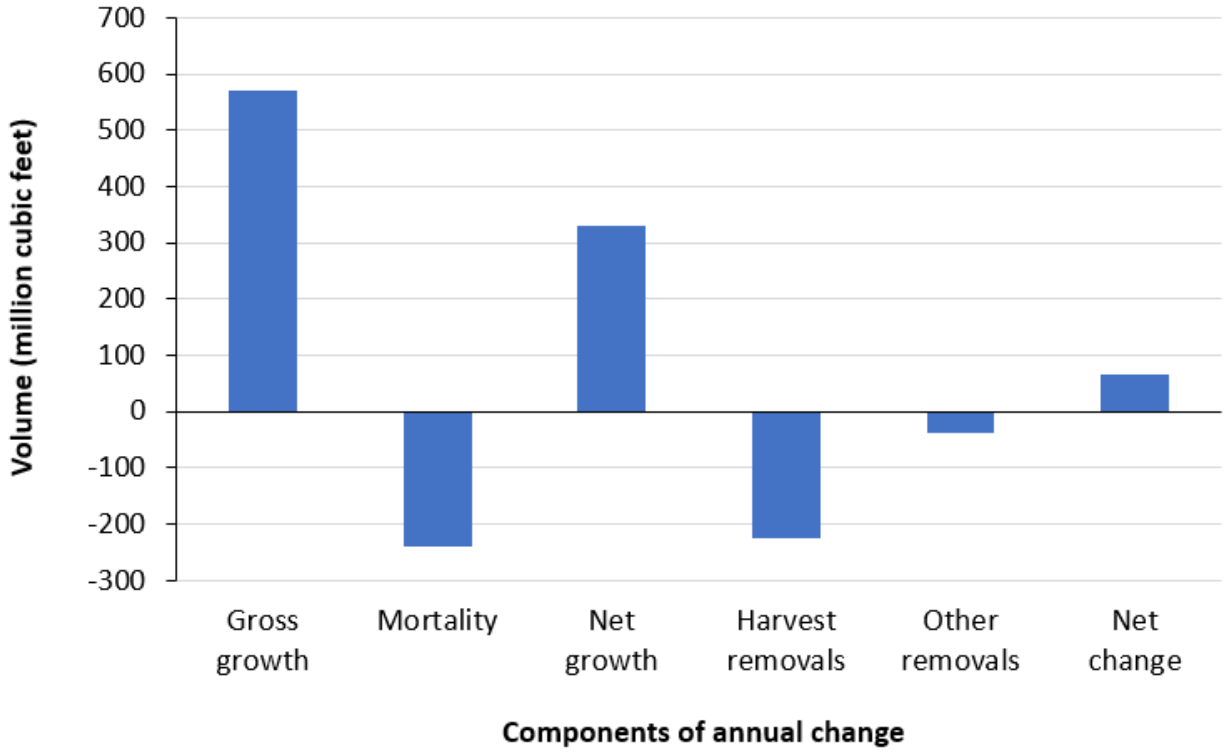

Figure 40. Components of volume change on timberland in 2018 (USDA Forest Service FIA data).

The net change in growth to removal ratios for individual species vary, but the trend is that most oak species have ratios less than 2:1 while maples, yellow-poplar, and hickory are greater than 2:1 (Figure 41). White oak and chestnut oak have ratios of less than 1:1, with harvest exceeding net growth. These trends show another mechanism in which the relative dominance of oaks is decreasing while that of maples is increasing. White ash has negative net growth due to high mortality. In the aggregate, growth continues to outpace removals and mortality resulting in increasing wood volumes in Ohio's forests (Figure 42).

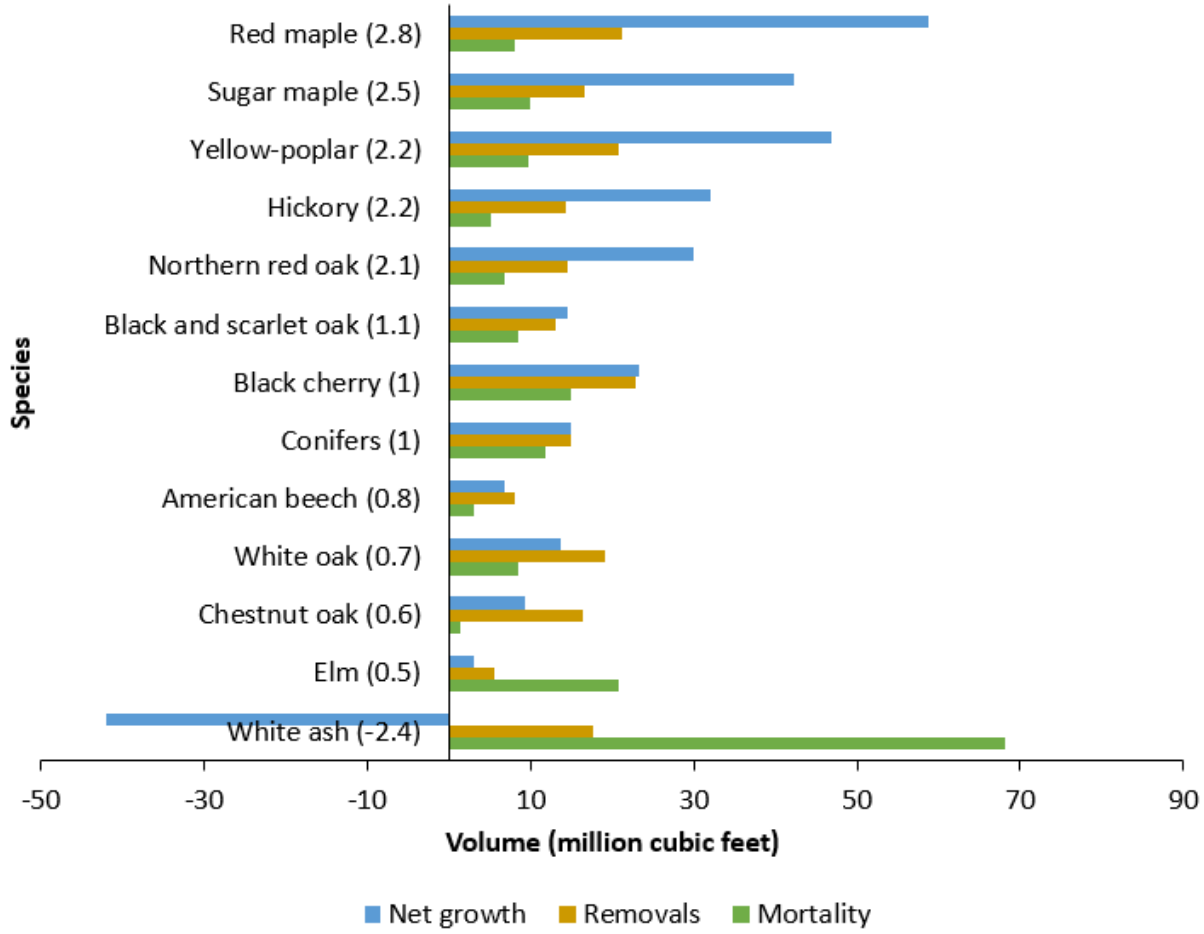

Figure 41. Average annual net growth, removals, and mortality volume, with growth to removals ratio in parentheses for major tree species and species groups by net volume on timberland in 2018 (USDA Forest Service FIA data).

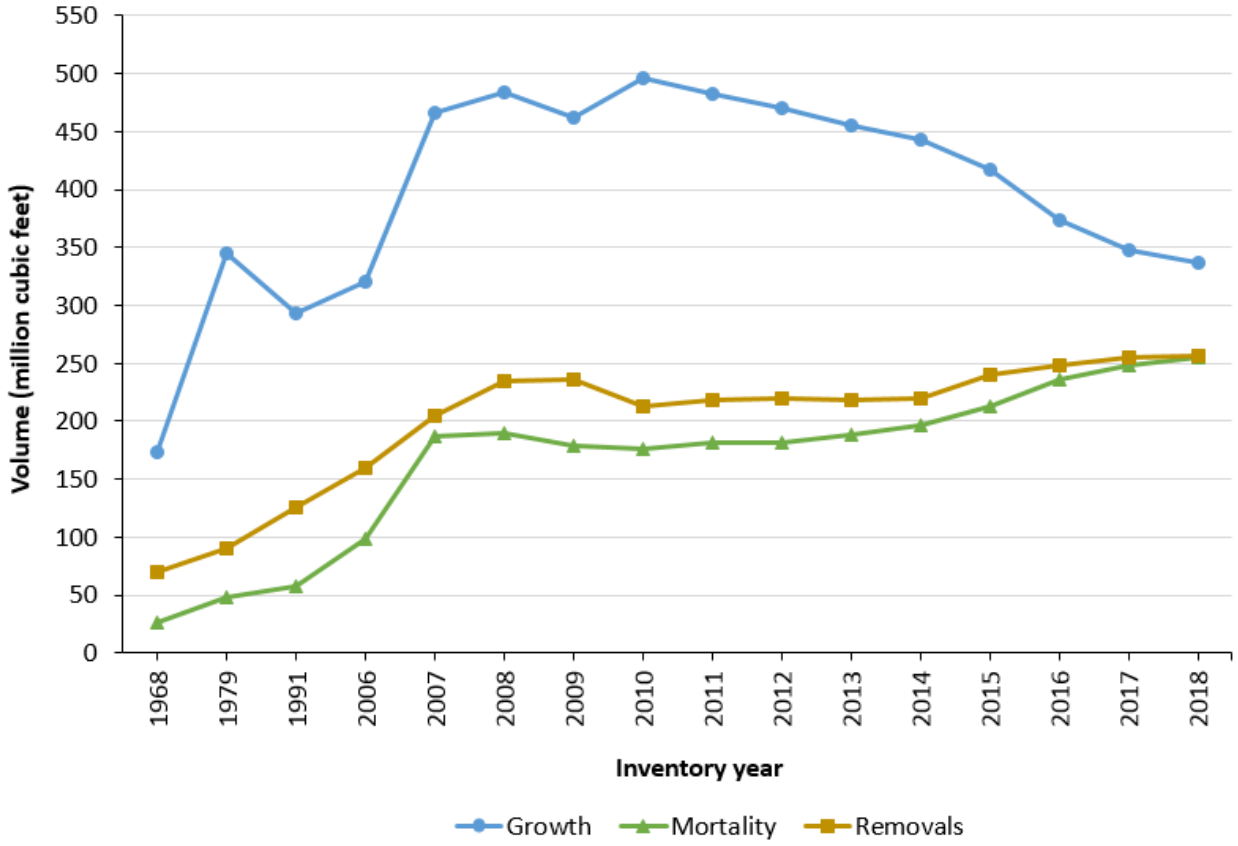

Figure 42. Growth and removal trends for growing stock trees on timberland (USDA Forest Service FIA data).

Type of removals

The definition of removals includes not only volume removed due to a harvest but also conversion of the land to a nonforest use and a reclassification of the land from timberland to noncommercial forestland. In 2018, 85% of the removals were due to harvesting of trees and 15% was due to land use change to either nonforest or to reserved forest land (USDA Forest Service FIA data). Estimates from the 2006 USDA Forest Service FIA report showed 65% of the removals were due to harvesting of trees, while 32% was due to land use change to nonforest (with 3% due to land use change to reserved forest land). Removals due to timber harvesting do not typically have a significant impact on long term productive capacity of timberland, as the forests generally regenerate successfully. Consequently, such removals are considered to be temporary. However, removals due to land use change are generally permanent. Therefore, a continued increase in the removals due to land use change would likely lead to a reduction in the productive capacity of Ohio's timberland, particularly since less "new" forest land is being added annually from croplands reverting back to forests (see discussion of forest land area in Indicator 1 section).

Criterion 3 – Maintenance of Forest Ecosystem Health and Vitality

"Ecosystem health depends on the functionality of natural, nondegraded ecosystem components and processes. The underlying premise is that forest species and ecosystems have evolved to

function within particular environmental conditions determined largely by geological and climatic forces. Humans, meanwhile, have historically (and prehistorically) adapted their economic and social activities to environmental conditions and to the resulting ecological processes. Substantial modification of environmental conditions therefore threatens species' adaptive capacities, ecosystems' functional capacities, and that of the associated human economies and societies" (Robertson et al. 2011).

Indicator 7 – Area and percent of forest land affected by biotic and abiotic processes and agents

This indicator shows the relative health and vitality of the forest. Ohio's forests are constantly under pressure from insects, diseases, invasive plants, and environmental pressures such as drought and flood. Climate change is an environmental pressure that will need to be considered when managing Ohio's forests for the future.

Mortality is a measure of trees that die from natural causes such as insect, disease, fire, and suppression from competing trees. Timber harvests are excluded from this metric. The annual mortality of growing stock on Ohio's timberland was estimated to be 240 million cubic feet, or 1.4% of total net volume per year (USDA Forest Service FIA data). Decreased gross growth along with increased mortality and removals has resulted in net change dropping more than 71% from 228 million ft^3 in 2008 to 65 million ft^3 in 2018 (USDA Forest Service FIA data). Some tree mortality is normal and beneficial to forest ecosystems, as dead standing and downed trees provide important food and habitat for wildlife and are a source of stored nutrients.

The primary causes of tree mortality in Ohio's forests are suppression resulting from stand dynamics/competition and insects and diseases that affect specific species. As reported previously in this document, Ohio's forests are experiencing a maturing trend. As forests mature, natural thinning occurs due to limited growing space and resources (i.e., sunlight). Many of the species that are experiencing the highest mortality are early-successional species that are intolerant of shade, like black cherry and yellow-poplar (Figure 43; USDA Forest Service FIA data). Insects and diseases are likely causing high mortality rates in a few other select species. For example, statewide, ash mortality was 86 million cubic feet per year, or 10% of ash total net volume annually, which is an increase of 614% from the 2008 estimate; largely due to the impacts of emerald ash borer, a non-native, invasive wood-boring beetle (USDA Forest Service FIA data). Insects and diseases will be discussed in more detail later in this section.

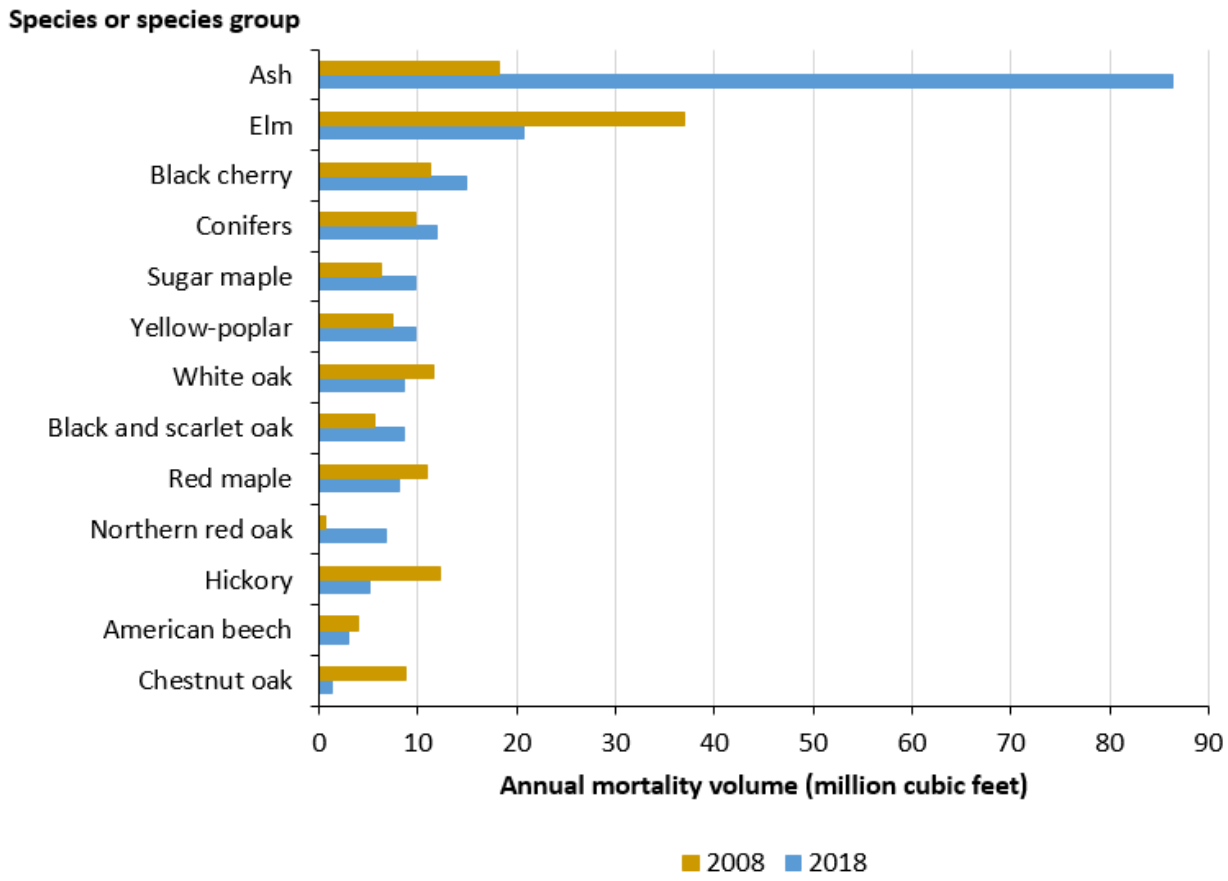

Figure 43. Annual mortality volume for major species and species groups in 2008 and 2018 (USDA Forest Service FIA data).

Area and percent of forest land affected by biotic processes and agents

Insect and disease issues continue to be a primary focus of forest health programs in Ohio. The National Insect and Disease Risk Map (NIDRM) was developed by the USDA Forest Service to show forest areas that are at risk of tree mortality (Krist et al. 2014). Risk areas on the map were defined as those areas where, without remediation, at least 25% of the standing live basal area of trees greater than 1-inch in diameter will die over the following 15 years (2013 to 2027) due to insects and diseases. The primary contributors to mortality in the "at risk" areas in Ohio are emerald ash borer, oak decline, gypsy moth, maple decline, oak wilt, and Dutch elm disease. An estimated 1% of the treed acreage in Ohio is at risk. In 2018, the NIDRM was updated and risk areas where significant disturbance occurred between 2012 and 2018, or the risk was attributed to emerald ash borer, were removed (Figure 44).

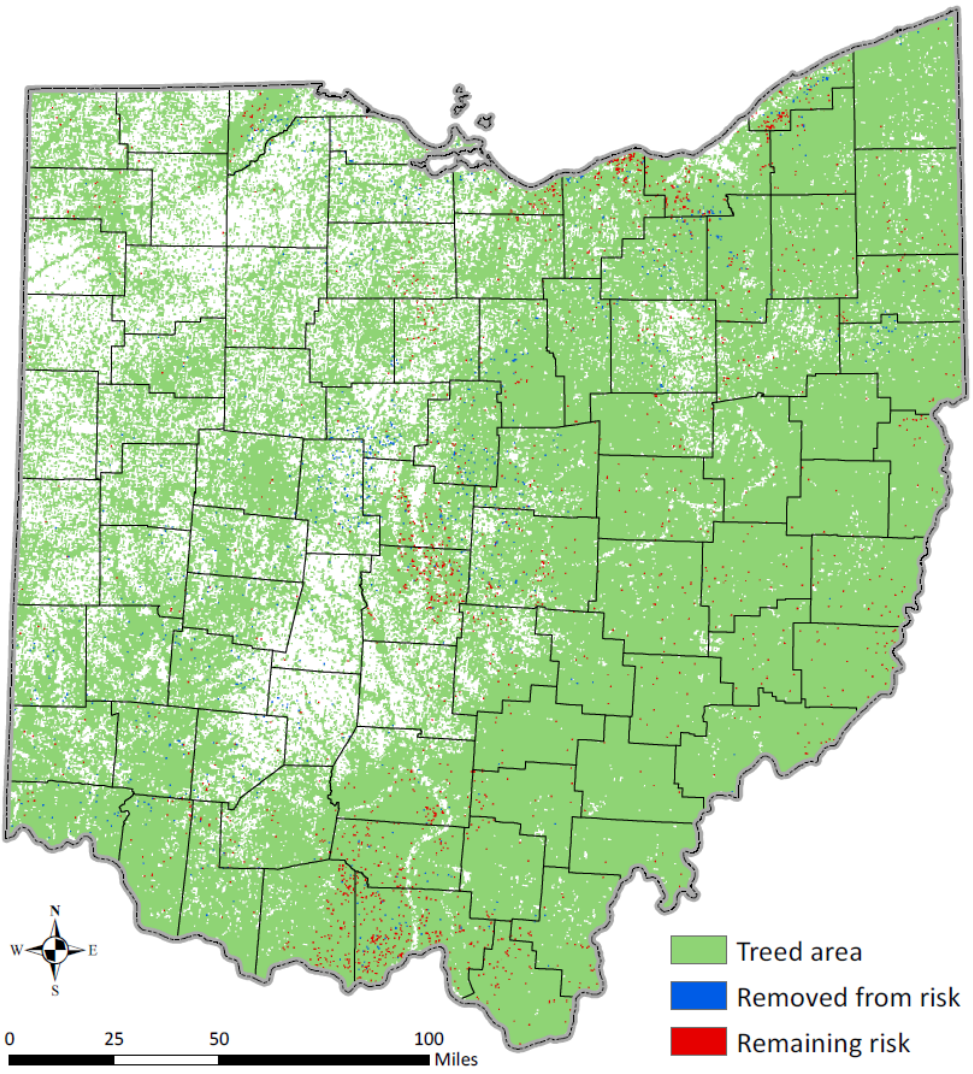

Figure 44. Updated risk map of mortality in Ohio's forests from insects and diseases in 2018 (USDA Forest Service Forest Health Protection 2019).

Significant insect pests

Emerald ash borer

The emerald ash borer (EAB) is a wood-boring beetle native to Asia. It was first detected in North America in 2002 in Michigan, likely accidentally imported years before in wood packaging material (Herms and McCullough 2014). EAB was first detected in Ohio in 2003, and in 2016, EAB infestations were confirmed in every Ohio county. Early attempts to slow or stop the spread of EAB through the removal of ash host trees within a given radius of a known EAB infestation were unsuccessful due to the ability of the insect to travel long distances either through flight of the adult beetles, or the movement of eggs, larvae, or adults, on or in firewood, vehicles, or other objects. EAB has been one of the most impactful pests in history for the forests of Ohio and the eastern United States. Native ash species like green and white ash are typically killed in three to six years from EAB infestation (Knight et al. 2013). This insect has likely killed hundreds of millions

of ash trees and Kovacs et al. (2010) estimated the costs to communities from damage from EAB between 2009 and 2019 to be over $10 billion.

Since its first detection in Ohio, the spread of EAB has been rapid and all of Ohio is now generally infested, in both urban areas and forested settings. In some counties in northwestern Ohio, where EAB has been established for the longest amount of time, more than 95% of the ash trees have been killed (Albright et al. 2018). In 2011, the Ohio Department of Agriculture (ODA) rescinded its county-level EAB quarantine due to EAB detections in Ohio and adjacent counties in neighboring states. The USDA Animal & Plant Health Inspection Service (APHIS) currently enforces a quarantine in all or a part of 35 states on EAB regulated articles (including firewood) to restrict the movement of EAB to uninfested areas (Figure 45). ODNR Division of Forestry Service Foresters continue to advise private woodland owners on managing their forests to salvage any potential remaining value in ash trees and make their woods more resilient to EAB in circumstances where healthy ash remain. ODNR Division of Forestry Urban Foresters assist communities by providing information about EAB, administering community grants, and promoting proactive EAB management plans.

In 2014, EAB was discovered to be infesting white fringetree (*Chionanthus virginicus*), an uncommon tree species in Ohio that is in the olive family (Oleaceae); the same botanical family as ash (Cipollini 2015). The impact of EAB on white fringetree populations may not be as impactful as it is on ash, since white fringetree is a small, usually multi-stemmed tree, that readily sprouts new stems, and may be able to put on new growth to offset stems killed by EAB larval feeding. Cipollini et al. (2017) also confirmed the ability of EAB to complete its lifecycle in cultivated olive (*Olea europaea*) in a laboratory setting. The threat EAB poses to cultivated olive, an important economic crop in the U.S. and internationally, needs further investigation.

Several tiny wasp species from the native range of EAB have been identified and approved for release as biological controls for EAB since 2007. The USDA APHIS manages the national EAB biocontrol program and works with cooperators to release parasitoids throughout the EAB-infested range (USDA 2019). ODNR Division of Forestry Forest Health staff and other cooperating partners work with USDA APHIS to release approved biological controls for EAB in Ohio. Early studies have shown that these parasitoids do reduce EAB attack on ash trees (Duan et al. 2015; Duan et al. 2017). Over 5 million parasitoids have been released since 2007 and releases have occurred in 27 states. Two of the parasitoid species (*Tetrastichus planipennisi* and *Oobius agrili*) are becoming established in many states and provinces, one of the parasitoids (*Spathius agrili*) is found periodically at some southern release sites, and one parasitoid, approved for release in 2015 (*Spathius galinae*), appears to be successfully establishing (USDA 2019). The establishment of these biological controls is a long-term management strategy to suppress the population of EAB, with the goal of allowing native North American ash trees to survive.

Several chemical insecticides are registered for the control of EAB. In most rural or urban forest situations, the use of a systemic insecticide, applied to the soil (roots) around the base of the tree's trunk or applied to the bark via a basal bark spray or trunk injection where they are moved through the tree's vascular system, is the most effective treatment option (Herms et al. 2019). Chemical insecticides are currently the most effective rapid-response measure for protecting ash

trees from decline and mortality from EAB. Several tools are available to landowners or communities managing ash trees to assess costs and benefits related to removal, treatment, and re-planting, such as fact sheets (Smith and Heiligmann 2010), the Purdue University EAB Cost Calculator (Purdue University 2008) and i-Tree (i-Tree 2019).

A small proportion of native ash trees appear to have some degree of resistance or tolerance to attack by emerald ash borer (Koch et al. 2010). Researchers have termed these trees "lingering ash" as their survival could be due to chance or unattractiveness for egg-laying by EAB females; not necessarily resistance to larval feeding (Knight et al. 2012). Possible lingering ash trees can be reported to researchers through the TreeSnap mobile app (TreeSnap 2019). Lingering ash trees are being screened for their tolerance or resistance to infestation by EAB and those that show some degree of tolerance or resistance can be propagated in a breeding program to produce seedling stock for restoration efforts (Koch et al. 2012).

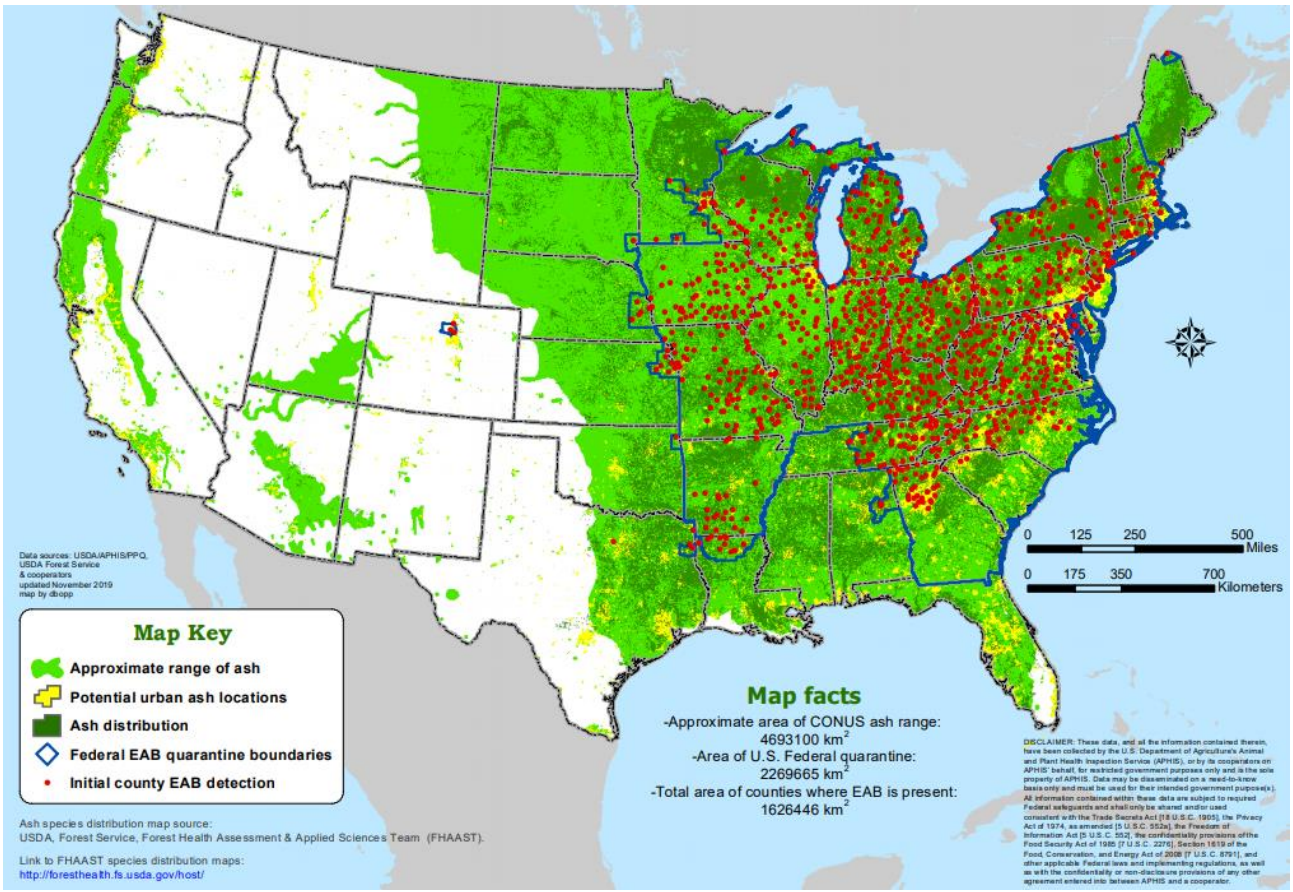

Figure 45. Range of ash species native to the U.S., initial county detections of EAB, and USDA APHIS EAB quarantine boundaries as of November 1, 2019 (USDA APHIS 2019a).

Asian longhorned beetle

The Asian longhorned beetle (ALB) is a wood-boring beetle native to Asia. Its host range includes tree species from 12 different genera (USDA APHIS 2016). It has been introduced in wood packaging material to several locations in North America, since the first North American detection in New York City in 1996, including in Ohio, in 2011 (Figure 46). In North America, its

preferred host plants are maples, particularly "soft maples" such as red and silver maple (*Acer rubrum* and *A. saccharinum*). Other host trees include elms, willows, buckeyes, and birches. The larvae of ALB are large, and their feeding behavior within the heartwood of tree branches and trunks can weaken their structural integrity, resulting in stem breakage. Several years of feeding by ALB larvae can also compromise the host tree's vascular system, resulting in decline and mortality (Haack et al. 2010). The wide host range of ALB and risk of its movement in or on wood packaging material and/or firewood or other plant material makes it a significant threat to forests of North America and Ohio.

Adult ALB typically do not disperse far by flight from the trees from which they emerged. This behavior facilitates eradication of ALB from known infested areas by limiting its natural dispersal. The USDA APHIS manages the ALB eradication efforts at the federal level, and working with state partners and others, the program has successfully eradicated several ALB infestations. In 2011, an ALB infestation was discovered in Tate Township in Clermont County, roughly centered over the Village of Bethel. Since that time, USDA APHIS has been working with ODA, ODNR, and other partners to eradicate ALB, which mainly involves the identification of ALB-infested trees using ground and climber survey crews followed by their removal. All material from removed infested and high-risk host trees is ground into chips (mulch), which kills any life stages of ALB present. As of November 22, 2019, over 3 million tree surveys have been conducted in Ohio, 19,532 ALB-infested trees have been identified, and of those, 19,105 have been removed (USDA APHIS 2019b). These agencies also enforce quarantines to restrict the movement of ALB-regulated items (including firewood) out of or through known infested areas to decrease the likelihood of human-assisted and long-distance dispersal of ALB. Two "satellite" infestations of ALB (a total of 5.5 square miles of regulated area) were identified near Tate Township, which were confirmed to be the result of movement of firewood infested with ALB from the Tate Township infested area. As a result of the eradication efforts, these two satellite infestations have been eradicated and were "deregulated" in 2018. The remaining regulated area surrounding the core infestation is 56.5 square miles (Figure 47).

In 2012, the ODNR Division of Forestry coordinated a Tree Canopy Enhancement Program that provided non-ALB host trees to landowners to plant as replacements for trees removed during ALB eradication activities. This program distributed more than 1,500 trees over four years. ODNR Division of Forestry Service Foresters have assisted landowners impacted by ALB eradication activities by enrolling them in various environmental incentive programs to help cover the costs of managing invasive plants and re-forestation through planting of seedlings. ODNR Division of Forestry Forest Health staff have coordinated with USDA APHIS and ODA to assist with survey of sites at high-risk for introduction of ALB (i.e., campgrounds, sawmills, landfills, industries that import goods in wood-packaging materials directly from Asia) throughout Ohio.

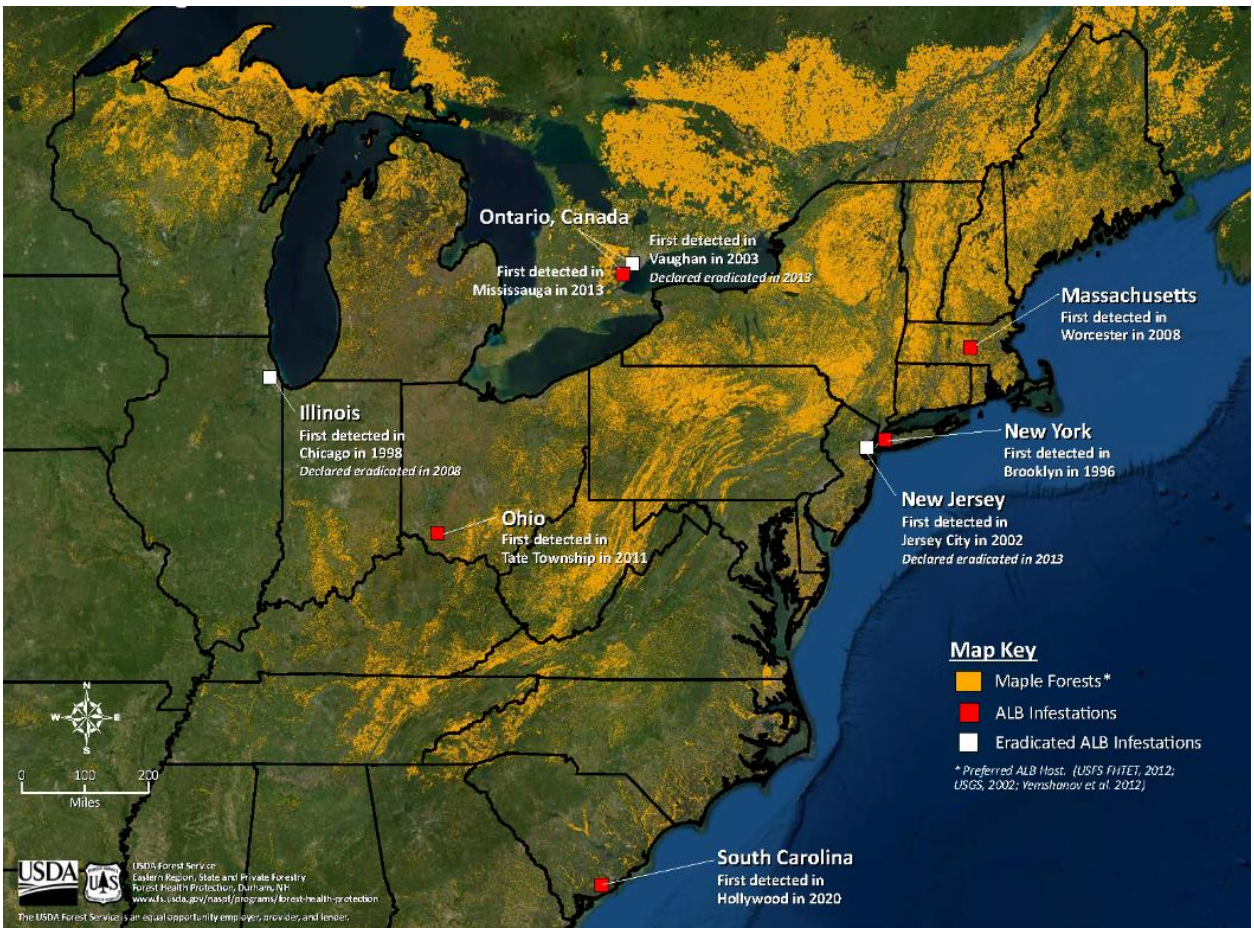

Figure 46. Infestations of ALB, their eradication status, and maple forests in North America (modified from Parker et al. 2012).

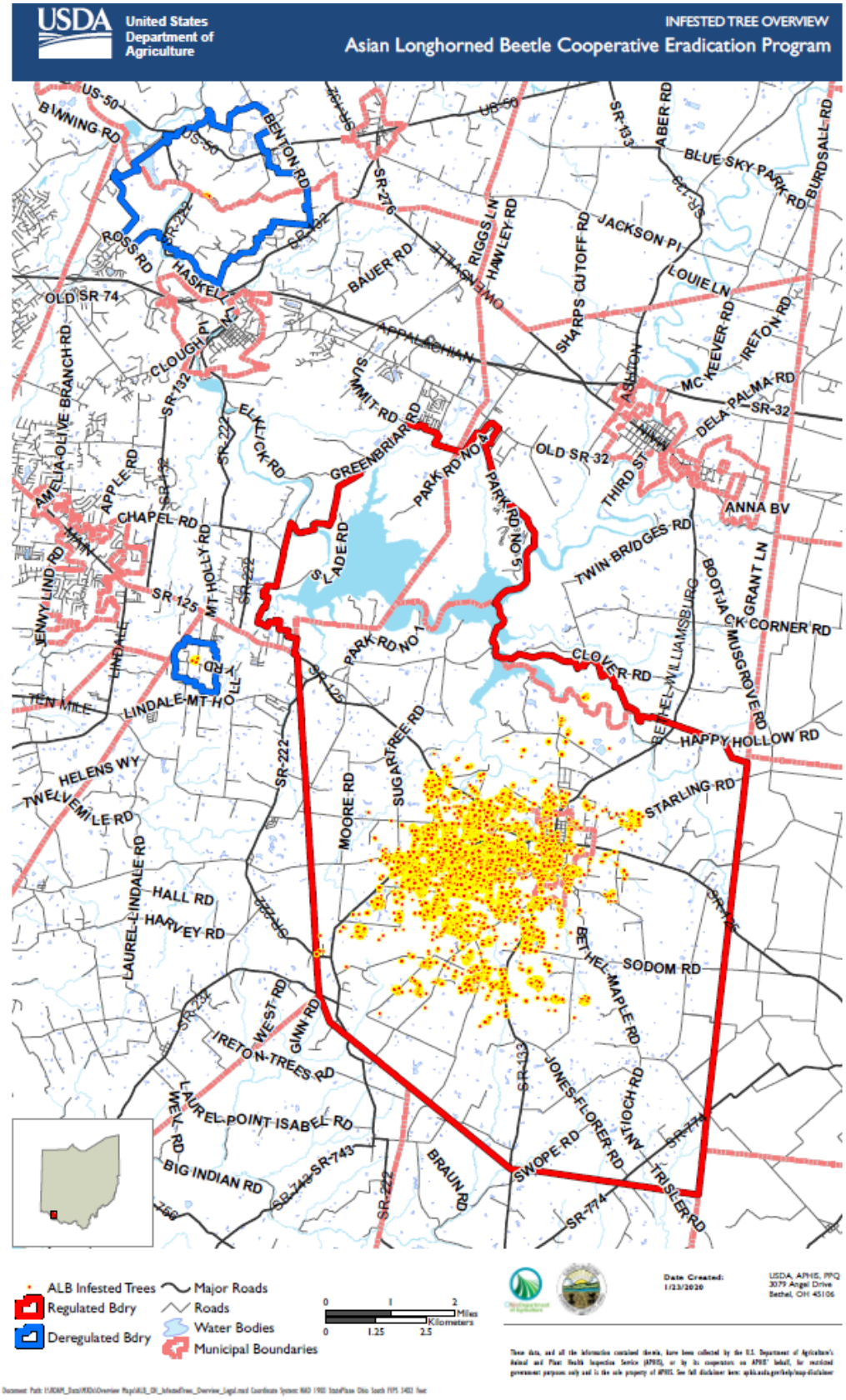

Figure 47. Areas regulated and de-regulated by USDA APHIS and ODA and ALB-infested tree locations in Ohio as of January 23, 2020 (USDA APHIS 2020).

Hemlock woolly adelgid and elongate hemlock scale

Hemlock woolly adelgid (HWA) and elongate hemlock scale (EHS) are tiny insects in the family Hemiptera native to Asia. HWA was first identified in eastern North America in 1951 in Virginia and has since spread across roughly half of the native range of eastern hemlock (Figure 48). Detections of HWA in Ohio have occurred since the 1990s on nursery plants or on yard plants, but it was not until 2012 that HWA was discovered infesting a natural forested stand of eastern hemlock in Ohio. Since that time, forest infestations of HWA have been confirmed in 12 counties (Figure 49). EHS was first identified in North America in New York in 1908 (Miller et al. 2005). It is established in the Northeastern and Mid-Atlantic states. In Ohio, EHS is known to be present on hemlocks planted in the landscape in the major metropolitan areas of Cleveland, Columbus, and Cincinnati, but is only known to be established in naturally growing eastern hemlock forests in the northeastern counties of Cuyahoga, Lake, and Geauga. Feeding by HWA and EHS depletes nutrients stored in the twigs and needles of eastern hemlock trees and over time, causes discoloration, needle drop, and mortality. Eastern hemlock forests are uncommon and unique ecosystems in Ohio. Eastern hemlock is considered a foundation species and provides critical habitat for certain plant and wildlife species; some of conservation concern (Howe and Mossman 1996; Yamasaki et al. 2000; Ellison et al. 2005). Eastern hemlock forests are also important economically in Ohio, as they attract people seeking to hike, camp, fish, hunt, and view wildlife, which can generate critical revenue for communities, especially in rural areas. Tourism generated $134 million and supported one in every seven jobs in 2015 in Hocking County (Tourism Economics 2016), where the majority of Ohio's eastern hemlock forests occur.

Several strategies and tools for the detection and management of HWA have been developed (Havill et al. 2014). The ODNR Division of Forestry led the effort to create the ODNR Eastern Hemlock Conservation Plan (ODNR 2017). This plan outlines the current options available for suppressing HWA and other hemlock pests in Ohio, recommends hemlock conservation strategies, and prioritizes Ohio's eastern hemlock forests. In general, the ODNR has adopted an integrated pest management (IPM) approach to addressing eastern hemlock pests, which involves detection survey and chemical and biological control of HWA. Since 2013, over 15,000 eastern hemlock trees have been treated with systemic insecticides to protect them from HWA on state lands and over 8,600 predator beetles (*Laricobius nigrinus* and *L. osakensis*) have been released as a biological control for HWA. The ODA enforces an HWA quarantine to restrict the movement of HWA regulated articles out of or through known HWA-infested counties (ODA 2018). To raise awareness of HWA and facilitate information sharing and project coordination, the ODNR Division of Forestry has also convened an "Ohio HWA Task Force," composed of representatives from government agencies, non-governmental conservation organizations, local park districts, and academic institutions who manage eastern hemlock or have an interest in eastern hemlock conservation in Ohio. In 2019, a Great Lakes Restoration Initiative grant was awarded to The Nature Conservancy and partner agencies and organizations for eastern hemlock pest survey and treatment in the Lake Erie watershed of northeastern Ohio.

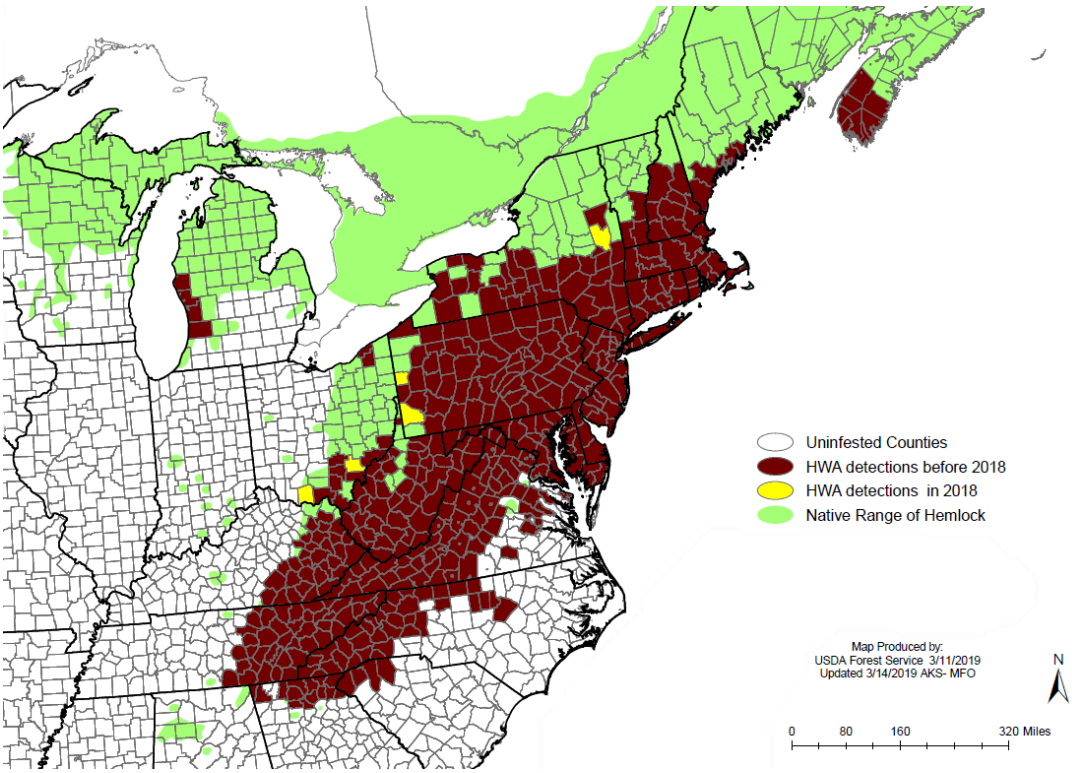

Figure 48. Distribution of HWA in eastern North America as of 2018 and the native range of eastern hemlock.

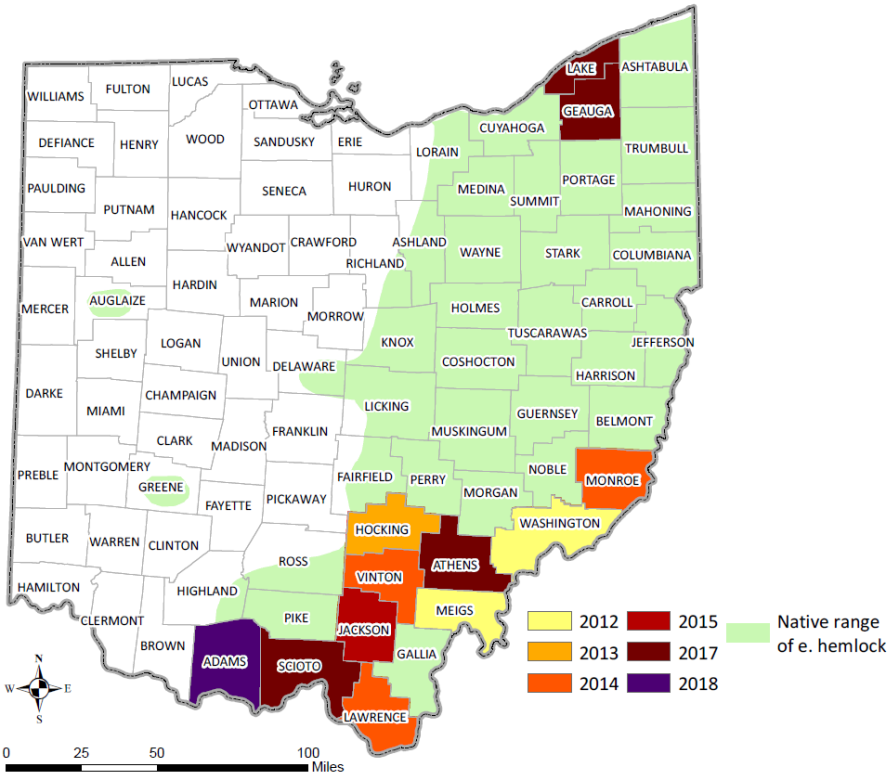

Figure 49. Distribution of HWA in Ohio by county and year discovered as of 2019.

Gypsy moth

The gypsy moth is native to Europe and was introduced to North America in the 1860s. It was first documented in Ohio in 1971. Gypsy moth is now present in 51 of Ohio's 88 counties – generally the northern and eastern parts of the state, and all or parts of several other Northeastern states and Canada (Figure 50). The larvae of gypsy moth consume the leaves of several hundred species of plants, but oaks (*Quercus* spp.) are their preferred and most commonly impacted host plants. In general, deciduous woody plants can withstand two to three consecutive years of springtime defoliation by gypsy moth before becoming weakened and predisposed to attack by other insects and diseases, leading to mortality. Coniferous trees are unable to sprout new foliage and are therefore killed after one defoliation event.

The Slow the Spread (STS) Program is a federally funded, multi-state effort to suppress the population and spread of gypsy moth. In Ohio, this program is administered by the ODA. The STS Program focuses on monitoring, detecting, and suppressing gypsy moth populations in the "transition zone" to slow its movement across the state. The transition zone is the edge of the gypsy moth infestation Ohio, separating generally infested areas from non-infested areas. The "infested zone" is the area of the state with established gypsy moth populations, and ODA conducts treatments here at the voluntary request of landowners. The "uninfested zone" is the area of the state without established gypsy moth populations, where ODA monitors for gypsy moth infestations out ahead of the transition zone and conducts eradication treatments in attempts to eliminate isolated populations. Gypsy moth treatments conducted by ODA are typically larvacides (bacterial or viral biocides specific to caterpillars in general or specific to gypsy moth) or female gypsy moth mating pheromones in a gel or plastic flake form designed to prevent male gypsy moths from locating females, thereby preventing mating, applied by aircraft (ODA 2019). Treatment areas are based on gypsy moth population estimates, determined through annual gypsy moth trapping. From 2009-2019, an average of 88,800 acres were treated annually in Ohio as part of the STS Program (USDA Forest Service 2019a). The ODA also enforces a quarantine in partnership with USDA APHIS to restrict the movement of gypsy moth regulated articles out of or through gypsy moth-infested counties.

Annual defoliation by gypsy moth in Ohio over the last decade is much reduced compared to annual defoliation acreage of the 1990s and early-2000s (USDA Forest Service 2018). In addition to the STS Program, suppression, and eradication treatments, gypsy moth populations in Ohio and across the range of infestation have been reduced over the last few decades by the fungus *Entomophaga maimaiga*, which can persist in the soil, and infect gypsy moth caterpillars, greatly reducing their populations, especially in years with abundant spring rainfall.

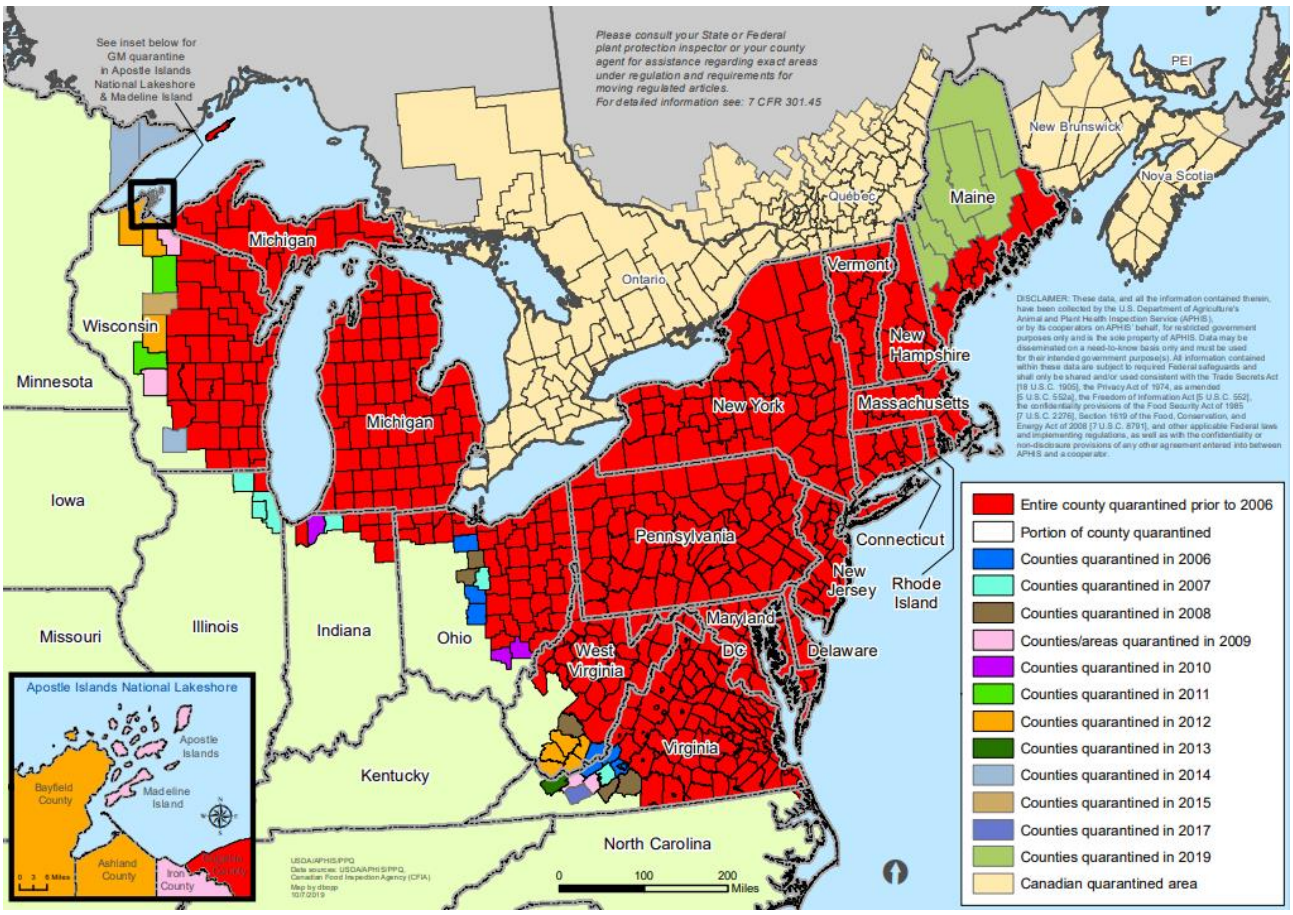

Figure 50. The distribution of gypsy moth and quarantined counties in North America as of 2019 (USDA APHIS 2019c).

Southern pine beetle

While Ohio's forests only contain a small component of pine species, there are areas with significant stands of naturally occurring or planted pine, that may be susceptible to infestation by southern pine beetle. Although southern pine beetle is native to North America, it is a major forest health concern in pine forests of the Southeastern U.S. Southern pine beetle has been documented in Ohio in low numbers and has done limited damage to pine trees here. The distribution of southern pine beetle appears to be expanding northward in recent years, making it a forest health threat of concern for Ohio.

Significant diseases and other pest organisms

Oak wilt

Oak wilt is a disease of oaks and a few other related tree species, caused by the fungal pathogen, *Bretziella fagacearum*. Transmission of oak wilt can occur aboveground through spores on sap-feeding beetles which are attracted to wounds on trees or belowground through root "grafting," whereby roots of trees of the same species grow together. Oak wilt can kill oaks in the red oak group in a single season and oaks in the white oak group in several years. Management of oak wilt requires removal of known infected trees as well as nearby buffer trees, to which the infected trees may be root-grated. Heavy equipment with vibratory plows, or herbicide application may

be effective at containing oak wilt pockets. Oak wilt has been documented throughout most of Ohio in the last few decades. Since 2017, many oak wilt infection centers have been confirmed from several eastern Ohio counties (including Carroll, Columbiana, and Tuscarawas). Several additional confirmed oak wilt pockets have been identified during this time in other parts of the state. ODNR Division of Forestry staff are working with partner agencies and landowners to manage this disease on state and private land where it is found.

Beech leaf disease

Beech leaf disease (BLD) is a relatively new issue impacting American beech (*Fagus grandifolia*) and possibly other non-native, ornamental beech species (Ewing et al. 2019). Symptoms of BLD (dark interveinal leaf striping, disfigured leathery leaves, branch dieback) were first noticed in 2012 in Lake County in northeastern Ohio. Symptoms have since been documented in 13 northeastern Ohio counties and parts of Pennsylvania, New York, Connecticut, and Ontario, Canada (Figure 51). Research and diagnostic work is ongoing regarding the causal organism of BLD, but recent findings suggest there is a link between the symptoms and the presence of a foliar nematode, *Litylenchus crenatae* (Carta et al. [submitted]). Survey and monitoring to delineate the extent of impacted areas and characterize BLD's effects on American beech and forest ecosystems are ongoing. These activities and continued investigation into potential causal agents and interactions with biotic and abiotic stressors will be key to informing management strategies.

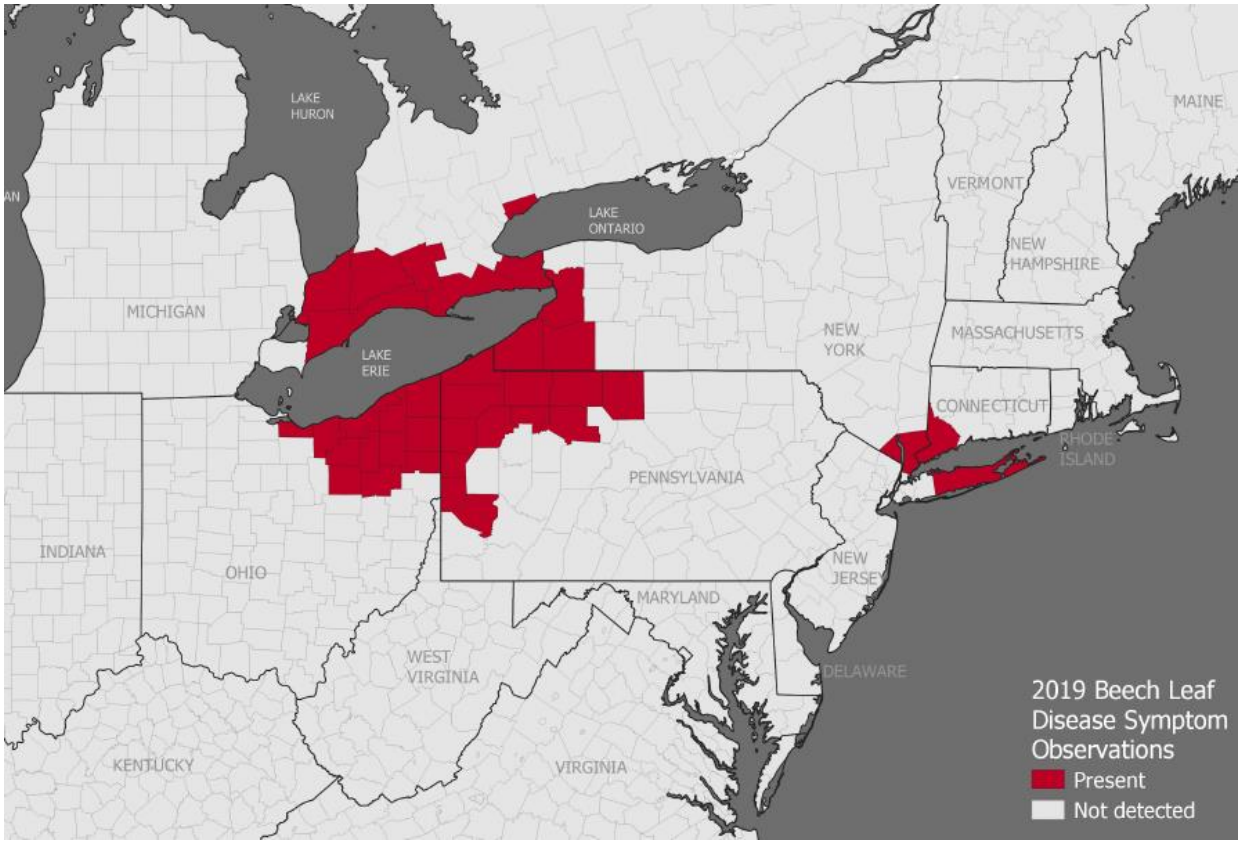

Figure 51. The distribution of BLD symptoms in North America in 2019.

Beech bark disease

Beech bark disease (BBD) is a disease complex, which requires the beech scale insect, *Cryptococcus fagisuga*, to colonize the bark of American beech trees, creating entry points for Neonectria fungi, which kill the trees over several years. BBD is generally established in New England, the northern Great Lakes states, and areas of the Central and Southern Appalachians (Figure 52). The beech scale insect has been observed in northeast Ohio since 1985 and the Neonectria fungus was discovered there in 2003. While there are areas of localized mortality of American beech in northeastern Ohio due to BBD, it has not yet caused widespread decline or mortality in Ohio.

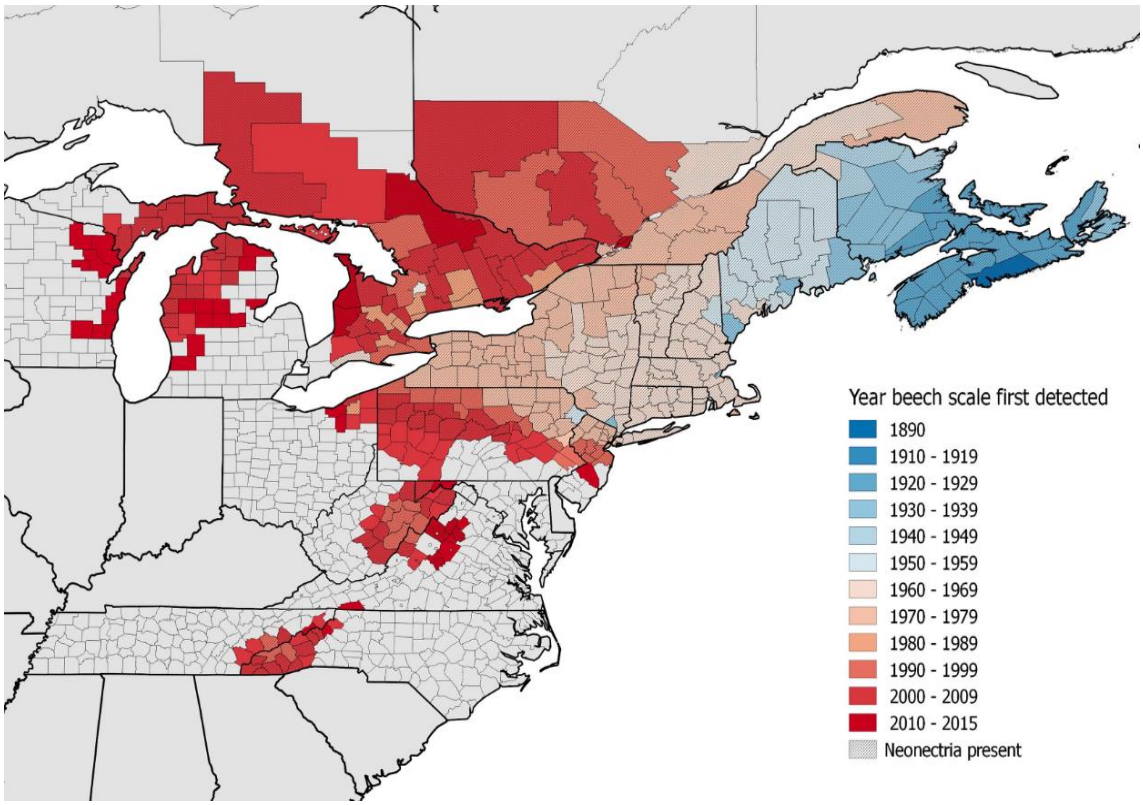

Figure 52. The distribution of BBD in North America as of 2015 (Cale et al. 2017).

White oak mortality

In the early 2000s, decline and mortality was observed in white oak (*Quercus alba*) across much of the forests of southern Ohio. Studies on this phenomenon (sometimes also referred to as "white oak decline" or "rapid white oak mortality") did not indicate a single causal agent, but rather a suite of pathogens and insect pests (Balci et al. 2010; Nagle et al. 2010). It is likely that periods of drought along with defoliation events by the half-wing geometer, common oak moth, and forest tent caterpillar caused the initial stress in white oaks, predisposing them to attack by secondary pests such as two-lined chestnut borer, Armillaria root rot, Hypoxylon canker and Phytophthora root rot. While active white oak mortality appears to have slowed since 2010, it remains a concern for Ohio's oak-dominated forests.

Thousand cankers disease

Thousand cankers disease (TCD) is a disease complex involving the walnut twig beetle (WTB) as a vector for the fungus *Geosmithia morbida* in black walnut (*Juglans nigra*). This insect and fungus are believed to be native in the southwestern U.S. and Mexico and have been introduced to several areas in the eastern U.S., including Butler County in southwest Ohio. WTB was detected there in traps monitored by the ODNR Division of Forestry in 2012 and the TCD fungus was confirmed there in 2013. The ODA enforces a quarantine on TCD regulated items in Butler County to restrict the movement of WTB or TCD out of or through infested areas.

Recent studies have shown that the Geosmithia fungus is a relatively weak plant pathogen and it may only be able to significantly damage black walnut trees already stressed due to other factors (Juzwik 2017). Additionally, cold winter temperatures may be barriers to the establishment of WTB in Ohio and other Northeastern states (Hefty 2016). While thousands of WTB were caught in traps at the Butler County site in 2012 and 2013, the number of WTB caught since 2013 is drastically reduced, with trapping by ODNR Division of Forestry and ODA catching no WTB in 2014 or 2015, and a single WTB caught in each of 2016, 2017, and 2018. This apparent crash in the WTB population could be due to multiple factors, including the colder than average winters of 2013-14 and 2014-15, and/or the fact that the declining black walnut trees in a residential yard close to the infestation site were removed as part of a study in 2014. There has also been documentation of recovery of declining black walnut trees confirmed to be infected with TCD (Griffin 2015). Considering this information, TCD is currently less of a concern than it was at the time of the discovery of WTB in Ohio in 2012, however it is still a forest health issue to monitor.

Eastern white pine decline

Decline events in eastern white pine (*Pinus strobus*) have occurred periodically over the last several decades. Beginning in 2017, another decline in eastern white pine is occurring mostly across southern and eastern Ohio. It is likely that wetter than average growing seasons over the last few years have created conditions conducive to needle fungal disease development, especially in pine plantations that have not been thinned and are overstocked. The discoloration and defoliation caused by a suite of needle pathogens (including *Lophodermium* spp. and *Lecanosticta* spp.) are commonly referred to as “white pine needle damage” (Livingston et al. 2019). In some areas, it is also likely that eastern white pine was planted in poorly-drained soils that are not optimal for eastern white pine growth and survival. In addition to the fungal needle infections, the greater than average rainfall could also lead to root rot diseases in these situations. About 1,400 acres of eastern white pine forests were affected by white pine needle damage in Ohio in 2019. Timely thinning of stands to improve the health and vigor of residual trees may be the best defense against eastern white pine decline.

Phytophthora ramorum/sudden oak death

Sudden oak death (SOD) is a disease that is causing extensive mortality of oaks and tanoaks on the west coast of the U.S. and is caused by the pathogen *Phytophthora ramorum*. *P. ramorum* can infect over 100 species of plants and while fatal to some oak and tanoak species, it commonly causes sub-lethal symptoms like leaf spots and twig dieback in other plants. This disease has been accidentally transported on nursery plants to various locations in North America. While

SOD has never been observed outside of coastal California and Oregon, and it is unclear whether the pathogen can survive climatic conditions in the eastern U.S., it remains a forest pest of concern in Ohio and is federally regulated by USDA APHIS in partnership with state agencies. In the spring of 2019, a large shipment of rhododendron and lilac plants infected with *P. ramorum* was sent to multiple retail outlets in at least 18 states, including Ohio (USDA APHIS 2019d). USDA APHIS and ODA responded to the retail outlets to remove plants from sale, but some potentially infected plants had already been sold. The ODNR Division of Forestry worked with these regulatory agencies to enhance outreach to landowners who might have purchased infected plants, urging them to make a report and properly dispose of the plant. This effort resulted in the removal of several plants from yards, including one that tested positive for *P. ramorum*. Additional surveys and monitoring for *P. ramorum* in Ohio are planned.

Chestnut blight

Chestnut blight, caused by the fungus *Cryphonectria parasitica*, has been one of the most devastating forest diseases in history in Ohio and throughout the eastern U.S. American chestnut (*Castanea dentata*) was once common in upland forests of unglaciated southern and eastern Ohio, but the arrival of chestnut blight in the early- to mid-1900s essentially eliminated it from Ohio's forests. Decades of work by the American Chestnut Foundation's (ACF) backcross breeding program has resulted in the production of hybrid chestnut seedlings that possess the genes for chestnut blight resistance, while retaining the growth form and habit of pure American chestnuts. Since the mid-2000s, multiple plantings of American chestnuts (pure and various hybrids) have been conducted on reclaimed coal-mined lands for experimental and reforestation purposes. Monitoring of these plantings is ongoing by several universities. The Ohio Chapter of the ACF was started in 2005. Approximately 5,000 American chestnut seedlings have planted on land owned by ODNR and other partner organizations since December 2015, including within six state forests, three state wildlife areas, five state parks, and five partner organization properties.

Dutch elm disease

Elm species have declined drastically in Ohio since the introduction of Dutch elm disease (DED), a fungal pathogen, in the 1930s. While young elm trees are still common in Ohio's forests, they rarely reach the size and dominance in Ohio's riparian and floodplain forests as they once did. Work by the USDA Forest Service Northern Research Station and others has identified and propagated American elms that have high levels of tolerance to DED. Some of these DED-tolerant selections are now commercially available and many are still being researched. Studies are examining their potential for out-planting into rural and urban forests for restoration purposes (Pinchot et al. 2017).

Bacterial leaf scorch

Bacterial leaf scorch (BLS) is caused by the bacterium *Xylella fastidiosa*, which infects the xylem of susceptible plants including oak, maple, elm, sycamore, mulberry, and sweetgum. BLS is transported between plants by sucking insects such as leafhoppers and treehoppers. As the disease compromises the xylem tissue, water movement into leaves is cut off, resulting in marginal leaf browning or "scorching," similar in appearance to drought stress symptoms. Symptom expression may vary slightly depending on host plant, but BLS can cause decline over several seasons and lead to tree mortality. There are no curative techniques to stop symptom

development after a tree has been infected. BLS has been documented in Ohio, mostly in urban situations, and is both an urban and rural forest concern.

Butternut canker

Butternut (*Juglans cinerea*) populations have been drastically reduced in Ohio over the last several decades due to butternut canker, a disease caused by the fungal pathogen *Ophiognomonia clavigignenti-juglandacearum*. Though butternuts are still occasionally encountered in Ohio's forests, it is possible they are not pure native butternuts, but are hybrids between butternut and Japanese walnut (*Juglans ailantifolia*). The hybrids are difficult to distinguish from the pure native butternut and have better butternut canker tolerance, imparted by the genes of Japanese walnut. Research and work on restoring butternuts to their native range are ongoing (Woeste et al. 2009).

Non-native, invasive earthworms

Recent research has linked non-native earthworms to forest health issues, including dieback in sugar maple (Bal et al. 2018). Several species of non-native earthworms are present in Ohio's forests. No formal surveys have been conducted of earthworms and their impacts on forests in Ohio, but anecdotal evidence indicates they may be impacting the leaf litter and upper soil layers, causing cascading effects on woody and herbaceous plant germination, tree regeneration, and facilitating the colonization of non-native invasive plant species in some parts of the state. Further investigation is needed to assess the effects non-native earthworms are having on Ohio's forests.

New and emerging forest health threats

Spotted lanternfly

The spotted lanternfly (SLF) is a species of planthopper native to Asia that was discovered in southeastern Pennsylvania in 2014. Additional infestations have since been found in parts of several other states including Delaware, Maryland, New Jersey, and Virginia, and West Virginia. There have also been discoveries of individual SLF in several additional Northeastern states without evidence of established infestations. This invasive insect is federally regulated by USDA APHIS in cooperation with state agencies. SLF appears to have a wide host range with over 70 plant species currently known, with studies ongoing. Grapes, hops, and some fruit trees are among known host plants, which may make this insect a significant agricultural pest in vineyards, hop farms, and orchards. It is also known to feed on many native and non-native woody plants, making it a potential forest pest. Interestingly, one preferred host appears to be the non-native invasive tree-of-heaven (*Ailanthus altissima*), especially for mating and egg-laying by adult SLF. Control of or local eradication of tree-of-heaven may be a strategy for reducing populations of, or likelihood of invasion by, SLF. Though SLF has not yet been identified in Ohio, it is a forest pest of concern known to occur in a neighboring state and monitoring and detection surveys for it will be important in the future in Ohio.

Laurel wilt

Laurel wilt is a disease complex affecting plants in the laurel family (Lauraceae), caused by the fungal pathogen *Raffaelea lauricola*, which is carried into host plants by the redbay ambrosia

beetle (*Xyleborus glabratus*), which is native to Asia. The fungus clogs the vascular system of host plants, resulting in rapid wilting and mortality. This disease complex was first identified in North America in Georgia in 2002 and has devastated redbay (*Persea borbonia*) forests in the Atlantic Coastal Plain of the Southeastern U.S. This disease has been spreading northward, and in 2019, laurel wilt was confirmed in southern Kentucky. Susceptible host plants in the laurel family, native to Ohio, include spicebush (*Lindera benzoin*) and sassafras (*Sassafras albidum*). Recent research has shown that winter temperatures will likely not be a barrier for the redbay ambrosia beetle to survive in Ohio (Formby et al. 2017). Survey and monitoring efforts for laurel wilt in Ohio are being planned.

Forest Health Initiatives

Coalition for Forest Tree Breeding

Some degree of host plant resistance or tolerance to invasive insect and disease pests exists in virtually all cases of forest pest invasions. This provides an opportunity to propagate and promote resistance and tolerance to pests and diseases in a tree breeding program, which would produce pest-resistant trees for out-planting and forest restoration. Even though demand for pest-resistant seedlings is strong, efforts to identify and screen seedlings for resistance and initiate breeding programs are largely unfunded in the eastern U.S. Funding reductions in federal and state tree breeding programs and a loss of plant genetics expertise over time has reduced the capacity for tree resistance breeding operations. Short-term (several year) grant funding sources are often unsustainable for tree breeding programs, which require long-term investment. In 2018, a proposal to form an Eastern States' Coalition for Forest Tree Breeding, originally proposed by Nelson and Koch (2017), was prepared by USDA Forest Service and various state agency forest health staff. The proposal presents a framework for sharing costs among states and increasing support of resistance breeding to respond to existing and emerging threats to eastern tree species. The proposal was presented to the Forest Health Committee of the Northeast-Midwest State Foresters Alliance (NMSFA; formerly known as the Northeastern Area Association of State Foresters) for consideration. In 2019, the NMSFA Forest Health Committee forwarded the proposal on to the NMSFA State Foresters and the Southern Group of State Foresters (SGSF) with the recommendation that NMSFA and the SGSF forward the proposal to the National Association of State Foresters Forest Science and Health Committee for consideration.

Don't Move Firewood

The Don't Move Firewood campaign is an outreach partnership managed by The Nature Conservancy and is focused on protecting North American forests from invasive insects and diseases that can be transported on or in firewood. This campaign has assisted with the creation of customized outreach materials to help raise awareness of various invasive species in Ohio.

Continental Dialogue on Non-Native Forest Insects & Diseases

The Continental Dialogue on Non-Native Forest Insects & Diseases is a group of organizations and individuals that encourages collaborative action among a wide variety of entities to address the threat of non-native insects and diseases to North American forests. This group focuses their

efforts on programs that help prevent non-native insects and diseases from arriving to the continent and minimizing the impact of those already present in North America's forests.

Invasive plants

Non-native invasive plants are a serious threat to the health and productivity of Ohio's public and private forests. Aggressive invaders like tree-of-heaven (*Ailanthus altissima*), Asian bush honeysuckles (*Lonicera* spp.), autumn-olive (*Elaeagnus umbellata*), and Japanese stiltgrass (*Microstegium vimineum*) are just a few of the invasive plants that displace native vegetation in Ohio forests. Additionally, they can negatively impact native wildlife which rely on native plant communities for food, shelter, and breeding habitat. Invasive plants often become established in forest edge areas, like roads, fields, or homesites, and they may spread into forests following disturbance events or other dispersal opportunities. Forest landscapes that are significantly fragmented tend to be more susceptible to invasive plant impacts as they have a high relative percentage of forest edge areas (and entryways for dispersal). See the Indicator 3 section for discussion on the current degree of fragmentation and parcelization in Ohio's forests. Some invasive plants are causing problems only at the local or regional scale, while others are common statewide. Table 9 provides a more comprehensive list of non-native invasive plants that are well-established in Ohio or on a watch list as potential problem species.

The Ohio Invasive Plants Council (OIPC) formed in 2005 and "is a coalition of agencies, organizations, and individuals throughout Ohio concerned about the introduction, spread, and control of invasive, non-native plants in Ohio's natural habitats. OIPC promotes public awareness of invasive species issues and encourages land management and research to detect invasive species and prevent new invasions into natural ecosystems" (OIPC 2018). The OIPC has also developed an invasive plant assessment protocol with representatives from academia, the green industry, and natural resources conservation. As of February 2019, the OIPC has assessed 74 plant species and of those, 47 were assessed as invasive and 16 are pending further review, with additional species planned to be assessed in the future.

In January of 2018, a state law enforced by the Ohio Department of Agriculture (ODA) went into effect prohibiting the sale, propagation, distribution, importation, or intentional dissemination of, invasive plants (Ohio Revised Code 2014). As of December 2019, there are 38 plant species listed. One of the listed species, Callery pear (*Pyrus calleryana*), has a five-year phase-out period due to its presence in nursery production and will be prohibited starting in January 2023. This law also established an advisory committee to recommend changes to the species list or other considerations, to the Director of the ODA.

Table 9. Non-native invasive plants present in or threatening Ohio's forests, assessed as "invasive" or "pending further review" by OIPC (2018), or included on "Ohio's Invasive Plant Species" list (ODNAP 2000). Those species also on the ODA prohibited invasive plant list are shown in bold.

Common name	Scientific name
Norway maple	*Acer platanoides*
tree-of-heaven	***Ailanthus altissima***
garlic mustard	***Alliaria petiolata***
porcelainberry	*Ampelopsis brevipedunculata*
Japanese barberry	*Berberis thunbergii*
common barberry	***Berberis vulgaris***
Asian bittersweet	***Celastrus orbiculatus***
air-potato	*Dioscorea batatas*
Russian-olive	***Elaeagnus angustifolia***
autumn-olive	***Elaeagnus umbellata***
winged euonymus or burningbush	*Euonymus alatus*
wintercreeper	*Euonymus fortunei*
glossy buckthorn	***Frangula alnus***
giant hogweed	***Heracleum mantegazzianum***
border privet	*Ligustrum obtusifolium*
common privet	*Ligustrum vulgare*
Japanese honeysuckle	***Lonicera japonica***
Amur honeysuckle	***Lonicera maackii***
Morrow's honeysuckle	***Lonicera morrowii***
Tatarian honeysuckle	***Lonicera tatarica***
moneywort	*Lysimachia nummularia*
Japanese stiltgrass or Nepalese browntop	***Microstegium vimineum***
Chinese silvergrass	*Miscanthus sinensis*
white mulberry	*Morus alba*
princesstree or royal paulownia	*Paulownia tomentosa*
Amur corktree	*Phellodendron amurense*
Japanese knotweed	*Polygonum cuspidatum*
mile-a-minute vine	*Polygonum perfoliatum*
giant knotweed	*Polygonum sachalinensis*
kudzu	***Pueraria montana* var. *lobata***
Callery pear	***Pyrus calleryana***
lesser celandine or fig buttercup	***Ranunculus ficaria***
European buckthorn or common buckthorn	***Rhamnus cathartica***
multiflora rose	***Rosa multiflora***
wineberry	*Rubus phoenicolasius*
European cranberry-bush	*Viburnum opulus* var. *opulus*
periwinkle or myrtle	*Vinca minor*
black swallow-wort	***Vincetoxicum nigrum***

Past efforts to map the distribution of invasive plants across Ohio have been generalized. The Early Detection and Distribution Mapping System (EDDMapS) is a collaboration among multiple stakeholders working to rapidly respond to new invasive populations. EDDMapS combines data from other databases and organizations as well as volunteer observations to create a national network of invasive species distribution data that is shared with educators, land managers, conservation biologists, and beyond. This network can display state and county level population details as well as provide details about unique observations and reports (Figure 53). While fine-scale mapping of the distribution of non-native invasive plants on public and private forestland across Ohio has not been achieved, efforts are underway to establish a network of weed management groups like those previously listed, to facilitate the sharing of records, to standardize protocols, and collaborate on surveys.

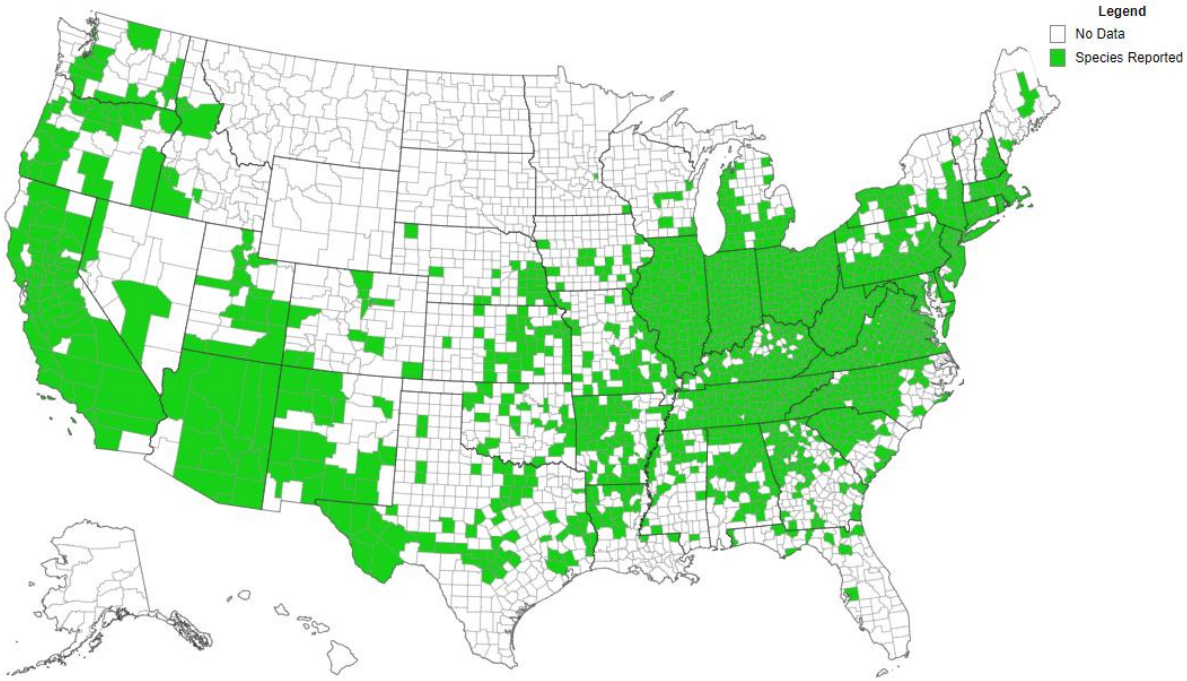

Figure 53. Example of an EDDMapS invasive species distribution map. Map shows county-level distribution of tree-of-heaven in the U.S. (EDDMapS 2018).

Recent projects involving mapping the distribution of invasive plants like tree-of-heaven, via helicopter, across parts of southeastern Ohio have been very successful. This work was conducted by ODNR, the USDA Forest Service Northern Research Station and the Wayne National Forest as part of a grant project. This technique was found to be more efficient than ground-based mapping and the resulting maps are informing invasive plant management practices on the ground (Rebbeck et al. 2015). Refinement of mapping via remote sensing techniques and unmanned aircraft systems (UAS) will help improve invasive plant mapping efforts.

Several cooperative invasive species management areas (CISMA), cooperative weed management areas (CWMA) and/or partnerships for regional invasive species management (PRISM) are operational in Ohio. These groups are based upon partnerships of federal, state, and local government agencies, individuals, and various interested groups that manage invasive

species in a defined area. In Ohio, there are currently five active efforts: Oak Openings Region CWMA, Crooked River CWMA, Lake Erie CWMA, Ohio River Valley CISMA, and the Central Ohio PRISM. The Appalachian Ohio Weed Control Partnership is a CWMA covering 16 southeastern Ohio counties, but due to lack of capacity, has been inactive since 2014. Collectively, these groups cover 50 of Ohio's 88 counties (57%) and aim to increase regional awareness of invasive plants, map invasive plant distributions, detect new invasives in early stages of invasion, and strategically control invasive plants (Figure 54).

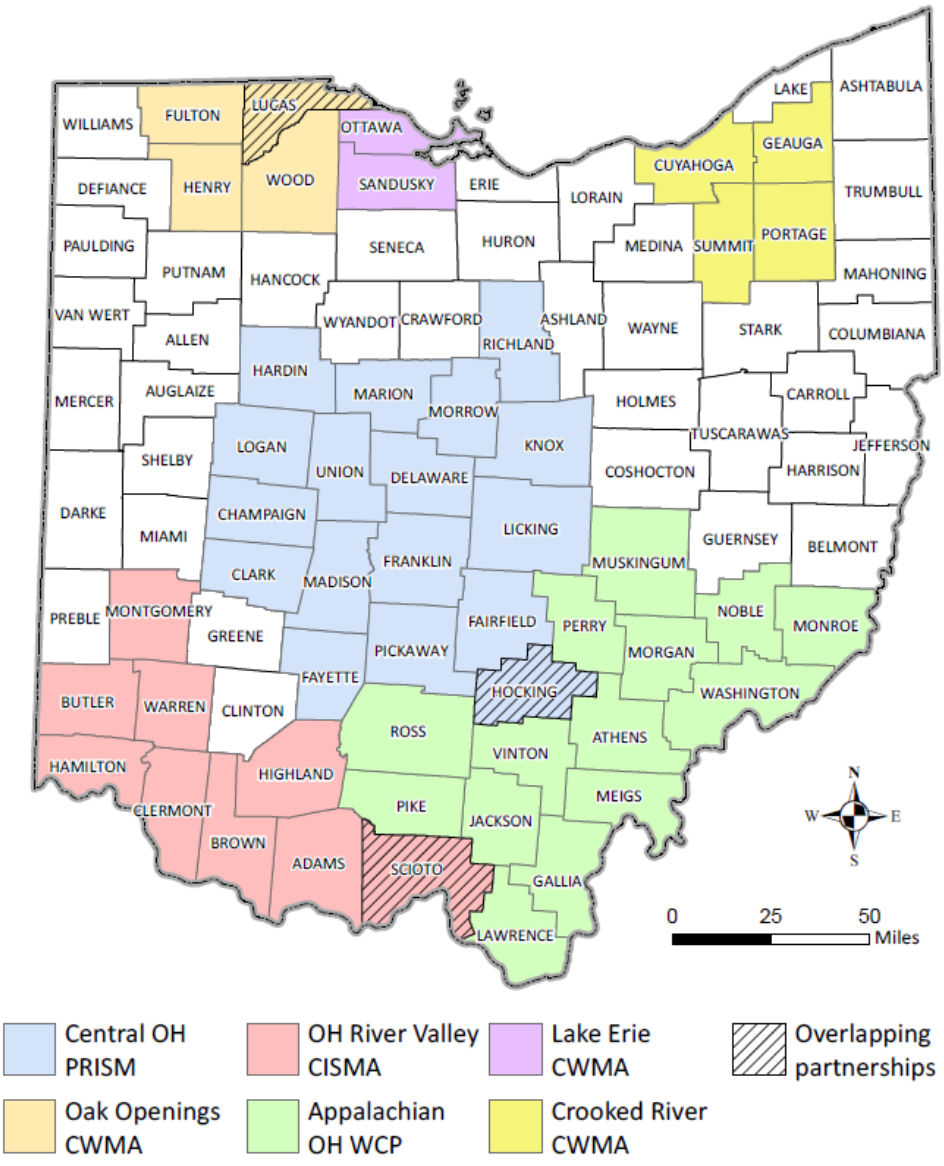

Figure 54. Map of collaborative invasive plant management efforts in Ohio.

Area and percent of forest land affected by abiotic agents

Wildfires annually affect Ohio's forests, causing some damage and mortality of trees. However, wildfires can also be beneficial to forest ecosystems and the regeneration of certain tree species (i.e., some oaks) when they occur at frequencies and intensities that were common historically

(Abrams et al. 2014; Hutchinson et al. 2012). Figure 55 shows the trend for annual fire occurrence (number of wildfires) and acres burned statewide from 2000 to 2019. Most of this data is obtained by the ODNR Division of Forestry through reports submitted by fire departments, and it is unlikely that it includes all wildfire occurrences. In 2009, the substantial increase in occurrence and acreage, with over 10,000 acres burned by 1,200 fires, resulted from dry spring conditions and a large fire in Shawnee State Forest; such spikes have typically occurred every 8 to 10 years in Ohio. Figure 56 shows the average annual occurrence and acres burned by county from 2010-2018. The counties with the most average acres burned annually are Lawrence and Scioto, averaging less than 300. Most of Ohio's wildfire activity occurs in unglaciated southeastern Ohio, particularly in the southernmost counties. Data on wildfire occurrence and acres burned is not collected by ODNR Division of Forestry outside of the wildfire protection area, which explains the lack of data from northern and western Ohio in Figure 56. Because of the recently expanded area in which wildfire statics are collected, recorded data on wildfire occurrence and acres burned will increase in future years. In Ohio, and the region, wildfires occur predominantly in the spring and the fall, when weather and vegetation conditions are most conducive to ignition and burning. Wildfires in Ohio are primarily human-caused by careless burning of debris and litter and arson.

Indigenous peoples utilized fire as a tool to promote plant communities that supported game abundance and enhanced ethnobotanically significant plants (Abrams and Nowacki 2008). According to archaeological evidence found at Archaic Period sites in Ohio, fire was being applied by Indigenous cultures as early as 8,000 years ago to propagate nut trees and reduce wildfire danger (Lepper 2005). Archaeological evidence of wild plant and animal remains from the prehistoric period indicates that more than 90% of plants were fire-adapted at 18 sites across the southern unglaciated Allegheny Plateau (Wayne National Forest 2019b).

As described by Iverson et al. (2019a), oaks persisted over a 10,000-year timespan despite climate fluctuations, with the most likely explanation being fire use by indigenous peoples. Fires set by indigenous peoples in the prehistoric timeframe was the natural fire regime that developed oak as a foundation species. Fire regimes began to shift, first with different historic tribes coming and going after major depopulation from disease, and then with Euro-American land uses and intense fires of the industrial period. However, due to extensive fire suppression policies in the early 20th century, fire no longer serves as a primary ecosystem driver in the modern landscape.

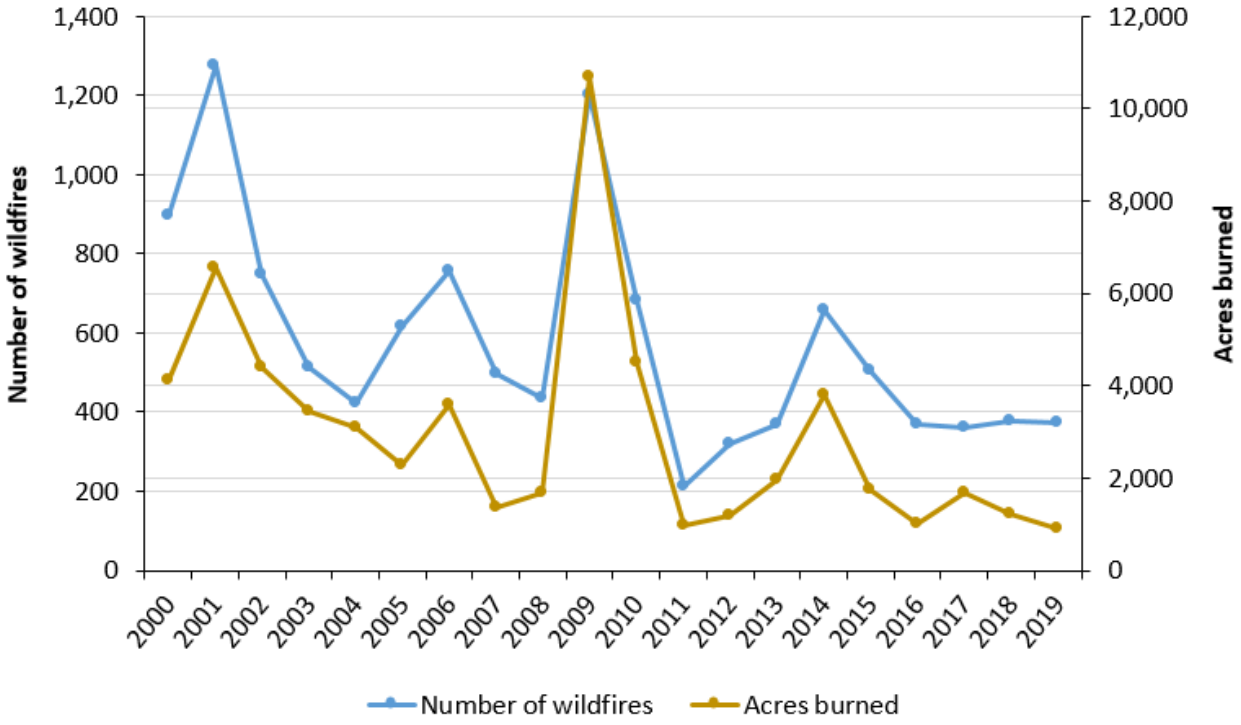

Figure 55. Annual fire occurrence (number of wildfires) and acres burned by wildfires in Ohio from 2000-2019. Data source: ODNR Division of Forestry.

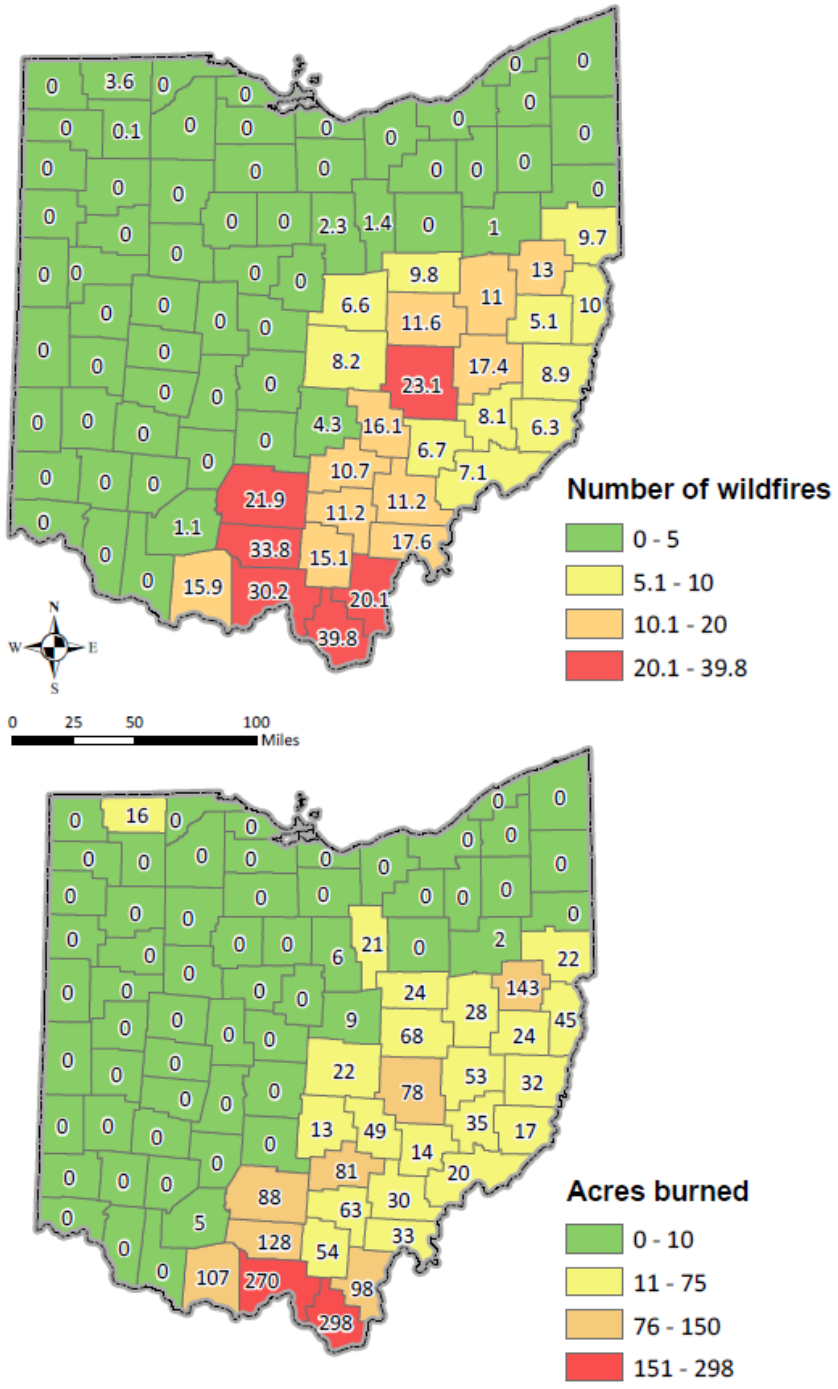

Figure 56. Average annual wildfire occurrence (top) and average acres burned (bottom) by county, 2010-2018. Data source: ODNR Division of Forestry.

Fire regime groups are based on the frequency (fire return intervals) and severity of fires that landscapes experienced prior to modern human intervention. The use of fire by indigenous peoples is considered in fire regime groups. Fire regime vegetation departure is a measure of the current departure from reference conditions. Reference conditions often consider natural fire regimes and associated vegetation from pre-settlement times (Hann et al. 2008). Figure 57

shows the current fire regime vegetation departure from reference conditions in Ohio. The majority of Ohio's forests fall within the moderate and high vegetation departure classes (33-66% and 66-100%, respectively). The few areas that have been determined to have low vegetation departure (0-33%) are located primarily in eastern Adams, southern Gallia, southern Jackson, Lawrence, and Scioto counties, where recent wildfire activity has been the greatest. Another related factor that may contribute to their low vegetation departure is the type of forest ecosystem that occurs in those counties – Allegheny-Cumberland Dry Oak Forest and Woodland, which typically occupy drier, nutrient-poor sites that might better support periodic fire because the average annual number of fire-prone days is greater.

Finer-scale data on how fire has shaped forest composition exists for the three management units of the Wayne National Forest in southeast Ohio, based on early land survey witness tree data (Iverson et al. 2019a, Wayne National Forest 2020b). These analyses show that the tree species composition in much of those areas is dominated by pyrophilic species; those considered fire-tolerant, such as oaks and hickories.

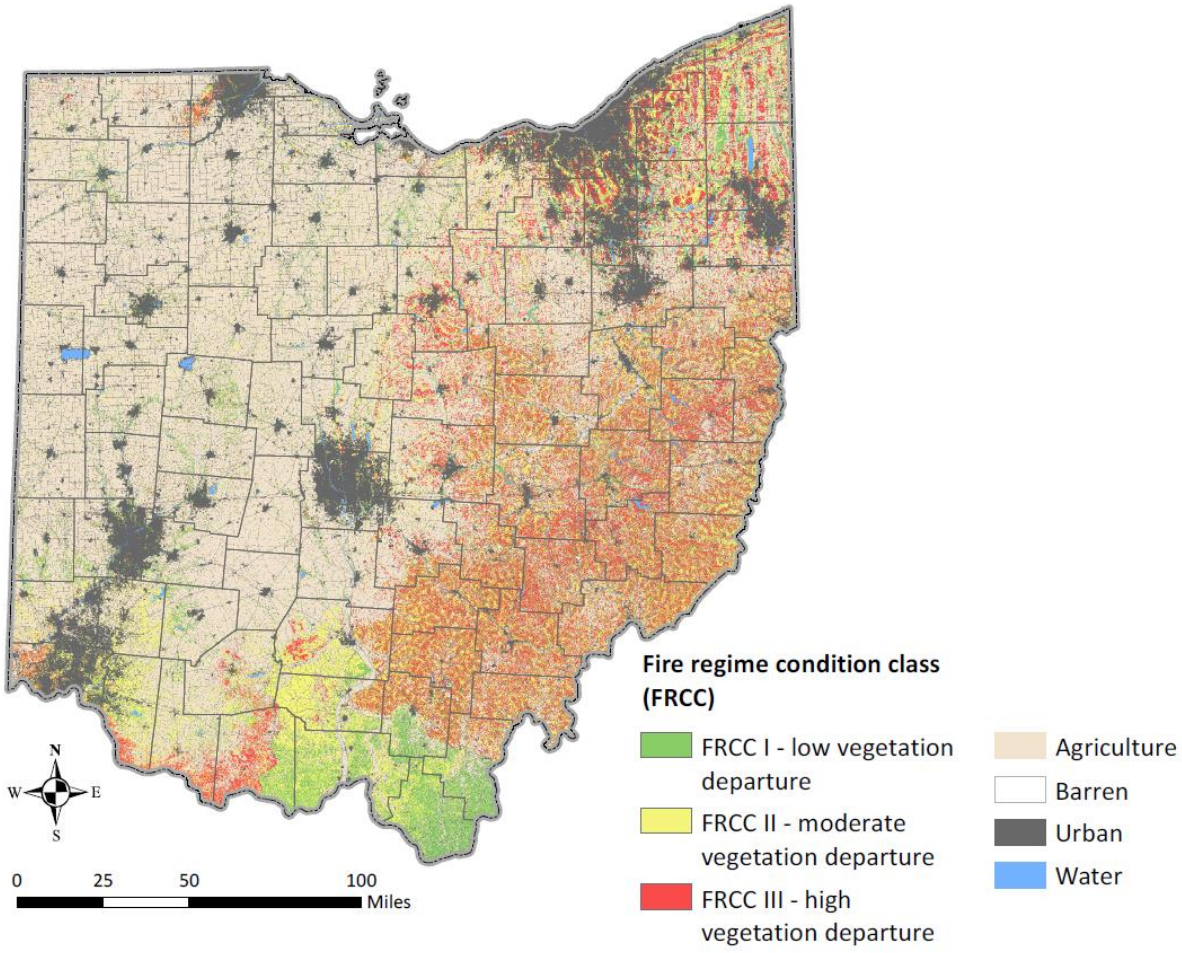

Figure 57. Fire regime condition classes and vegetation departure from reference conditions of Ohio's forests (LANDFIRE 2016b).

Another important resource to consider when evaluating the threat of wildfires in Ohio are rural fire departments. In Ohio, rural fire departments are often the first responders on the scene of wildfires within proximity of residential properties or communities (i.e., wildland-urban interface areas). These departments play an invaluable role when it comes to protecting communities from wildland fire. However, fires at the wildland urban interface present firefighters with situations for which they may be unprepared or are inadequately trained to face. Ensuring that Ohio's local, rural and volunteer fire departments are provided with sufficient training and equipment resources to suppress wildfires helps to minimize the effects of those fires at the wildland urban interface. The ODNR Division of Forestry conducts periodic surveys of Ohio's rural fire service to assess needs and steer wildfire program support opportunities to meet the demands of this constituency. Surveys have been conducted in 1984, 1994, 2003, and most recently in 2018. In the 2018 exercise, rural fire departments in Ohio were surveyed to determine their training, funding, and equipment needs and capabilities. The survey found that rural fire departments rated wildland fire as one of the top three emergency situations impacting them. Some specific needs of fire departments include basic and advanced wildland firefighting training, search and rescue training, pump operations and maintenance, safety and personal protective equipment (PPE), and additional wildland firefighting equipment (particularly bunker gear, pumper trucks, and communication equipment).

During a normal year, Ohio gets abundant precipitation distributed throughout the year. The two driest periods of the year are January/February and October (Table 10). Some geographic variation in precipitation exists across Ohio. In general, the southern and northeast portions of the state receive greater annual precipitation while the northwest part of the state receives the least (ODNR 2011; Figure 58). Average annual precipitation increased in some areas of Ohio between the 1931-1980 average and 1981-2010 average (Figure 59). From January 2010 to January 2019 in Ohio, the mean value of the Palmer Modified Drought Index value (PMDI), which measures the duration and intensity of long-term drought, was 1.52, indicating generally moist conditions (NOAA 2020; Figure 60). Short-term wet or dry spells are common in Ohio, but droughts occur on average twice per decade (ODNR 2011). During droughts, Ohio's forests experience increased fire hazard, decreased growth during prolonged drought periods, failure of new tree plantings, and increased susceptibility to insect and disease problems.

Table 10. Average monthly statewide precipitation (in inches) for Columbus, Ohio from 1981 to 2010 (NOAA 2011).

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
2.53"	1.97"	2.99"	3.42"	4.41"	4.49"	4.37"	3.39"	2.92"	2.5"	3.18"	2.81"	38.98"

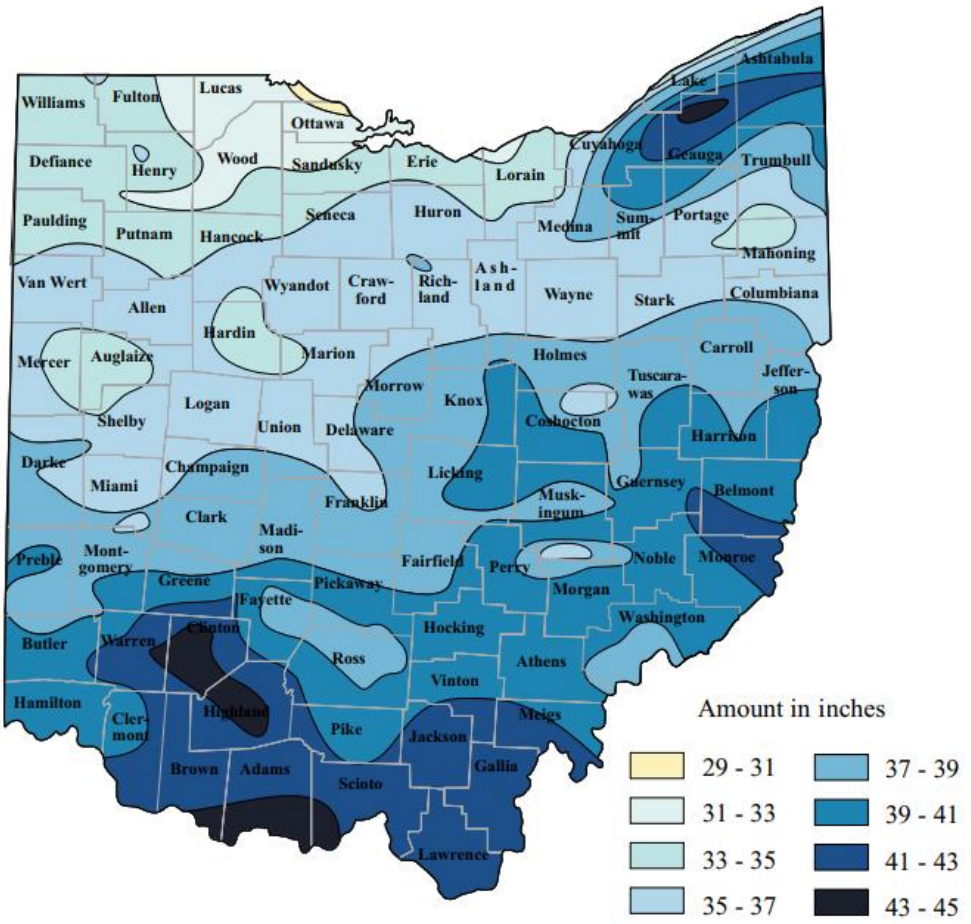

Figure 58. Statewide map of average annual precipitation in Ohio from 1931-1980 (ODNR 2011).

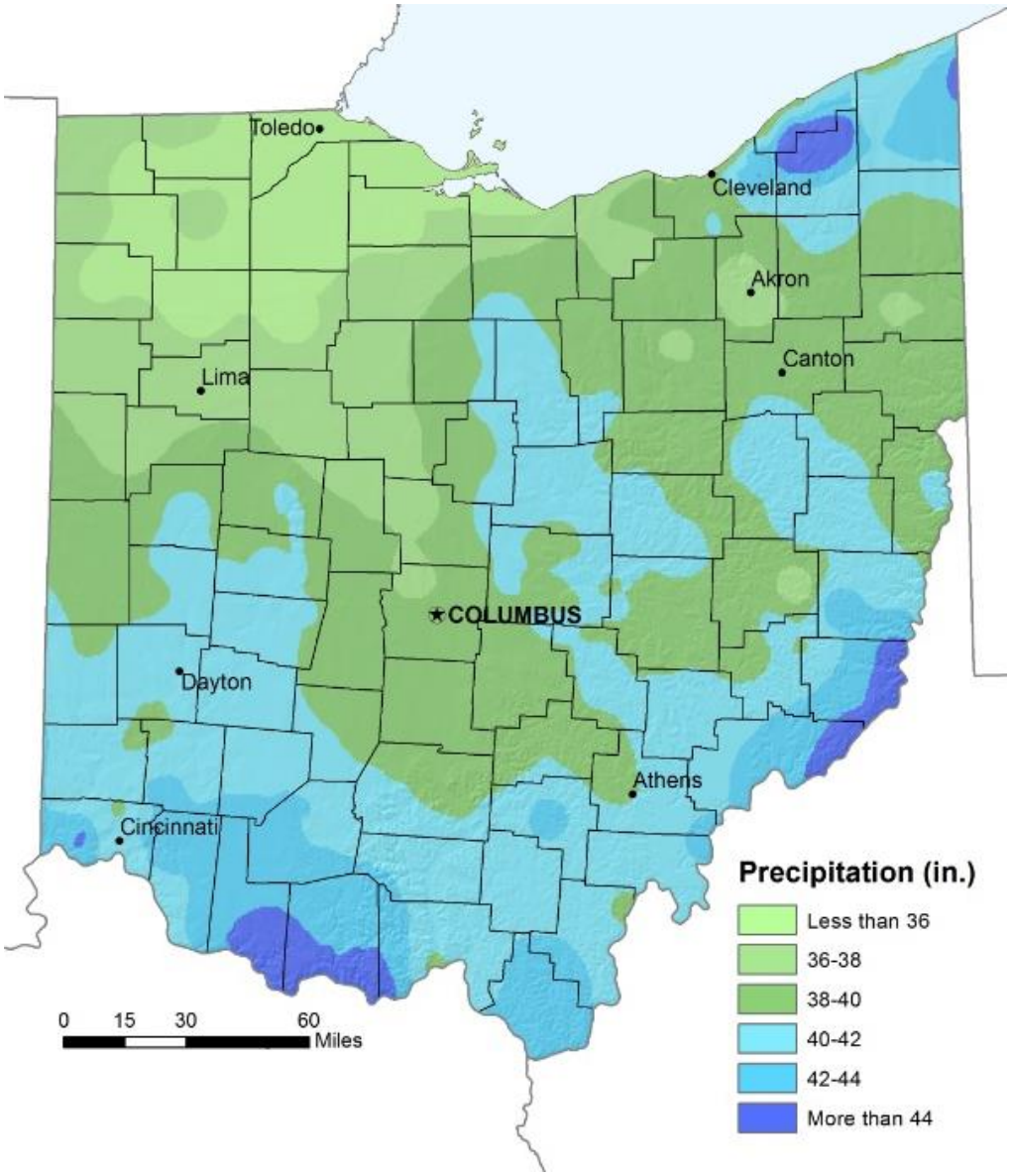

Figure 59. Statewide map of average annual precipitation in Ohio from 1981-2010 (PRISM Climate Group 2014).

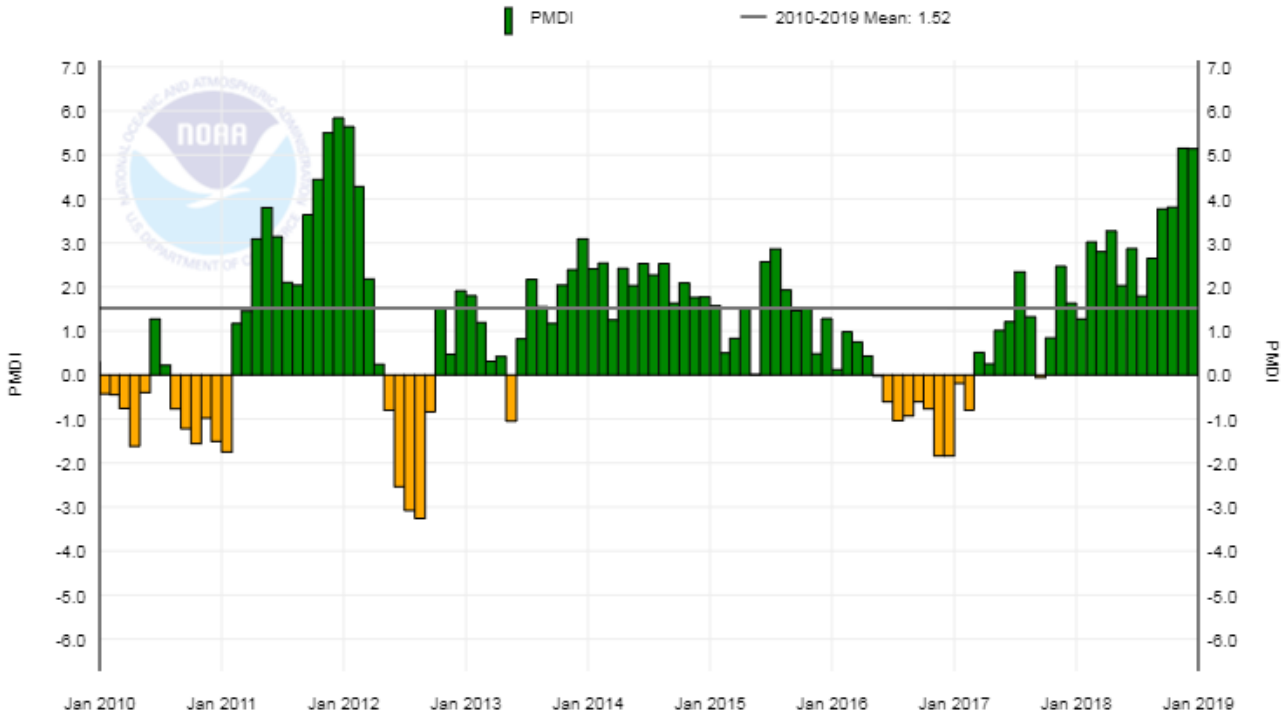

Figure 60. Monthly Palmer Modified Drought Index (PMDI) in Ohio from January 2010 to January 2019. Positive values of the PMDI indicate moist conditions, and negative values indicate drought conditions (NOAA 2020).

Climate change

Forest ecosystems across the Central Appalachians will be affected directly and indirectly by a changing climate over the 21st century (Butler et al. 2015). At the global and national level, the data show a significant trend in warming over the last few decades (Figure 61) and impacts from this change are already being observed (Wuebbles 2017). In Ohio, a warming trend is also evident (Figure 62), and temperature is projected to continue warming throughout the 21st century, in all seasons (Butler et al. 2015). Precipitation in Ohio is projected to increase slightly (~5%), however and changes to soil moisture resulting from altered precipitation is expected to be offset by increases in evaporative demand from higher temperatures. Extreme events are difficult to model, but Ohio has experienced a significant increase in the number of extreme (and damaging) rain events in recent decades, and models project more frequent intense rain events in the future (Frankson et al. 2017). At the same time, the potential for intense physiological drought is also projected to increase, due to higher temperatures coupled with longer durations between storm events especially in late summer (Butler et al. 2015; Frankson et al. 2017). The specific impacts of those changes on flora and fauna will depend on many factors, including past management, habitat quality, and the ability of organism to tolerate disturbances. As such, climate change must be considered when planning current and future management of forests in the state. Understanding potential impacts is an important first step to sustaining healthy forests in the face of changing conditions. An assessment evaluating the vulnerability of forest ecosystems in the Central Appalachians of Ohio, West Virginia, and Maryland was completed for a range of future climates (Butler et al., 2015) and several components of that document are summarized

below. Generally, the changing climate tends to intensify the stressors that may already exist for many species and increases susceptibility to drought, pests, diseases, or competition from other species (Butler et al. 2015).

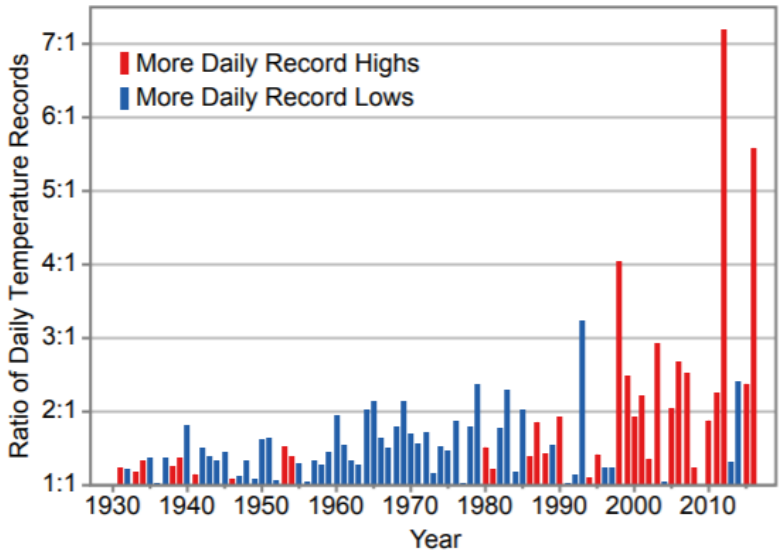

Figure 61. Observed changes in the occurrence of record-setting daily temperatures in the contiguous United States. Red bars indicate a year with more daily record highs than daily record lows, while blue bars indicate a year with more record lows than highs. The height of the bar indicates the ratio of record highs to lows (red) or of record lows to highs (blue) (Wuebbles et al. 2017).

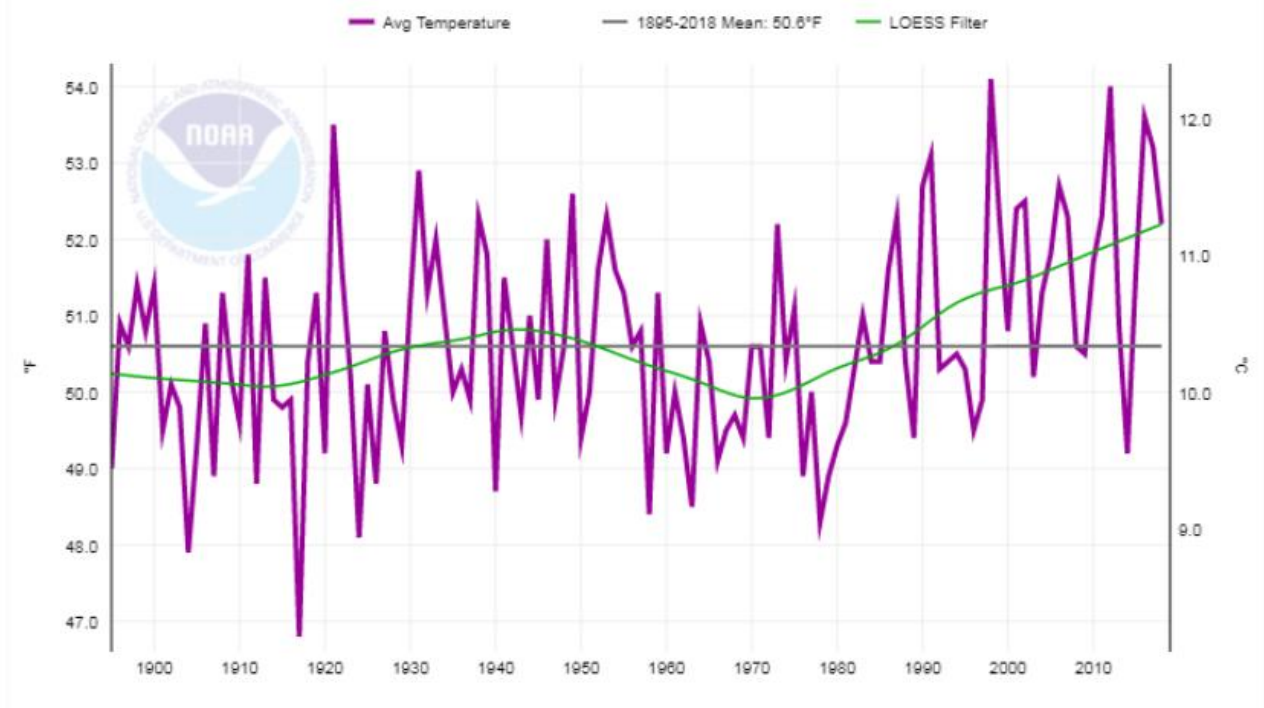

Figure 62. Annual average temperature for Ohio from 1895-2018 presented as the departure from the long-term average temperature (NOAA 2020).

Ecosystem responses (vulnerabilities)

Nine forest ecosystems were assessed in the Central Appalachians Vulnerability Assessment (Butler et al. 2015) and assessments of five of the forest ecosystem types most prevalent in Ohio are summarized below.

The dry oak and oak/pine forest and woodland ecosystem was rated low vulnerability to climate change. This ecosystem is the most resilient to heat and drought, with many of the species currently doing well, and projected to do well under future climate. Periodic conditions that limit regeneration may be buffered by oak's ability to resprout. Increased drought and fire are likely to benefit this ecosystem, discourage invasive species, and maintain an open structure that promotes oak and pine regeneration. Many of the common species in this ecosystem are projected to remain relatively stable in total volume, but volume is expected to shift from many smaller trees in younger age classes to fewer larger trees in older age classes unless active management, such as prescribed fire, is used to stimulate regeneration.

The dry/mesic oak forest ecosystem was also rated as low vulnerability to climate change. This ecosystem supports a high number of tree species and occurs over a wide range of habitats. Many species are tolerant of dry soil conditions and fire, although young regeneration may be sensitive to severe drought and fire. Model results project common tree species will do well throughout the next century, with southern oak and hickory species likely to benefit from projected changes in climate. A history of fire suppression and timber harvesting has facilitated a shift to more mesic conditions, favoring the associated hardwood species (i.e., sugar maple, American beech, yellow-poplar). Increased fire frequency could help regenerate oak species and restore the understory composition. However, very frequent, or uncontrolled fires have the potential to kill young seedlings of any species, even those species that have relatively fire-resistant, thick bark when mature. Further, wildfires have the potential to cause major damage to forest ecosystems, human-made structures, and threaten human health and safety. Prescribed fires can be carefully applied by experienced burn managers to obtain management goals without the inherent risks that come with uncontrolled wildfires and is the preferred option over the expectation that wildfires will enhance oak regeneration.

The large stream floodplain and riparian forest ecosystem was rated high vulnerability to climate change. Climate change is expected to alter the water regimes in riparian systems, and may amplify the effects of drought, insect pests, invasive species, and pollution. Dependence on periodic inundation, combined with competition from invasive species, may result in a reduced ability of native tree species to tolerate increased disturbances. Models project these species to fare poorly under future climate conditions. Many riparian species in this ecosystem have shallow root systems and are especially threatened by potentially drier soil conditions; forests located along river corridors may be buffered from water deficit better than those located farther away on the floodplain but will be more exposed to flooding effects. This ecosystem is extremely altered by habitat destruction, fragmentation, and disconnection of floodplain forests from rivers and streams by roads or other infrastructure that impedes the flow of water. The high number of invasive species outcompeting natives has already reduced the adaptive capacity of this ecosystem, and mortality of ash species from emerald ash borer is likely to essentially eliminate these species by mid-century, reducing overall native species diversity.

The mixed mesophytic and cove forest ecosystem was rated moderately vulnerable to climate change. This ecosystem currently has high species diversity, and its sheltered position on concave slopes in complex topography may buffer it against climate changes. The ability of coves to collect water and nutrients from upslope areas and their protected positions may benefit species by creating refugia from temperature increases, precipitation changes, and wind. However, models project potential declines for these tree species due to changes in temperature and precipitation, and several of these species are also susceptible to stresses resulting from indirect impacts of climate change, such as moisture stress, beech bark disease, mortality from hemlock woolly adelgid, and others. In the mountains, species may be able to migrate upwards more easily than northwards to escape warming temperatures. Emerald ash borer infestations have already damaged and killed many ash trees. This forest ecosystem has also been diminished by fragmentation and conversion to agriculture, coal mining, and logging. Especially in southeastern Ohio, most of the remaining forest blocks occur in a highly fragmented mosaic of second-growth forests that are likely to have relatively low biodiversity.

The north-central interior beech/maple forest ecosystem was rated moderately vulnerable to climate change. This ecosystem supports relatively high species diversity. Its position on moist soils and lake-effect precipitation over portions of the ecosystem helps maintain soil moisture, which buffers against drought and discourages conditions that promote wildfire. However, these benefits decrease with increasing distance from Lake Erie. Although model results project sugar maple and American beech to decline, many other species in this ecosystem are projected to do well under a range of future climates. Many of the dominant tree species are not tolerant of drought or fire. Drought-stressed trees may be more susceptible to invasives or disease complexes, resulting in decreased productivity or increased mortality. An increase in wildfire could promote a transition to more fire-adapted species (i.e., oaks), changing the identity of this ecosystem. Heavy deer browsing is also limiting seedling establishment and growth, and protection from herbivory will be critical in establishing regeneration, now and under future climate conditions.

Invasive plants, insect pests, and pathogens

Evidence indicates that an increase in temperature and more frequent natural disturbances will lead to increases in invasive plant species, insect pests, and pathogens. Many invasive plant and animal species that currently threaten Ohio forests are expected to benefit directly from projected climate change or simply outcompete slower responding native species. Increases in carbon dioxide can increase plant productivity, and warmer temperatures may allow some invasive plant species to expand their ranges northward, such as Asian bush honeysuckles, privet, kudzu, and cogongrass (Ziska 2003). Once established, invasive plant species can also limit regeneration of native tree species through increased competition or allelopathic defenses (Gorchov and Trisel 2003). Invasive species such as tree-of-heaven and Asian bush honeysuckles may exude a toxin that discourages the growth of other plants and have been shown to impair forest productivity (Hartman and McCarthy 2007; Knapp and Canham 2000). Increases in riparian flooding are expected to contribute to more frequent disturbance, and therefore increased impacts from invasive species. Pests and pathogens are generally more damaging in drought-stressed ecosystems, so there is high potential for these agents to interact with other climate-mediated stressors. For example, susceptibility of trees to sudden oak death (caused by the

water mold *Phytophthora ramorum*) is linked to periods of drought stress. Warmer conditions have been linked to an increased number of generations for emerald ash borer and range expansion for hemlock woolly adelgid (DeSantis et al. 2013; Venette and Abrahamson 2010; Wei et al. 2007), and outbreaks of native pest species (i.e., forest tent caterpillar and spruce budworm), are observed more often when trees are stressed by factors such as drought (Babin-Fenske and Anand 2011; Gray 2008).

Drought stress and mortality

There is evidence for an increased risk of future drought stress in Ohio, largely due to increasing temperatures and a resulting increase in evapotranspiration (Asbjornsen et al. 2019; Matthews et al. 2018). Moisture stress is likely to occur when increases in evapotranspiration are not offset by a corresponding increase in precipitation. Additionally, precipitation is more likely to occur during larger precipitation events, which may increase the interval between rainfall events (Diffenbaugh et al. 2005). Models project a change in seasonality of the precipitation as well, with wetter springs and early summer accompanied by very dry later summers and early fall. Drought stress later in the year is particularly hard on newly establishing germinants.

The potential effects of drought on forests will depend upon a number of factors, including drought duration and severity, as well as site-level characteristics of the forest. High stand density may compound susceptibility to moisture stress because high-density stands face increased competition for available moisture (Keyser and Brown 2014; Olano and Palmer 2003). Additionally, drought-stressed trees are typically more vulnerable to insect pests and diseases (Dukes et al. 2009).

Wildfire

Wildfire was historically an important driver for some forest ecosystems in Ohio, although it has been largely suppressed since 1923 (Hutchinson et al. 2008). The conditions responsible for wildfire behavior are the result of land use, weather, topography, and fuels (Moritz et al. 2012). Climate can directly affect the frequency, size, and severity of fires, and indirectly affect fire regimes through effects on vegetation vigor, structure, and composition (Moritz et al. 2012; Sommers et al. 2011). A study by Tang et al. (2015) suggests a future increase in the number of days with a high Haines Index (a fire weather index that has been employed to operationally detect atmospheric conditions favorable for large and erratic fire behavior). One study calculated the potential probability of fire occurring in various future climates using the Physical Chemistry Fire Frequency Model (PC2FM). When climate data from the Coupled General Circulation Model 3.1T47 (CGCM) was applied to the PC2FM, fire probability was estimated to increase by 40 to 60 percent across southern Ohio and by 60 to 80 percent in northern Ohio (Guyette et al. 2014; Figure 63). However, the authors point out that many non-climate factors can be greater influences on fire occurrence than climate, including human ignitions, fire suppression, and road access.

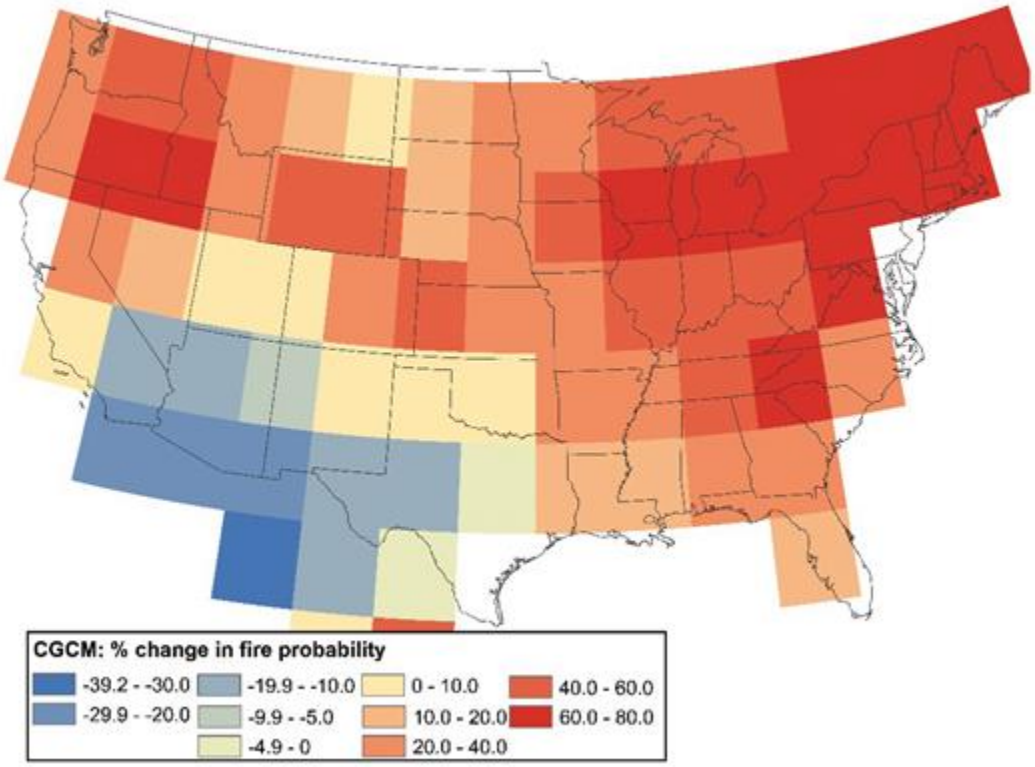

Figure 63. Coarse-scale mapping of climate-driven changes in the probability of fire occurrence in the U.S. based on CGCM 3.1 T47 model scenario (Guyette et al. 2014).

Authors of a review paper on climate and wildfire conclude that fire-related impacts may be more important to some ecosystems than the direct effects of climate change on species fitness and migration because fire can drive more rapid change than would be expected from only the changes in temperature and moisture availability (Sommers at al. 2011).

Invasive species may also interact with climate to increase the frequency, intensity, or length of the fire season (Brooks and Lusk 2008). Invasive shrubs and herbs may increase the density of the understory, thereby increasing fuel. On the other hand, many invasive shrubs (especially Asian bush honeysuckles) and herbs begin growing earlier in spring than native plants. This early green-up may reduce the flammability of fire-adapted communities during the spring fire season (Brooks and Lusk 2008). Invasive pests can also interact with climate and wildfire by altering forest fuels and forest structure (Ehrenfeld 2010; Krist et al. 2007; Lovett et al. 2006; Szlavecz et al. 2010).

Some potential impacts of local and regional climate change on Ohio's forest include (from Pryor et al. 2014; Butler et al. 2015; Reidmiller 2018):

- Shift in plant hardiness zones (Figure 64) leads to northern expansion of species from the southern U.S., including non-native invasive plants. Tables 11-15 show the modeled potential of tree species in Ohio in the future as a result of climate change. For additional species-specific climate change scenarios, see the *Climate Change Tree Atlas* (Prasad et al. 2014).

- Increase in stressors on forests, including insect outbreaks, expansion of invasive plants, more storm events and weather extremes (i.e., summer droughts), and decreased air quality.
- Increases in carbon dioxide and nitrogen, leading to a potential for increased forest productivity, although some or all of these gains may be negated by other negative impacts like the preceding stressors.
- The timing of activities, including prescribed fire, tree planting, recreation, or timber removal may need to be shifted as temperatures and precipitation patterns change.
- Projected temperature increases will continue the current trend of longer growing seasons in Central Appalachian forest types (Matthews et al. 2018).

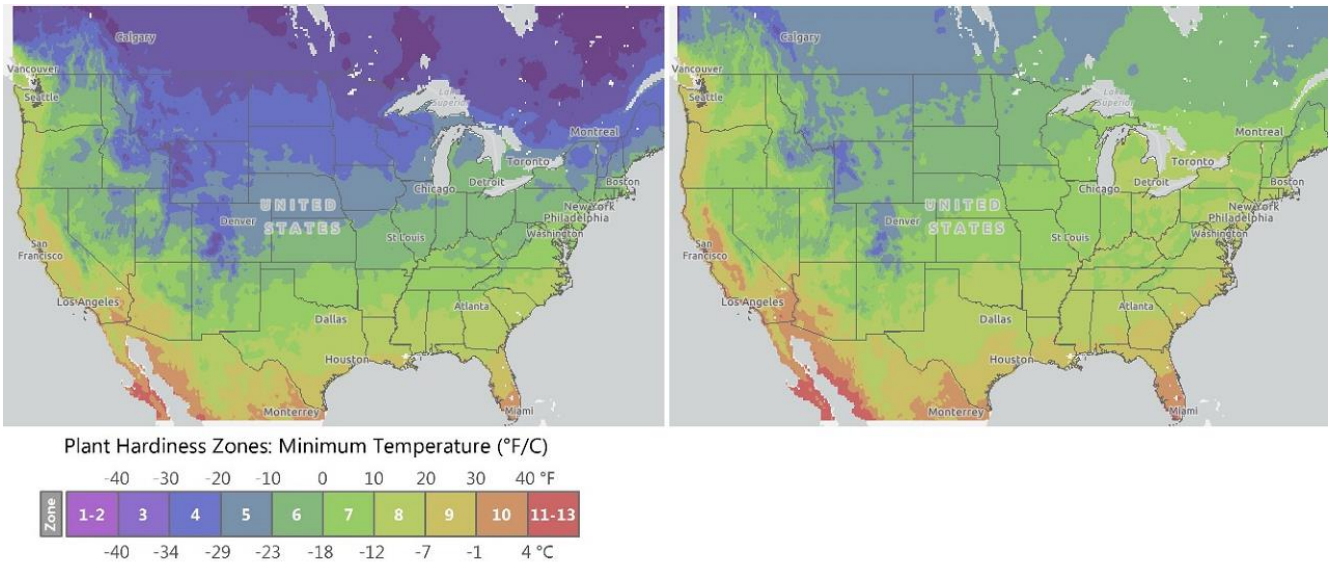

Figure 64. The map on the left shows the historical plant hardiness zones (1980-2010) and the map on the right shows projected future plant hardiness zones (2070 to 2099) (Matthews et al. 2018). Maps available at: https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=96088b1c086a4b39b3a75d0fd97a4c40.

Tree species responses

Tree species' responses to future climate changes will be driven by local conditions, and responses can vary among species and even individuals of the same species. Models have been generated by the Landscape Change Research Group of the Northern Institute of Applied Climate Science which provide potential futures for tree species throughout the eastern U.S. (www.nrs.fs.fed.us/atlas). Potential tree species' responses to two climate emission scenarios at the end of the century are presented below for the tree species from 1 x 1° areas representing the four corners of Ohio: northwest (bounded by 41° latitude on the south and 84° longitude on east, S41_E84); northeast (S41_E81); southeast (S39_E82); and southwest (S39_E84) (Figure 65). The Climate Change Tree Atlas modeled potential changes in suitable habitat for 66 (northwest Ohio) to 81 (southeast Ohio) species. Tables for each of the nine 1 x 1° areas that encompass Ohio (or anywhere in the eastern U.S.) are available at https://www.fs.fed.us/nrs/atlas/combined/resources/summaries/ (Iverson et al. 2019c). Each

table presents a picture of species importance within the region (FIAsum, a value of decreasing species importance based on basal area, tree density, and areal coverage within the 1 x 1° block); the potential for the habitat suitability to increase, decrease or remain the same under lower emissions (Representative Concentration Pathway, RCP 4.5) or higher emissions (RCP 8.5) (ChngCl45 or ChngCl85, based on ratios of future potential FIAsum to current FIAsum); the adaptability of the species to the expected climatic changes (Adap, scored as low, medium, or high); the capability of the species to cope with the expected climatic changes based on its current abundance, adaptability, and change classes under RCP 4.5 and RCP 8.5); the model reliability (color coded as low (pink), medium (orange), high (green) under SSO column; and a grading of model results suggesting species selection options regarding planting or otherwise encouraging (SSO, where 1 indicates the species is currently present and has at least a fair capability to cope, 2 indicates the species is rare or close to the edge of its distribution and has a good chance of spreading into the area, and 0 indicates further evaluation may be required, unless it is a non-native invasive species (NNIS).

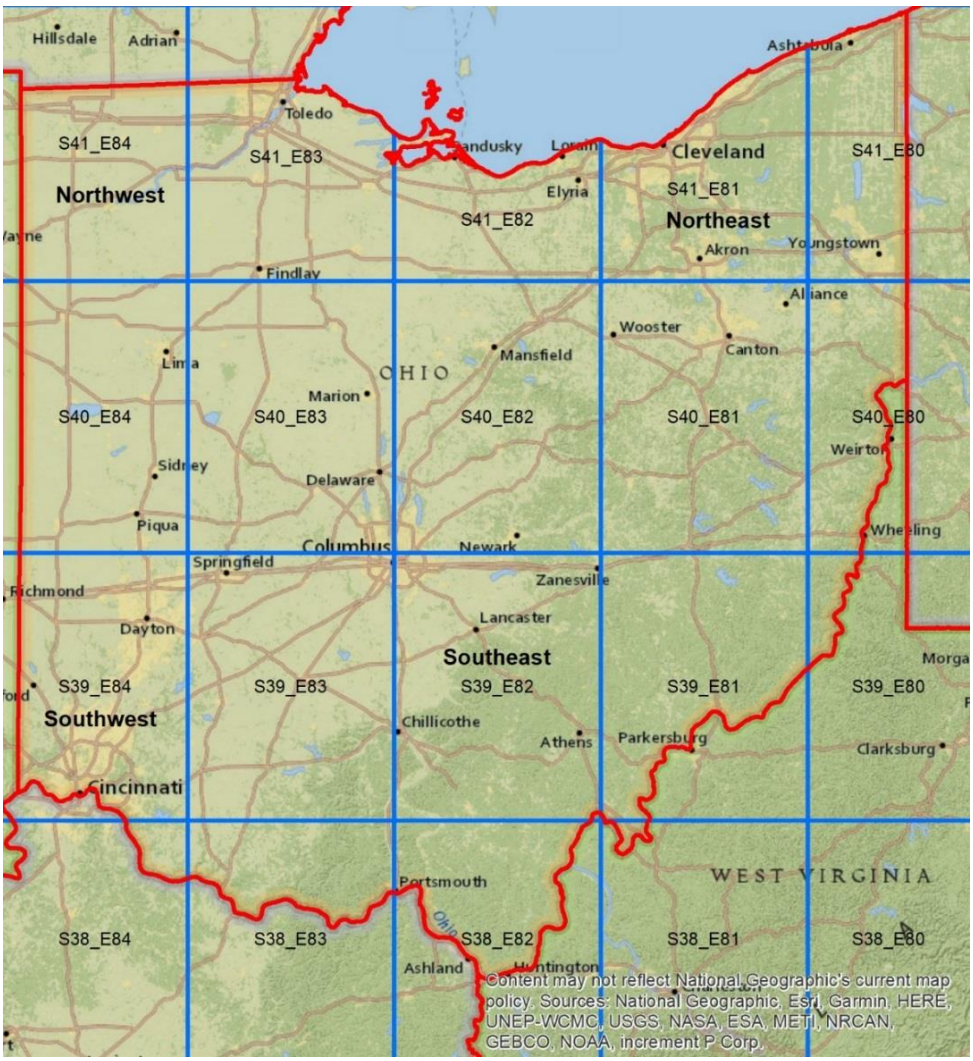

Figure 65. Map showing the four 1 x 1° blocks (northwest, northeast, southeast, southwest) used in this analysis of tree species presence and potential future changes. Each block is named by the southern latitude and eastern longitude, so that any GPS or mapping tool will enable discernment of which block is used.

Also presented for each of the four 1 x 1° blocks is a list of species that could be considered for proactive, assisted migration while considering the potential future climate under RCP 8.5 (Table 15) along with the model reliability (MR) and adaptability (Adap) of the species. These are species with models projecting habitat moving into the area, and with at least a small potential for the species to arrive there naturally within 100 years, according to the SHIFT model (Iverson et al. 2019c; Prasad et al. 2016).

In the northwest, American elm is the highest-ranking species, though with a fairly low FIAsum (322) because of low forest cover, and clustered together in importance with shagbark hickory, American basswood, black cherry, red maple, green ash, and sugar maple (Table 11). None of them are expected to thrive well in future climates, with change classes of either no change or decreasing. Because of high adaptability, the maples will be fair to good in capability to cope. Other species with potential to increase are white oak, northern red oak, black oak, silver maple,

boxelder, and bitternut hickory. Species currently uncommon with potential to expand include hackberry, bur oak, eastern cottonwood, sassafras, sycamore, yellow-poplar, and eastern redcedar. Potential species that could migrate into the area, and would likely be the most successful species if used in assisted migration, include six species, comprised of three oaks, redbud, persimmon, and blackgum (Table 15)

In the northeast, red maple is by far the dominant species (FIAsum=1325, indicating nearly twice the prominence over the second rank species sugar maple (FIAsum=738) (Table 12). Because the importance is calculated based equally on tree density and basal area, the species with many small stems, like red maple, are often highly ranked, and it also emphasizes issues with the transition from oak-dominated to maple-dominated forests in Ohio and beyond (Iverson et al. 2019a, b). Despite being ranked as species with decreasing habitat, these two maples are expected to do well in the future, with high adaptability and good capability to cope with the changing climate. Several other species common in the 1 x 1° area, with fair to good capability to cope with the changing climate include black cherry, American elm, yellow-poplar, and northern red oak. Green and white ash are also listed but the models do not adequately account for emerald ash borer, nor is Dutch elm disease for American elm. Species with potential to increase include white oak, silver maple, blackgum, sassafras, black locust, boxelder, Osage-orange, black walnut, and black oak. This 1 x 1° block has the largest pool of potential species for assisted migration, with a dozen species, most already located in southeastern Ohio (Table 15). These include four oaks (Shumard, post, shingle, and southern red), loblolly and shortleaf pine, redbud, persimmon, honeylocust, eastern redcedar, red mulberry, and winged elm.

The southeast block has the highest species richness, with 70 species recorded by FIA plots (Table 13). Sugar maple (FIAsum=831), yellow-poplar (FIAsum=782), and red maple (FIAsum=734) lead the way, but 20 other species are quite common, with FIAsum>100. Of those 20 species, five are oaks and four are hickories. Twelve of the 23 top species are modeled to have a good capability to cope with the changing climate, including three oaks, two hickories, yellow-poplar, and the two maples. Species modeled to increase in importance include blackgum, boxelder, hackberry, loblolly pine, redbud, honeylocust, persimmon, sweetgum, eastern redcedar, post oak, and red mulberry. Seven species are modeled to be potentials for assisted migration, including three oaks (water, blackjack, and southern red), shortleaf pine, and sugarberry (Table 15).

The southwest block also has high species richness, with 60 species located by FIA and another two species modeled as likely present (Table 14). Here, white ash is the current leader (FIAsum=692) as of when the FIA plots were measured (2007-2012), although its presence is declining due to emerald ash borer. Sugar maple was also prominent (FIAsum=533), with another 14 species with FIAsum>100. Interestingly, only one hickory (bitternut) and no oaks made this list of top 16 species, although most Ohio oaks and hickories did occur farther down the list. Here, those common species rated good or better for capability to cope included sugar maple, Osage-orange, American elm (if Dutch elm disease-tolerant selection), hackberry, eastern redcedar, bitternut hickory, boxelder, honeylocust, and sycamore. Uncommon species modeled to increase in importance include white oak, pignut and mockernut hickory, eastern hophornbeam, sweetgum, and sugarberry. Species modeled as potential species for assisted

migration include four oaks (post, water, blackjack, southern red) and two pines (shortleaf, loblolly) (Table 15).

Model results should be interpreted carefully and used only as general guidelines for management. As is the case for interpreting any spatial model outputs, local knowledge of soils, landforms, and other factors is necessary to determine if particular sites may indeed be suitable habitat for a given species in the future. The modeled outputs are based on coarse data, and primarily indicate broad trends. Models are unable to include every threat and interaction that may cause a species to do better or worse than predicted, and threats may change over time. Ongoing agents, such as emerald ash borer and Dutch elm disease, will continue to wreak havoc on current species. Invasive plants, pests, and pathogens are expected to increase or become more damaging, especially when trees are stressed by other disturbances, heat, or drought. A warming climate is allowing some invasive plant species, insect pests, and pathogens to survive farther north than they have previously. Threats such as the southern pine beetle, oak decline, and many invasive species such as tree-of-heaven and Asian bush honeysuckles may increase in the future. Introductions of non-native species from other ecosystems are expected to occur on an ongoing basis and currently unknown threats will likely arise in the future.

Table 11. Current and modeled future potential of tree species within the northwest region of Ohio (Iverson et al. 2019c). See text for explanation of columns.

Common name	Scientific name	FIAsum	ChngCl45	ChngCl85	Adap	Capab45	Capab85	SSO
American elm	*Ulmus americana*	322	NC	NC	Medium	Fair	Fair	1
shagbark hickory	*Carya ovata*	306.88	Sm. dec.	Lg. dec.	Medium	Poor	Poor	0
American basswood	*Tilia americana*	302.83	Lg. dec.	Lg. dec.	Medium	Poor	Poor	0
black cherry	*Prunus serotina*	265.97	NC	Sm. dec.	Low	Poor	Poor	0
red maple	*Acer rubrum*	261.38	Sm. dec.	Sm. dec.	High	Fair	Fair	1
green ash	*Fraxinus pennsylvanica*	258.37	NC	NC	Medium	Fair	Fair	1
sugar maple	*Acer saccharum*	237.05	NC	Sm. dec.	High	Good	Fair	1
black walnut	*Juglans nigra*	180.56	NC	NC	Medium	Fair	Fair	1
eastern white pine	*Pinus strobus*	156.95	Lg. dec.	Lg. dec.	Low	V. poor	V. poor	0
white ash	*Fraxinus americana*	139.96	Sm. inc.	Sm. inc.	Low	Fair	Fair	1
white oak	*Quercus alba*	135.57	Sm. inc.	NC	High	V. good	Good	1
northern red oak	*Quercus rubra*	113.81	Sm. inc.	NC	High	V. good	Good	1
black oak	*Quercus velutina*	104.09	Sm. inc.	Sm. inc.	Medium	Good	Good	1
silver maple	*Acer saccharinum*	86.16	Lg. inc.	Sm. inc.	High	V. good	V. good	1
boxelder	*Acer negundo*	61.8	Sm. inc.	Sm. inc.	High	V. good	V. good	1
bitternut hickory	*Carya cordiformis*	59.73	Sm. inc.	Sm. inc.	High	V. good	V. good	1
scarlet oak	*Quercus coccinea*	58.95	Lg. dec.	Lg. dec.	Medium	Poor	Poor	0
Scotch pine	*Pinus sylvestris*	53.49	Unknown	Unknown	NA	NNIS	NNIS	0
swamp white oak	*Quercus bicolor*	50.46	NC	NC	Medium	Fair	Fair	2
hackberry	*Celtis occidentalis*	46.7	Lg. inc.	Lg. inc.	High	Good	Good	2
eastern hophornbeam	*Ostrya virginiana*	45.1	Sm. dec.	Lg. dec.	High	Poor	Poor	1
bur oak	*Quercus macrocarpa*	44.15	Sm. inc.	Sm. inc.	High	Good	Good	2
slippery elm	*Ulmus rubra*	42.78	NC	Sm. inc.	Medium	Poor	Fair	1
Norway spruce	*Picea abies*	33.11	Unknown	Unknown	NA	NNIS	NNIS	0
white mulberry	*Morus alba*	28.73	Unknown	Unknown	NA	NNIS	NNIS	0
eastern cottonwood	*Populus deltoides*	28.59	Lg. inc.	Lg. inc.	Medium	Good	Good	2
American beech	*Fagus grandifolia*	27.78	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	2
bigtooth aspen	*Populus grandidentata*	25.05	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	0
pignut hickory	*Carya glabra*	21.14	Lg. inc.	Sm. inc.	Medium	Good	Fair	2
pin oak	*Quercus palustris*	20.53	Lg. inc.	Lg. inc.	Low	Fair	Fair	2
honeylocust	*Gleditsia triacanthos*	15.38	Lg. inc.	Lg. inc.	High	Good	Good	2
Ohio buckeye	*Aesculus glabra*	14.83	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	0
yellow birch	*Betula alleghaniensis*	13.7	Sm. dec.	Sm. dec.	Medium	V. poor	V. poor	0
blue ash	*Fraxinus quadrangulata*	12.37	Sm. dec.	Sm. dec.	Low	V. poor	V. poor	0
quaking aspen	*Populus tremuloides*	11.99	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	0
sassafras	*Sassafras albidum*	10.85	Lg. inc.	Lg. inc.	Medium	Good	Good	1
black locust	*Robinia pseudoacacia*	9.81	Sm. inc.	Lg. inc.	Medium	Fair	Good	2
black ash	*Fraxinus nigra*	9.63	Lg. dec.	Lg. dec.	Low	V. poor	V. poor	0
winged elm	*Ulmus alata*	9.49	NC	Lg. inc.	Medium	Poor	Good	2
black willow	*Salix nigra*	8.77	Sm. dec.	NC	Low	V. poor	V. poor	2
sycamore	*Platanus occidentalis*	8.68	Lg. inc.	Lg. inc.	Medium	Good	Good	2
yellow-poplar	*Liriodendron tulipifera*	8.23	Lg. inc.	Lg. inc.	High	Good	Good	1
American hornbeam	*Carpinus caroliniana*	7.21	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	0
Osage-orange	*Maclura pomifera*	6.1	Sm. inc.	Lg. inc.	High	Good	Good	2
chokecherry	*Prunus virginiana*	5.93	Unknown	Unknown	Medium	FIA Only	FIA Only	0
northern pin oak	*Quercus ellipsoidalis*	5.39	Lg. dec.	V. lg. dec.	High	Poor	Lost	0
red pine	*Pinus resinosa*	3.8	Lg. dec.	Lg. dec.	Low	V. poor	V. poor	0
ailanthus	*Ailanthus altissima*	3.29	Unknown	Unknown	NA	NNIS	NNIS	0
flowering dogwood	*Cornus florida*	3.28	Sm. dec.	Lg. dec.	Medium	V. poor	V. poor	2
mockernut hickory	*Carya alba*	2.67	NC	Sm. inc.	High	Fair	Good	2
eastern redcedar	*Juniperus virginiana*	2.53	Lg. inc.	Lg. inc.	Medium	Good	Good	2
chinkapin oak	*Quercus muehlenbergii*	2.38	NC	NC	Medium	Poor	Poor	2

Table 12. Current and modeled future potential of tree species within the northeast region of Ohio (Iverson et al. 2019c). See text for explanation of columns.

Common name	Scientific name	FIAsum	ChngCl45	ChngCl85		Adap	Capab45	Capab85	SSO
red maple	*Acer rubrum*	1325.38	Lg. dec.	Lg. dec.		High	Good	Good	1
sugar maple	*Acer saccharum*	737.55	NC	Sm. dec.		High	V. good	Good	1
black cherry	*Prunus serotina*	568.53	Sm. dec.	Sm. dec.		Low	Fair	Fair	0
green ash	*Fraxinus pennsylvanica*	428.73	NC	NC		Medium	Fair	Fair	1
American elm	*Ulmus americana*	419.96	NC	Sm. inc.		Medium	Fair	Good	1
yellow-poplar	*Liriodendron tulipifera*	396.93	NC	Sm. dec.		High	Good	Fair	1
white ash	*Fraxinus americana*	368.07	Sm. inc.	Sm. inc.		Low	Fair	Fair	1
northern red oak	*Quercus rubra*	358.87	NC	Sm. dec.		High	Good	Fair	1
American beech	*Fagus grandifolia*	346.8	Sm. dec.	Lg. dec.		Medium	Poor	Poor	0
shagbark hickory	*Carya ovata*	208.9	NC	NC		Medium	Fair	Fair	1
bitternut hickory	*Carya cordiformis*	198.06	NC	NC		High	Good	Good	1
pin oak	*Quercus palustris*	163.27	NC	NC		Low	Poor	Poor	0
American basswood	*Tilia americana*	148.32	Sm. dec.	Sm. dec.		Medium	Poor	Poor	0
white oak	*Quercus alba*	141.25	Lg. inc.	Lg. inc.		High	V. good	V. good	1
silver maple	*Acer saccharinum*	115.85	Sm. inc.	Sm. inc.		High	V. good	V. good	1
sycamore	*Platanus occidentalis*	109.68	NC	NC		Medium	Fair	Fair	1
eastern white pine	*Pinus strobus*	108.94	Lg. dec.	Lg. dec.		Low	V. poor	V. poor	0
eastern cottonwood	*Populus deltoides*	101.43	Sm. dec.	Sm. dec.		Medium	Poor	Poor	0
Norway spruce	*Picea abies*	92.95	Unknown	Unknown		NA	NNIS	NNIS	0
blackgum	*Nyssa sylvatica*	67.07	NC	Sm. inc.		High	Good	V. good	1
ailanthus	*Ailanthus altissima*	61.15	Unknown	Unknown		NA	NNIS	NNIS	0
swamp white oak	*Quercus bicolor*	56.31	Sm. dec.	Lg. dec.		Medium	Poor	Poor	0
sassafras	*Sassafras albidum*	56.13	Lg. inc.	Sm. inc.		Medium	V. good	Good	1
black locust	*Robinia pseudoacacia*	54.43	Lg. inc.	Lg. inc.		Medium	V. good	V. good	1
boxelder	*Acer negundo*	53.82	NC	NC		High	Good	Good	1
black willow	*Salix nigra*	49.28	Sm. dec.	NC		Low	V. poor	V. poor	0
bigtooth aspen	*Populus grandidentata*	47.97	Lg. dec.	Lg. dec.		Medium	V. poor	V. poor	0
eastern hophornbeam	*Ostrya virginiana*	44.96	Sm. inc.	Sm. inc.		High	Good	Good	1
Osage-orange	*Maclura pomifera*	42.96	NC	NC		High	Fair	Fair	2
Scotch pine	*Pinus sylvestris*	35.94	Unknown	Unknown		NA	NNIS	NNIS	0
slippery elm	*Ulmus rubra*	34.91	NC	Sm. inc.		Medium	Poor	Fair	1
black walnut	*Juglans nigra*	33.8	Lg. inc.	Lg. inc.		Medium	Good	Good	1
black oak	*Quercus velutina*	29.08	Lg. inc.	Lg. inc.		Medium	Good	Good	2
bur oak	*Quercus macrocarpa*	22.52	Sm. dec.	Lg. dec.		High	Poor	Poor	0
cucumbertree	*Magnolia acuminata*	21.92	Sm. dec.	Sm. dec.		Medium	V. poor	V. poor	0
American hornbeam	*Carpinus caroliniana*	17.36	Lg. dec.	Lg. dec.		Medium	V. poor	V. poor	0
yellow birch	*Betula alleghaniensis*	16.93	Lg. dec.	Lg. dec.		Medium	V. poor	V. poor	0
quaking aspen	*Populus tremuloides*	16.29	Lg. dec.	Lg. dec.		Medium	V. poor	V. poor	0
chokecherry	*Prunus virginiana*	12.94	Unknown	Unknown		Medium	FIA only	FIA only	0
pignut hickory	*Carya glabra*	11.85	Sm. inc.	Sm. inc.		Medium	Fair	Fair	2
eastern hemlock	*Tsuga canadensis*	11.21	Lg. dec.	V. lg. dec.		Low	V. poor	Lost	0
serviceberry	*Amelanchier spp.*	6.81	Lg. dec.	Lg. dec.		Medium	V. poor	V. poor	0
flowering dogwood	*Cornus florida*	5.26	V. lg. dec.	V. lg. dec.		Medium	Lost	Lost	0
chinkapin oak	*Quercus muehlenbergii*	4.96	Lg. inc.	Lg. inc.		Medium	Good	Good	2
black maple	*Acer nigrum*	4.45	Lg. dec.	V. lg. dec.		High	Poor	Lost	0
swamp chestnut oak	*Quercus michauxii*	2.69	Sm. dec.	Lg. dec.		Medium	V. poor	V. poor	0
black ash	*Fraxinus nigra*	2.29	V. lg. dec.	V. lg. dec.		Low	Lost	Lost	0
sweetgum	*Liquidambar styraciflua*	1.31	Lg. inc.	Lg. inc.		Medium	Good	Good	2
scarlet oak	*Quercus coccinea*	0.18	Sm. inc.	Sm. inc.		Medium	Fair	Fair	2

Table 13. Current and modeled future potential of tree species within the southeast region of Ohio (Iverson et al. 2019c). See text for explanation of columns.

Common name	Scientific name	FIAsum	ChngCl45	ChngCl85	Adap	Capab45	Capab85	SSO
sugar maple	*Acer saccharum*	830.74	Sm. dec.	Sm. dec.	High	Good	Good	1
yellow-poplar	*Liriodendron tulipifera*	781.75	Lg. dec.	Lg. dec.	High	Good	Good	1
red maple	*Acer rubrum*	733.97	Lg. dec.	Lg. dec.	High	Good	Good	1
white oak	*Quercus alba*	450.87	Sm. inc.	NC	High	V. good	Good	1
black cherry	*Prunus serotina*	372.81	Sm. dec.	Sm. dec.	Low	Poor	Poor	0
white ash	*Fraxinus americana*	332.39	NC	NC	Low	Poor	Poor	0
shagbark hickory	*Carya ovata*	280.44	Sm. dec.	Lg. dec.	Medium	Poor	Poor	0
black oak	*Quercus velutina*	275.08	Sm. inc.	Sm. inc.	Medium	Good	Good	1
sassafras	*Sassafras albidum*	246.27	Sm. dec.	Sm. dec.	Medium	Poor	Poor	0
chestnut oak	*Quercus prinus*	233.6	Lg. dec.	Lg. dec.	High	Fair	Fair	1
black locust	*Robinia pseudoacacia*	228.67	Lg. dec.	NC	Medium	Poor	Fair	1
American elm	*Ulmus americana*	218.68	NC	Sm. inc.	Medium	Fair	Good	1
American beech	*Fagus grandifolia*	215.28	Sm. dec.	Lg. dec.	Medium	Poor	Poor	0
northern red oak	*Quercus rubra*	194.21	NC	NC	High	Good	Good	1
bigtooth aspen	*Populus grandidentata*	183.08	V. lg. dec.	V. lg. dec.	Medium	Lost	Lost	0
pignut hickory	*Carya glabra*	169.05	Sm. inc.	NC	Medium	Good	Fair	1
mockernut hickory	*Carya alba*	149.94	Sm. inc.	Sm. inc.	High	V. good	V. good	1
slippery elm	*Ulmus rubra*	138.16	NC	NC	Medium	Fair	Fair	1
sycamore	*Platanus occidentalis*	131.54	Sm. inc.	Sm. inc.	Medium	Good	Good	1
bitternut hickory	*Carya cordiformis*	127.96	NC	Sm. inc.	High	Good	V. good	1
black walnut	*Juglans nigra*	115.9	Sm. inc.	Sm. inc.	Medium	Good	Good	1
yellow buckeye	*Aesculus flava*	111.93	Lg. dec.	Lg. dec.	Low	V. poor	V. poor	0
scarlet oak	*Quercus coccinea*	101.83	NC	Sm. dec.	Medium	Fair	Poor	1
boxelder	*Acer negundo*	96.96	NC	Sm. inc.	High	Good	V. good	1
Virginia pine	*Pinus virginiana*	91.63	NC	Sm. dec.	Medium	Fair	Poor	1
sourwood	*Oxydendrum arboreum*	89.98	Lg. dec.	Lg. dec.	High	Fair	Fair	1
blackgum	*Nyssa sylvatica*	88.27	Sm. inc.	Lg. inc.	High	V. good	V. good	1
silver maple	*Acer saccharinum*	63.9	Sm. dec.	NC	High	Fair	Good	1
river birch	*Betula nigra*	61.48	Lg. dec.	Sm. dec.	Medium	V. poor	V. poor	0
eastern white pine	*Pinus strobus*	58.34	V. lg. dec.	V. lg. dec.	Low	Lost	Lost	0
flowering dogwood	*Cornus florida*	50.1	Sm. inc.	Sm. inc.	Medium	Good	Good	1
ailanthus	*Ailanthus altissima*	41.46	Unknown	Unknown	NA	NNIS	NNIS	0
eastern hemlock	*Tsuga canadensis*	37.04	Lg. dec.	V. lg. dec.	Low	V. poor	Lost	0
American hornbeam	*Carpinus caroliniana*	34.15	Lg. dec.	NC	Medium	V. poor	Poor	1
sweet birch	*Betula lenta*	29.06	Lg. dec.	Lg. dec.	Low	V. poor	V. poor	0
pitch pine	*Pinus rigida*	27.67	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	0
hackberry	*Celtis occidentalis*	26.24	Lg. inc.	Lg. inc.	High	Good	Good	1
loblolly pine	*Pinus taeda*	25.06	NC	Lg. inc.	Medium	Poor	Good	2
American basswood	*Tilia americana*	24.87	Lg. dec.	V. lg. dec.	Medium	V. poor	Lost	0
eastern redbud	*Cercis canadensis*	24.61	Sm. inc.	Lg. inc.	Medium	Fair	Good	1
honeylocust	*Gleditsia triacanthos*	23.59	Sm. dec.	Lg. inc.	High	Poor	Good	1
green ash	*Fraxinus pennsylvanica*	22.66	Lg. inc.	Lg. inc.	Medium	Good	Good	1
Ohio buckeye	*Aesculus glabra*	22.41	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	0
black willow	*Salix nigra*	22	Sm. dec.	NC	Low	V. poor	V. poor	0
eastern hophornbeam	*Ostrya virginiana*	20.86	Lg. dec.	Sm. inc.	High	Poor	Good	1
pawpaw	*Asimina triloba*	20.14	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	0
red pine	*Pinus resinosa*	17.21	Lg. dec.	Lg. dec.	Low	V. poor	V. poor	0
common persimmon	*Diospyros virginiana*	15.84	NC	Lg. inc.	High	Fair	Good	1
chinkapin oak	*Quercus muehlenbergii*	14.71	NC	NC	Medium	Poor	Poor	2
shingle oak	*Quercus imbricaria*	13.33	Sm. dec.	Sm. dec.	Medium	V. poor	V. poor	0
Osage-orange	*Maclura pomifera*	12.65	NC	Lg. inc.	High	Fair	Good	1
eastern cottonwood	*Populus deltoides*	12.43	NC	NC	Medium	Poor	Poor	2
shellbark hickory	*Carya laciniosa*	10.73	Sm. dec.	Sm. dec.	Medium	V. poor	V. poor	0
Scotch pine	*Pinus sylvestris*	8.97	Unknown	Unknown	NA	NNIS	NNIS	0
Norway spruce	*Picea abies*	7.78	Unknown	Unknown	NA	NNIS	NNIS	0
sweetgum	*Liquidambar styraciflua*	7.73	Lg. inc.	Lg. inc.	Medium	Good	Good	1

Common name	Scientific name	FIAsum	ChngCl45	ChngCl85	Adap	Capab45	Capab85	SSO
quaking aspen	*Populus tremuloides*	7.35	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	0
black maple	*Acer nigrum*	5.71	Lg. dec.	V. lg. dec.	High	Poor	Lost	0
pin oak	*Quercus palustris*	4.71	NC	NC	Low	V. poor	V. poor	2
serviceberry	*Amelanchier spp.*	4.41	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	0
eastern redcedar	*Juniperus virginiana*	3.19	Lg. inc.	Lg. inc.	Medium	Good	Good	2
cucumbertree	*Magnolia acuminata*	2.88	Sm. dec.	Sm. dec.	Medium	V. poor	V. poor	0
butternut	*Juglans cinerea*	1.7	Unknown	Unknown	Low	FIA Only	FIA Only	0
chokecherry	*Prunus virginiana*	1.5	Unknown	Unknown	Medium	FIA Only	FIA Only	0
post oak	*Quercus stellata*	1.43	Lg. inc.	Lg. inc.	High	Good	Good	2
northern catalpa	*Catalpa speciosa*	1.07	Unknown	Unknown	Medium	FIA Only	FIA Only	0
white mulberry	*Morus alba*	1.04	Unknown	Unknown	NA	NNIS	NNIS	0
red spruce	*Picea rubens*	0.89	Sm. dec.	Sm. dec.	Low	V. poor	V. poor	0
red mulberry	*Morus rubra*	0.68	V. lg. dec.	Lg. inc.	Medium	Lost	Good	2
bur oak	*Quercus macrocarpa*	0.52	Lg. dec.	NC	High	Poor	Fair	2

Table 14. Current and modeled future potential of tree species within the southwest region of Ohio (Iverson et al. 2019c). See text for explanation of columns.

Common name	Scientific name	FIAsum	ChngCl45	ChngCl85	Adap	Capab45	Capab85	SSO
white ash	*Fraxinus americana*	692.1	Sm. dec.	Sm. dec.	Low	Fair	Fair	0
sugar maple	*Acer saccharum*	533.26	Sm. dec.	Sm. dec.	High	Good	Good	1
black walnut	*Juglans nigra*	254.58	NC	NC	Medium	Fair	Fair	1
Osage-orange	*Maclura pomifera*	249.27	NC	NC	High	Good	Good	1
black locust	*Robinia pseudoacacia*	241.39	Sm. dec.	NC	Medium	Poor	Fair	1
American elm	*Ulmus americana*	237.55	Sm. inc.	Sm. inc.	Medium	Good	Good	1
black cherry	*Prunus serotina*	202.01	NC	Sm. dec.	Low	Poor	Poor	0
hackberry	*Celtis occidentalis*	194.98	Sm. inc.	Sm. inc.	High	V. good	V. good	1
eastern redcedar	*Juniperus virginiana*	194.4	Lg. inc.	Lg. inc.	Medium	V. good	V. good	1
red maple	*Acer rubrum*	167.41	Sm. dec.	Sm. dec.	High	Fair	Fair	1
bitternut hickory	*Carya cordiformis*	146.68	Sm. inc.	NC	High	V. good	Good	1
slippery elm	*Ulmus rubra*	137.19	NC	NC	Medium	Fair	Fair	1
boxelder	*Acer negundo*	131.25	Sm. inc.	Sm. inc.	High	V. good	V. good	1
honeylocust	*Gleditsia triacanthos*	120.36	NC	Sm. inc.	High	Good	V. good	1
sycamore	*Platanus occidentalis*	101.3	Sm. inc.	Sm. inc.	Medium	Good	Good	1
Ohio buckeye	*Aesculus glabra*	100.95	Lg. dec.	Lg. dec.	Medium	Poor	Poor	0
shagbark hickory	*Carya ovata*	96.76	Sm. inc.	NC	Medium	Good	Fair	1
chinkapin oak	*Quercus muehlenbergii*	90.77	NC	NC	Medium	Fair	Fair	1
northern red oak	*Quercus rubra*	85.46	Sm. inc.	Sm. inc.	High	V. good	V. good	1
eastern cottonwood	*Populus deltoides*	78.96	Sm. dec.	NC	Medium	Poor	Fair	1
green ash	*Fraxinus pennsylvanica*	74.78	Lg. inc.	Lg. inc.	Medium	V. good	V. good	1
white mulberry	*Morus alba*	67.44	Unknown	Unknown	NA	NNIS	NNIS	0
yellow-poplar	*Liriodendron tulipifera*	63.82	NC	Sm. dec.	High	Good	Fair	1
yellow buckeye	*Aesculus flava*	51.36	Lg. dec.	Lg. dec.	Low	V. poor	V. poor	0
pin oak	*Quercus palustris*	49.5	NC	NC	Low	V. poor	V. poor	2
American beech	*Fagus grandifolia*	47.39	Sm. dec.	Lg. dec.	Medium	V. poor	V. poor	2
shellbark hickory	*Carya laciniosa*	44.85	Sm. dec.	Sm. dec.	Medium	V. poor	V. poor	0
blue ash	*Fraxinus quadrangulata*	41.57	Lg. dec.	Lg. dec.	Low	V. poor	V. poor	0
white oak	*Quercus alba*	41.35	Lg. inc.	Lg. inc.	High	Good	Good	1
sassafras	*Sassafras albidum*	38.97	Sm. inc.	Sm. dec.	Medium	Fair	V. poor	1
eastern redbud	*Cercis canadensis*	38.23	NC	Sm. inc.	Medium	Poor	Fair	1
black oak	*Quercus velutina*	35.82	Sm. inc.	Sm. inc.	Medium	Fair	Fair	2
American basswood	*Tilia americana*	29.08	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	0
black maple	*Acer nigrum*	28.14	Lg. dec.	Lg. dec.	High	Poor	Poor	0
Norway spruce	*Picea abies*	24.61	Unknown	Unknown	NA	NNIS	NNIS	0
eastern white pine	*Pinus strobus*	24.18	Lg. dec.	V. lg. dec.	Low	V. poor	Lost	0
pignut hickory	*Carya glabra*	20.72	Lg. inc.	Sm. inc.	Medium	Good	Fair	1
mockernut hickory	*Carya alba*	17.73	Sm. inc.	Lg. inc.	High	Good	Good	1
silver maple	*Acer saccharinum*	16.67	NC	NC	High	Fair	Fair	2
eastern hophornbeam	*Ostrya virginiana*	15.49	Sm. inc.	Lg. inc.	High	Good	Good	2
pawpaw	*Asimina triloba*	14.81	Lg. dec.	Lg. dec.	Medium	V. poor	V. poor	0
ailanthus	*Ailanthus altissima*	12.7	Unknown	Unknown	NA	NNIS	NNIS	0
black willow	*Salix nigra*	12.11	Sm. dec.	Lg. inc.	Low	V. poor	Fair	1
blackgum	*Nyssa sylvatica*	11.22	Sm. dec.	NC	High	Poor	Fair	2
scarlet oak	*Quercus coccinea*	9.98	Sm. dec.	Sm. dec.	Medium	V. poor	V. poor	2
swamp white oak	*Quercus bicolor*	9.38	Sm. dec.	Lg. dec.	Medium	V. poor	V. poor	0
shingle oak	*Quercus imbricaria*	9.22	NC	NC	Medium	Poor	Poor	2
sweetgum	*Liquidambar styraciflua*	9.16	Lg. inc.	Lg. inc.	Medium	Good	Good	2
northern catalpa	*Catalpa speciosa*	6.68	Unknown	Unknown	Medium	FIA only	FIA only	0
bur oak	*Quercus macrocarpa*	6.28	Sm. dec.	NC	High	Poor	Fair	2
flowering dogwood	*Cornus florida*	5.96	NC	NC	Medium	Poor	Poor	1
Kentucky coffeetree	*Gymnocladus dioicus*	5.18	Unknown	Unknown	Medium	FIA only	FIA only	0
red mulberry	*Morus rubra*	5.13	NC	NC	Medium	Poor	Poor	2
red pine	*Pinus resinosa*	4.83	Lg. dec.	Lg. dec.	Low	V. poor	V. poor	0
American hornbeam	*Carpinus caroliniana*	4.28	NC	NC	Medium	Poor	Poor	0
rock elm	*Ulmus thomasii*	3.47	Unknown	Unknown	Low	FIA only	FIA only	0
Virginia pine	*Pinus virginiana*	2.89	Lg. dec.	V. lg. dec.	Medium	V. poor	Lost	0
sugarberry	*Celtis laevigata*	0.97	Lg. inc.	Lg. inc.	Medium	Good	Good	2
black ash	*Fraxinus nigra*	0.66	Lg. dec.	Lg. dec.	Low	V. poor	V. poor	0
sourwood	*Oxydendrum arboreum*	0.56	V. lg. dec.	V. lg. dec.	High	Lost	Lost	0

Table 15. Modeled future potential of tree species that did not occur in FIA plots in four regional 1 x 1° blocks in Ohio but may have potential for colonization within 100 years (Iverson et al. 2019c). 'MR' equals model reliability.

Region	Common name	Scientific name	MR	Adap
NW	eastern redbud	*Cercis canadensis*	Low	Medium
	common persimmon	*Diospyros virginiana*	Low	High
	blackgum	*Nyssa sylvatica*	Medium	High
	shingle oak	*Quercus imbricaria*	Medium	Medium
	Shumard oak	*Quercus shumardii*	Low	High
	post oak	*Quercus stellata*	High	High
NE	eastern redbud	*Cercis canadensis*	Low	Medium
	common persimmon	*Diospyros virginiana*	Low	High
	honeylocust	*Gleditsia triacanthos*	Low	High
	eastern redcedar	*Juniperus virginiana*	Medium	Medium
	red mulberry	*Morus rubra*	Low	Medium
	shortleaf pine	*Pinus echinata*	High	Medium
	loblolly pine	*Pinus taeda*	High	Medium
	southern red oak	*Quercus falcata*	Medium	High
	shingle oak	*Quercus imbricaria*	Medium	Medium
	Shumard oak	*Quercus shumardii*	Low	High
	post oak	*Quercus stellata*	High	High
	winged elm	*Ulmus alata*	Medium	Medium
SE	pecan	*Carya illinoinensis*	Low	Low
	sugarberry	*Celtis laevigata*	Medium	Medium
	shortleaf pine	*Pinus echinata*	High	Medium
	southern red oak	*Quercus falcata*	Medium	High
	blackjack oak	*Quercus marilandica*	Medium	High
	water oak	*Quercus nigra*	High	Medium
	winged elm	*Ulmus alata*	Medium	Medium
SW	pecan	*Carya illinoinensis*	Low	Low
	black hickory	*Carya texana*	High	Medium
	shortleaf pine	*Pinus echinata*	High	Medium
	loblolly pine	*Pinus taeda*	High	Medium
	southern red oak	*Quercus falcata*	Medium	High
	blackjack oak	*Quercus marilandica*	Medium	High
	water oak	*Quercus nigra*	High	Medium
	post oak	*Quercus stellata*	High	High
	winged elm	*Ulmus alata*	Medium	Medium

Air pollution & ozone

Air quality can influence forests and their management in various ways. Because trees have the ability to sequester some air pollutants and improve air quality, an understanding of the locally abundant air pollutants is useful when developing strategic plans for tree plantings or reforestation efforts, especially in urban areas. Various air pollutants (i.e., ozone) can also cause health problems for many tree species. The regulated air pollutants for which parts of Ohio are frequently in non-attainment are particulate matter (PM 2.5, 12.0 µg/m^3), ozone, and sulfur dioxide; the highest pollution levels are often in the largest metropolitan areas (see Figure 66 for non-attainment counties of ozone as of August 2018).

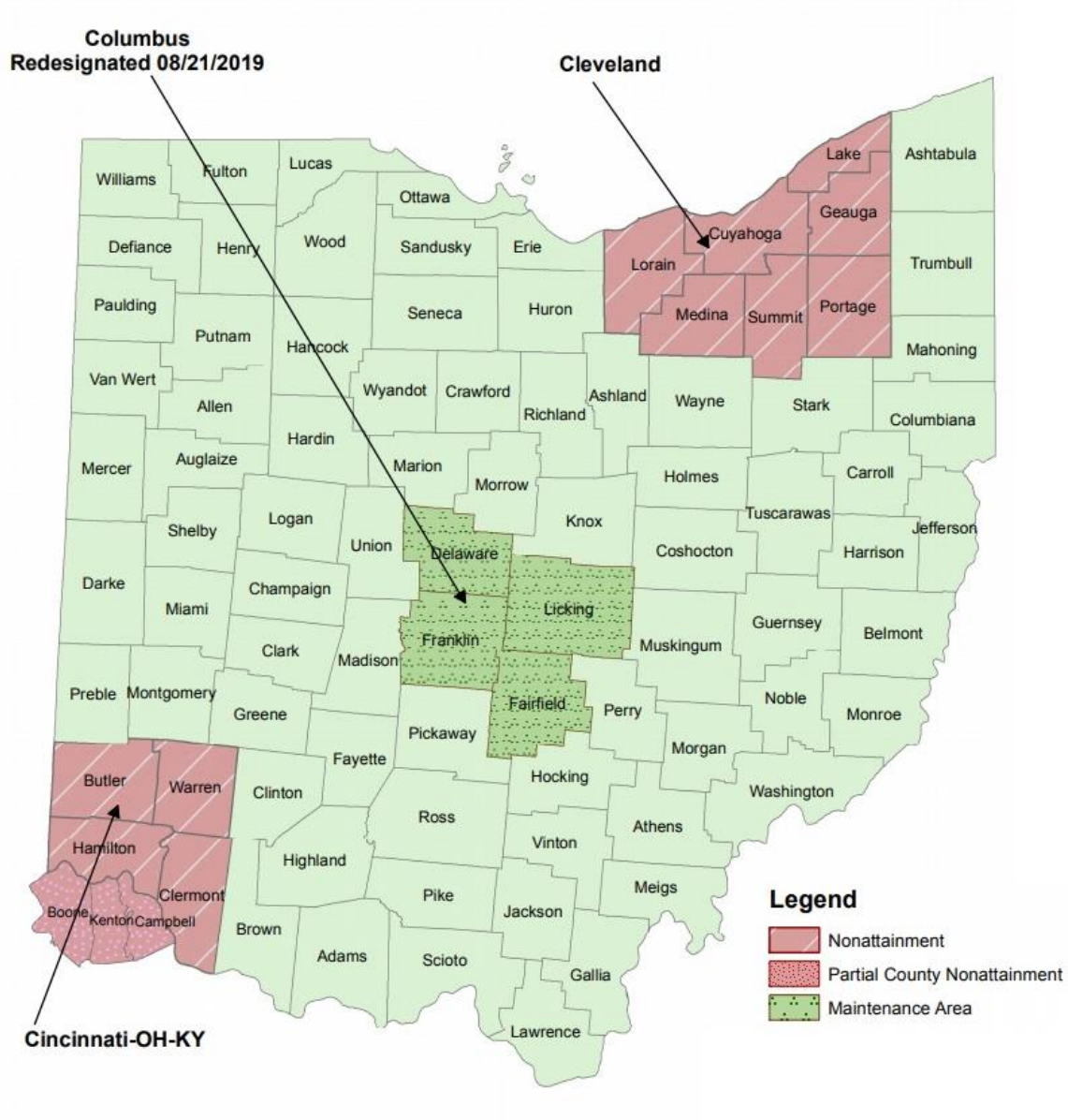

Figure 66. Non-attainment areas in Ohio for ozone (0.070 ppm). Data and map are from the Ohio Environmental Protection Agency (http://www.epa.state.oh.us/dapc/general/naaqs).

Criterion 4 – Conservation and Maintenance of Soil and Water Resources

Indicator 8 – Soil quality on forest land

Recent data on forest soils in Ohio on a state-wide level is lacking. The Ohio Forests: 2006 report included details on soil carbon, Soil Quality Index (a combination of physical and chemical soil properties), and calcium-aluminum ratios. While these data did not provide a comprehensive assessment of Ohio's forest soils, they did provide insight into the quality of Ohio's forest soils and showed that Ohio's northern hardwood forests occurred where there is greater effective cation exchange capacities (more mineral nutrients), and that the calcium:aluminum ratio was generally greater than 0.5 (Widmann et al. 2009). The boundaries of Ohio's 12 soil regions largely

correspond to boundaries between other natural and cultural regions (Figure 67). Estimates of the amount of forest soil organic carbon generally match the forest coverage of Ohio (Wilson et al. 2013; Figure 68).

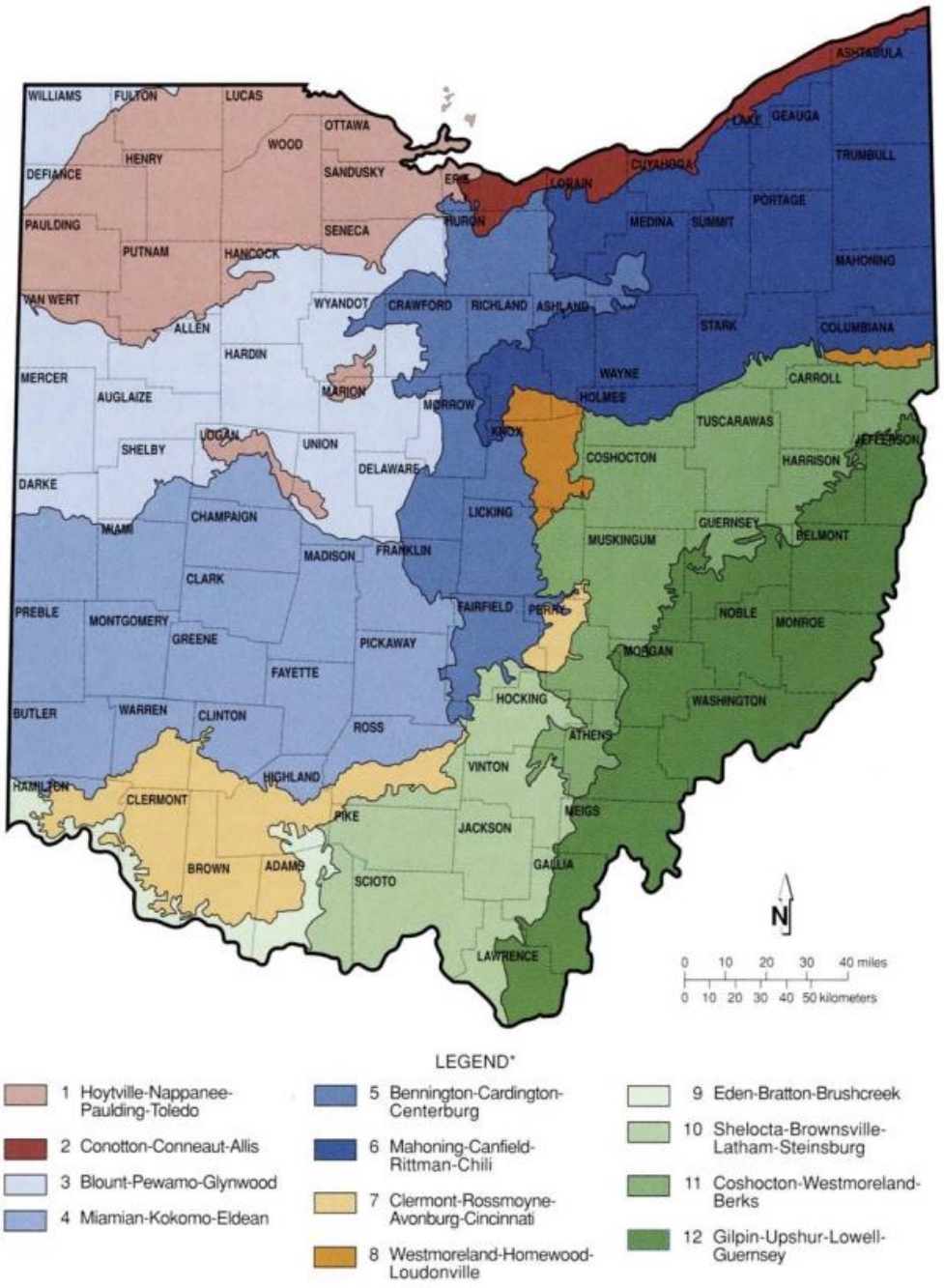

Figure 67. Soil regions of Ohio. Data source: Ohio Department of Agriculture Division of Soil & Water Conservation.

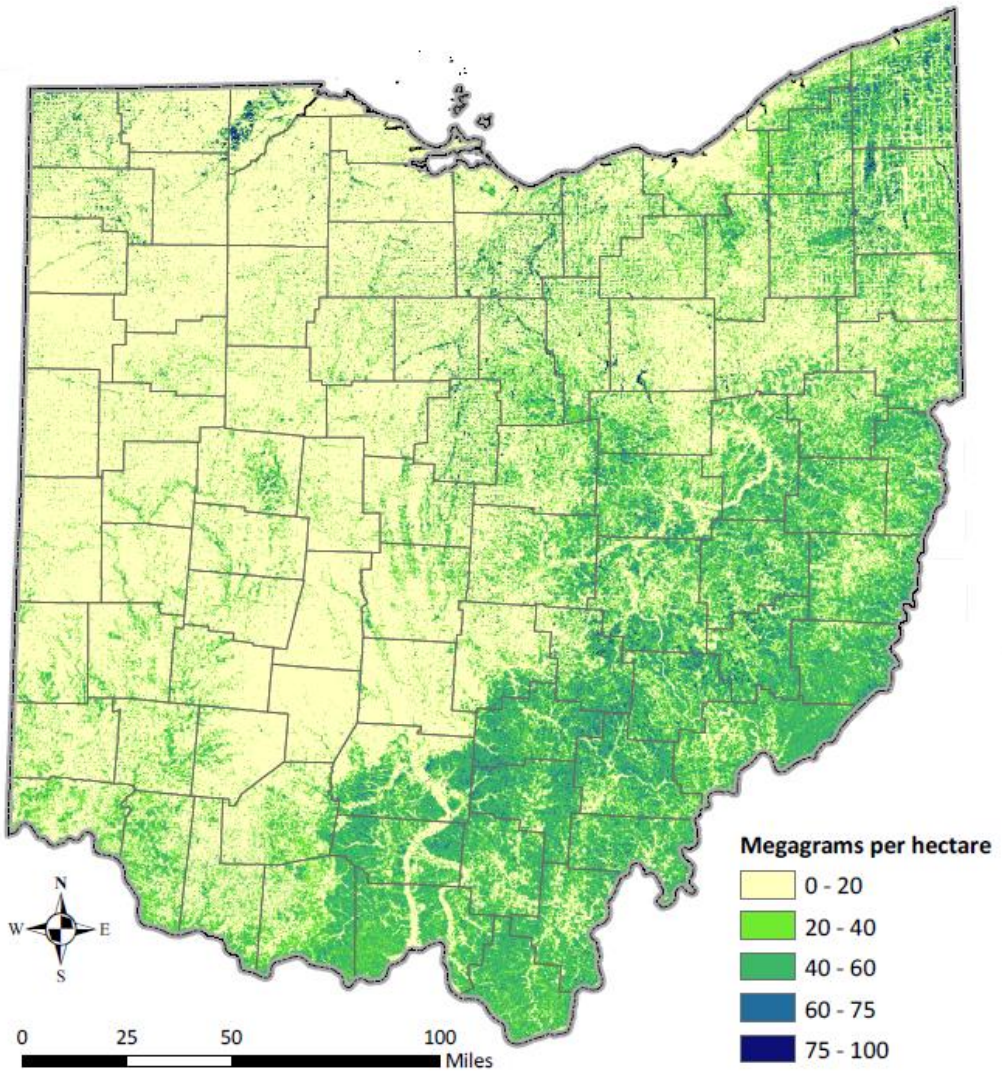

Figure 68. Estimate of forest soil organic carbon in Ohio, 2000-2009 (Wilson et al. 2013).

Soils in the urban forest are historically compromised. Land-use conversion, vegetation clearing, grading, and construction have resulted in artificial soil conditions, compaction, lack of organic matter, and limited function. Tree lawns, the greenspace adjacent to streets developed during the 1870's sanitation reforms to accommodate tree growth, are increasingly narrowed as streets are widened for vehicles. They have also become a mutual home for underground utilities which alters soil profiles and compromises soil health. Parkland, lawn, and other greenspace soils are damaged from construction, lawn equipment, pedestrian traffic, leaf collection, and fertilizer/weed control products that result in soil compaction, sterilization, reduced function, inadequate water storage capacity, and altered pH. These increasing pressures on urban soils create significant challenges for tree establishment and growth, tree canopy cover potential, and species diversity which further limits urban soil and water conservation efforts.

Management focused on conserving soil and water resources

To evaluate the area of forest in Ohio that is currently being managed to conserve soil and water resources, available data on ownership and forest management commitments were considered. Specifically, the ODNR protected lands database was overlaid with the NLCD 2016 forest cover data to highlight protected forest lands in the state (Figure 11), which totaled approximately 946,944 acres. The protected lands database includes all ODNR lands (i.e., state forests, parks, wildlife areas, nature preserves), Wayne National Forest, National Park Service lands (i.e., Cuyahoga Valley National Park), The Nature Conservancy lands, watershed conservancy districts, park districts, and other community forests. While this database covers most lands in the state protected through ownership by natural resource agencies or organizations, some lands, like private lands under conservation easements (i.e., lands protected by land trusts) are not included. A total of 73,340 acres of private forest lands are enrolled in the Ohio Forest Tax Law program under the "new law" rules implemented in 1993, which require a commitment to manage for soil and water conservation. Combining protected forest lands and "new law" Ohio Forest Tax Law forest lands, approximately 1,014,771 acres, or 12.6% of Ohio's forests have commitments to soil and water conservation.

Ohio's forestry pollution abatement rules and standards require all landowners and loggers conducting harvesting operations or other silvicultural activities to utilize best management practices (BMPs) to prevent water quality degradation associated with soil erosion (Ohio Revised Code 1503.50 to 1503.55; enacted 2016). Ohio does not require logging licenses, permits, or the mandatory submission of erosion prevention plans. However, the state does maintain a system whereby private citizens and public agencies may report alleged violations of state water quality standards. Through a cooperative working agreement, the ODNR Division of Forestry and Ohio's 88 soil and water conservation districts (SWCDs) respond to these complaints and work with the responsible parties to bring the sites back into compliance. Ultimately, if the responsible parties fail to achieve compliance in a timely manner, they may be found guilty of a first-degree misdemeanor. Each day of non-compliance is regarded as a separate offense.

Under the forestry pollution abatement rules, persons responsible for a logging operation may also file a voluntary timber harvest plan with the SWCD in the county where the logging is to occur. The plan describes the BMPs that will be used to control soil erosion and protect water quality. These sites generally receive a significant level of monitoring by SWCD staff before, during, and after the harvest to ensure that the plans are followed.

Soil and water conservation are growing concerns in urban areas but is complicated because economic vitality is often gauged by development. Land conversion from functioning soils to hardscape and damaged soils results in increased pH and lack of water storage capacity in Ohio's communities which impacts urban tree canopy potential. The risk to public safety and property is increasing due to climate change-related rain events. The ODNR Division of Forestry's Urban Forestry Assistance Program, some county SWCDs, and a handful of private arborist consultants work with communities, tree commissions, design firms, and engineers on a voluntary basis to adopt soil and water-friendly construction techniques and specifications with an end goal of creating capacity for quality, tree canopy cover.

The Ohio Urban Site Index, created by the ODNR Division of Forestry, is being utilized by communities state-wide to evaluate treelawn soil quality. Developed to quantify soil quality in order to best match tree species to sites, it has served to identify at-risk soils, incentivize alternate construction techniques, and promote dialogue about soil protection between urban planners, engineers, and urban forest managers.

One of the 19 U.S. EPA Urban Waters Partnership designated areas is in the Western Lake Erie Basin (WLEB). Over 45 federal, state, and local partners including the USDA Forest Service and ODNR Division of Forestry have been active since 2013 to identify major areas of concern, proposing tools and ideas to address those concerns, and identifying the needs to target solutions. The WLEB covers almost 6 million acres and drains portions of 29 counties into the shallow western third of Lake Erie (Figure 69). Although land is used predominantly agriculture (60-80%), the basin is home to over two million citizens. The largest metropolitan area in the basin is the port and industrial city of Toledo, Ohio. The WLEB serves as the municipal water source for Toledo. The area is also home to diverse plant and wildlife communities (Oak Openings Region and the Great Black Swamp) and includes several federal and state endangered and threatened species.

Figure 69. Map showing the location of the Western Lake Erie Basin (red hashed area).

Indicator 9 – Area of forest land adjacent to surface water, and forest land by watershed

There is a direct link between the amount of forest cover within a watershed and water quality within streams. Forests filter the water and retain nutrients and potential pollutants within the soil and humus layers, keeping them from reaching streams. In the soil and humus layers these potential pollutants can be utilized or broken down into harmless compounds. Forests also detain runoff from storm events and allow time for the precipitation to infiltrate the soil and recharge aquifers. Trees within the riparian area also help to anchor stream banks to keep them from eroding and create shade, reducing stream temperatures. All of these factors benefit humans and aquatic life.

Forested riparian area

This metric will indicate the amount of forest area around various streams and water bodies within a designated "riparian forest buffer." For the purposes of this analysis, the National Hydrography Dataset (NHD) was used to identify intermittent and perennial streams, open water in rivers, and water bodies such as ponds and lakes. Intermittent streams were given a designated buffer of 50 feet on each side of the stream. Perennial streams, open water (referred to in the analysis as "Areas"), and water bodies were each given a designated buffer of 100 feet. The amount of forest cover within these designated buffers was calculated using the NLCD 2016 dataset. The data were aggregated at the eight-digit hydrologic unit code (HUC) level (of which all or portions of 43 occur in Ohio). Given the mix of land uses throughout Ohio, a reasonable threshold for riparian forest cover was designated as 50% for all four categories (Figure 70). For intermittent streams, perennial streams, areas, and water bodies, 19, 1, 8, and 1 watersheds respectively, were at or above the 50% threshold.

Based on the 2006 and 2016 NLCD datasets, the trend appears to be declining riparian forest cover, as the average change across all types of streams and water bodies between 2006 and 2016 is -2.4%. However, the greatest decline has occurred within the water bodies buffer area, and when considering riparian areas without water bodies, the average trend could be described as stable, with a statewide average between a 1% loss and a 1% gain (-0.5%). The trend for intermittent stream forest cover is stable, with a statewide average decline of 0.3%; the number of watersheds in the declining, stable, and gaining categories are 4, 37, and 2 watersheds, respectively (Figure 71). Perennial streams were generally stable in forest cover with a statewide average decline of 0.4%; the number of watersheds in the declining, stable, and gaining categories are 18, 14, and 1, respectively. Areas (river/stream open water) were generally stable in forest cover with a statewide average decline of 0.8%; the number of watersheds in the declining, stable, and gaining categories are 17, 17, and 9, respectively. Water bodies (ponds, lakes, etc.) declined significantly in forest cover with a statewide average decline of 8.3%; the number of watersheds in the declining, stable, and gaining categories are 42, 1, and 0, respectively.

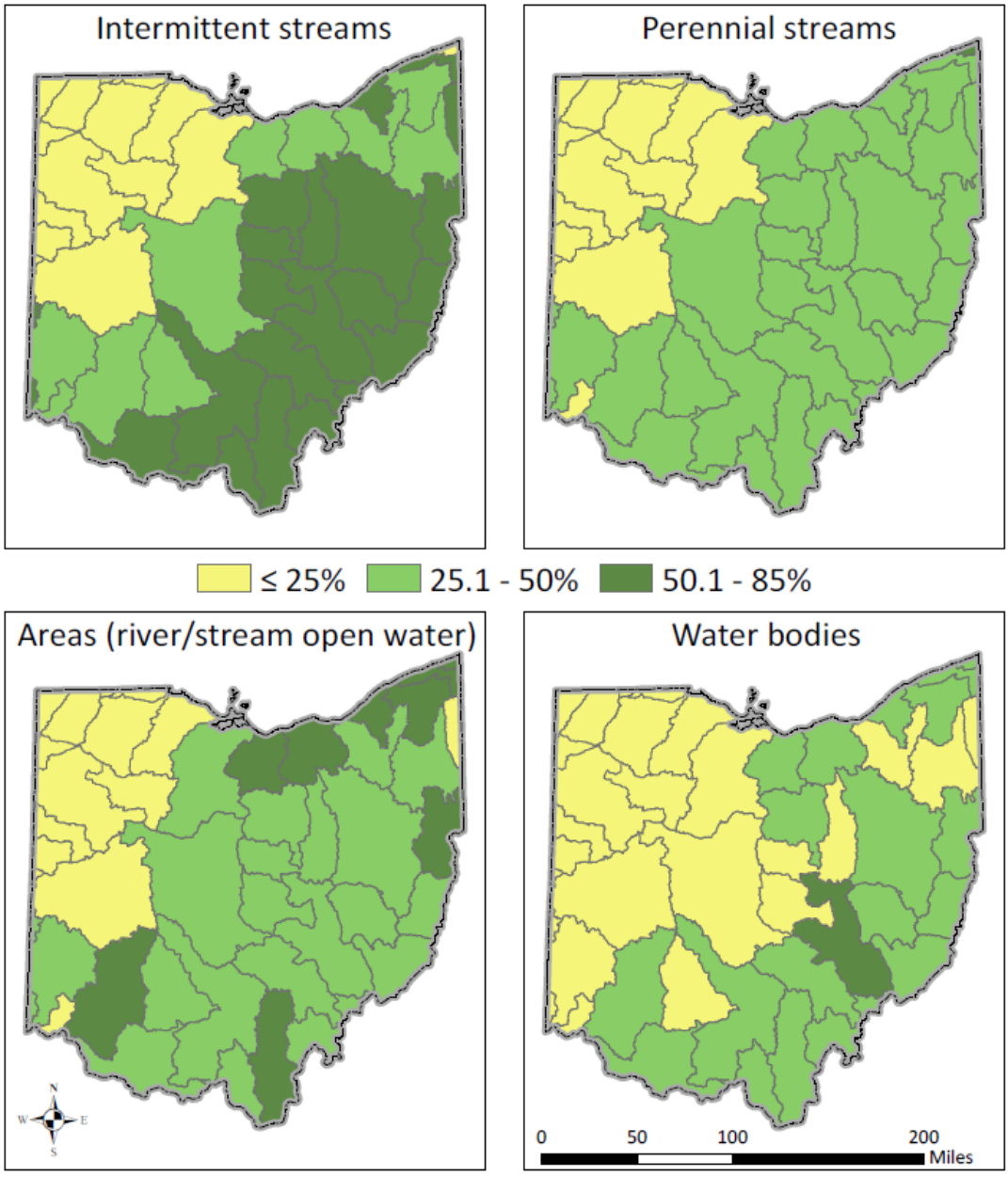

Figure 70. Percent forest cover in riparian areas and water bodies by 8-digit HUC watershed. Data source: 2016 NLCD and USGS NHD.

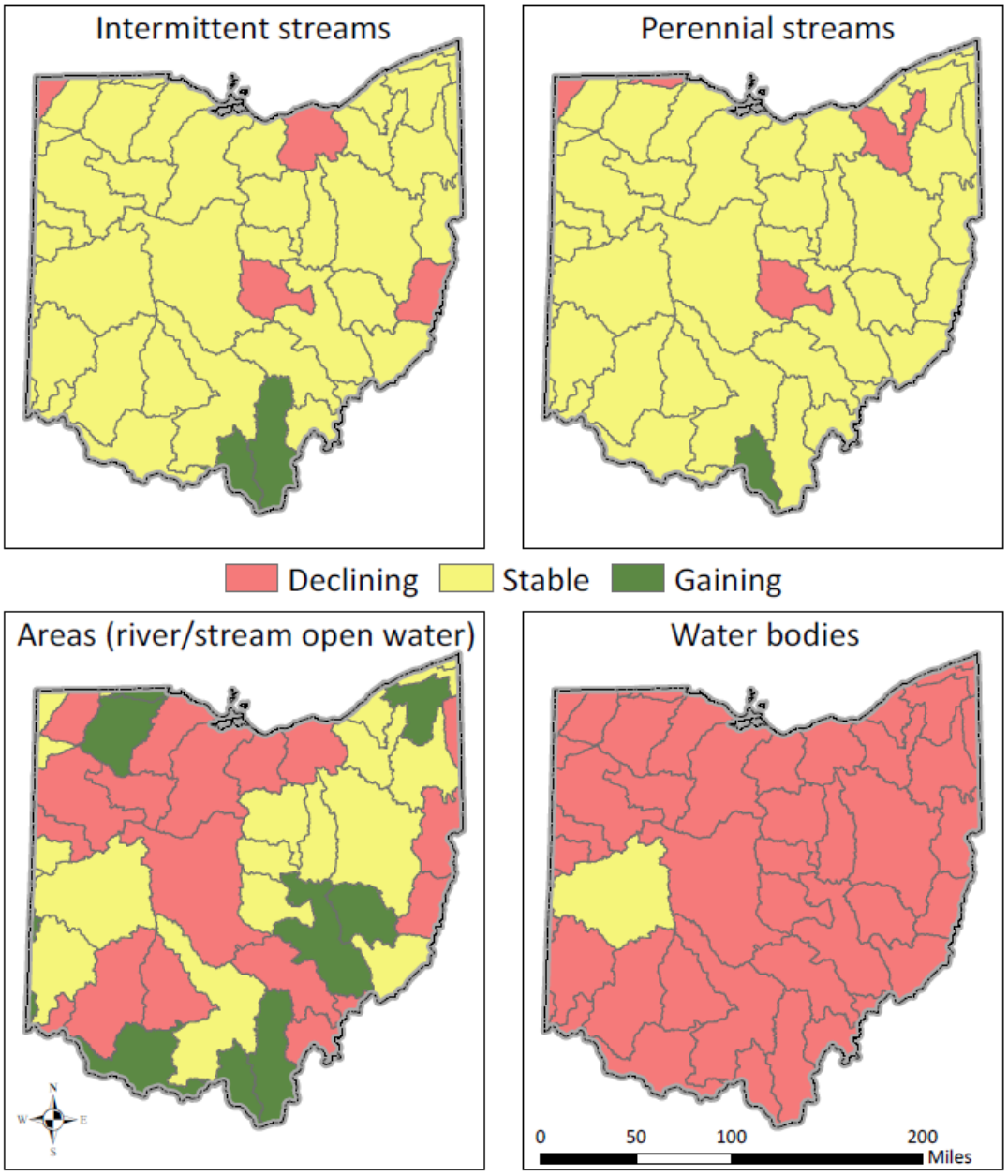

Figure 71. Change in riparian forest cover from 2006-2016 by 8-digit HUC watershed (declining = greater than 1% loss, stable = between 1% loss and 1% gain, and gaining = greater than 1% gain). Data source: NLCD and USGS NHD.

Forest land by watershed

Similar to riparian forest, the amount of forest in the watershed influences the streams that drain them. The influence of forests on infiltration rates and the amount and timing of runoff that reaches streams is very important. The majority of forest land within watersheds of the state is stable with the most heavily forested watersheds located in southeastern Ohio (Figure 72). Comparing the NLCD datasets of 2006 and 2016, the watersheds varied from losing 15.5% of their

forest cover to gaining almost 2.5% (Figure 73). This overall stability is also supported by the USDA Forest Service FIA statistics showing relatively stable forest cover since the last survey.

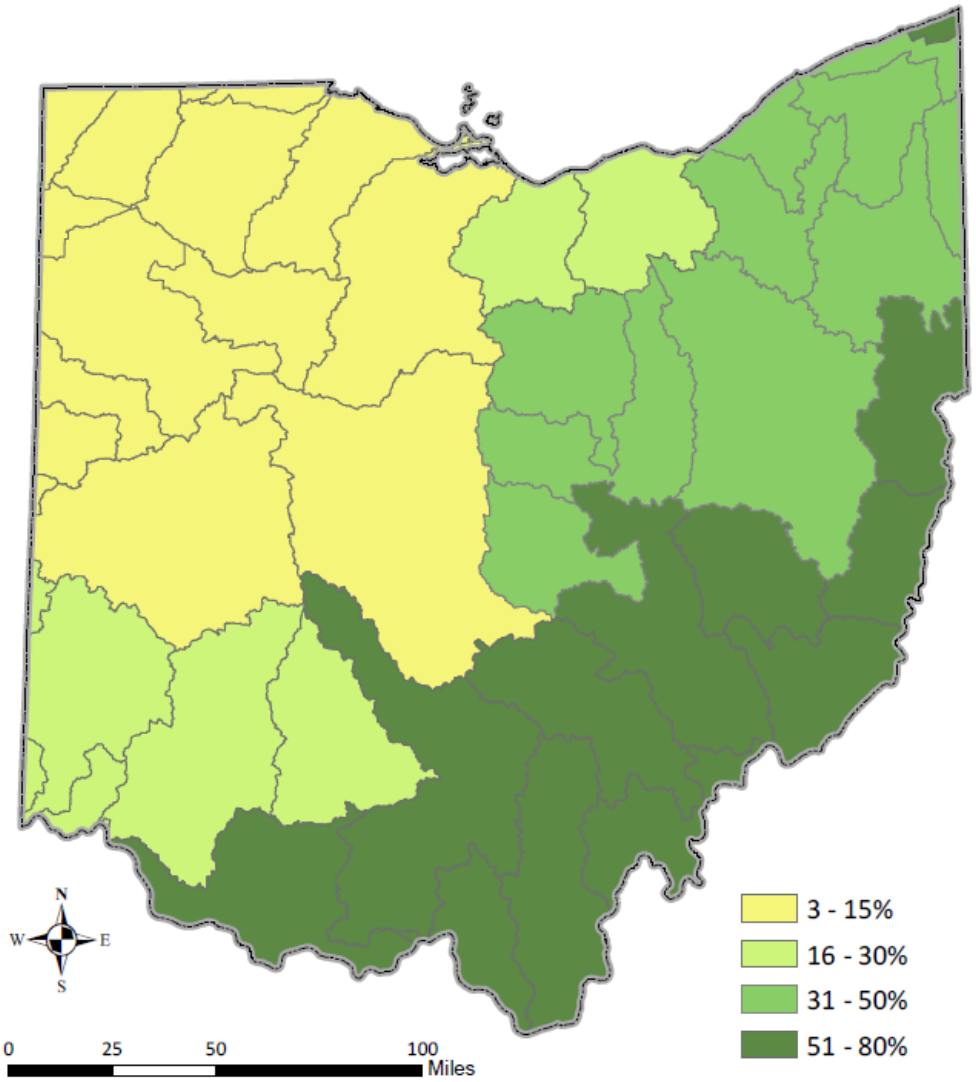

Figure 72. Percent forest cover by 8-digit HUC. Date source: 2016 NLCD.

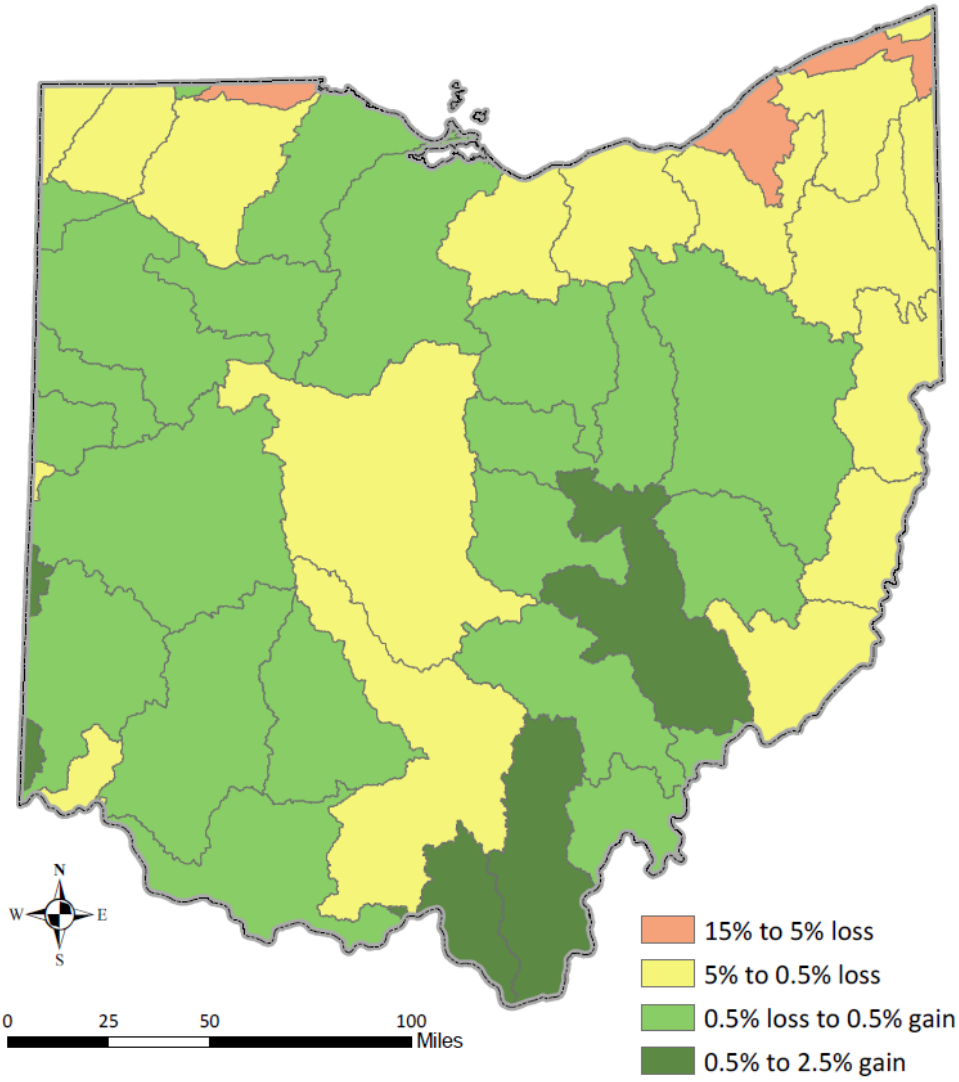

Figure 73. Percent change in forest cover by 8-digit HUC between 2006 and 2016. Data source: NLCD.

Indicator 10 – Water quality in forested areas

As previously indicated, the most heavily forested watersheds are in southeastern Ohio. The water quality of the heavily forested watersheds varies (Figure 74). Reports on total maximum daily loads (TMDLs) exist for some of the impacted watersheds. The principal causes of impairment of Ohio's forested watersheds are related to landscape modification from agricultural land use and urban development (OEPA 2010). More specifically, pollutants that are often cited in water quality reports include nutrient loading from human sewage, livestock manure, and agricultural chemicals, and sediment flowing into streams from agricultural and developing areas (OEPA 2018a; OEPA 2019). Acid mine drainage is also an issue in forested watersheds. Additionally, the oil and gas industry in Ohio, which is largely implemented with hydraulic fracturing methods, has grown significantly since 2012. The U.S. Environmental Protection Agency (EPA) has found scientific evidence that hydraulic fracturing activities can

impact drinking water resources under some circumstances (U.S. EPA 2016). The Ohio EPA identifies and protects high quality waters through its antidegradation rule (OEPA 2017). Two categories of high-quality waters are given greater protection under antidegradation rule: superior high-quality waters and outstanding state waters (Figure 75).

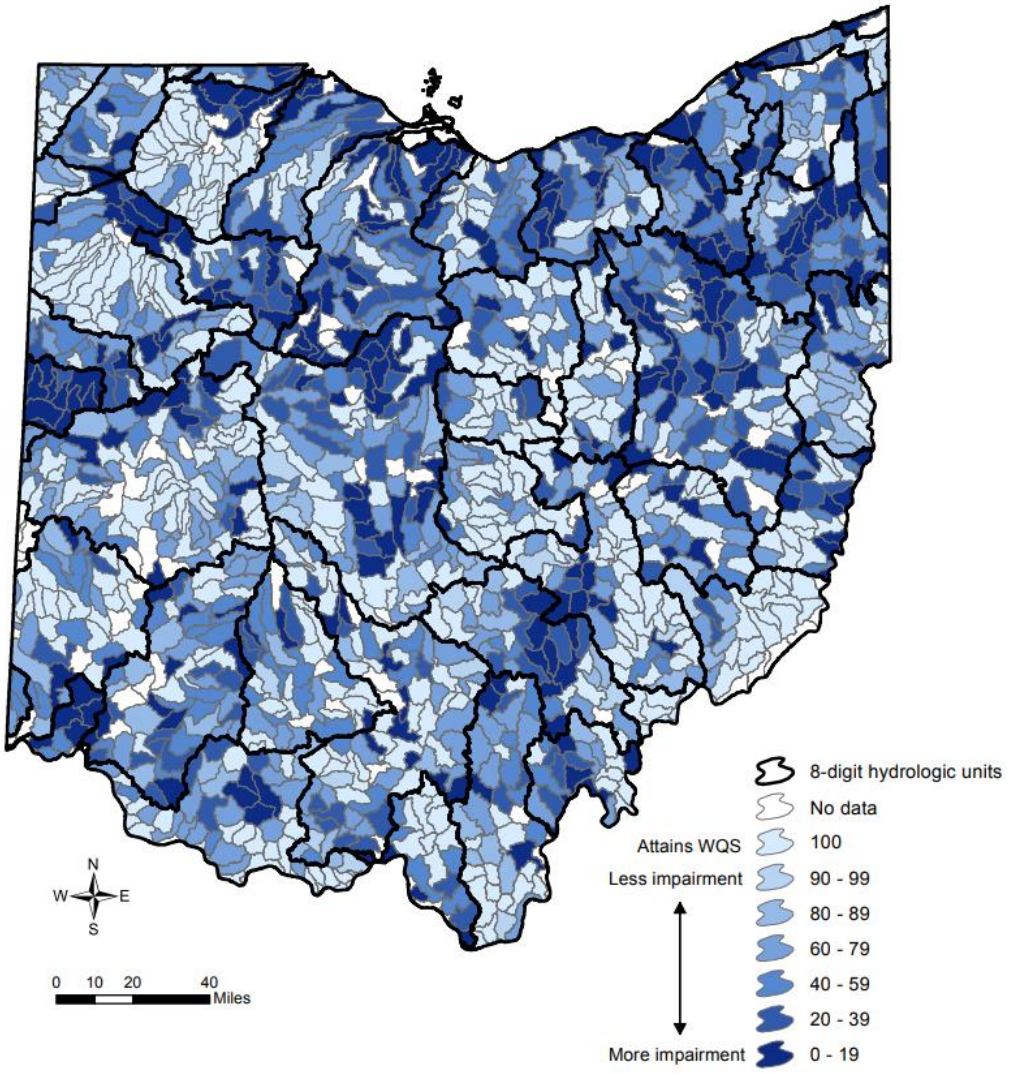

Figure 74. Assessment of impairment of Ohio's 12-digit HUC watersheds based on aquatic life use index scores (OEPA 2018b).

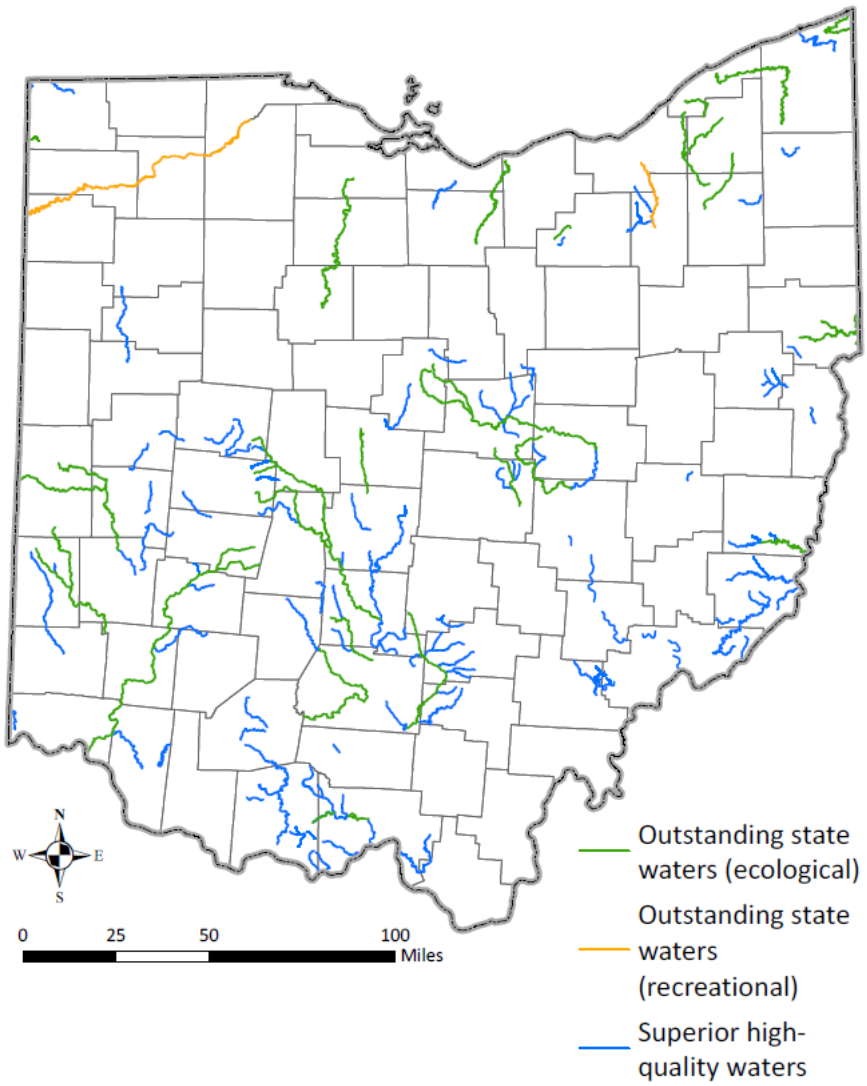

Figure 75. Outstanding state waters and superior high-quality waters. Data source: Ohio EPA.

The USDA Forest Service Forests to Faucets project uses geographic information systems (GIS) to identify areas important for drinking water in the U.S., the role forests play in protecting these areas, and the risk to forests by development, insects and disease, and wildland fire (USDA Forest Service 2019b). This assessment can be used to identify areas of interest for protecting surface drinking water quality and can be incorporated into broad-scale planning efforts. The results of the Forests to Faucets 2.0 project include a rating of the importance of forests for surface drinking water (Figure 76) and the risk to water yield based on several factors including wildfire potential, projected insect and disease impacts, and risk of development based on socioeconomic and climate scenarios (Figure 77).

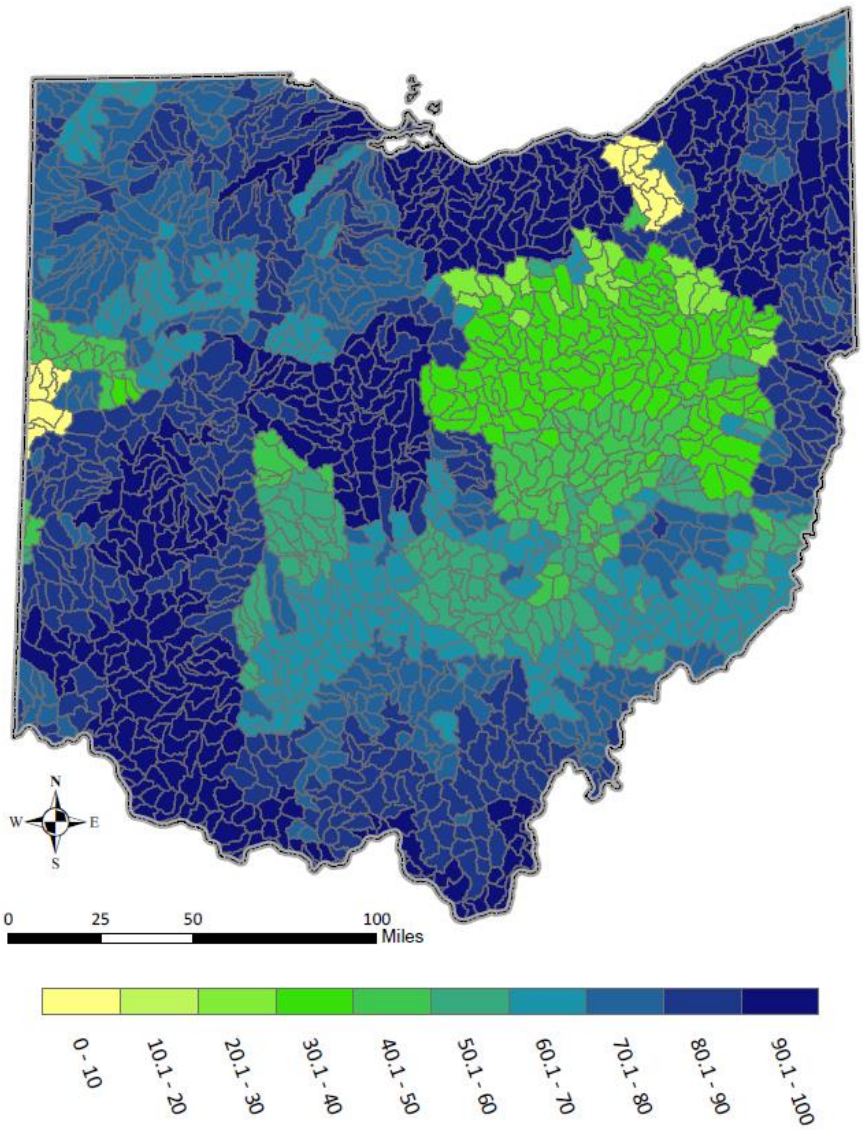

Figure 76. The relative importance (0 being least important and 100 being most important) of forests to surface drinking water, by 12-digit HUC (USDA Forest Service 2019b).

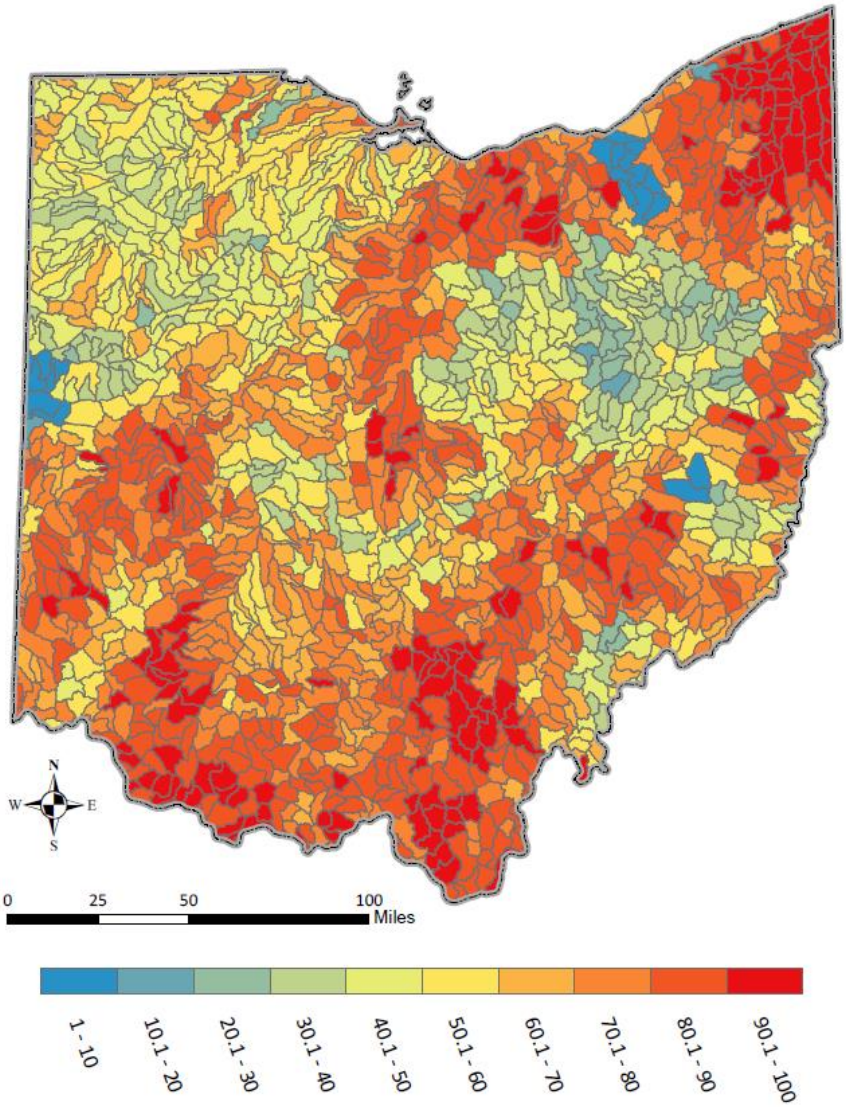

Figure 77. The relative risk (1 being least risk and 100 being greatest risk) to water yield from 2010–2040 based on high emissions scenario, by 12-digit HUC (USDA Forest Service 2019b).

Criterion 5 – Maintenance of Forest Contribution to Global Carbon Cycles.

Globally, forest ecosystems are one of largest reservoirs of biomass and carbon, and they play an important role in the global carbon cycle. Carbon sequestered by U.S. forests represented an offset of approximately 10% of total U.S. greenhouse gas emissions in 2015 (Albright et al. 2018). The carbon budgets of forests include carbon uptake through photosynthesis, allocation to living tissue (biomass), and soil accumulations, as well as carbon loss through cellular respiration and decomposition of soil organic matter (Malhi et al. 1999). Forests can accumulate or sequester carbon and function as carbon sinks, but they can also be a net source of carbon. In general, forests that are more productive have a greater net storage of carbon in biomass. Certain forest management practices can increase carbon sequestration (Perschel et al. 2007), and thereby enhance the role that forest ecosystems play in mitigating climate change. An evaluation of

success in carbon sequestration efforts requires data on local or statewide carbon pools and their change over time. This criterion describes the current state of biomass and carbon storage in Ohio's forests, as well as recent trends.

Indicator 11 – Forest ecosystem biomass and forest carbon pools

The distribution of above- and belowground carbon in trees across the state mirrors that of forest cover, with the greatest stores of forest carbon occurring in southern and eastern Ohio (Figure 78). Carbon pools in Ohio's forests include live trees, dead trees (standing and downed), understory plants, forest floor (i.e., leaf litter), and organic soil. The largest single pool of carbon is in live trees, followed closely by soil organic matter (Table 16). Of the statewide forest carbon pool in live trees, 65.7% is classified in the oak-hickory forest type group (Table 17). The second most abundant forest type group is the maple-beech-birch group, at 21.7% of forest carbon in live trees. As discussed earlier in this assessment, Ohio's forests have been experiencing a trend of maturing; however, the amount of carbon stored per unit area has experienced some change from 2004 to 2018 (Figure 79). During that 14-year span, the annual mean total forest carbon ranged from 574 million short tons (in 2005) to 612 million short tons (in 2013). Gioglio et al. (2019) estimated that carbon sequestration by forests provide $404 per acre of forestland annually in Ohio (note that this is an economic valuation of benefits and not representative of revenue received or economic activity). Carbon storage by Ohio's urban forests is estimated at 36.5 million tons, with an estimated value of $4.7 billion and the annual gross carbon sequestration by Ohio's urban forests is estimated at 1.2 million tons, with an estimated value of $152 million (Nowak et al. 2018a).

Mycorrhizae are soil fungi which are obligate symbionts with all forest tree species. These fungi take in nutrients and water from the soil, benefiting their host trees, and in exchange use nutrients generated through photosynthesis by the tree. Mycorrhizal fungi are considered primary vectors for plant carbon to soils, and conversely, primary vectors of soil nutrients to plants (Simard 2010). Plants invest photosynthate carbon in mycorrhizal fungi because the small and profuse hyphae have 60 times more absorptive area than fine plant roots (Simard 2010). Mycorrhizae fall into two general categories: ectomycorrhizal fungi (ECM) and arbuscular mycorrhizal fungi (AM). These two classes have some key differences and tree species such as oaks, hickories, and beech are associated with ECM networks and species such as maples and yellow-poplar are associated with AM networks. The two types of mycorrhizae also appear to compete and can inhibit growth of the other, where established. Ectomycorrhizal fungi networks sequester much more carbon compared to AM networks (Averill 2014). The importance of mycorrhizae in sequestering carbon in forest ecosystems is being increasingly recognized and actively studied.

Table 16. Forest carbon pools on forestland in Ohio, 2018. Data source: USDA Forest Service FIA.

Carbon Pool	Oven-dry short tons of carbon
Total non-soil	327,879,694
Live trees	239,712,223
Soil organic	221,478,623
Forest floor (litter)	42,703,743
Downed woody debris (stumps, logs, coarse roots)	24,172,363
Standing dead trees (at least 1 inch dbh)	15,451,799
Understory vegetation	5,839,566

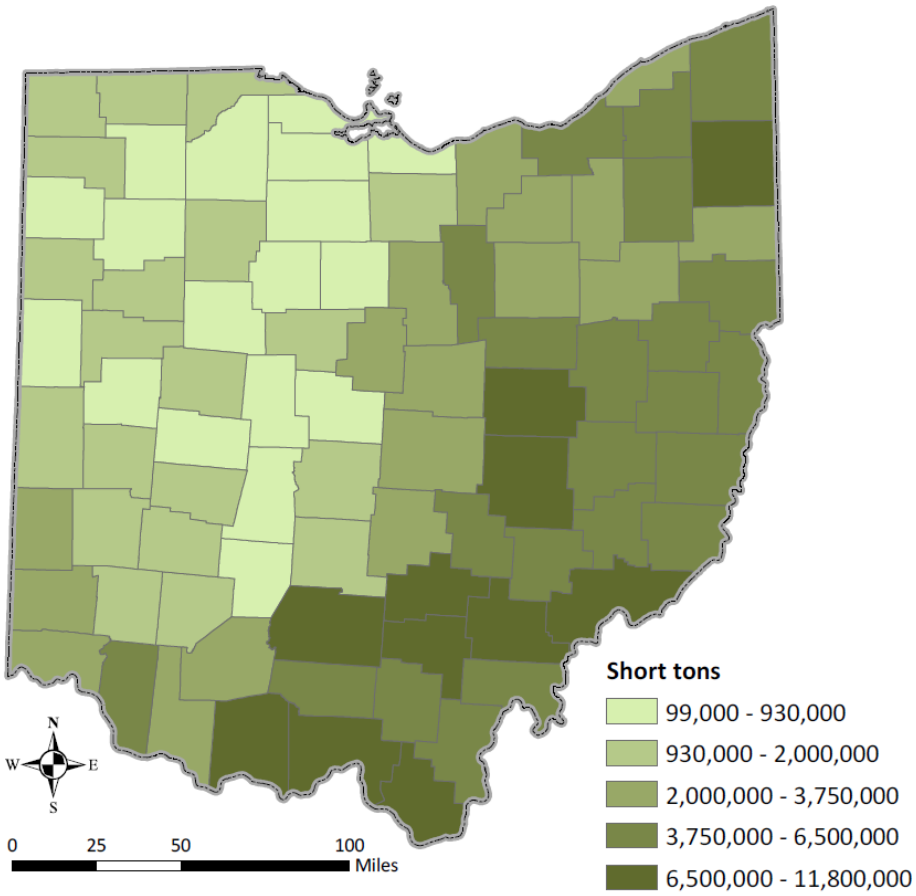

Figure 78. Above- and belowground carbon in live trees (at least 1-inch dbh) in short tons, by county in 2018. Data source: USDA Forest Service FIA.

Table 17. Forest carbon in live trees by forest type group on forestland in Ohio, 2018. Data source: USDA Forest Service FIA.

Forest type group	Oven-dry short tons of carbon
Total (all live trees)	239,712,223
Oak/hickory	157,578,858
Maple/beech/birch	52,022,814
Elm/ash/cottonwood	16,656,472
White/red/jack pine	2,820,901
Oak/pine	2,176,669
Aspen/birch	1,587,347
Loblolly/shortleaf pine	1,538,346
Oak/gum/cypress	681,121
Exotic softwoods	500,699
Exotic hardwoods	461,881
Other hardwoods	371,703
Other eastern softwoods	248,802
Nonstocked	66,609

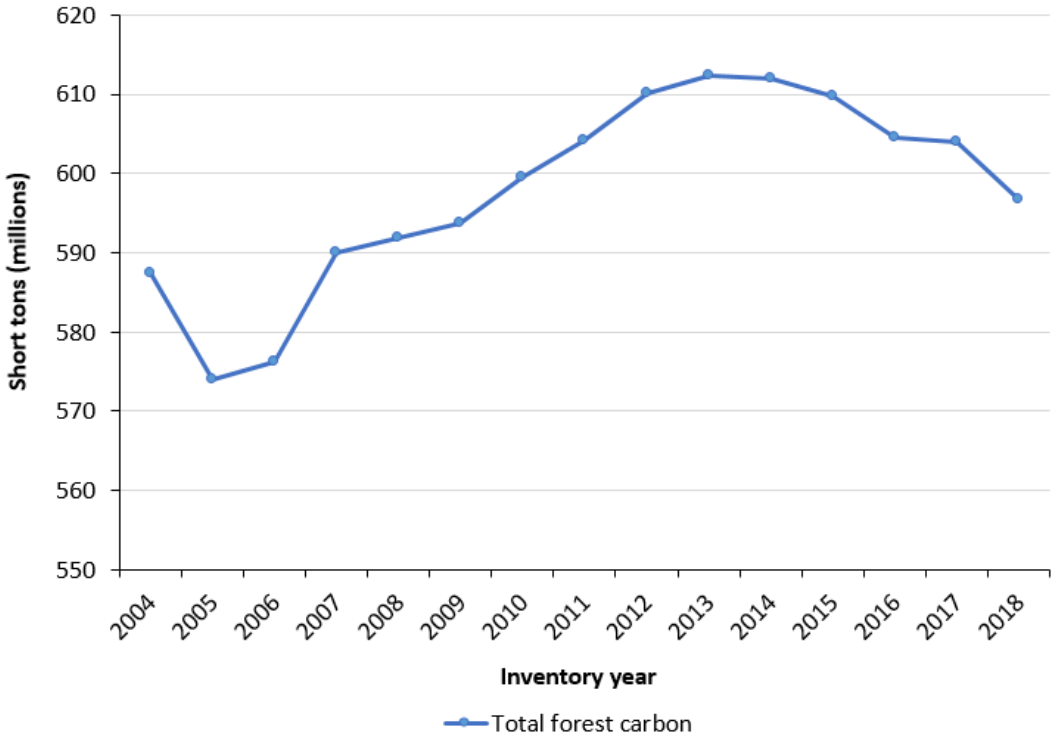

Figure 79. Annual means for total forest carbon in Ohio from 2004 to 2018. Data source: USDA Forest Service FIA.

Criterion 6 – Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies

Indicator 12 – Wood products and non-timber forest products production, consumption, and trade

Value of wood-related products

Gross domestic product (GDP) is a commonly used measure of economic output or value of products. It represents the total market value of all products from a given geographic area, and GDP can also be calculated for specific industrial classifications. In 2017, the total GDP in Ohio for wood products manufacturing (North American Industry Classification System 321; NAICS) and furniture and related products manufacturing (NAICS 337) was $2.3 billion which represents 0.35% of the GDP for all industries in Ohio in 2017 (Larrick 2019). Since 1997, the GDP for paper manufacturing (NAICS 322) has been relatively stable, while GDP for furniture and wood products has been bottomed out in 2012 and 2013, respectively. Since then, GDP in both sectors has been gradually increasing in value (Figure 80). NAICS 322 includes the manufacturing of pulp and paper, as well as converted paper products. Ohio consistently ranks in the top 20 states in GDP for wood-related products. In 2017, Ohio had the 14th highest GDP for wood products manufacturing in the United States (Figure 81) and the 8th highest GDP for furniture and related products manufacturing (Figure 82). Another indicator of the value of wood products is the trend for timber prices in Ohio (Figure 83). One trend for timber prices is the overall decline from 2005 to 2010-2011 with a slow trend of increasing of timber prices since that time. Another trend of note includes the substantial increase in black cherry prices in the early to mid-2000s followed by a substantial decline which stabilized around 2010 with the exception of a small spike in 2014. Also, black walnut pricing has increased much faster than any other species since the 2010-2011 low, but its market appears to be more volatile as evidenced by frequent considerable fluctuations in value.

A unique wood-manufacturing sector that emerged in Ohio several years ago and continues to influence hardwood lumber production and value in the state and beyond is the Amish furniture cluster. A cluster of many small firms (median firm size of 4 employees) has firmly established itself in Holmes County, Ohio that provides consumers with customized, solid-wood products. The Amish furniture cluster in Ohio consumes 42 MMBF of hardwood lumber annually, which represents 13.5% of Ohio's total hardwood production, and has a value of shipments of $282.5 million (Bumgardner et al. 2011).

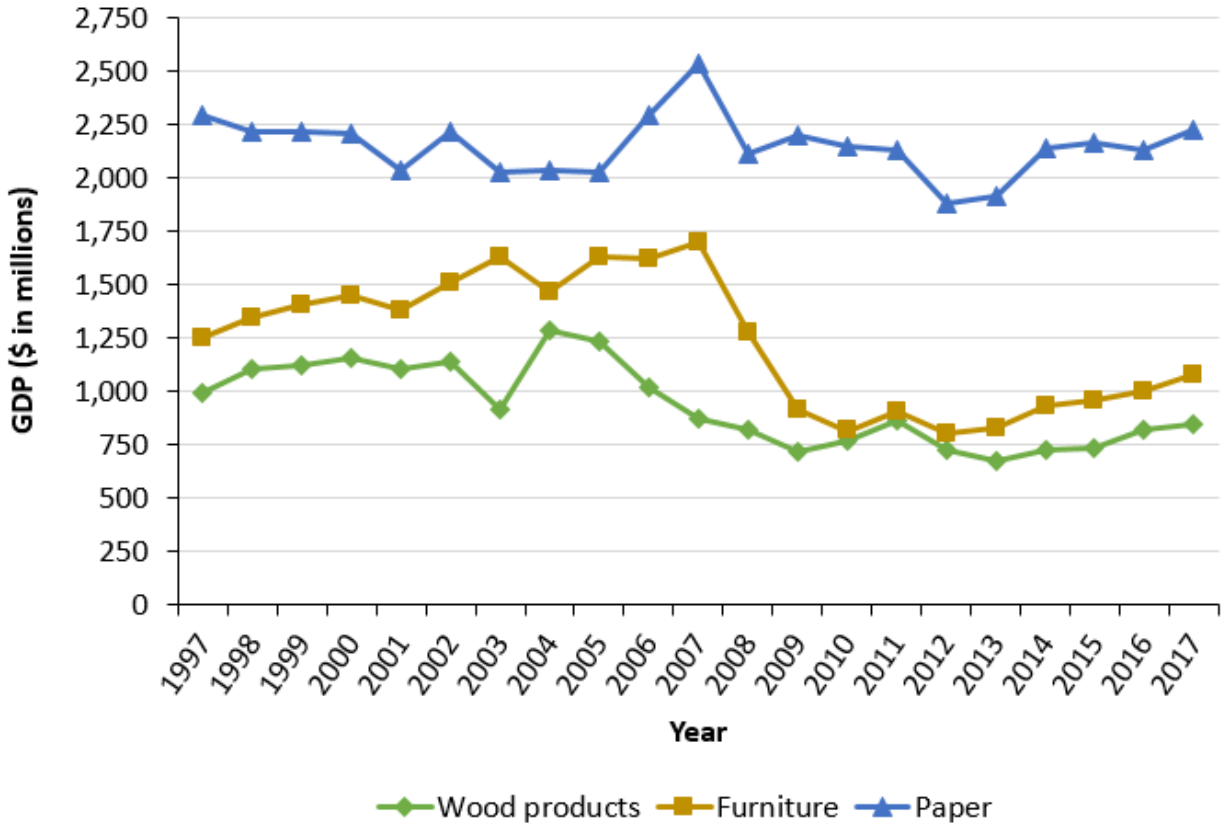

Figure 80. Gross Domestic Product (GDP) of wood product manufacturing (NAICS 321), paper manufacturing (NAICS 322), and furniture and related product manufacturing (NAICS 337) in Ohio from 1997 to 2017. Data source: Office of Research, Ohio Development Services Agency.

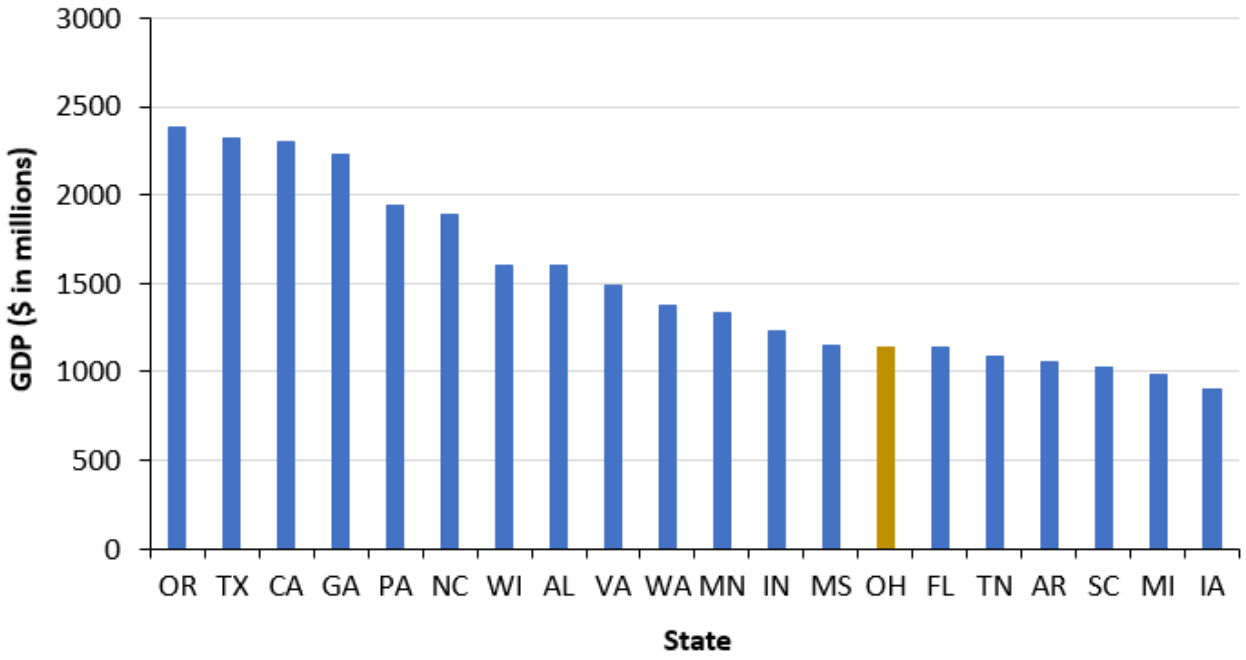

Figure 81. The top 20 states in gross domestic product (GDP) for wood product manufacturing (NAICS 321) in 2017. Data source: Bureau of Economic Analysis, U.S. Department of Commerce.

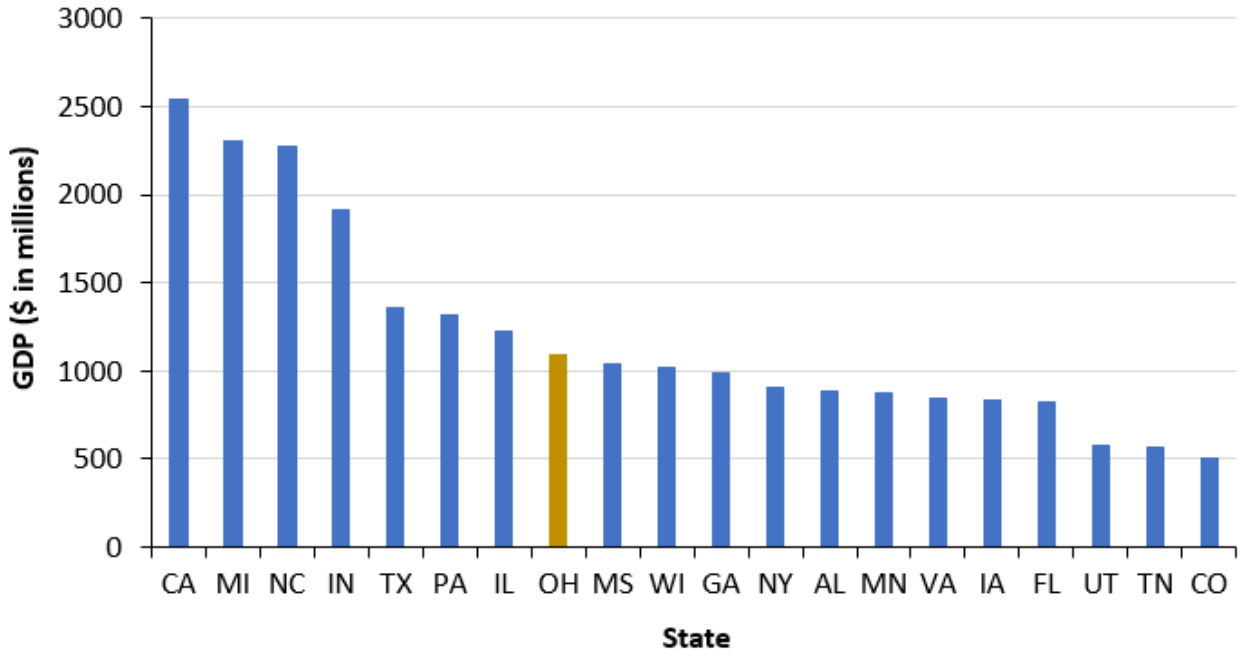

Figure 82. The top 20 states in gross domestic product (GDP) for furniture and related product manufacturing (NAICS 337) in 2017. Data source: Bureau of Economic Analysis, U.S. Department of Commerce.

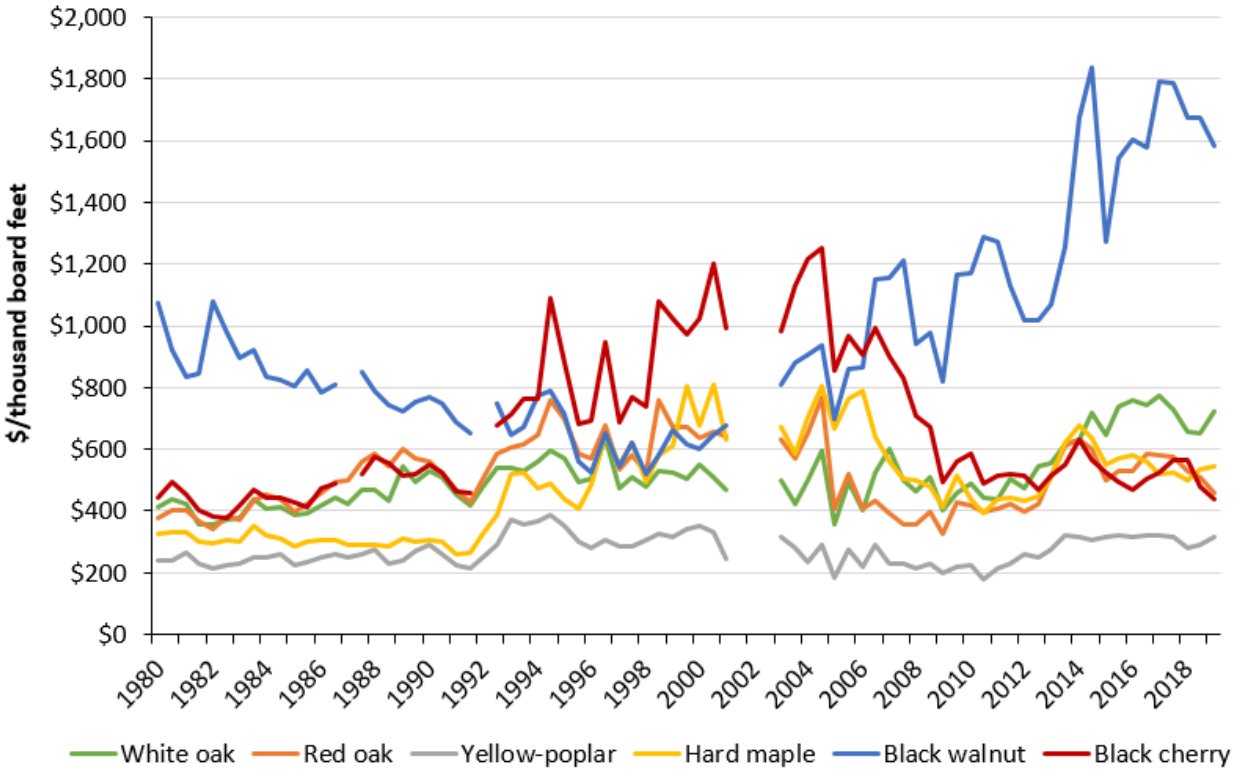

Figure 83. Ohio timber prices for select hardwood species from 1980 to 2019. Stumpage prices are presented, adjusted for 2019 inflation. Data source: Ohio Timber Price Reports (available online at: https://woodlandstewards.osu.edu/ohio-timber-price-report).

Production of roundwood

An evaluation of roundwood utilization provides a measure of the volume of wood utilized by primary wood processors in the state as well as the volume of wood harvested from Ohio's forest lands. Harvest removals increased very slightly from 2008 to 2018 (225 million cubic feet per in 2008 to 225 million cubic feet in 2018; an increase of 0.25%). In 2018, harvesting was concentrated in sawtimber diameter classes with trees ranging from 14 to 20 inches diameter at breast height (4.5 feet above ground level; dbh), accounting for 50% of harvested volume (Figure 84). Trees in the 18-inch diameter class made up 15% of the total harvest volume at 30.8 million cubic feet. In 2018, white oaks were the dominant species group harvested in the sawlog size class, with red oaks and ash, ranking second and third, respectively. Yellow-poplar and soft maple finish out the top five species groups (Figure 85).

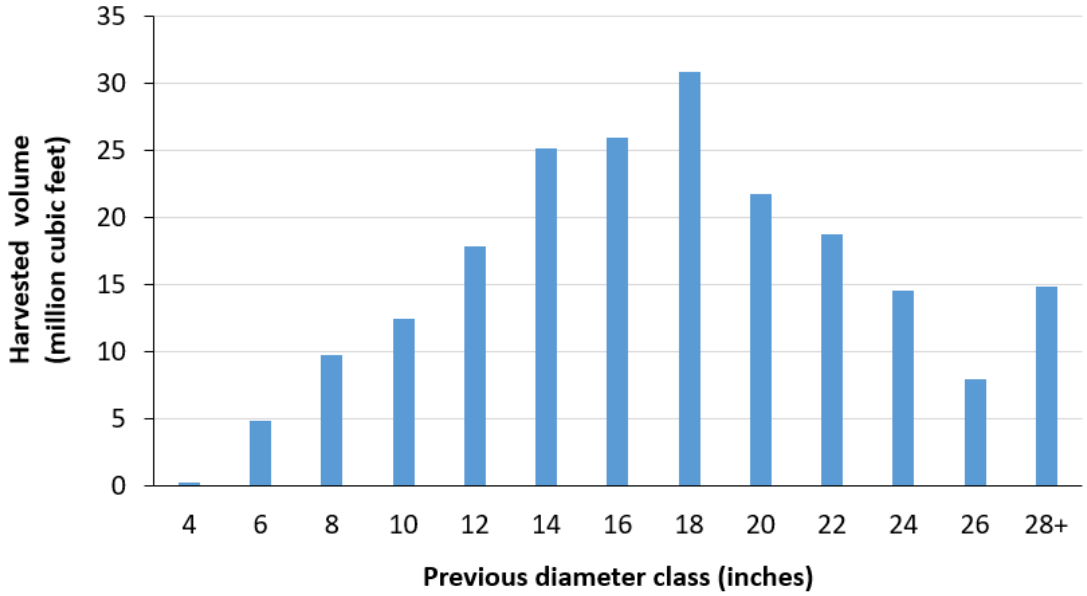

Figure 84. Average annual harvest removal of sound volume by previous diameter class on timberland, Ohio, 2018. Data source: USDA Forest Service FIA.

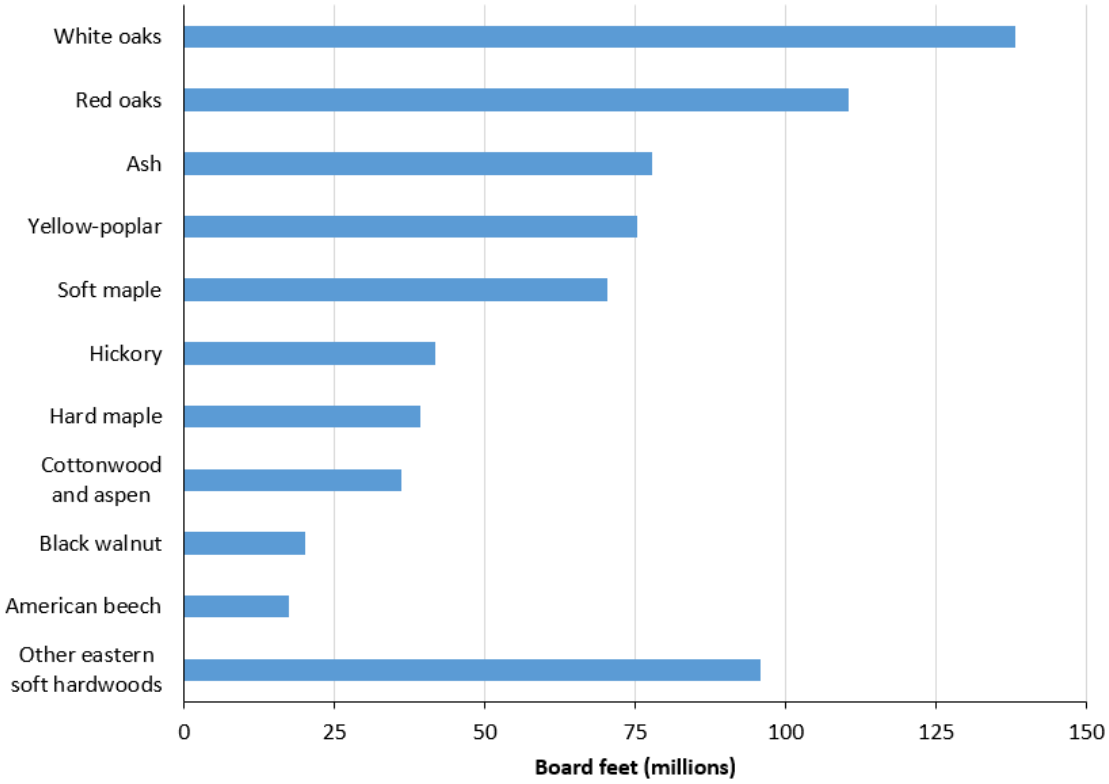

Figure 85. Sawlog harvests in Ohio by major species group, 2018. Data source: USDA Forest Service FIA.

Energy from wood biomass

The USDA Economic Research Service defines bioenergy as renewable energy derived from biological sources, to be used for heat, electricity, or vehicle fuel. Biomass from woody plants is often presented as one of the key sources of renewable energy available for large-scale energy production (Jeanty et al. 2004; Ray and Ma 2009). Large-scale energy production using biomass will likely come as both dedicated biomass facilities and the co-firing of wood in coal-fired facilities (Ray and Ma 2009).

Currently, New England states have the greatest electrical capacity from wood-fired facilities but planned future projects in Ohio and other neighboring states will significantly expand their wood-fired electrical capacity (Ray and Ma 2009). Figure 86 shows the current distribution and relative size of wood-fired and coal-fired facilities in the Central and Midwestern United States and demonstrates the potential impact of future conversion to wood co-firing (Springer et al. 2017).

Various potential sources of woody biomass exist for energy production in Ohio. While mill residue or by-products from current forest industry operations would provide a readily available source, the actual percentage of wood residue that is currently unused is low (Table 18). A 2004 report found that mill residue only represents ~1% of the potential woody biomass available for bioenergy in Ohio (Jeanty et al. 2004). Woody biomass sources with significantly greater potential in the state include municipal solid waste, forest residue, and construction and demolition debris (Jeanty et al. 2004). The key areas of forest biomass stocked in timberland in the Midwest are in northern Minnesota, Wisconsin, and Michigan as well as southern Missouri and Ohio (Figure 86; Springer et. al 2017). Further analysis is needed on sources of woody biomass and their sustainable use. Once wood co-firing reaches a level of 3%, the impact on wood demand in Ohio (8.0 million green tons) begins to reach a level where co-firing facilities will negatively impact the competing wood-using industries (Ray and Ma 2009). In addition to concerns about ensuring sustainable supplies of woody biomass, resource managers are considering the potential ecological impact on Ohio's forests from woody biomass harvesting. Ecological considerations are already an important component of timber harvest planning by forestry professionals, and they would continue to be prominent in the context of harvesting for woody biomass. Nevertheless, some unique forest management practices may be applicable, such as the retention of organic matter from deadwood and logging slash for soil productivity and wildlife habitat (Janowiak and Webster 2010). Some states have developed specific management guidelines or Best Management Practices (BMPs) to address concerns about sustainability and environmental impacts. According to *A Review of Biomass Harvesting Best Management Practices Guidelines* published by the North East State Foresters association (July, 2012) Pennsylvania, New Hampshire, California, and Oregon have some of the most well-developed BMP guidelines.

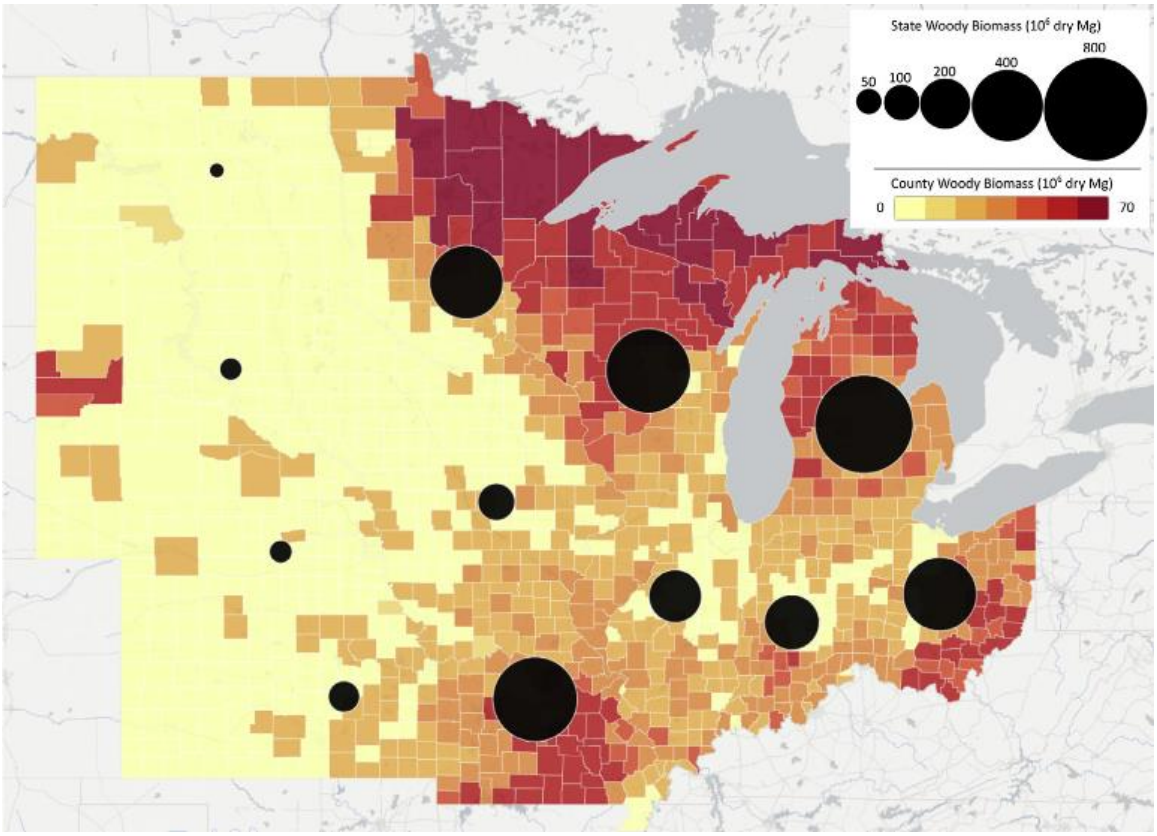

Figure 86. Total live forest woody biomass stock on all forestlands in 2012 in dry Mg (Springer et al. 2017).

Table 18. Uses of hardwood and softwood residues in Ohio in relative percentages. The data are weighted using roundwood consumption volumes of firms that responded to a timber product survey (Wiedenbeck and Sabula 2008).

Type of Residue	Boiler fuel, external	Boiler fuel, internal	Chemical products	Household fuel	Livestock bedding	Mulch	Composite panels	Pulp	Other	Not used
Hardwood bark	1.8	3.3	2.3	16.7	9.4	57.3	1.1	4.3	0.6	3.2
Hardwood coarse	8.9	8.5	0.0	2.7	4.2	5.2	0.1	58.2	0.5	11.7
Hardwood fine	33.6	26.8	0.2	0.4	23.6	2.5	0.2	5.5	0.0	7.2
Softwood bark	0.0	0.0	2.8		0.0	20.8	0.0	0.1	0.0	10.7
Softwood coarse	0.0	0.0	0.0	0.0	0.1	95.6	0.0	0.0	0.0	4.3
Softwood fine	0.7	67.9	0.1	0.0	11.0	18.0	0.0	1.0	0.0	1.3

Trade or wood flow

Ohio is a net importer of saw logs, with a ratio of imports to exports of 5.6:1 in 2006 (Wiedenbeck and Sabula 2008). However, 81% of logs utilized by Ohio sawmills were harvested in Ohio, indicating that Ohio's wood product industry meets the majority of its demand using local (in-state) sources. Sawmills represent Ohio's largest primary wood products sector. However, not all industry sectors follow that trend; only 15% of veneer logs used by the Ohio's veneer manufacturers originated from Ohio timberlands in 2006 (Wiedenbeck and Sabula 2008). Conversely, the percentage of hardwood lumber being consumed as an export rose considerably from 8% in 1991 to 17% by 2017 nationally, with domestic consumption declining per capita by at least half (Buehlmann et al. 2017). Increased reliance on global export market for hardwoods in the future will be more sensitive to global demand.

Table 19, Table 20, and Table 21 show the value of Ohio's international exports from 2014 to 2018 for the various stages of wood products manufacturing. Forestry and logging (North American Industry Classification System; NAICS 113) has been relatively stable during that period, with an overall peak in 2014 and a low in 2016. Wood products manufacturing (including primary sawmills) (NAICS 321) had a downturn from 2014 to 2015 but increased from 2015 to 2017. Finally, furniture and related products exports (NAICS 337) have been in steady decline since 2014. Overall, the recent trend for international exports from Ohio shows relative stability when looking at all three industries but the decline in furniture and related products exports is somewhat concerning.

In 2017, the forest industry generated $27.2 billion in Ohio. An estimated 39% of the value of the entire forest products industry in Ohio came from out-of-state exports and 4% from international exports. Approximately 59% of total industry output (GDP) was from pulp and paper products, 22% from solid wood products, 13% from wood furniture, and 4% from forestry services and logging (Mehmood 2019).

Table 19. Exports from Ohio (top five from 2018) in industrial classification NAICS 113, Forestry and Logging. Data source: Foreign Trade Division, U. S. Census Bureau.

Destination	**2014**	**2015**	**2016**	**2017**	**2018**
	$ (in thousands)				
China	27,689	24,427	25,402	36,486	43,163
Japan	3,603	3,550	5,522	7,599	8,629
Vietnam	2,060	2,690	2,115	3,473	5,196
Mexico	3,622	3,491	2,375	2,294	3,296
Canada	913	1,696	1,256	2,075	2,382
Rest of world	37,411	30,809	23,751	14,876	17,399
Total	**75,298**	**66,662**	**60,422**	**66,787**	**80,065**

Table 20. Exports from Ohio (top five from 2018) in industrial classification NAICS 321, *Wood Product Manufacturing*. Data source: Foreign Trade Division, U. S. Census Bureau.

Destination	2014	2015	2016	2017	2018
	$ (in thousands)				
Canada	95,908	81,531	90,761	93,792	90,949
China	59,306	59,140	81,265	98,546	76,362
Vietnam	5,587	5,521	7,024	8,318	9,427
United Kingdom	7,893	5,785	9,568	10,379	7,776
United Arab Emirates	2,447	3,303	3,467	5,600	7,638
Rest of world	87,237	76,022	73,432	78,540	77,526
Total	**258,378**	**234,302**	**265,517**	**295,175**	**269,678**

Table 21. Exports from Ohio (top five from 2018) in industrial classification NAICS 337, *Furniture and Related Product Manufacturing*. Data source: Foreign Trade Division, U. S. Census Bureau.

Destination	2014	2015	2016	2017	2018
	$ (in thousands)				
Canada	202,517	141,515	146,558	130,905	127,294
Mexico	16,869	16,882	18,975	14,025	15,517
United Kingdom	6,480	6,222	9,623	5,111	5,722
Japan	6,325	5,312	5,283	6,465	5,058
Saudi Arabia	7,091	5,373	1,620	3,370	3,793
Rest of world	54,438	53,148	44,856	46,762	42,147
Total	**293,720**	**228,452**	**226,915**	**206,638**	**199,531**

Non-timber forest products

Non-timber forest products (NTFPs) are products that come from the forest that are not timber-based. Wildlife or other fauna are generally not included as NTFPs (Chamberlain 2007). NTFPs are harvested for a variety of purposes, including medicinal, decorative, culinary, and spiritual. They have economic and cultural value and contribute to Ohio's forest-based economy. Several factors make it difficult to track NTFPs harvests or removals. For example, culinary NTFPs that are harvested for personal consumption are generally not reported, and some high-value products, like ginseng, that are collected illegally (i.e., poaching) may be reported with false information, if reported at all. NTFPs in Ohio include ginseng, bloodroot, goldenseal, black cohosh, maple syrup, walnut, various mushrooms, vines used in decorative items, and various berries (i.e., blackberry and blueberry). Christmas trees are also considered to be NTFPs. Data exist for maple syrup, ginseng, and Christmas trees, but data are lacking for most other NTFPs.

Maple syrup

Maple syrup is one of the most valuable NTFPs in Ohio. Reporting of maple syrup production numbers is not required, so numbers reported are not exact, and likely very much an underestimate. In 2013, the total value of maple syrup production was $5,719,500, and that

represents the highest annual total of the past 10 years (Table 22). In 2013, Ohio ranked 5th nationally in maple syrup production based on volume (Figure 87).

Table 22. Annual production, average price per gallon, and total annual value of maple syrup in Ohio. Data source: USDA National Agricultural Statistics Service (NASS).

Year	Total production (1000 gallons)	Price per gallon	Total value (1000 dollars)
2007	63	$39.00	$2,457.00
2008	100	$37.90	$3,790.00
2009	90	$40.30	$3,627.00
2010	65	$42.70	$2,775.50
2011	125	$40.30	$5,037.50
2012	95	$42.50	$4,037.50
2013	155	$36.90	$5,719.50
2014	130	$42.80	$5,564.00
2015	115	$41.20	$4,738.00
2016	70	$39.80	$2,786.00
2017	80	$38.50	$3,080.00
2018	90	$45.40	$4,086.00

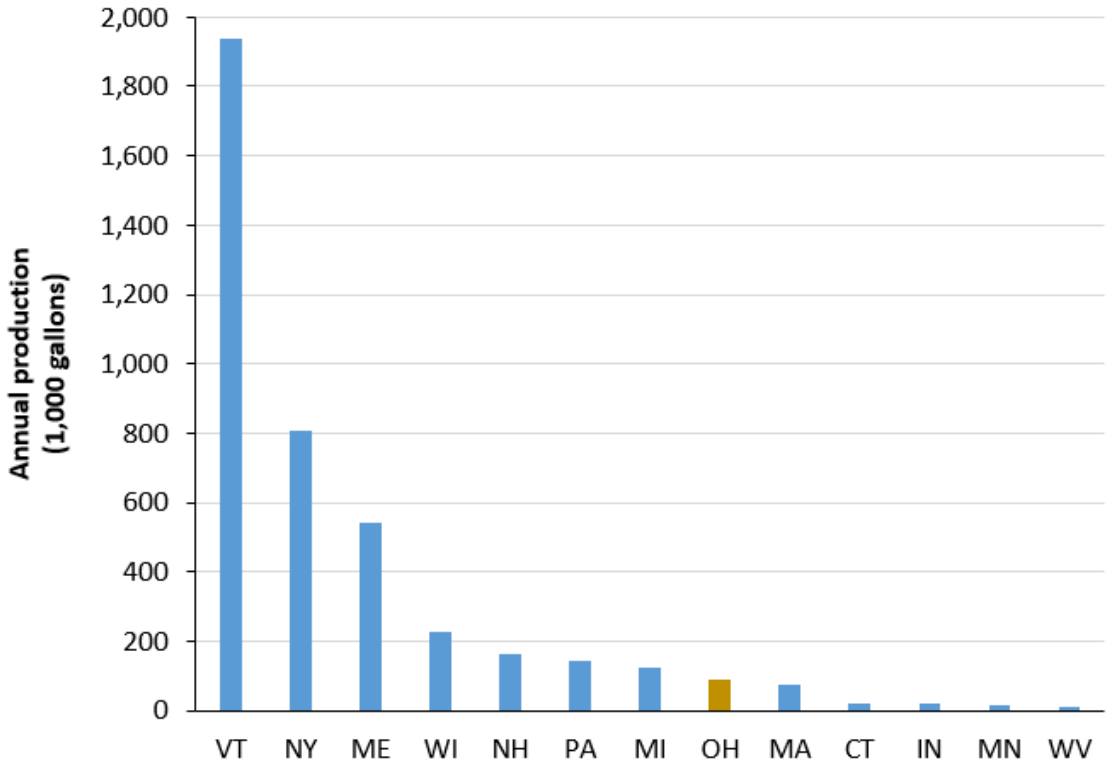

Figure 87. Maple syrup production by state in 2018. Data source: USDA NASS.

Ginseng

Per unit weight, ginseng is one of the most valuable non-timber products. Records indicate that over the last 10 years, annual wild ginseng prices have ranged from $250 to $880 per pound, with an average annual price of $483 per pound (Source: Purdue Extension). Based on annual reports from the ODNR Division of Wildlife's Ginseng Program, harvests dropped significantly in the late 1990s but have remained relatively steady since then (Figure 88) with 3,060 pounds dry weight harvested in 2017. Ohio ranked 3rd among states that responded to requests for ginseng harvest amounts for 2017 (Figure 89). However, when looking at figures published in Ohio's 2010 Forest Resource Assessment, Ohio ranked 6th when more states are represented. Ohio Administrative Code sets laws governing the harvesting, selling, and buying of ginseng, and the ODNR Division of Wildlife administers Ohio's ginseng program. More details about Ohio's ginseng laws are available online at: http://wildlife.ohiodnr.gov/licenses-and-permits/specialty-licenses-permits#tabr2.

One challenge when evaluating data on ginseng harvests is the lack of information on how the harvested ginseng was produced. In addition to naturally occurring wild populations of ginseng, ginseng producers may grow "wild-simulated" ginseng or use "woods-cultivated" methods. Wild-simulated growers purchase seeds and plant them in the woods for future harvest, and their plantings are often less than 1 acre in size. Woods-cultivated growers expend much effort on site preparation, often using mechanized equipment, and plant large beds of ginseng over several acres. Woods-cultivated growers may also use more intensive agricultural practices, like pesticide applications and tilling. In Ohio, a conservative estimate of at least 400 wild-simulated growers have been made, with possibly an additional 30 woods-cultivated growers (Persons and Davis 2008; Rural Action pers. comm.), but no comprehensive data exist on ginseng harvests in Ohio that distinguishes between wild ginseng, wild-simulated, and woods-cultivated ginseng.

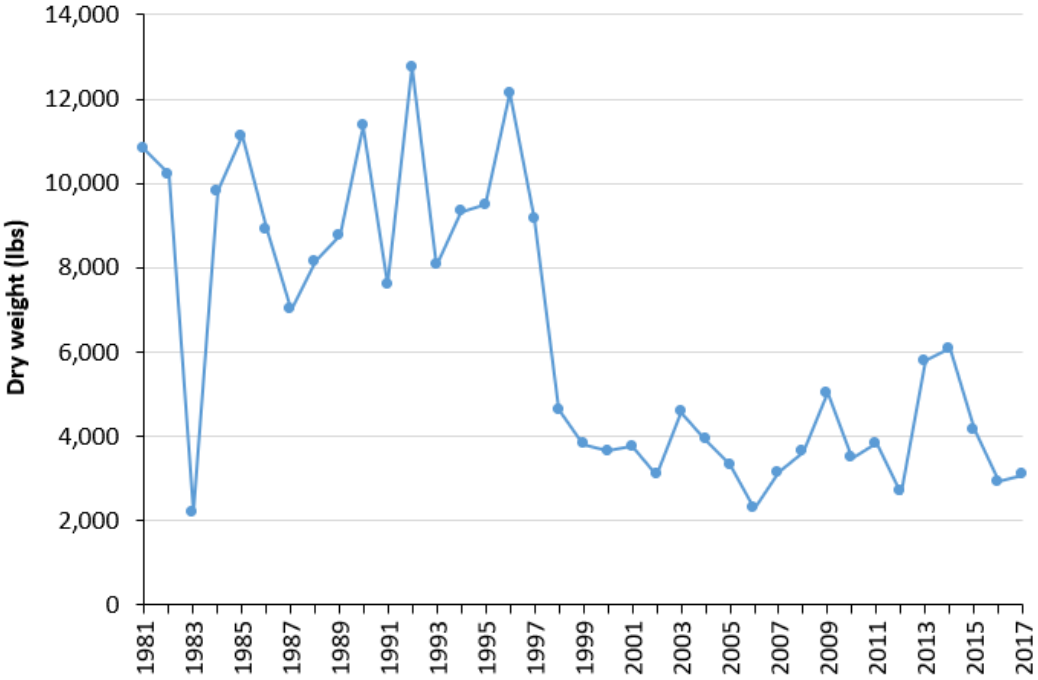

Figure 88. Annual ginseng harvests in Ohio, as reported by the ODNR Division of Wildlife Ginseng Program.

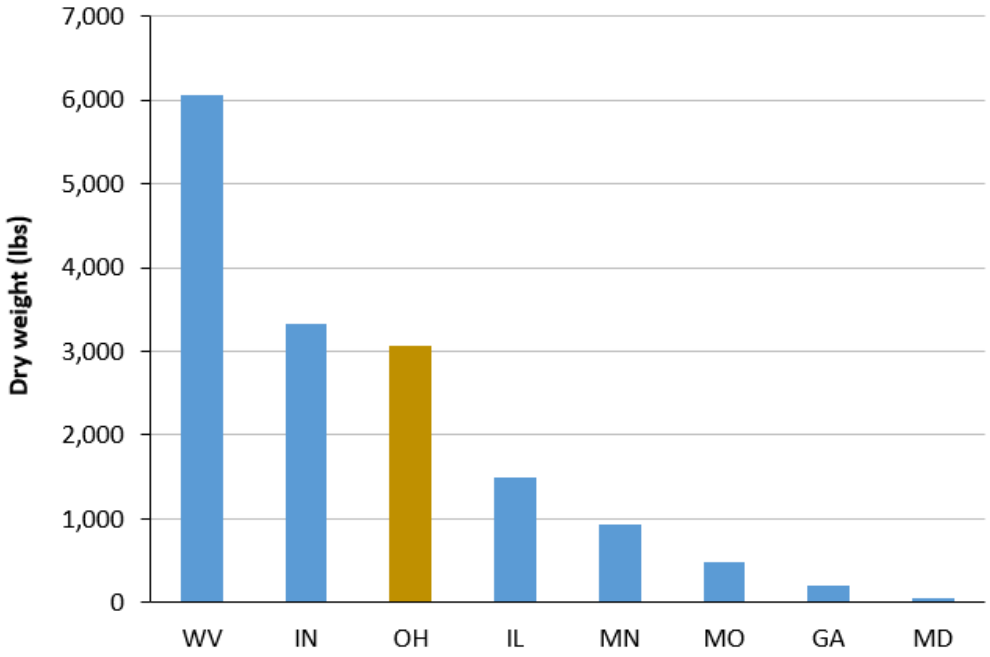

Figure 89. Ginseng production in dry weight pounds by state for 2017. Individual state departments of natural resources were contacted for ginseng yield. Only those states that responded to this request for data are displayed.

Christmas trees

Christmas trees are another important NTFP in Ohio. Gross sales from Christmas trees totaled over $7 million in 2014 (Table 23). Ohio ranked 8th among states based on gross sales of Christmas trees in 2014 (Figure 90).

Table 23. Comparison of Christmas tree production in Ohio between 2003 and 2017, by number of producers, number of trees sold, gross sales, and area in production. Data source: USDA National Agricultural Statistics Service.

	2003	2006	2009	2012	2014	2017
Producers	17	21	79	489	129	447
Quantity sold (trees)	51,000	49,000	69,942	N/A	231,951	N/A
Gross sales (million $)	1.997	1.587	2.575	3.630	7.122	4.889
Area in production (acres)	1,000	1,069	1,974	7,173	3,284	7,714

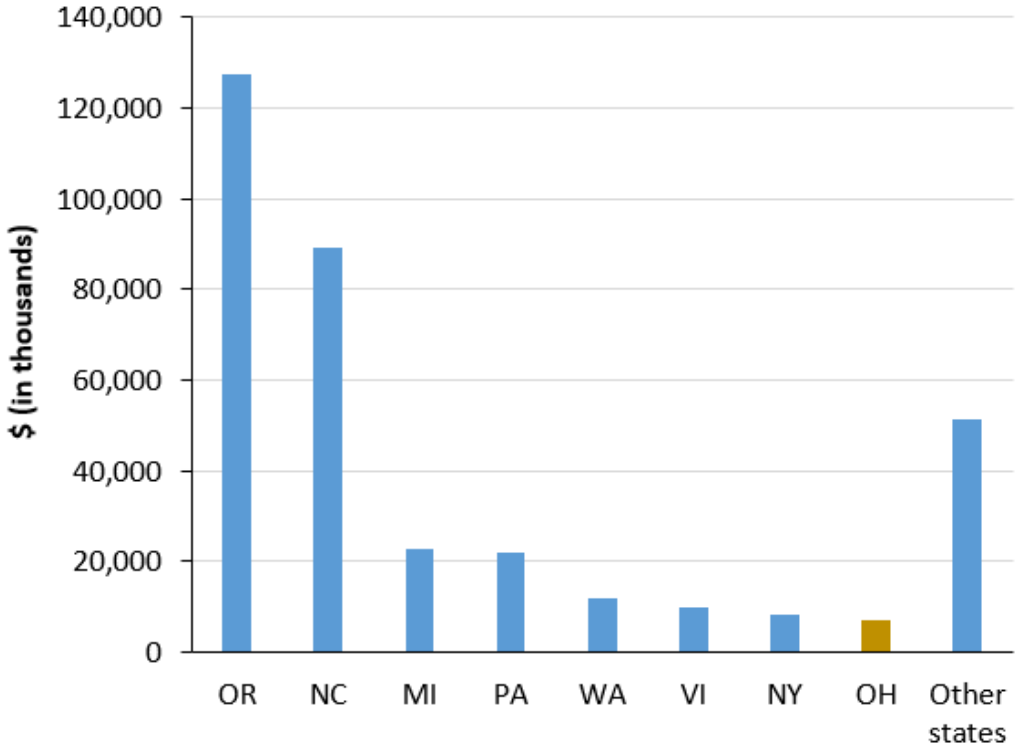

Figure 90. Christmas tree production by state by gross sales in 2014. Data source: USDA National Agricultural Statistics Service.

Indicator 13 – Outdoor recreational participation and facilities

Forests are an important aspect of outdoor recreation in Ohio. Recreational aspects of property consistently rank high as a reason for owning forest land. According to the Outdoor Industry Association, in 2017, 58% of Ohioans participate in some form of outdoor recreation every year, generating $24.3 million in consumer spending and sustaining an estimated 215,000 direct jobs, $7 billion in wages and salaries, and $1.5 billion in state and local tax revenue (Outdoor Industry

Association 2017). According to Ohio's 2018 Statewide Comprehensive Outdoor Recreation Plan (SCORP), state forests support numerous outdoor recreation opportunities with over 26,000 hikers, 18,000 hunters and anglers, and 17,000 horseback riders utilizing Ohio's state forest lands annually (ODNR 2018a). Visitors to state forests can enjoy more than 350 miles of backcountry bridle trails, 80 miles of hiking and backpacking trails, and 50 miles of mountain bike trails. State forests also offer a variety of camping opportunities, including family campgrounds, primitive horse camps, primitive backpacking sites, and "park and pack" campsites for novice backpackers. The Division also manages the 8,000-acre state designated wilderness area at Shawnee State Forest in southern Ohio (ODNR 2018a). An Ohio State University study found that outdoor recreation was an industry valued at over $8 billion in 2017, or 1.3% of income for Ohioans, and employed nearly 133,000 workers; 1.9% of Ohio's total workforce (Gioglio et al. 2019). Further, forests on public land in Ohio generate $273 million in recreational benefits annually, or $309 per acre.

Participation in outdoor recreation

The 2018 SCORP does not provide the number of user days of outdoor recreation experiences but uses the number of times that households participated in a given outdoor recreational activity and the percentage of households that participated. As indicated in Figure 91, outdoor activities for which forests provide a context are popular. Activities such as wildlife observation, trail use, and picnicking are assumed here to have at least a significant forest base to them.

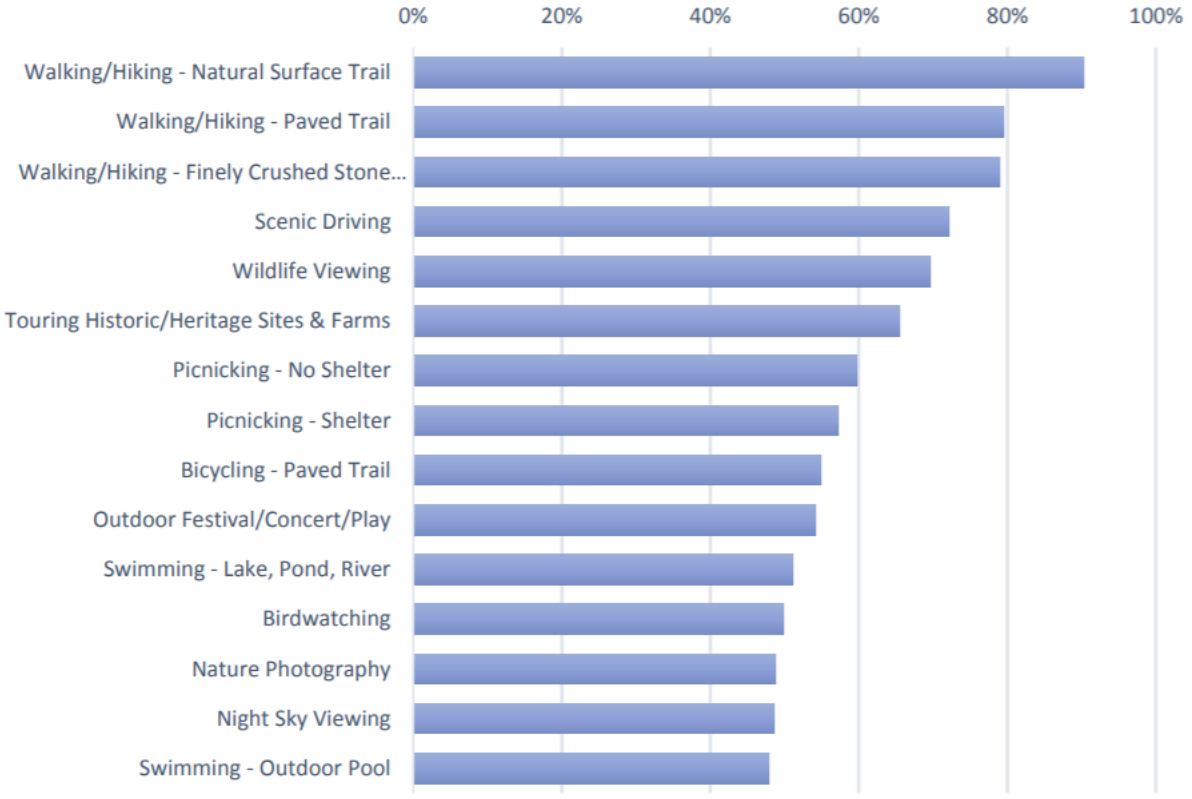

Figure 91. Statewide (percent of households) participation in outdoor recreation categories (ODNR 2018a).

Several trends are noted in the 2018 SCORP germane to this forest resource assessment. Backcountry camping has increased and newly surveyed outdoor recreational activities such as winter camping and snowshoeing are in demand. It is also noted that many Ohioans still have a strong interest in quiet, nature-based activities such as hiking, wildlife observation and photography, mountain biking, kayaking, and camping. Also, hiking, walking, and jogging on Ohio trails is still a major source of recreation for Ohioans as walking and hiking on natural surface trails was the top outdoor recreation area (ODNR 2018a). Gioglio et al. (2019) found that Ohioans take 171 million outdoor recreational trips annually and spend $5.9 billion on these trips.

Ohio's forest land is important in providing hunting opportunities. While national and regional surveys indicate a decline in hunting overall (White et al. 2016), the number of non-residents hunting in Ohio has risen since 2011 (ODNR 2018b). Public land is also very important for hunting in Ohio. Eighteen percent of non-resident deer harvest occurred on public land, more than twice the rate of Ohio-resident deer harvest (ODNR 2018b).

Land open to recreation

Ohio's forests are 85% privately owned. Only 6% of privately-owned forest is leased for recreational purposes, making the demand for recreation on the 14% of publicly owned forest, quite high (Butler et al. 2016). There are four main federal entities that own and manage properties in Ohio: the USDA Forest Service, Department of Defense, Fish and Wildlife Service, and the National Park Service. In the aggregate, these areas account for approximately 342,416 acres (USDA Forest Service FIA data). The Department of Defense, through the Army Corp of Engineers, manages 23 areas for the purposes of flood control; these areas are typically open water or an associated area to handle the flood pool level for the reservoirs. The primary uses for the reservoirs are flood control, navigation, hydropower, and water supply, but they also offer opportunities for outdoor recreation and fish and wildlife management (ODNR 2018a). While not directly a forest-based recreation type, forests often provide a backdrop for the water-based recreation. The Department of Defense also manages three major military installations: Wright-Patterson Air Force Base, the Ravenna Arsenal, and the Defense Construction Supply Center. While Wright-Patterson AFB and the Ravenna Arsenal in particular contain forest land, these lands are not typically open for recreation. As such, Department of Defense lands are not considered for the purposes of this analysis.

The U.S. Fish and Wildlife Service maintains nearly 9,000 acres within three national wildlife refuges in Ohio: Cedar Point National Wildlife Refuge, Ottawa National Wildlife Refuge, and West Sister Island National Wildlife Refuge. These areas have some forest cover but are primarily water and marsh and, while open to recreation and providing a great deal of recreational value, do not provide forest-based recreation. Therefore, these areas are not considered for the purposes of this analysis.

In Ohio, the primary role of the National Park Service is managing 11 Park Service units: Charles Young Buffalo Soldiers National Monument, Cuyahoga Valley National Park, David Berger National Memorial, Dayton Aviation Heritage National Historical Park (NHP), Fallen Timbers

Battlefield and Fort Miami's National Historic Site (NHS), First Ladies NHS, Hopewell Culture NHP, James A. Garfield NHS, Ohio & Erie Canalway National Heritage Corridor, Perry's Victory and International Peace Memorial, and William Howard Taft NHS (ODNR 2018a). These areas, to a varying degree, contain forest land. The Cuyahoga Valley National Park, at 33,000 acres in size, contains a large amount of forest. The USDA Forest Service manages the Wayne National Forest in Ohio. This forest contains over 244,000 acres, all of which is open to some form of recreation. Of the approximate 342,416 acres of federal land in Ohio, 264,000 acres are open for forest based recreational activities.

Both the USDA Forest Service and National Park Service buy lands as budgets and lands become available within their areas of interest. Neither can be considered to be in a rapid expansion phase. The Wayne National Forest in the recent past has had local resistance to expansion for fear of the impacts on local economies when lands are removed from the local tax base. In some cases, organizations have purchased lands for ultimate transfer to the USDA Forest Service until federal funds come available for acquisition by the Wayne National Forest.

Recreational facilities

Recreational opportunities on state land can be found throughout all ODNR lands but the division with the most robust system of recreational facilities is housed within the Division of Parks and Watercraft (Table 24). The ODNR Division of Parks and Recreation and Division of Watercraft merged into the Division of Parks and Watercraft in 2016 to streamline functions and improve service to both park visitors and boaters. The Division manages a system of 74 state parks in 59 counties encompassing more than 180,000 land and water acres and over 1,000 miles of trails (ODNR 2018a).

Table 24. Recreational Facilities under Division of Parks and Watercraft (ODNR 2018a).

Facility type	Amount	Comment
Beaches	74	
Golf courses	6	
Picnic sites	450	
Trails (miles)	440	hiking, mountain biking, and horseback riding
Resort lodges	9	
Family campgrounds	57	
Campground sites	9000	
Horseman's campgrounds	18	
Designated water trails	10	

Trails

Trail-based recreation is a significant source of recreation in Ohio. In 2019, the Ohio Trails Vision was released, which is a document that serves as a valuable framework for state governments to work with communities, land managers, trail advocates and users to advance the trail systems in Ohio. There is no one comprehensive inventory of trails located on all facilities in Ohio but according to the 2018 Ohio SCORP, trail-based recreation is noted as being the highest ranked

outdoor recreation activity by participation (Figure 91). The ODNR's 23 state forests, 136 nature preserves, 150 wildlife areas, and 74 state parks offer over 1,700 miles of recreational trails, which includes nearly 660 miles of hiking trails, 625 miles of horse/bridle trails, 210 miles of multi-use trails, 186 miles of mountain biking trails, over 50 miles of all-terrain vehicle (ATV) trails, and 19 miles of snowmobile trails. There are 2 national trails that cross Ohio: the North Country Trail (a National Scenic Trail) and the American Discovery Trail. There are 2 statewide trails that cross or circumnavigate the state in the Ohio to Erie Trail and the Buckeye Trail respectively. There are 63 county trails and 33 community trails that also serve the recreating public. Figure 92 shows the location of recreation trails in Ohio outside of national forest lands.

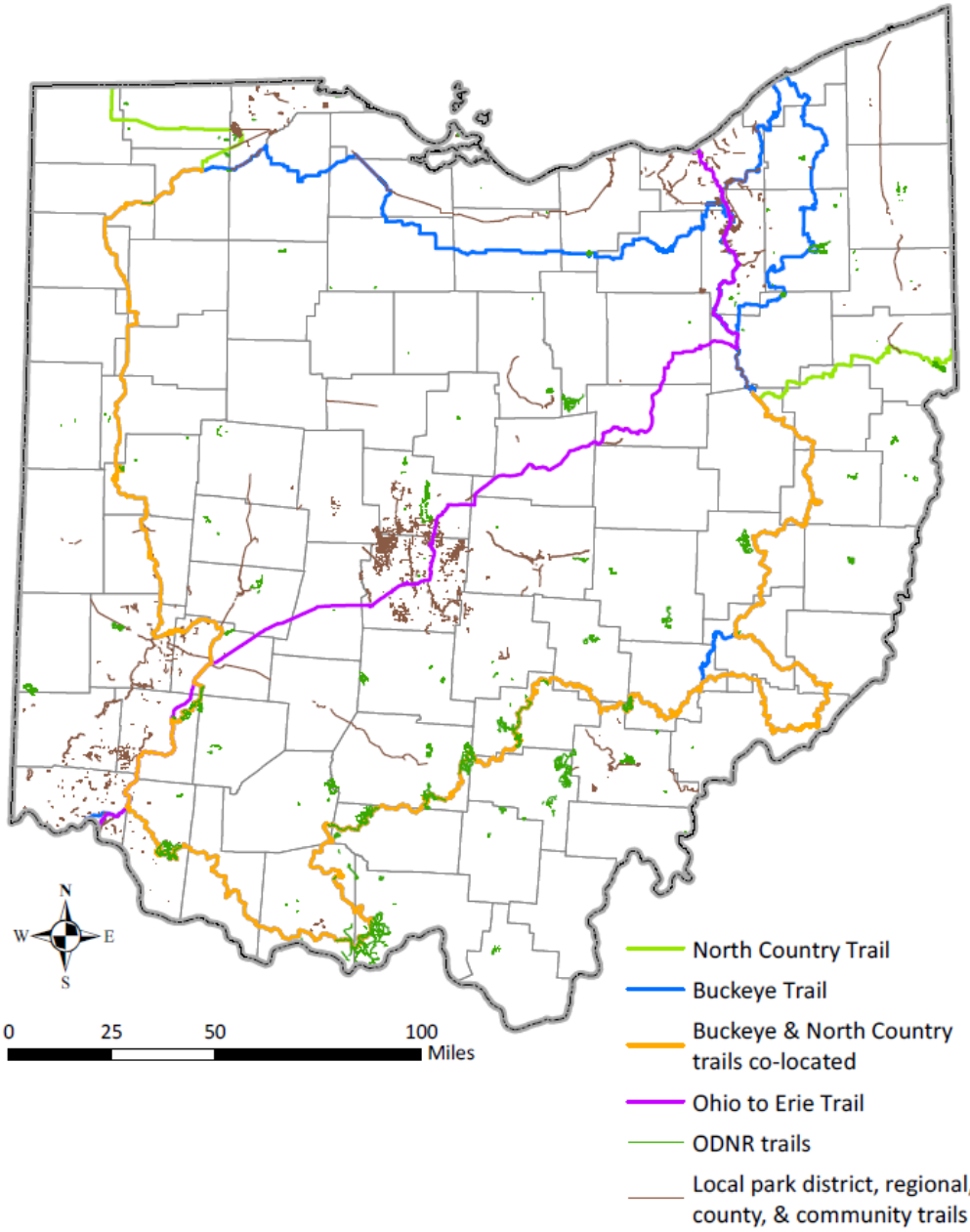

Figure 92. Map of Ohio's recreational trails. Data source: Ohio Department of Natural Resources.

Interest in trails has been growing across the state by both the citizens and the state legislature. This interest resulted in the development of a strategic plan in 2005 called "Trails for Ohioans – A Plan for the Future." Two strategic areas were noted in that plan: 1) Connecting Trails – to address the finding that many existing trails are discontinuous and not connected or easily accessible; and 2) Private Land and Trails – to address opportunities for trails on private lands or adjacent to private lands have not been maximized because of concerns about liability, privacy, litter, vandalism, theft and other real and/or perceived problems (ODNR 2005). Since the development of that report The Ohio Legislative Trails Caucus has partnered with the Ohio

Department of Natural Resources to develop a comprehensive online trail map that continually collects and consolidates Ohio's trail data which showcases much of the progress made towards those two strategic areas.

Campgrounds

According to the 2018 Ohio SCORP, the percent participation of camping has increased since the 2013 SCORP survey (ODNR 2018a). According to the inventory done in support of the 2018 Ohio SCORP, it was shown that Ohioans are wanting more developed and undeveloped campgrounds to better match their recreational interests.

Recreational facilities in national forests

Numerous recreational facilities are available on the Wayne National Forest in Ohio. The Wayne National Forest is comprised of 244,000 acres, all of which is open for some form of recreation for approximately 204,000 annual visitors. There are, however, a number of facilities constructed or specifically designated for recreational purposes (Table 25).

Table 25. Recreational facilities on the Wayne National Forest (ODNR 2018a).

Facility type	Amount
Campgrounds	10
Picnic group shelters	5
Fishing ponds	100
100-acre lakes	2
Boat launches	2
Swim areas	1
Multiple use trails (miles)	340

The state's first environmental impact bond was initiated on the Wayne National Forest to partially finance a $12.3 million, 88-mile mountain biking trail outside of Athens, known as the Baileys Trail System. This trail system is expected to generate $20 million annually in increased spending, $7 million in wages, $7 million in tax revenue, and 66 new jobs in 10 years (Quantified Ventures 2018).

Indicator 14 - Investments in forest health, management, research, and wood processing

Significant investments occur in the areas of forest health, management, research, and wood processing in Ohio. Some of the major organizations that are investing in Ohio's forest resources and their management include the USDA Forest Service (Wayne National Forest, State & Private Forestry, and Northern Research Station), the USDA Natural Resources Conservation Service, the U.S. Fish & Wildlife Service, the Ohio Department of Natural Resources (Divisions of Forestry, and Wildlife), county soil & water conservation districts, the Ohio Environmental Protection Agency, the Ohio Department of Agriculture, the Ohio State University Extension, Central State University Extension, The Nature Conservancy, the Ohio Forestry Association, Pixelle Specialty Solutions,

and American Electric Power. Numerous colleges and universities have faculty who are conducting research in Ohio, including the Ohio State University, Ohio University, University of Dayton, and the University of Cincinnati. Descriptions of two federal agencies with significant investments in Ohio's forests follow. The ODNR Division of Forestry also invests significant resources through its various program areas; details about those programs can be found in the Statewide Strategy document.

USDA Forest Service Research funding

The Northern Research Station of the USDA Forest Service has a research laboratory in Delaware, Ohio. While significant research from the Delaware Laboratory is conducted in Ohio, the research is not exclusive to Ohio. As of 2019, five research work units of the USDA Forest Service have researchers stationed at the Delaware Laboratory. The research work units include: NRS-1 "Ecological and Economic Sustainability of the Appalachian Forest in an Era of Globalization," NRS-2 "Sustaining Forests in a Changing Environment," NRS-5 "Forest Inventory and Analysis," NRS-6 "Climate, Fire, and Carbon Cycle Sciences," and NRS-16 "Restoration and Conservation of Rural and Urban Forests." The Northern Research Station's Communications and Science Delivery unit also has staff located at Delaware. USDA Forest Service researchers receive funding from a variety of sources, including grants from the National Fire Plan (https://www.forestsandrangelands.gov/resources/overview/) and the Joint Fire Science program (https://www.firescience.gov/).

USDA Natural Resources Conservation Service & Farm Service Agency

The USDA Natural Resources Conservation Service (NRCS) administers multiple programs that invest in forest and wildlife management in Ohio, including the Environmental Quality Incentive Program (EQIP) and the Conservation Stewardship Program (CSP). Several Farm Service Agency (FSA) programs fund tree plantings on private property including the Conservation Reserve Program (CRP), and the Conservation Reserve Enhancement Program (CREP). One NRCS program that focuses on various forest management practices and encourages such management through landowner incentives is EQIP. Through Forestry EQIP, forest landowners receive incentive payments to complete practices like tree plantings, invasive plant and grapevine control, structures for wildlife construction, crop tree release thinning, and forest management plan development. Figure 93 shows the recent trend for Forestry EQIP funding in Ohio. In 2015, a special forestry EQIP program was established that emphasizes oak management in a 17-county area in southeastern Ohio.

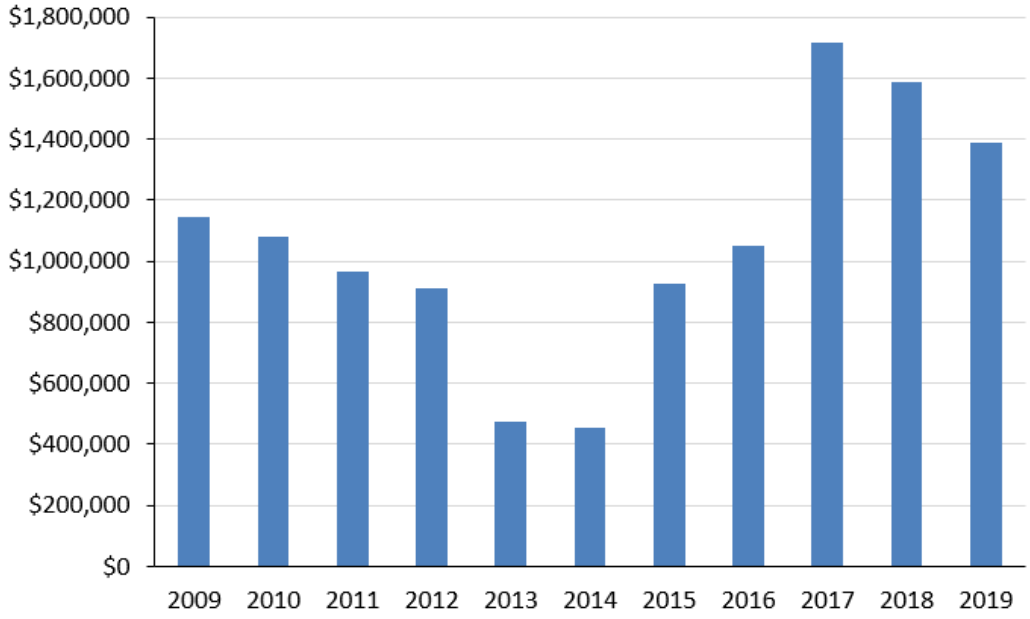

Figure 93. Annual investment in forestry practices through the Environmental Quality Incentive Program (EQIP) administered by the USDA NRCS from 2009-2018.

Indicator 15 – Forest certification

Forest certification systems utilize independent, third-party monitoring and verification to assure compliance with established sustainability standards for forest management. Table 26 summarizes the major certification systems in the United States. North America has experienced significant growth in forest certification in recent years. This growth has been fueled in large part by increased interest and demand for environmentally friendly paper products and the green building movement. As of January 2018, the Forest Stewardship Council (FSC) had 35,323,927 acres certified in the U.S. and 3,954 companies were chain-of-custody certified in the U.S. (FSC-US 2018). Figure 94 shows the annual growth in total FSC chain of custody certificates in Ohio. In 2018, 197 Ohio companies held FSC certificates, including a mix of printers, paper manufacturers, and primary and secondary wood products companies (many of which likely supply the green building market). The Sustainable Forestry Initiative (SFI) has also seen a rapid increase in certificates over the past several years, primarily related to paper products. For example, the number of Ohio companies holding SFI certificates went from 1 in 2006 to 53 in March 2018 (Figure 95); these 53 companies are mostly printers or manufacturers of paper products with only two being wood manufacturers. A check of SFI's online database indicated 41 chain of custody certificates in Ohio as of August 2020.

Table 26. General overview of forest certification systems in the United States. The three systems that are described are: Sustainable Forestry Initiative (SFI), American Tree Farm System (ATFS), and Forest Stewardship Council (FSC). PEFC stands for Programme for the Endorsement of Forest Certification Systems.

	SFI	**ATFS**	**FSC**
Date established	1994	1941	1993
Scope	All forests in North America	Non-industrial private forests in the United States	All forests; worldwide
Certificate length	5 years	5 years	5 years
Monitoring	Annual surveillance audit	Annual surveillance audit	Annual surveillance audit
Product labeling	Yes	No; eligible for SFI or PEFC label	Yes
Group certificate	No	Yes	Yes
LEED recognized	Yes	Yes	Yes
Number of Ohio companies or individuals with forest management certificates	1	1,200	2
Acres of certified forest land in Ohio	199,901	155,194	222,551
No. of Ohio companies with chain of custody certificates	53	53 (SFI chain of custody)	197

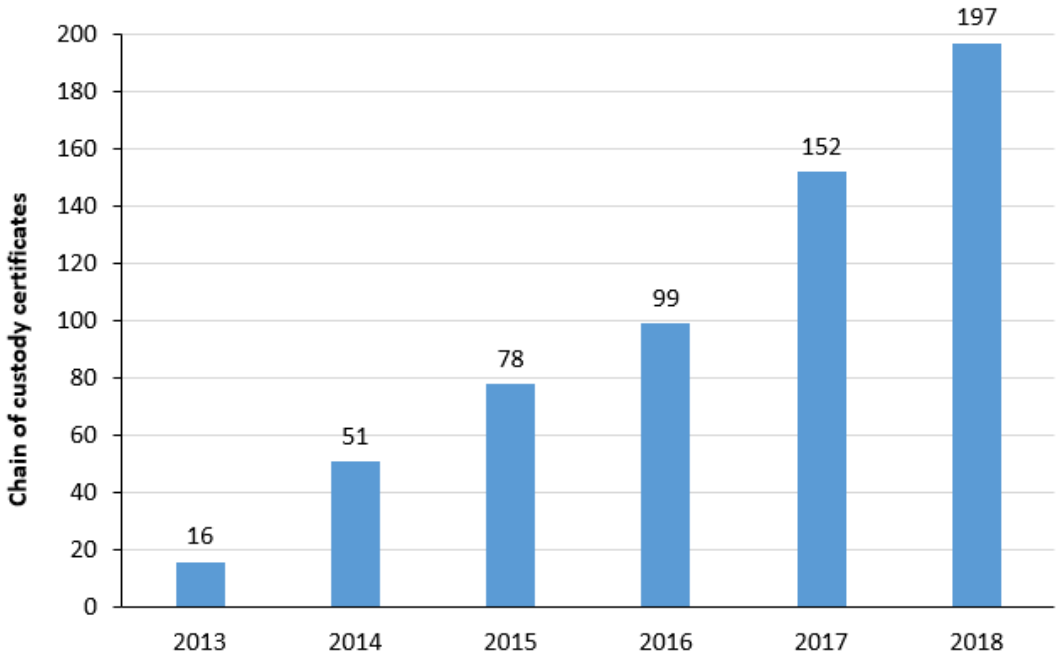

Figure 94. Forest Stewardship Council (FSC) chain of custody certificates in Ohio from 2013 to 2018 (FSC-US 2018).

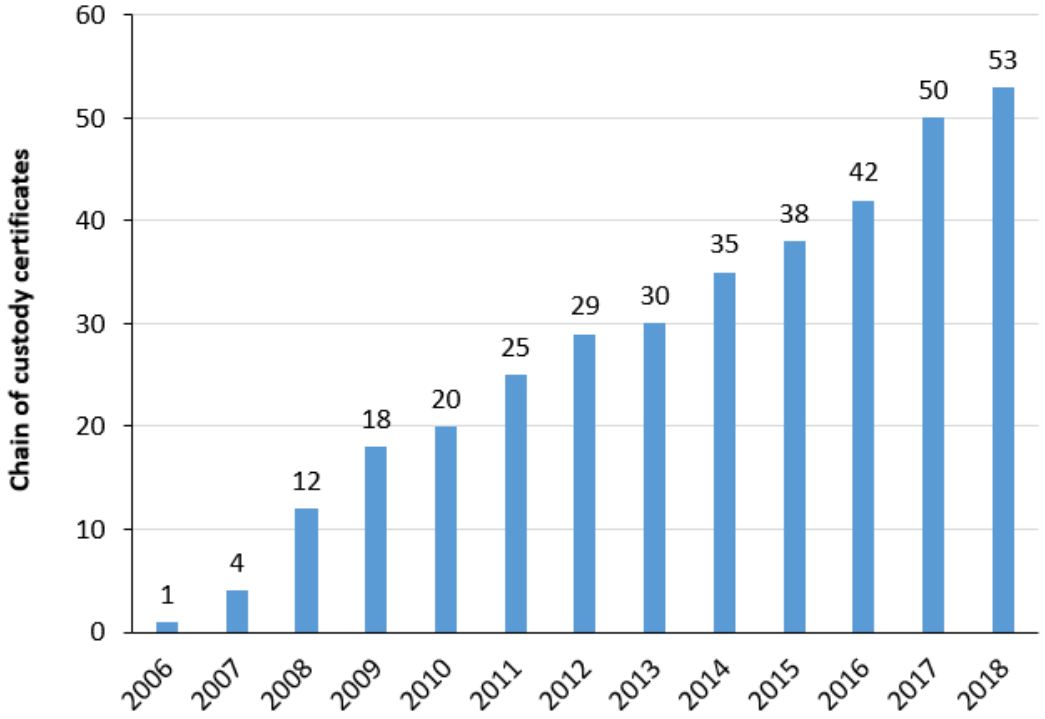

Figure 95. Sustainable Forestry Initiative (SFI) chain of custody certificates in Ohio from 2006 to 2018. Data source: SFI.

Current certification efforts in Ohio

In 2010, the ODNR Division of Forestry received certification to the principles and criteria of the FSC and SFI. All of Ohio's 23 state forests covering more than 200,000 acres are now certified. In 2009, the ODNR Division of Forestry also conducted a feasibility study of implementing a private lands forest certification program in Ohio. While options exist for certification of private forest lands in Ohio, including a group certificate of the Division's Ohio Forest Tax Law program, no private lands certification program has been initiated in Ohio outside of the American Tree Farm System.

The American Tree Farm System (ATFS) certification standards are endorsed by PEFC. The system decided to allow states to opt in or out of certification in 2014, and the Ohio Tree Farm Committee determined to remain as a certified state. The state is assessed every five years and was assessed in 2015 and is undergoing assessment again in 2020. While there are no documented cases of tree farm wood bringing additional prices at the mills, Ohio's largest timber buyers are positive about Ohio's tree farm certification. Additionally, there are anecdotal reports that the certification is helpful for sales of non-timber forest products (NTFP), particularly maple syrup. The ATFS achieved recognition from the American Green Building Council in 2016.

Indicator 16 – Employment and wages in forest-related sectors

The major recession of 2007-2009 impacted most businesses in the country, and world, including forest-related sectors. Some of the key triggers of the recession were associated with the housing sector, which has direct links to forest-related sectors based on the construction materials that the forests and forest products industries supply, as well as secondary impacts on furnishings such as furniture. However, since that time the economy has improved, and most metrics of employment and wages within the various forest-related fields have improved with the subsequent economic upturn.

Wood-related products manufacturing

From 2010 to 2018, employment in the wood products manufacturing sector experienced an overall increase (Table 27). Similarly, the furniture and related products sector also experienced an overall increase in employment. However, the forestry and logging sector has declined with the net change from 2010 to 2018 being over 22%. Data on total wages showed that the forestry and logging sector was flat while wood products manufacturing and furniture and related products increased (Table 28). For number of establishments, the furniture and related products sector realized a small increase while the wood products manufacturing and forestry and logging sectors saw declines (Table 29).

Table 27. Number of employees in Ohio forest products manufacturing by NAICS industrial classifications. NAICS 113 represents forestry and logging, NAICS 321 represents wood products manufacturing, and NAICS 337 represents furniture and related products manufacturing. Data source: Bureau of Labor Statistics, U.S. Department of Labor.

Year	NAICS 113	NAICS 321	NAICS 337
2010	372	11,155	14,918
2011	354	10,939	13,737
2012	364	11,203	13,792
2013	365	11,588	14,165
2014	341	11,971	14,703
2015	336	12,264	14,894
2016	284	12,988	15,545
2017	263	13,008	16,077
2018	287	12,925	16,146

Table 28. Total wages (in thousands of dollars) in Ohio forest products manufacturing by NAICS industrial classifications. NAICS 113 represents forestry and logging, NAICS 321 represents wood products manufacturing, and NAICS 337 represents furniture and related products manufacturing. Data source: Bureau of Labor Statistics, U.S. Department of Labor.

Year	NAICS 113	NAICS 321	NAICS 337
2010	10,038	374,261	585,289
2011	9,580	366,644	565,523
2012	10,031	386,174	571,623
2013	10,355	405,064	591,552
2014	10,837	443,592	628,376
2015	11,121	478,545	638,374
2016	8,943	514,018	673,102
2017	9,003	532,361	720,973
2018	10,055	557,861	739,373

Table 29. Number of establishments in Ohio forest products manufacturing by NAICS industrial classifications. NAICS 113 represents forestry and logging, NAICS 321 represents wood products manufacturing, and NAICS 337 represents furniture and related products manufacturing. Data source: Bureau of Labor Statistics, U.S. Department of Labor.

Year	NAICS 113	NAICS 321	NAICS 337
2010	85	633	706
2011	86	629	687
2012	78	609	689
2013	80	590	688
2014	80	589	701
2015	79	590	706
2016	74	607	708
2017	73	608	718
2018	78	595	723

Criterion 7 – Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

Indicator 17 – Forest management standards/guidelines

Forest management standards and guidelines are typically composed of scientifically proven silvicultural means to accomplish desirable ends, assembled into policy or recommendations as forest management standards or guidelines. Forest management decisions by their nature have long-term consequences. Management decisions made today can impact the forest for decades. One should note that what is considered to be an acceptable, even beneficial, practice today can be found to be detrimental decades from now. The goal of forest management standards and guidelines is to place some sideboards on the range of potential forest management decisions; discouraging or prohibiting those practices currently believed to be detrimental and encouraging those currently believed to be beneficial. Such standards are important in the management of natural resources where there are intricate interdependencies among various natural resources.

Types of forest management standards/guidelines

There are several forest management standards and guidelines. Where they apply depends on the framework within which they were developed and adopted. Ohio is home-rule state with each jurisdiction/political subdivision having the ability to, within limits, adopt regulations that may include forest management standards or guidelines. There is no comprehensive listing of these regulations. The list below is what is known at this time.

- State forest management manual
- Ohio Forest Tax Law (OFTL)
- Current Agricultural Use Value (county-specific)
- American Tree Farm System (ATFS)
- BMPs for Erosion Control for Logging Practices in Ohio
- Sustainable Forestry Initiative (SFI)
- Forest Stewardship Council (FSC)

- Program for Endorsement of Forest Certification (PEFC)
- USDA Forest Service Forest Stewardship Program
- USDA NRCS Conservation Activity Plan 106 (Forest Management Plan)
- Local municipal ordinances
- Township and county resolutions
- ANSI standards for tree care, nursery stock, and safety (ISA, TCIA, ANLA)
- Tree Risk Assessment Qualification (ISA)
- Tree City/Campus/Line/Health USA (ADF)
- National Wildfire Coordinating Group (NWCG)
- Firewise Communities USA/National Fire Protection Association (NFPA)

Each of these standards/guidelines is continually evolving. Interest and utilization of third-party certification schemes (SFI, FSC, ATFS, PEFC) continues to rise. There is also increasing interest by local governments (municipal, county and township) in developing zoning ordinances/resolutions to apply some level of standard to forest management.

Voluntary and mandatory standards/guidelines

Most of the forest management standards and guidelines for privately owned/family forests are ultimately voluntary. The programs for family forests listed in the preceding paragraph (which excludes the state forest management manual and the governed state forest lands) are all voluntary in nature. In each of these programs, a landowner voluntarily enrolls and simultaneously agrees to manage to the standards of the program. The landowners may also voluntarily remove their properties from the programs with little or no penalty to the individual landowner.

The extent of urban and community forest management standards and guidelines varies greatly from community to community. Ohio communities fall under the rules of Ohio Revised Code (ORC), in particular 723.01 and 2744.02 which gives political subdivisions the authority to manage public infrastructure and states that they "…are liable for injury, death, or loss to person or property caused by their negligent failure to keep public roads in repair and other negligent failure to remove obstructions from public roads…" As society becomes increasingly litigious, pressure continues for Ohio's local governments to develop quality ordinances, resolutions, policies, and specifications. The Tree City/Campus/Line/Health voluntary programs require basic, minimum management standards.

Monitoring of standards/guidelines

Each of the programs mentioned previously requires some monitoring of standards and guidelines. State forest management requires routine monitoring. The Ohio Forest Tax Law requires that properties be monitored at least every five years for compliance with management plans. The three principle forest certification programs, SFI, ATFS and FSC, require periodic audits for conformance to management standards. Some monitoring of best management practice (BMP) compliance occurs periodically. For example, members of Ohio's Master Logger program (administered by the Ohio Forestry Association) must permit Logging Standards Council inspectors to review all aspects of their logging operations, including BMP compliance. The USDA

Forest Stewardship Program has also recently required plan monitoring on a random basis for adherence to program guidelines.

The Tree City/Campus/Line/Health programs are supported by the Arbor Day Foundation, USDA Forest Service, National Association of State Foresters, and other private entities. Standards for each program are reviewed annually by the ODNR Division of Forestry Regional Urban Foresters as local administrators of the program. Local political subdivisions are responsible for enforcing their ordinances and resolutions as well as overseeing contract and in-house work. Occupational Safety and Health Administration (OSHA) and American National Standards Institute (ANSI) standards are critically important in managing the urban forest resource and developing local policy and specifications. Awareness about local responsibility per ORC continues to be an incentive to exercise their duty of care by adhering to local law, policy, and specifications.

Additionally, Ohio's forestry pollution abatement rules and standards require all landowners and loggers conducting harvesting operations or other silvicultural activities to utilize best management practices (BMPs) to prevent water quality degradation associated with soil erosion (Ohio Revised Code 1503.50 to 1503.55; enacted 2016). Ohio does not require logging licenses, permits, or the mandatory submission of erosion prevention plans. However, the state does maintain a system whereby private citizens and public agencies may report alleged violations of state water quality standards. Through a cooperative working agreement, the ODNR Division of Forestry and Ohio's 88 soil and water conservation districts (SWCDs) respond to these complaints and work with the responsible parties to bring the sites back into compliance. Ultimately, if the responsible parties fail to achieve compliance in a timely manner, they may be found guilty of a first-degree misdemeanor. Each day of non-compliance is regarded as a separate offense. Under the forestry pollution abatement rules, persons responsible for a logging operation may also file a voluntary timber harvest plan with the SWCD in the county where the logging is to occur. The plan describes the BMPs that will be used to control soil erosion and protect water quality. These sites generally receive a significant level of monitoring by SWCD staff before, during, and after the harvest to ensure that the plans are followed.

Indicator 18 – Forest-related planning, assessment, policy, and law

Since the 1940s, periodic assessments of Ohio's forest resources have occurred through the USDA Forest Service's FIA Unit, with the most recent FIA report evaluating Ohio's forests through 2016. Beyond the scope of the FIA reports, Ohio's last statewide evaluation of forest resources was the 2010 Ohio Statewide Forest Resource Assessment (of which, this document is the 10-year update), which represented the first complete comprehensive statewide assessment of Ohio's forest resources using the criteria and indicator approach. This Forest Resource Assessment has a life expectancy of 10 years, and it will be updated at the end of that period, in conjunction with the accompanying Forest Resource Strategy document.

Forest assessment and planning by state forestry agencies

Ohio's state forests are managed by the ODNR Division of Forestry. The ODNR Division of Forestry has detailed descriptions of policies, laws, and guidelines relevant to core state forest management programs in a series of manuals. The Land Management Manual was updated in 2016.

The state forest management plan sets forth desired future conditions and goals for all state forests over a five-year period. The plans are guided by the statewide forest action plan and responsibilities delegated to the ODNR Division of Forestry in the Ohio Revised and Administrative Codes. Annual work plans are written for individual forests (Maumee and Mohican state forests) or all the state forests within a given forest district, that outline more detailed work expectations for a given year. The annual work plans are created by the district manager with input from forest managers and program administrators. They shall be presented to the public at the first available opportunity, typically at annual open house events.

Forest management plan

The forest management plan will reference principles set forth in the statewide forest action plan to set the priorities for the five-year period. The purpose of the forest management plan is to set forth the overall state forest system goals that will guide the development of various projects. The forest management plan shall explain the state forest system's history, description in terms of specific features and landscape level importance, general management objectives at the forest level, give more specific information about the land management, fire management, recreation, and operations programs. These descriptions may be as specific as necessary but do not need to state work at a project level. The forest management plan will also incorporate inventory, growth and yield data, and calculations in order to determine sustainable harvest levels.

Annual work plans

The annual work plans should be written primarily from information contained in the forest management plan. Program areas detailed include resource management, recreation, maintenance, wildland fire, employee development, public outreach, and budgets. These plans are more specific and task-oriented than is the forest management plan. The work plans are intended to be used both internally to set work priorities and personnel goals. The annual work plans should list specific projects, i.e. cruising compartment A-1, marking a 25-acre shelterwood harvest in compartment G-3, presenting fire prevention messages in 3 parades, rerouting 3 miles of a specific trail, etc.

Program integration

Integration across program areas is important to effectively manage the entire forest system and ensure consistency across unit boundaries. An integration team exists that is composed of the Chief of the Division of Forestry, land management administrative staff and other program administrative staff. The integration team meets on an "as-needed" basis to review plans and other projects. State forests are the only forest lands in Ohio that are "dual-certified," by both the Forest Stewardship Council and the Sustainable Forestry Initiative and the efforts of the integration team are largely a means to implement these certification programs. The integration team will review forest management plans and annual work plans prior to public release, review the Shawnee Wilderness Area plan update every 10 years, and review public comments from open houses. They will review any expanded recreation proposals recommended at the forest level. They will also review other projects as needed, particularly when they cross unit boundaries and program areas.

Forest assessment and planning by private forest owners

The State Forest Stewardship Committee is an important advisory group for state-level planning related to non-industrial private forest lands (i.e., family forests). The committee includes representatives from key agencies and organizations across the state with forestry-related interests. Currently, the forest stewardship committee includes representatives from the following groups: the ODNR Division of Forestry, ODNR Division of Wildlife, USDA Forest Service State & Private Forestry, USDA Forest Service Wayne National Forest, the Ohio State University Extension, Central State University Extension, the Ohio Forestry Association, The Nature Conservancy, the Sierra Club, the USDA Natural Resources Conservation Service and Farm Service Agency, the Ohio Association of Soil & Water Conservation Districts, the Ohio Tree Farm Committee, Pixelle, Redoutey Logging, and the Appalachian Ohio Alliance. Some of the key statewide programs that provide family forest owners with support or guidance include the Forest Stewardship Program, the Forest Legacy Program (discussed in more detail below), the American Tree Farm System, Ohio Forest Tax Law, Ohio Woodland Stewards, U.S. Fish & Wildlife Service's Partners for Fish and Wildlife program, and several USDA cost-share or incentive programs (e.g., EQIP, CSP, CRP). Some private forest landowner assistance programs are also available at a more localized scale, like some Soil & Water Conservation Districts' forestry and/or wildlife programs and Rural Action programs (http://www.ruralaction.org/). Many programs supporting family forest owners either provide or require forest management plans specific to a landowner's property. The forest management plan is the primary tool for documenting current conditions on their properties and outlining recommended forest management practices to achieve landowner goals. Across the state, 85% of private landowners (with greater than 10 acres of forest land) do not have a forest management plan for their property (Butler et al. 2020). Of the 12% who are following a management plan, 42% of those plans were written by a state or local government forester and 58% of those plans were written by a private consulting or industry foresters. Private forest landowners also benefit from several programs that provide training and guidance to forest products industry and logging companies, like the Master Logger program administered by the Ohio Forestry Association and the Timber Harvest Plan program jointly offered by soil and water conservation districts and the ODNR Division of Forestry.

Future planning for family forests in Ohio could also consider a myriad of other programs or planning tools. One potential area for future programs is related to carbon markets. Partner organizations, including The Nature Conservancy and the American Forest Foundation, have developed private lands carbon programs in other states, and such opportunities could have potential in Ohio.

Forest assessment and planning for urban/community lands

Urban and community forestry assessment and planning varies from community to community. The ODNR Division of Forestry Urban Forestry Assistance Program offers free management assistance for all villages, cities, townships, and counties. The Urban Forestry program has focused significant effort in promoting local urban forest management plans and have developed a basic template as a starting point for communities of all sizes and expertise level.

The ODNR Division of Forestry Urban Forestry Assistance Program is required to participate in the USDA Forest Service Community Accomplishments Reporting System (CARS) which provides a valuable window to the progress, gaps, and trends including professional forestry staff, advisory boards, management plans, and ordinances on the local level. The addition of urban areas in the Forest Inventory Analysis (FIA) offers a new layer of assessment and monitoring. Annual sampling in Ohio's metropolitan areas and urban clusters will provide Ohio's urban forest managers and public decision-makers additional tools to monitor status/trends and assess ecosystem services, canopy cover, values, health, and risk from pests, diseases, climate change, and invasive species. The Urban National Landowner Survey (UNLS) examines the social dimensions of the urban forest. An assessment of urban wood processing and use is currently in development.

Other agencies and organizations offer a variety of assistance needs including the USDA Forest Service, local tree commissions/boards, SWCDs, Ohio State and Central State University Extension, Ohio Chapter of the International Society of Arboriculture (OISA), Ohio Independent Arborist Association (OIAA), Arbor Day Foundation, Urban Waters Federal Partnership (U.S. EPA), private and public electric utilities, and some local non-profits. In addition, Ohio has several private sector urban forest management firms that offer a variety of professional urban forest assessment and monitoring services.

Forest assessment and planning for federal lands

Ohio's only national forest is the Wayne National Forest. In the United States, each national forest and grassland is governed by a management plan in accordance with the National Forest Management Act (NFMA). These plans set management, protection, and use goals and guidelines. Monitoring conditions on a national forest ensure projects are done in accordance with plan direction and determine effects that might require a change in management. The current plan for the Wayne National Forest went into effect in 2006. Additional information about forest planning for the Wayne National Forest, including copies of the 2006 Forest Plan and supporting documents, can be accessed online at the Wayne National Forest website (https://www.fs.usda.gov/land/wayne/landmanagement) or by contacting the Wayne National Forest headquarters office at 740-753-0101. A summary of related efforts follows.

Related planning efforts for the Wayne National Forest:

- Programmatic Biological Opinion from the U.S. Fish and Wildlife Service – November 2005
- Roads Analysis Process – January 2003
- Wayne National Forest Recreation Feasibility Report – February 2003
- Wayne National Forest Five Year Facility Analysis and Program of Work – October 2007
- Wayne National Forest Assessment, an evaluation of the ecological, economic, and social conditions and trends – July 2020
- Wayne National Forest Five Year Facility Analysis and Program of Work - October 2007
- Wayne National Forest Assessment, an evaluation of the ecological, economic, and social conditions and trends – July 2020
- 10 supplemental reports to the Assessment – July 2020. The supplemental reports are on the following topics and provide further context: Air Quality, Aquatic Ecosystem and Watersheds, At-Risk Species, Carbon, Mineral Resources, Socioeconomic Conditions,

Terrestrial Ecosystems, Wildland Fire and Fuels, Wilderness Inventory, and Wild and Scenic Rivers Eligibility

Forest laws and policies, including forested acres in state current use taxation programs

Many laws at the federal and state level relate to forestry and broader natural resource management. Some of the major laws and legal policies that are relevant to forest management in Ohio are listed below with links to websites that provide more information. Ohio Revised Code (ORC) and Ohio Administrative Code (OAC) can be viewed online at: http://codes.ohio.gov/.

Laws that specifically impact management at the Wayne National Forest:

- Organic Administration Act (http://www.fs.fed.us/forestmanagement/aboutus/histperspective.shtml)
- Multiple-Use Sustained Yield Act (http://www.fs.fed.us/emc/nfma/includes/musya60.pdf)
- National Forest Management Act (http://www.fs.fed.us/emc/nfma/index.htm)
- USDA Forest Service Directives (http://www.fs.fed.us/im/directives/)

Other forest-related laws relevant statewide:

- National Environmental Policy Act (http://www.epa.gov/compliance/nepa/)
- Endangered Species Act (http://www.fws.gov/endangered/)
- Clean Water Act (http://www.epa.gov/regulations/laws/cwa.html)
- Clean Air Act (http://www.epa.gov/air/caa/)
- ORC Title 15: Conservation of Natural Resources, including the following chapters:
    - ORC 1501 (Department of Natural Resources)
    - ORC 1503 (Division of Forestry)
    - ORC 1518 (Endangered species)
    - ORC 1519 (Recreational trails)
    - ORC 1531 (Division of Wildlife)
- ORC Title 29: Crimes – Procedure, including:
    - ORC 2909 (Arson and related offenses)
    - ORC 2935 (Arrest, citation, and disposition alternatives)
- OAC 1501:3 (Division of Forestry)
- Ohio's forestry pollution abatement laws
    - http://forestry.ohiodnr.gov/forestpollutionabatement
    - http://codes.ohio.gov/orc/1503.50v1
    - http://codes.ohio.gov/oac/1501%3A3-12
- Ohio's outdoor burning regulations (various OAC chapters)
    - https://www.epa.ohio.gov/dapc/general/openburning
    - http://codes.ohio.gov/orc/1503.18
- OAC 1501:3-13-01 (Division of Forestry prescribed fire regulations) http://codes.ohio.gov/oac/1501:3-13-01v1
- Ohio fence law – ORC 971 (https://farmoffice.osu.edu/sites/aglaw/files/site-library/Ohio_Partition_Fence_Law_for_%20Townships_0.pdf)

- Ohio drainage law (http://www.hcswcd.org/uploads/1/5/4/8/15484824/drainage_law.pdf)

Forest land in tax reduction program

Ohio has two real estate tax reduction programs that are available for forested property: the Ohio Forest Tax Law (OFTL) and the Current Agricultural Use Value (CAUV) programs. Forest landowners must choose between the two programs, as only one tax reduction program can be used on a given acre of land. The Current Agricultural Use Value program (Ohio Revised Code Sections 5613.30-38) provides reduced real estate tax values based on the production capacity of the soil. The Ohio Forest Tax Law (Ohio Revised Code Sections 5713.22-26) provides a 50% real estate tax reduction on forest land that is managed for the purpose of timber production. The ODNR Division of Forestry administers the OFTL program and county auditors administer the CAUV program with support through the Ohio Department of Taxation. See the OFTL document in Appendix D for more details of the changes to the OFTL program from 1925 to present. Counties in the northeast and southeast regions of the state have the largest areas of forest land in OFTL, with the top five counties (in terms of acres enrolled) being Geauga, Ashtabula, Hocking, and Athens (Figure 96). Data for the CAUV program are not available, but in general, a significantly higher number of Ohio's private forestlands are enrolled in CAUV than in OFTL, as CAUV generally provides a higher tax reduction.

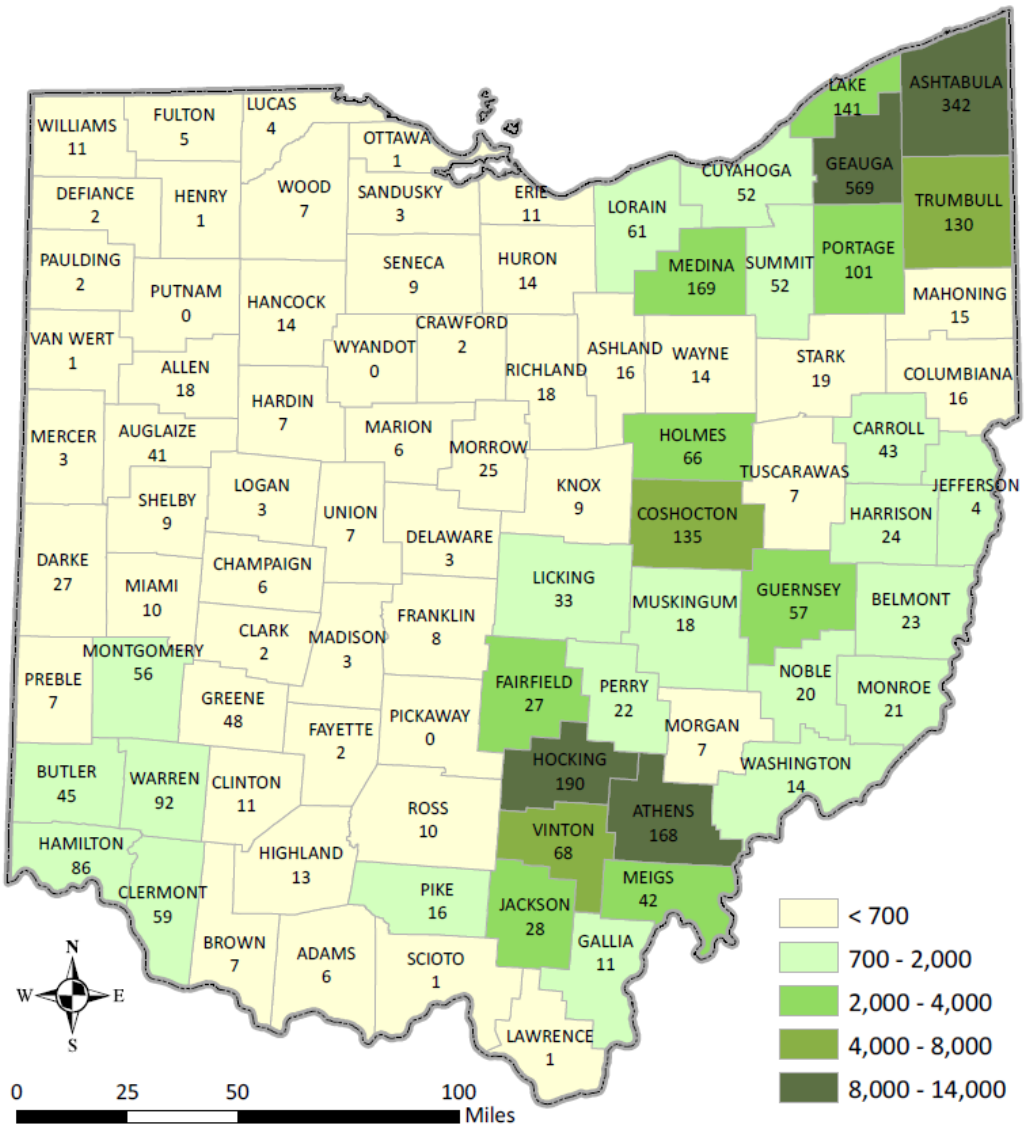

Figure 96. Acres of forest land enrolled (color coding) and number of active certificates (number under county name) in the Ohio Forest Tax Law (OFTL) program by county as of August 2020.

State forest advisory committees

In addition to the advisory committees described elsewhere in this section, several other state advisory committees support forest planning and policy development in Ohio. The Ohio Revised Code (ORC) established the Forestry Advisory Council to advise the Chief of the Division of Forestry on forestry practices and programs in the state and to assist the Division in promoting cooperation on forestry practices and programs with other agencies, political subdivisions, and private interests (ORC 1503.40). The eight members of the council are appointed by the governor with the advice and consent of the senate, and they represent a diversity of interests, including forest research, private landowners, forest industry, recreation, and the public.

Other state committees that support planning in the state include the State Technical Committee (chaired by the USDA NRCS State Conservationist), the State Recreational Vehicle advisory board, the Mid-Atlantic Interstate Forest Fire Protection Compact (ORC 1503.41), and the Ohio Prescribed Fire Council, an interagency effort.

Urban forestry planning

Ohio's Urban Forestry Advisory Committee is a subcommittee of the legislative mandated Forestry Advisory Council of the ODNR Division of Forestry. Its purpose is to serve the urban residents of this state by furthering the objectives of the Urban Forestry Assistance Program. Committee members advise on the current program and policies, recommend new directions and opportunities, provide feedback on administrative initiatives, help execute some activities and advocate the program's mission. The ten- to fifteen-member committee represents a cross-section of user groups and allied urban forestry professions, creates their own governing rules and serves under a three-year, staggered term format. Membership on the committee includes representatives from the Ohio Department of Agriculture, Ohio Environmental Protection Agency, Ohio Department of Transportation, USDA Forest Service, urban foresters, utilities, nursery/landscaping industry, educational institutions, townships, and municipal planning organizations.

Ohio Interagency Forestry Team

The Ohio Interagency Forestry Team was formed in 2008 to effectively address key forest issues in Ohio. Founding members were the ODNR Division of Forestry, Wayne National Forest, and Ohio office of the USDA Natural Resources Conservation Service. During the period from 2015 to present, the Interagency Team invested significantly in organizing its operations and communications and expanded its membership. Current team members include the USDA Forest Service (Wayne National Forest, Northern Research Station, and State & Private Forestry), USDA Natural Resources Conservation Service, ODNR (Divisions of Forestry and Wildlife), Ohio State University Extension, and Central State University Extension. In September 2019, leaders from all member agencies signed a five-year plan that provides a framework for operations. The Team's primary focus is working collaboratively to conserve Ohio's oak-dominated ecosystems in southeastern Ohio through shared stewardship based on a science framework, shared communication, and economically viable forest management.

Ohio Interagency Forest Health Team

In 2017, the Ohio Interagency Forest Health Team was convened at its first annual meeting. This team consists of mostly state and federal agency staff, tasked with monitoring, managing, or researching forest health concerns in Ohio, including ODNR, USDA Forest Service (Wayne National Forest, Northern Research Station, and State & Private Forestry), Ohio Department of Agriculture, USDA Animal & Plant Health Inspection Service (APHIS), USDA Natural Resources Conservation Service (NRCS), and Ohio State University Extension. The team meets annually at the Ohio Forest Health Meeting and share periodic communications throughout the year to discuss ongoing and recent projects and upcoming issues and projects, to facilitate coordination of forest health-related work.

Ohio Hemlock Woolly Adelgid Task Force

The Ohio Hemlock Woolly Adelgid (HWA) Task Force was formed in 2014 and is composed of personnel from various state, federal, and local agencies, non-governmental conservation organizations, park districts, researchers, and natural resource managers from across the state that work on, or have an interest in, Ohio's eastern hemlock forests. Meetings are typically held annually and updates on hemlock health-related concerns are regularly communicated to increase coordination and facilitation of hemlock conservation statewide.

Wildfire protection areas and community wildfire protection plans

Through statute, the ODNR Division of Forestry can establish wildfire protection areas within the state. These wildfire protection areas are created with a primary goal of protection Ohio's forest resources from negative impacts of wildfire. The ODNR Division of Forestry's declared wildfire protection areas have historically been focused on eastern and southern Ohio because of the concentration of forest resources in those areas. Most of northern and western Ohio have been excluded from the wildfire protection areas because of the predominant agriculture and urbanization in those areas (exception being Maumee State Forest areas in northwestern Ohio). The ODNR Division of Forestry wildfire protection area was expanded in January 2019 to include only entire counties and reaches farther into southwest and northeast Ohio (Figure 97). This expansion was created based in part upon forest recovery in those areas and the need for increased forest resource protection. Data on wildfire occurrence and acres burned is not collected by ODNR Division of Forestry outside of the wildfire protection area, which explains the lack of data from northern and western Ohio in Figure 56. Because of the recently expanded area in which wildfire statics are collected, recorded data on wildfire occurrence and acres burned will increase in future years.

The overarching goal of an Ohio community wildfire protection plan (CWPP) is to strike a balance between plan usefulness, practicality, and feasibility of plan implementation, in consideration of Ohio's wildland fuels, wildfire situation, and resources available to implement the CWPP. The CWPP is an important tool that helps Ohio communities become better prepared to face wildfires in the wildland urban interface (WUI). WUI wildfires are very common in Ohio due to the main cause of wildfire ignition: escaped debris burning. All Ohio CWPPs include the basic required CWPP elements: collaboration, prioritized fuel reduction, and measures to reduce structural ignitability. Ohio CWPPs also address common issues like wildfire response, general hazard mitigation, and community preparedness, as well as community-specific wildfire related hazards and potential mitigation activities. In Ohio, CWPPs are usually developed at the county level in conjunction with the county emergency management agency (EMA) but are occasionally installed at the sub-county level congruent to the primary response area of one or more fire departments. In 2012, the ODNR Division of Forestry developed a statewide wildfire hazard assessment map that identifies communities at risk (Figure 97). In developing CWPPs in Ohio, priority is given to areas that contain more communities at risk to fire. However, several counties with less elevated wildfire risk have developed CWPPs and incorporated them into their county EMA's emergency operations plan as a wildfire hazard specific annex to enhance response capability and awareness. The ODNR Division of Forestry partners with the county EMA, all fire departments in the county, and the Wayne National Forest, if applicable, in creating functional and practical

CWPPs. The development of CWPPs is a cooperative procedure where the local perspective is critical to success because a major component of CWPPs is proactive prevention and preparedness measures, which are most effective when implemented by the local fire departments. The ODNR Division of Forestry occasionally offers cost share grants to fire departments for the specific purpose of implementing community wildfire hazard mitigation measures identified in CWPPs.

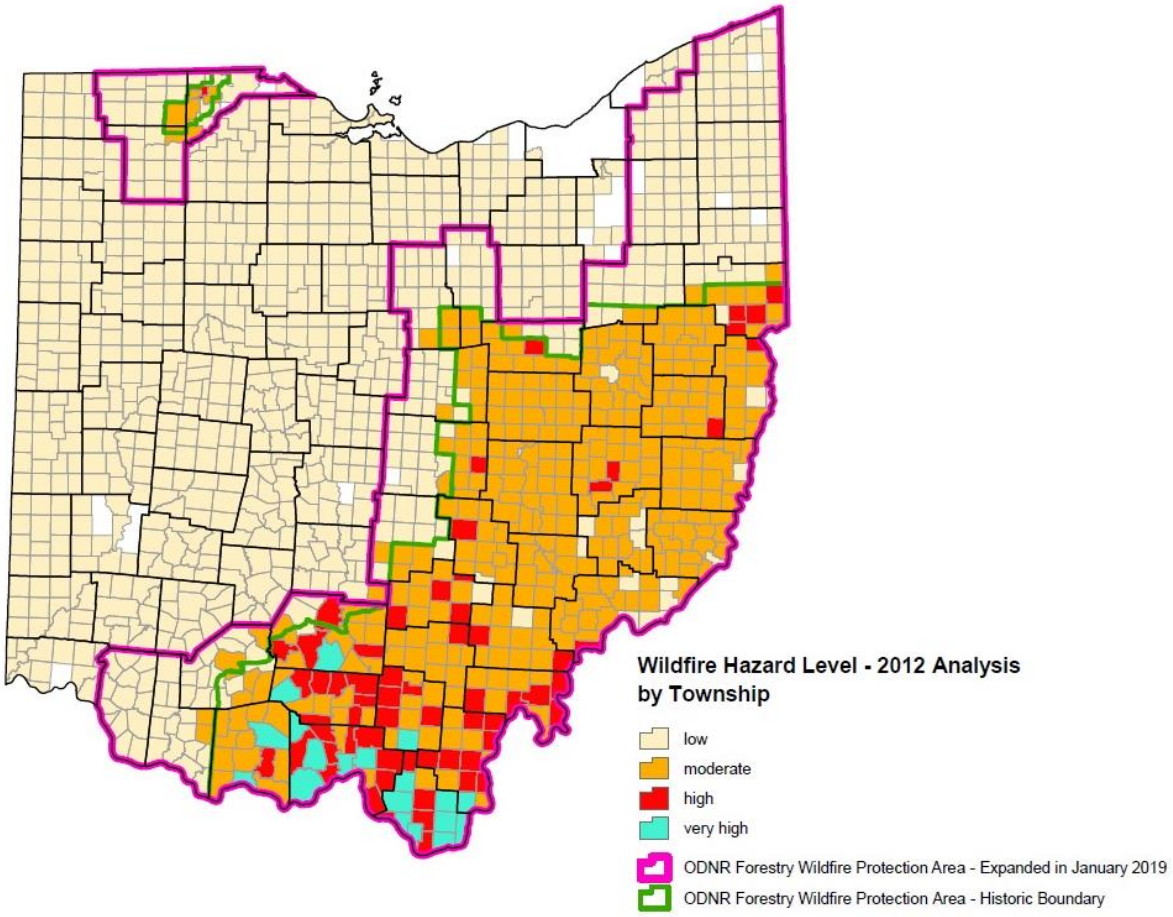

Figure 97. Ohio Wildfire Hazard Assessment. Data source: ODNR Division of Forestry.

Section 3 – Existing and Emerging Benefits and Services

Ohio's forests provide many ecological, economic, and social benefits and services. With 85% of the state's forests in private ownership, Ohio's citizens play an important role in providing these benefits and services. In terms of ecology, forests in Ohio are rich in biodiversity, providing habitat for about 56 species of mammals, 200 species of breeding birds, 84 species and subspecies of amphibians and reptiles, 170 species of fish, 100 species of mollusks, and 20 species of crustaceans (data source: ODNR Division of Wildlife) and over 500 species of plants (USDA Forest Service FIA data). In some forests, over 30 species of canopy trees can be found at one site. The ecological impact of Ohio's forests goes beyond terrestrial ecosystems. Forests play a critical role in maintaining quality aquatic habitat in waters of the state by filtering nutrients and other pollutants, reducing soil erosion, and maintaining cooler water temperatures through shade cover.

Forests also provide extensive economic benefits in Ohio. In 2016, Ohio ranked eighth nationally in GDP from manufacturing of furniture and related products (U.S. Dept. of Commerce). A 2017 study found that Ohio's forest products industry contributed $27 billion to Ohio's economy and employs over 132,400 people with annual payrolls of $7.7 billion (Mehmood 2019). That total did not include additional inputs to Ohio's economy from wildlife (hunting, fishing, and wildlife watching), nature-based tourism, or non-timber products like maple syrup, Christmas trees, and herbal medicines (i.e., ginseng, goldenseal, black cohosh). Ohio consistently ranks in the top ten nationally for statewide production of these non-timber products.

Finally, Ohio's forests provide a suite of social benefits. They enhance our quality of life and personal health by improving air quality, providing clean drinking water, and sequestering carbon. Urban trees reduce energy costs (Heisler 1986), increase property values (Neely 1988), reduce stormwater runoff (USDA 2003), and have been shown to reduce crime (Kuo and Sullivan 2007). Forests also provide a wide range of leisure and recreational activities to Ohioans, including hiking, hunting, fishing, bird-watching, canoeing/kayaking, horseback riding, and all-terrain vehicle use.

Emerging Benefits and Services

In addition to the forest benefits and services described previously that Ohioans have enjoyed for years, there are some emerging forest benefits and services that are worth mentioning: human health benefits of forests and trees and the market for forest carbon capture. Both of these present opportunities for expanding the services that forests provide in Ohio, but they also warrant further evaluation of the costs and benefits associated with their utilization, from economic, environmental, and social perspectives.

Human health benefits of forests and trees

There is a growing body of evidence that being in and around forests and trees, in both rural and urban settings, can greatly benefit human physical and mental health (Meyer and Bürger-Arndt 2014, Nowak et al. 2018, Wolf et al. 2020). These many benefits, including stimulation of child development, improved cardiovascular health as a result of recreation, lessening of symptoms of

anxiety and depression, decreased incidence of asthma from breathing cleaner air, and lowering blood pressure, highlight a more recently recognized benefit of trees and forests. This ecosystem service, and the capability of all people to access urban and rural forests, appears to be gaining attention and may be an important area of focus for forest managers and owners in the future.

Forest carbon markets

As forests grow, trees absorb carbon dioxide from the atmosphere through photosynthesis and store it within their growing biomass (trunks, branches, leaves and root systems). A "forest carbon offset" is a metric ton of carbon dioxide equivalent – the emission of which is avoided or newly stored, that is purchased by greenhouse gas emitters to compensate for emissions occurring elsewhere. Offsets may be developed under voluntary market standards or compliance market standards, each of which has specific carbon accounting and eligibility rules. Carbon markets can provide a new source of income for forest owners implementing practices that increase or retain forest carbon. With recent developments in the cap-and-trade system and innovations in voluntary carbon market standards, some forest owners are engaging in carbon markets as an option to diversify revenue and support sustainable management. However, there are still many questions facing forest landowners as they consider the opportunity and risks of integrating a carbon project in their forests. This emerging ecosystem service may become more widespread and have impacts to forests and forest management in the future.

Section 4 – Issues, Threats, and Opportunities

The list of issues or threats was developed through consideration of the data included in this Forest Resource Assessment, input received at various advisory group meetings, five regional public stakeholder meetings held across the state in January and February 2020, as well as a stakeholder survey. Announcements requesting stakeholder input were made through a statewide news release, the ODNR Division of Forestry website, and an email to known stakeholders. The stakeholder survey was available online via a link on ODNR Division of Forestry's website and a paper version that could be completed and submitted or mailed to the ODNR Division of Forestry. A total of 1,108 stakeholder surveys were collected, and the regional stakeholder meetings had a total of 165 participants. See Appendix B for more details on stakeholder input. Comments from ODNR Division of Forestry staff were incorporated to develop the final list. The final list of threats and key issues to be used in the Forest Resource Strategy follow.

Key Threats to Ohio's Forests

- Lack of public awareness of forest benefits and services
- Non-native invasive species (plants and animals)
- Climate change
- Low incentives for private landowners to retain forests and/or manage them sustainably
- Loss of biological diversity (rare species or communities are most vulnerable)
- Forest fragmentation and urban development (i.e., parcelization and land conversion)
- Inadequate funding for conservation programs and organizations
- Poor timber harvesting practices on private lands
- Wildlife habitat loss, especially for early-successional species
- Lack/loss of urban forest cover
- Change in forest composition trending away from oak-dominated forest types
- Soil & water quality impacts of poor land management practices and urbanization
- Lack of comprehensive planning or effective zoning in urban areas
- Wildfire
- The ongoing COVID-19 pandemic is impacting global and national economies and could have significant impacts on various aspects of forest management and industries in the future

Key Issues for Ohio's Forests (and Associated Objectives)

State Issue 1: Sustainable forest management on all forest lands

Objectives:
- 1.1 – Sustainably manage public forest lands for multiple public benefits
- 1.2 – Increase the number of private landowners sustainably managing their forest lands
- 1.3 – Increase the number of municipalities managing their urban forests

State Issue 2: Public benefits from Ohio's forests

Objectives:
- 2.1 – Increase public awareness of forest benefits and services
- 2.2 – Increase public safety in and around Ohio's forests
- 2.3 – Increase recreational opportunities and use of Ohio's forests
- 2.4 – Enhance Ohio's diverse markets for forest products and services
- 2.5 – Improve the quality of urban life through proper urban forest resource management
- 2.6 – Increase funding for forestry programs and organizations

State Issue 3: Conservation of soil and water resources

Objectives:
- 3.1 – Reduce soil and water quality impacts from poor land management practices and urbanization
- 3.2 – Maintain high quality public water supplies

State Issue 4: Conservation of biological diversity

Objectives:
- 4.1 – Sustain oak-dominated forests
- 4.2 – Protect Ohio's native forest plant and animal species and biological communities
- 4.3 – Maintain habitat for forest-associated wildlife
- 4.4 – Promote long-range planting designs to encourage urban forest species diversity

State Issue 5: Threats to forest health

Objectives:
- 5.1 – Monitor and manage for existing and future forest health threats
- 5.2 – Increase the resiliency of Ohio's forests to a changing climate
- 5.3 – Reduce the impact of forest health stressors including non-native invasive species
- 5.4 – Apply appropriate wildland fire management

State Issue 6: Forest fragmentation, parcelization, and loss

Objectives:
- 6.1 – Slow the trend of increasing forest fragmentation, parcelization, and loss in previously rural forest land
- 6.2 – Mitigate the impact of forest fragmentation and urban development in forested landscapes
- 6.3 – Increase education and outreach to small woodlot owners on sustaining forest benefits in urbanizing areas

Section 5 – Priority Forest Areas and Issues

Ohio's approach to identifying priority forest areas relies heavily on geospatial analyses. Separate geospatial analyses were used for both the rural land category and wildland-urban interface (WUI) lands. Additionally, the 17-county focus area of the Ohio Interagency Forestry Team has been included as a priority forest area. Ohio's urban forests have been included as a statewide priority forest landscape with associated priority urban forest issues. Note that these priority forest areas are not mutually exclusive, and it is possible that a certain forest area be included in more than one of these separate analyses. For example, northeastern Ohio has significant areas of forests that occur in urban or suburban areas, and those areas are likely included in a both the rural and WUI maps. Such overlap was allowed because the separate analyses had different goals and may have different future applications.

Rural Lands

For rural lands, the geospatial methodology used in this assessment is a weighted overlay analysis of 10 core themes to assess stewardship potential of private forest lands across the state. Public lands were masked out of the analysis, to only consider private forest lands, and the most current data available were utilized for each of the 10 themes (Table 30). A more detailed description of each theme is included in Appendix C. The results of the weighted overlay analysis for rural forest lands are shown in Figure 98. The blue areas represent Ohio's rural, private land priority forest areas (ranking of 4), prioritized for their high stewardship potential and important forest benefits. Acreage (and percent statewide private forest cover) for each ranking level are: 1=1,580,083 acres (20% of private forest land), 2=1,631,019 acres (21%), 3=3,345,429 acres (43%), and 4=1,226,627 acres (16%). Large forest blocks with high concentrations of priority forest areas were digitized "freehand" using ArcGIS and they are identified as priority forest landscapes in this assessment (Figure 99).

Table 30. Description of the layers used in the geospatial analysis to identify high-priority rural forest landscapes in Ohio and data sources.

Data Layer	Description/Source
Forest pest	Union of known county-level occurrences of the following forest pests & diseases: Asian longhorned beetle, gypsy moth (those counties ≥50% within the Slow the Spread action area), hemlock woolly adelgid, and beech leaf disease (Ohio Dept. of Agriculture and ODNR)
Housing change	Integrated Climate and Land-Use (ICLUS) housing density scenario "base case" (BC) data, areas projected to be "rural" in 2040 (U.S. EPA)
Priority watersheds	Union of Ohio EPA's 401 water quality certification "ineligible" and "possibly eligible" areas with areas identified by the USDA Forest Service "Forests 2 Faucets 2.0" data that have ≥80 (on a 0-100 scale, 0 being lowest risk) relative risk to water yield, by 12 digit HUC watersheds (Ohio EPA & USDA Forest Service)
Proximity to protected land	1-mile buffer around protected lands (public land or land owned by conservation organizations) (USGS Protected Areas Database 2.0)
Public water supply	Drinking water source protection areas (Ohio EPA)
Resilient and Connected Landscapes	Areas identified to be resilient to a changing climate and that may function as connected corridors for movement of plants and animals under a changing climate (The Nature Conservancy)
Riparian	300 ft. buffer around all perennial streams and water body shorelines (USGS National Hydrography Dataset)
Spatial integrity index (SII)	Areas of forest cover identified as being "core forest" or having high "spatial integrity," (pixel classes 8-10) based on factors such as local forest density, distance to "core" forest, and local patch size (USDA Forest Service)
Threatened and endangered species	Natural Heritage Database records for state or federally threatened or endangered species, buffered by 3-mile wide hexagons (ODNR)
Wetlands	Union of National Wetland Inventory (freshwater emergent wetland and freshwater forest/shrub wetland types) and Gap Analysis Project (north central interior & Appalachian rich swamp, Laurentian-Acadian swamp systems, central interior & Appalachian shrub-herbaceous wetland systems, Great Lakes coastal marsh systems, and Great Plains prairie pothole cover types) (U.S. Fish & Wildlife Service and USGS)

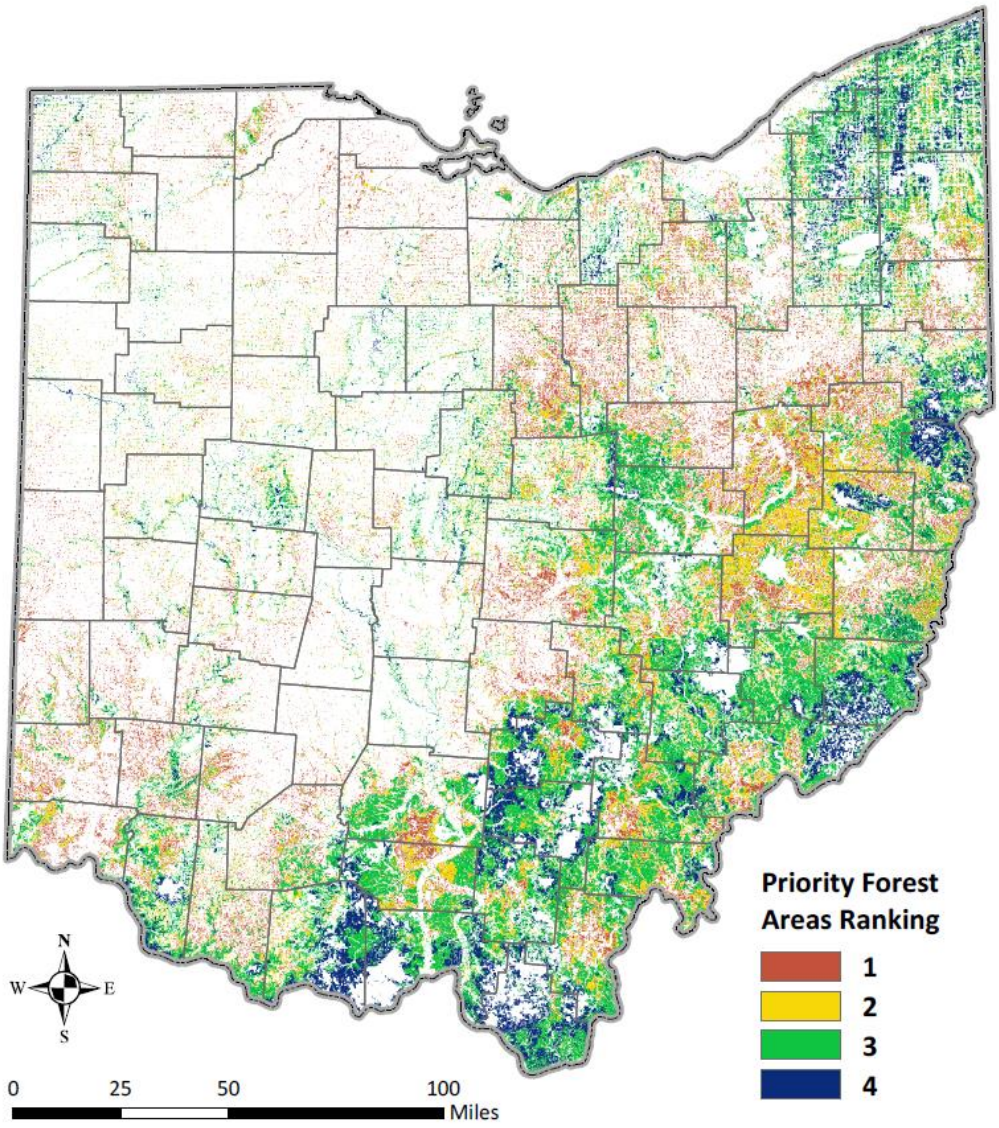

Figure 98. Ohio's rural, private land priority forest areas. Priority rankings go from 1 to 4 (4 = highest priority).

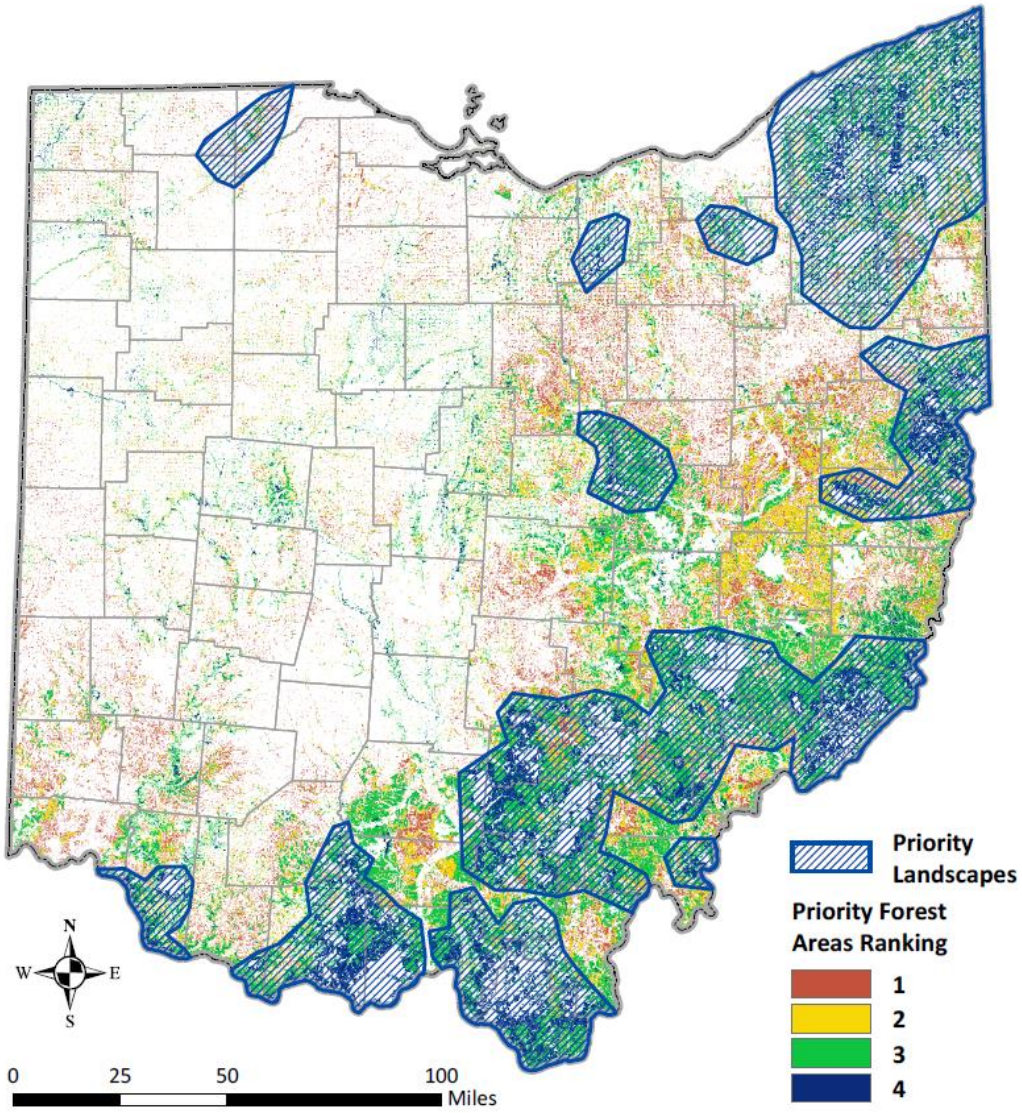

Figure 99. Ohio's priority forest landscapes (hashed and outlined in blue), which represent large concentrations of priority forest areas from the rural lands analysis (see Figure 98).

Forest Legacy Areas

As the state lead agency, the ODNR Division of Forestry has concluded that Ohio's Forest Legacy Program (FLP) will continue to be implemented using same Forest Legacy areas from the original Assessment of Need (AON) approved on August 5, 2005. Descriptions of Ohio's Forest Legacy areas and program implementation are included in the Strategy section of the Ohio Forest Action Plan. A copy of the state lead agency designation letter and the AON approval letter can be found in Appendix A. Figure 100 shows the current approved Forest Legacy areas, which are the only areas in Ohio that are eligible for Forest Legacy projects.

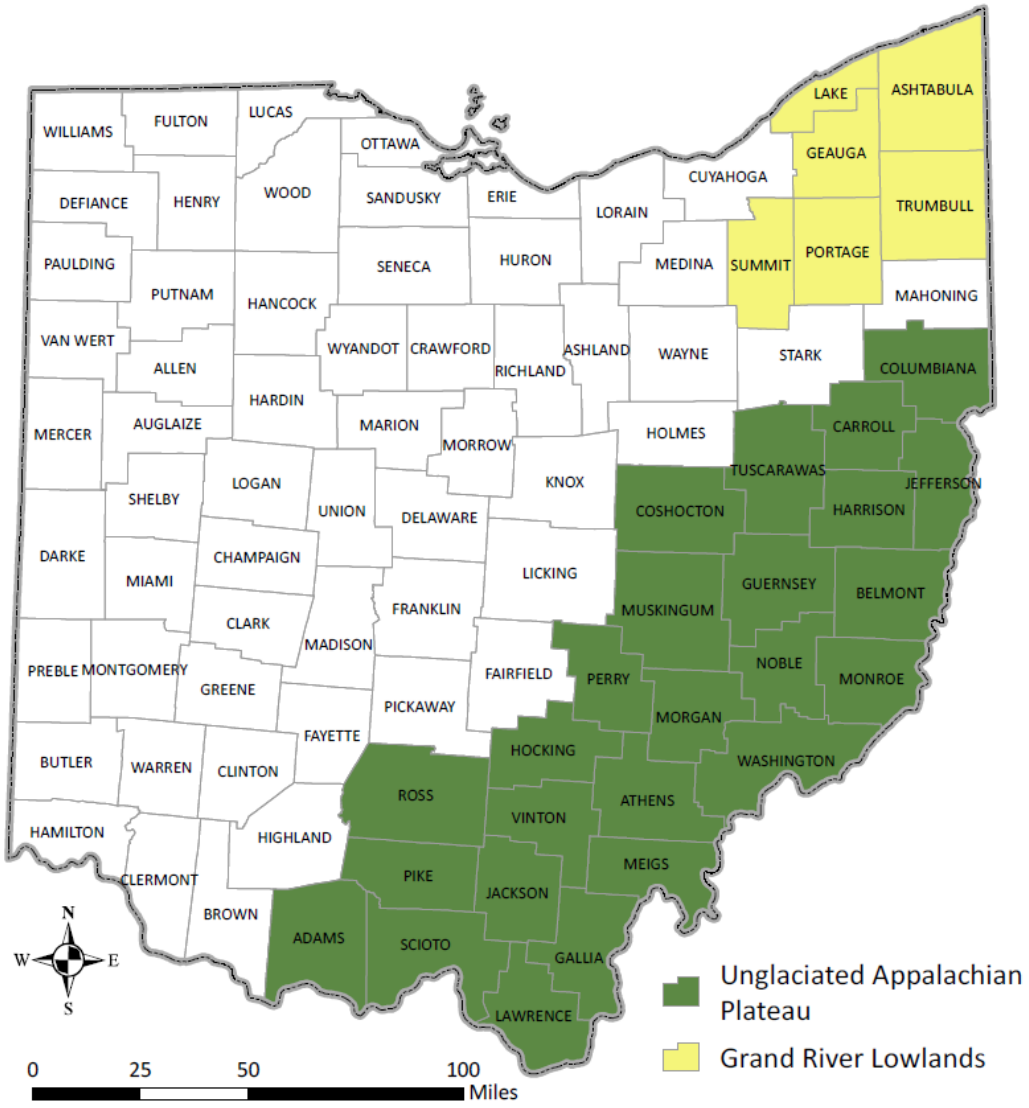

Figure 100. Ohio's Forest Legacy areas.

Urban Forests

All urban forests in Ohio are identified as priority forest landscapes to help focus specific, coordinated efforts toward priority issues in the most populated areas of the state (Figure 101). This departure from the geospatial methodology adopted in the 2010 Forest Resource Assessment is selected to address statewide trends of leveling urban forest management indicators, decreasing urban tree canopy, and increasing impervious cover and the projected 3.3 million acres of urban growth in Ohio by 2060. Urban forests are essential to the health and well-being of the nearly 80% of Ohioans that live in urban areas. However, as urbanization and urban populations continue to increase, all Ohioans are directly and indirectly affected by issues that extend beyond urban land including air pollution, water quality, invasive plants, insects, and diseases, fragmentation, and parcelization. Proper management of all urban forests to maximize their ecosystem benefits is critical for improving the quality of life for all Ohioans. Priority issues specific to Ohio's urban forests will further focus the coordinated efforts of private and non-profit

organizations and local, state, and federal governments. These priority issues include sustainable urban forest management, public urban forest benefits, urban soil and water quality, and urban forest threats and pressures.

Sustainable Urban Forest Management

As noted earlier, the program elements that are key indicators of communities developing sustainable urban forestry programs include codified and routinely enforced tree ordinances and/or policies, the employment of professional urban forestry staff, possessing, using, and periodically updating an urban forestry management plan, and the establishment of advocacy/advisory organizations such as local tree commissions. The limiting program elements for many Ohio communities include professional staff and urban forestry management plans. Ensuring Ohio communities receive the technical and financial assistance to obtain these vital program elements is a priority urban forest issue.

Public Urban Forest Benefits

The public is often unaware of the valuable benefits and ecosystem services provided by urban forests. Furthermore, urban tree canopy and the associated benefits is not equally distributed throughout many densely populated communities, resulting in greater health risks and lower quality of life. Low-income neighborhoods and some neighborhoods of color are often disproportionately affected by lack of tree cover. Addressing urban tree canopy inequity and other associated environmental inequities is a priority issue for Ohio's urban forests.

Urban Soil and Water Quality

The limited volume and poor quality of urban soil inhibits the growth and longevity of urban tree canopy which in turn negatively affects water quality in urban and rural areas. Furthermore, soil is often damaged or removed in development and redevelopment projects reducing the water holding capacity and placing additional stress on stormwater control facilities. A focus on protecting and enhancing urban soils and utilizing trees and soil as green infrastructure to improve water quality and stormwater control is a priority urban forest issue.

Urban Forest Threats and Pressures

Extreme weather events are becoming more frequent and intense, resulting in direct and indirect impacts to Ohio's urban forest resources from storm damage, drought, flooding, and increasing pressures from pests and diseases. The resulting assessment, cleanup, and mitigation responsibilities are a challenge for many communities. Addressing climate change and its associated threats and pressures is a priority urban forest issue in Ohio.

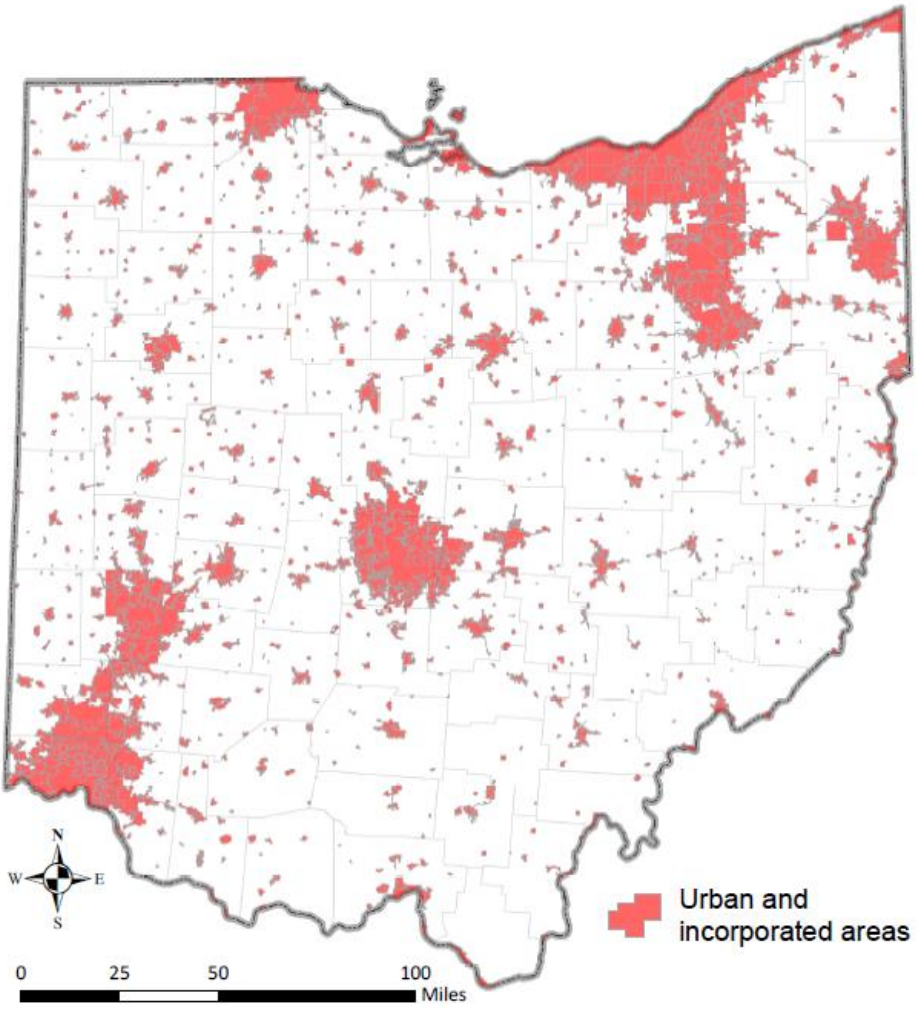

Figure 101. Urban and incorporated areas in Ohio, 2019. Data source: U.S. Census Bureau TIGER/Line.

Wildland-Urban Interface Lands

Another land category for landscape prioritization is the wildland-urban interface (WUI). The WUI represents areas that historically were rural, non-agricultural lands (i.e., rural forest land) that are experiencing urbanization or development but still retain many of their wildland characteristics or land cover. Because these areas do not fit nicely into either the rural land or urban lands analyses, they are considered an additional prioritization category. The WUI areas identified in the below map were developed by Riemann (2019) using 2010 census data and 2011 NLCD data, while the non-WUI forest areas are derived from the 2016 NLCD data (Figure 102). Figure 103 shows where WUI co-occurs with "core" forest areas (defined as those pixels in class 10). Priority forest areas in the WUI are these WUI areas co-occurring with core forests.

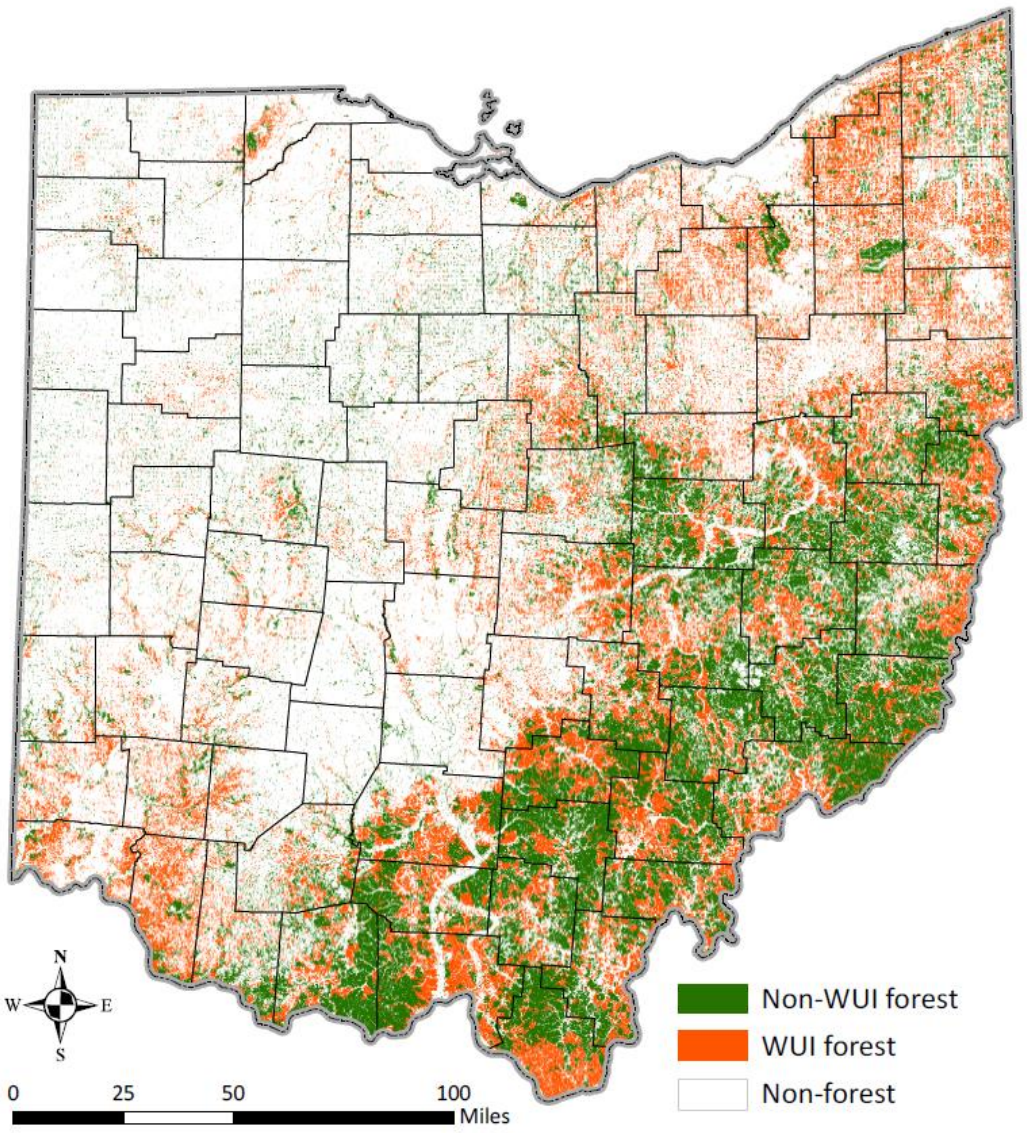

Figure 102. Wildland urban interface (WUI) forest and non-WUI forest in Ohio.

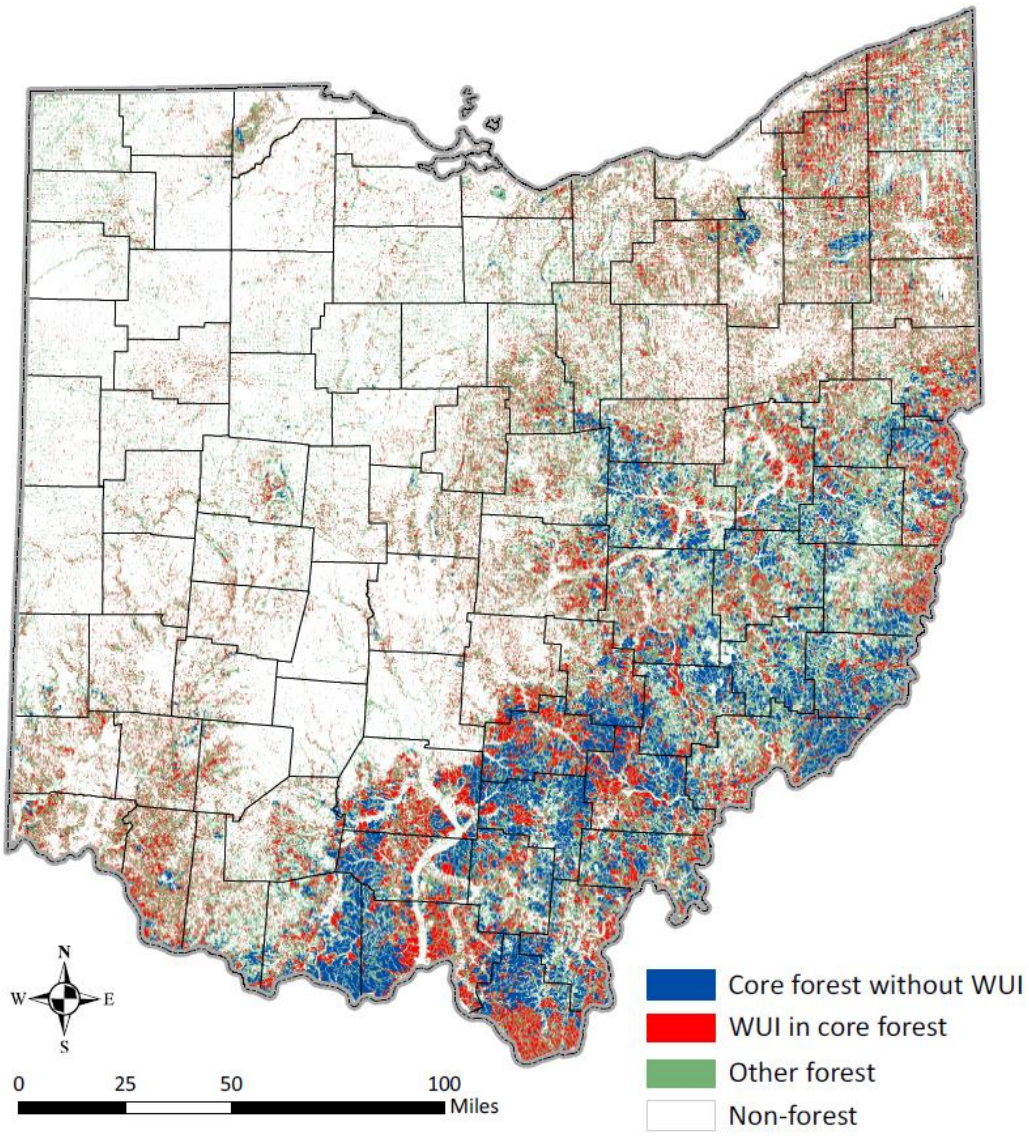

Figure 103. Map of wildland urban interface (WUI) forest occurring in core forest, core forest without WUI, and other forest in Ohio.

Southeastern Ohio Collaborative Focus Area

Southeast Ohio's forest ecosystems are the largest and most biologically diverse in the state. Regionally, southeastern Ohio lies within the Southern Unglaciated Allegheny Plateau terrestrial ecoregion and the Upper Ohio River Basin freshwater region. It is part of the Appalachian Mountains ecosystem which contains the oldest and most biologically diverse forest and freshwater systems in North America. The forests in the southeastern Ohio collaborative focus area have been dominated by oaks for thousands of years and support an array of associated plant, vertebrate, and invertebrate species. The area was settled, harvested, farmed, and mined in the late 19th and early 20th centuries because of the abundant timber, coal, and water resources. The present oak-dominated ecosystems in southeastern Ohio continue to provide significant economic, social, and ecological values for the people who live there and for the state

of Ohio and the Central Appalachian region. The 17-county southeastern Ohio collaborative focus area (Figure 104) contains Ohio's only national forest (the Wayne National Forest), 17 out of 21 state forests and 46% of the total forest resource in Ohio. The oak-dominated forest ecosystems largely remain intact, but they are at a tipping point – regeneration of oaks is absent from many stands and being replaced by shade-tolerant species such as red maple and American beech. Shade-tolerant species are increasing at a rate that is nearly four times their harvest rate. Sixty-seven percent of trees harvested in Ohio are oaks and removals have already exceeded growth for white oak, the most common oak species in Ohio. The raw timber value is significant, but the value-added segment is very low. The forest industry workforce is aging, and the capital cost of timber operations has risen steadily, making it difficult for new foresters to become established. Seventy-six percent of the land base is owned by small family woodland owners which are under-supported, with only three forestry extension agents and seven State Service Foresters to provide knowledge-sharing and planning services to 17 counties and thousands of woodland properties. Younger (<20 years) and older (> 120 years) forest age classes of all forest types are under-represented in the regional landscape as well. If these trends continue, the health and viability of the oak-dominated ecosystem will decline and change local communities, forest industry, and ecological relationships with associated plants and animals, forever.

The Ohio Interagency Forestry Team (OIFT) was formed in 2008 to address forest management needs across land ownership and agency boundaries in the 17-county area to help increase and restore healthy, regenerating oak-dominated ecosystems. The OIFT recognizes that "going alone" will result in little change. Working together with agencies, non-profits, and private landowners is the most efficient and effective way to "tip the scale" toward these desired changes and keep oak on the landscape for future generations. The current OIFT includes the Ohio Department of Natural Resources (ODNR) Divisions of Forestry and Wildlife, United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) and Forest Service, and Ohio cooperative extension. These are the agencies in Ohio with forest management in their mission areas. Leaders of these agencies have a grand vision for the forested landscape, requiring cooperation as well as expansions of public and private programs and partnerships. They recognize that relationship building and investment in programs and staff are cornerstones of this work. The OIFT envisions working with others to restore a vibrant and sustainable working landscape that includes healthy forest ecosystems through science-based, economically viable forest management. The mission of the OIFT is to work together to restore healthy forest ecosystems, especially oak-dominated forests, in a mix of age classes in southeastern Ohio. These ecosystems will contribute to a vibrant, working landscape that sustains both people and wildlife.

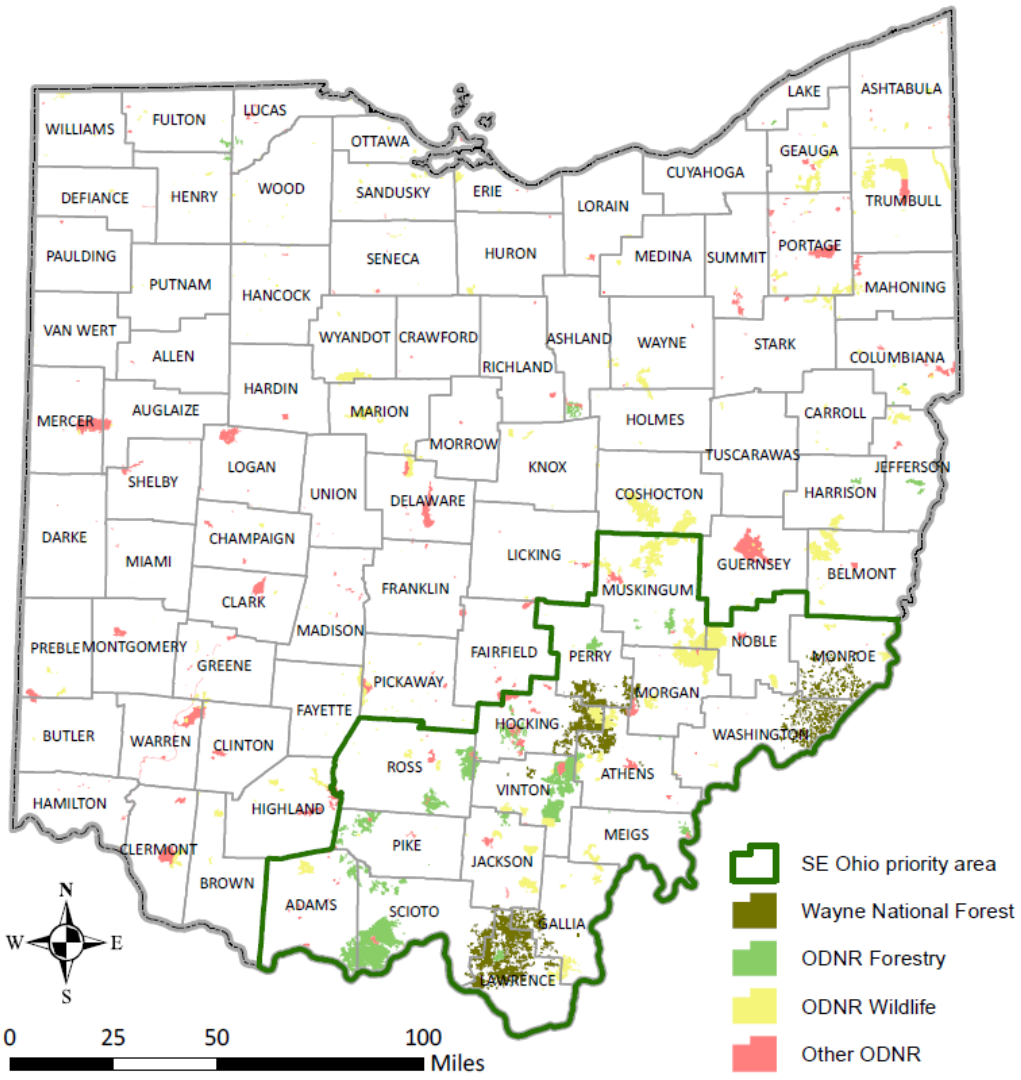

Figure 104. Southeastern Ohio collaborative focus priority area and Wayne National Forest and ODNR lands.

Forest Stewardship Priority Areas

Privately-owned forests within a 17-county southeastern Ohio collaborative focus area (Figure 104) have high stewardship potential as described in the preceding southeastern Ohio collaborative focus area section. Private forest land is the highest ownership category in the area, and engaging private woodland owners is a key part of the landscape-scale strategy that relies on cross-boundary management. (Figure 105) shows Ohio's Forest Stewardship Priority areas, per requirements of the National Forest Stewardship Program Standards and Guidelines.

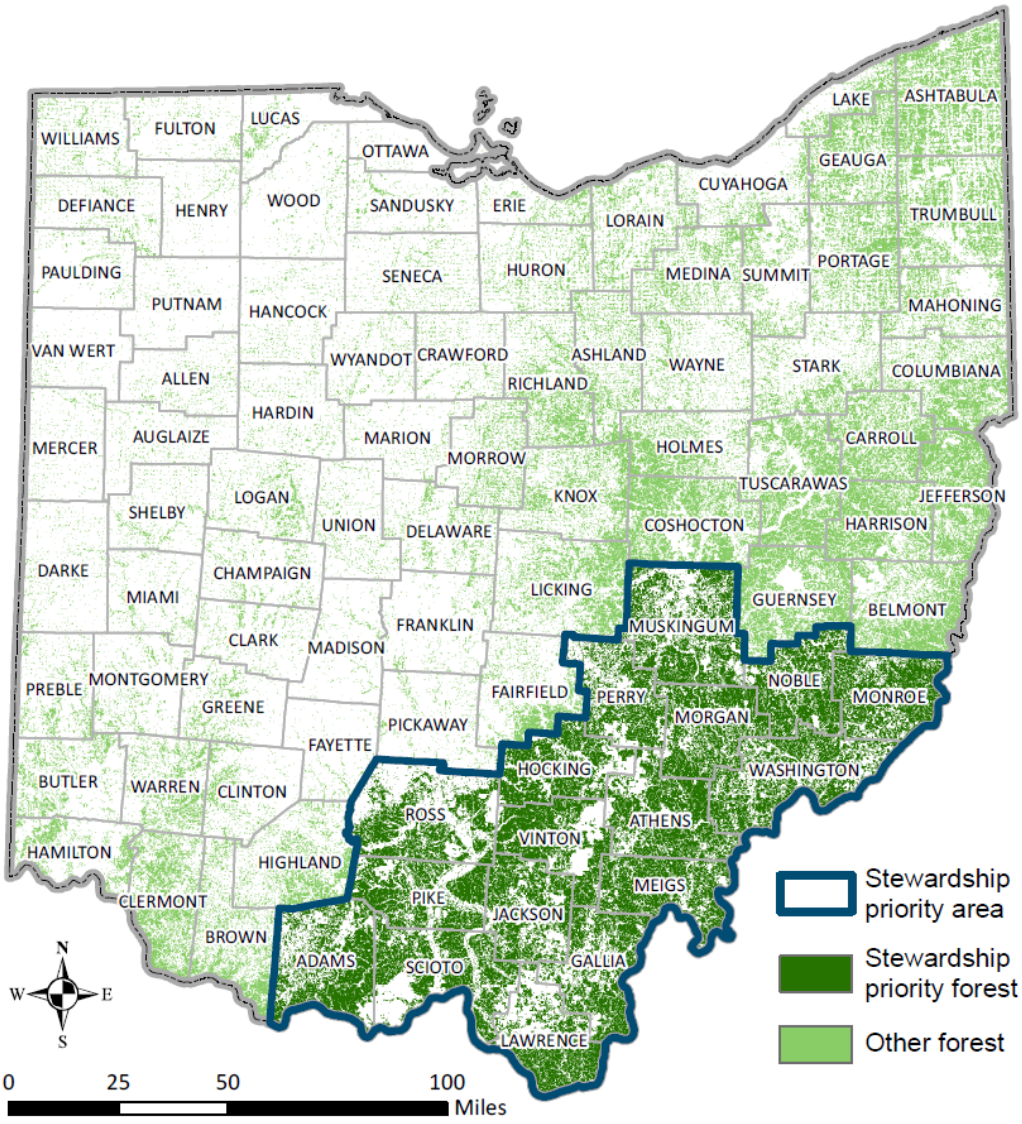

Figure 105. Forest stewardship priority forest.

Multi-State Priority Forest Areas and Issues

The priority forest areas and landscapes identified in this assessment will be critical to strategically addressing the statewide forest issues. However, Ohio's forest-related issues are not exclusive to the state; they are shared with other neighboring states and sometimes shared regionally or nationally. To better address forest issues that go beyond political boundaries, the identification of multi-state priority areas is important. Below are descriptions of some existing multi-state projects and issues.

Multi-State Priority Areas

Appalachian Forests

The forests of the Appalachian Mountains stretch from Alabama to Maine and include eastern Ohio. The Appalachians are one of the most biologically diverse areas in North America, containing an array of forest types, including oak-dominated forests, northern hardwoods, spruce-fir stands at high elevations, and open pine communities. These forests and habitats have changed drastically over the last two centuries due to the timber boom of the late 1800s and early 1900s, the increase and subsequent abandonment of farmland from the mid-1900s through the 1980s, and extraction of fossil fuels. Natural disturbance processes, such as fire and grazing by bison and eastern woodland elk, that historically maintained a dynamic and resilient forest landscape across the Appalachians are now largely absent. The loss of these processes, coupled with additional stressors such as disease, insect pests, invasive species, over-browsing by deer, climate change, and continued energy development further alter the Appalachian landscape. The processes needed to maintain a dynamic, healthy forest that support thriving populations of birds and other wildlife have been severely altered or are non-existent. These factors necessitate a comprehensive approach for forest conservation in the Appalachians that includes a range of strategies, such as active forest management, restoration, and protection. There are a number of tools that create diversity in stand age and structure of eastern forests, including active forest management and timber harvesting. Considerable research has been completed over the past couple of decades confirming the benefits of sustainable, science-based active forest management to forest health as well as birds and other wildlife.

Appalachian Mountain Joint Venture

The Appalachian Mountains Joint Venture (AMJV; http://amjv.org/) is a regional partnership of over 55 state and federal agencies, conservation organizations, and universities. The AMJV is committed to the conservation of habitat for the benefit of birds, wildlife, and people in the core of the Appalachian Region. The focus area of the AMJV stretches from the southwestern Appalachians in Alabama to the northeastern highlands in southern New York. This area encompasses 103 million acres across portions of Tennessee, Kentucky, Ohio, Alabama, Georgia, North Carolina, Virginia, Maryland, Pennsylvania, New Jersey, New York, and all of West Virginia, and contains some of the largest expanses of forest remaining in the eastern United States. In Ohio, the area of focus of the AMJV is the unglaciated Allegheny Plateau of southeastern Ohio. Working both collectively and independently, AMJV staff and partners conduct activities in support of bird conservation goals developed by the partnership. AMJV staff develop annual work plans that are informed by the goals and priorities in our Strategic Plan. Much of the AMJV's bird conservation work revolves around enhancing and protecting forest habitat for birds. This work addresses priorities established in several national bird conservation plans. AMJV staff work with partners to provide regional planning, project coordination and development, and networking resources to connect the conservation community, while its partners provide financial, technical, and local expertise to deliver conservation projects on the ground. In addition, the AMJV supports local conservation partnerships, state agencies, and other partners by developing various conservation tools and resources, as well as providing educational opportunities through workshops, webinars, and other venues that assist partners with delivering the most effective habitat conservation.

Lake Erie Allegheny Partnership for Biodiversity (LEAP)

The Lake Erie Allegheny Partnership for Biodiversity (LEAP; https://www.leapbio.org/) is a consortium of organizations operating within a wide spectrum of conservation missions with regard to the natural world. The partnership was first convened in 2004. LEAP's geographic boundary encompasses the glaciated lands and waters south of Canada from Sandusky Bay to the Allegheny Mountains. This region contains diverse habitats and rare ecosystems that harbor many unique and uncommon species. These natural communities are found within an extensive network of public and private lands throughout the glaciated Allegheny Plateau region of northeastern Ohio, northwestern Pennsylvania, and western New York. Member organizations of LEAP include government agencies, universities, research centers and conservation organizations involved with conservation of biodiversity, environmental education, and public outreach. These partners share a common goal of enhancing the biodiversity of the region's habitats and ecosystems. The work of LEAP partners involves identifying, protecting, and restoring ecosystems and habitats in the region. The partnership was formed in order to recognize and collectively address the issues (challenges, obstacles, opportunities) that impede member groups from conducting their work and achieving a shared goal. LEAP's three major focus areas are: 1) communication and exchange of information among Partnership organizations, 2) organizational capacity of each Partnership member, and 3) public awareness and engagement. LEAP's commitment to work collaboratively enables it to leverage available resources – human, capital, and informational. LEAP strives to initiate research and share technical information, conduct public education and outreach efforts, and to establish core volunteer groups to address its key issues.

Great Lakes Watershed

The Great Lakes – Superior, Michigan, Huron, Erie, and Ontario – hold about 21% of the world's fresh surface water, providing habitat for a variety of fish and wildlife and drinking water for more than 40 million people. Recreational and commercial fishing are among the region's major industries and the lakes facilitate transportation and commerce in the nine jurisdictions that border them. The jurisdictions that cooperate in the management of the Great Lakes are Indiana, Illinois, Michigan, Minnesota, New York, Ohio, Ontario, Pennsylvania, and Wisconsin. Within Ohio, a key initiative was started in 2019 to address water quality issues, known as H2Ohio (http://h2.ohio.gov/). This effort, led by the Ohio Department of Natural Resources, Ohio Department of Agriculture, and Ohio Environmental Protection Agency, is a comprehensive, data-driven approach to improving water quality over the long term. H2Ohio focuses specifically on reducing phosphorus, creating wetlands, addressing failing septic systems, and preventing lead contamination.

Great Lakes Restoration Initiative (GLRI)

This Great Lakes Restoration Initiative (https://www.glri.us/), led by the U.S. Environmental Protection Agency (EPA), targets the most significant problems in the region, including invasive aquatic species, nonpoint-source pollution, and contaminated sediment. The U.S. EPA and its federal partners coordinate with state, tribal, local, and forest industry entities to protect, maintain and restore the chemical, biological, and physical integrity of the Great Lakes. To date, the USDA Forest Service Eastern Region, State and Private Forestry alone has administered grants for nearly 100 projects that will plant tens of thousands of trees and treat hundreds of acres of

contaminated brownfields. The Great Lakes Restoration Initiative (GLRI) was launched in 2010 with the USDA Natural Resources Conservation Service (NRCS) as one of several federal agency partners. The GLRI helps the USDA NRCS accelerate conservation efforts on private lands located in targeted watersheds throughout the region. The USDA NRCS works with farmers and landowners to combat invasive species, protect watersheds and shorelines from non-point source pollution and restore wetlands and other habitat areas. The USDA NRCS is also working with partners in the eight U.S. Great Lakes states. Through financial and technical assistance, the USDA NRCS helps private landowners with conservation planning and practices such as cover crops, conservation crop rotations, filter strips, prescribed grazing, and wetlands restoration.

Oak Openings Region Green Ribbon Initiative

The Oak Openings Region Green Ribbon Initiative (https://www.oakopenings.org/) is a partnership of conservation groups that have been working together to protect the natural beauty and biological diversity of the Oak Openings Region. The Green Ribbon Initiative was originally formed in northwestern Ohio in 2000 and the partnership has since been broadened to include partners from the Oak Openings region of southwest Michigan. The Green Ribbon Initiative is a shared vision of public and private organizations, landowners and individuals working to conserve, enhance and restore critical natural areas in the Oak Openings Region of northwest Ohio and southeast Michigan. Its primary activities include informing the community about the Oak Openings Region, identifying critical natural areas, supporting the preservation of critical natural areas, supporting the restoration and enhancement of critical natural areas, building partnerships and coalitions, and supporting partner organizations to ensure ongoing, sustainable efforts in the Oak Openings Region.

Upper Mississippi/Great Lakes Joint Venture

The Upper Mississippi/Great Lakes Joint Venture (UMGLJV; https://umgljv.org/) is a large bird conservation partnership consisting of Midwest government agencies and non-government organizations that share expertise and resources to achieve bird habitat conservation on a large scale. At over 240 million acres the UMGLJV encompasses a large and most diverse regions of the U. S. The UMGLJV region also contains all or part of four of the Great Lakes. Much of the land within the UMGLJV (39%) is currently in crop production. Forest communities, which include deciduous and evergreen forests, woodlands, savannas, and shrublands make up 26% of the focus area. A primary goal of the UMGLJV is to integrate continental migratory bird priorities into conservation actions at regional, state, and smaller scales by providing wildlife managers guidance in designing landscapes with greater value to birds. The UMGLJV also strives to move regional and state-level managers from opportunity-driven bird habitat projects toward more biologically based projects and programs through biological planning and resource assessment, landscape conservation design, program delivery, and evaluation via monitoring and research.

Urban Waters Federal Partnership

The Urban Waters Federal Partnership (UWFP; https://www.epa.gov/urbanwaterspartners) is supported by 14 federal agencies and more than 28 non-governmental organization partners working in 19 designated locations across the United States. The Western Lake Erie Basin is one project area of the UWFP, which falls within Ohio, Indiana, and Michigan. The UWFP reconnects urban communities, particularly those that are overburdened or economically distressed, with

their waterways by improving coordination among federal agencies and collaborating with community-led revitalization efforts to improve our nation's water systems and promote their economic, environmental and social benefits. The key priorities of the UWFP are to promote clean urban waters, reconnect people to their waterways, conserve water, use urban water systems as a way to promote economic revitalization and prosperity, encourage community improvements through active partnerships, listening to and engage communities, and measure results to fuel future success.

Ohio River Basin

The Ohio River is 981 miles long, starting at the confluence of the Allegheny and the Monongahela Rivers in Pittsburgh, PA, and ending in Cairo, IL, where it flows into the Mississippi River and eventually the Gulf of Mexico. It is a direct source of drinking water for more than 3 million people. The human population living within the Ohio River Basin is over 22 million, an area that encompasses 204,000 square miles and covers parts of 14 states. There is a growing recognition that conservation efforts to address water quality and urbanization issues within the Ohio River Basin would highly benefit the environment along this major national waterway. Forestry would be a major part of any such wide-scale effort. Efforts underway include an Ohio River Basin climate change mitigation/adaptation strategy study led by the U.S. Army Corps of Engineers (https://www.lrh.usace.army.mil/Portals/38/docs/orba/USACE%20Ohio%20River%20Basin%20CC%20Report_MAY%202017.pdf). Additionally, the Ohio River Basin Consortium for Research and Education (https://www.ohio.edu/orbcre/) has been in operation since 1985 and is an association of universities, colleges, governmental agencies, industries, and individuals. The Consortium's mission is to promote inter-institutional research, education and information exchange in water-related concerns and other environmental issues in the Ohio River Basin.

Multi-State Priority Issues

Climate Change

Changes in climate have the potential to profoundly affect forests of the Central Appalachians region. Many tree species that are currently present may fare worse with warmer temperatures and altered precipitation patterns. Other species may do better under these conditions, and some species not currently present may have the potential to do well if conditions allow them to disperse to newly suitable areas. In addition, climate change can have indirect effects on forests in the region by changing the populations and dynamics of insect pests, pathogens, invasive species, nutrient cycling, and wildfire regimes.

Central Appalachian Climate Change Response Framework

The Climate Change Response Framework is a collaborative effort that addresses the major challenges that land managers face when considering how to integrate climate change into their planning and management. The Northern Institute of Applied Climate Science (NIACS) leads the Climate Change Response Framework with support from many partners. The framework was designed as a model for collaborative climate change response across large and diverse landscapes, providing a broad approach that can be adjusted and applied to other locations and landscapes. Currently, the framework is being applied in several locations in the eastern U.S.

through coordinated place-based projects. The glaciated and unglaciated Allegheny Plateau regions of Ohio fall within the Central Appalachian Climate Response Framework (https://forestadaptation.org/assess/ecosystem-vulnerability/central-appalachians). The Central Appalachian Climate Response Framework provides an integrated set of tools, partnerships, and actions to support climate-informed conservation and management. These include a vulnerability assessment, forest adaptation resources, and adaptation demonstration areas and workshops.

Forest Health Threats

Forest health stressors, including insect pests, diseases, and non-native invasive plants, have significant impacts on forest ecosystems and many occur across multiple state (and national) boundaries. Some of these issues have multi-state or even international initiatives to help address them across broad landscape areas. They typically focus on the coordination of various agencies and organizations to increase efficiency and the capacity for early detection of the forest health threat, conduct suppression or management where it occurs, and increase education, outreach, and technical knowledge transfer. The gypsy moth Slow the Spread Foundation (https://www.gmsts.org/index.html) was created in 2000 and is a federally funded program of 15 eastern states led by the USDA Forest Service to minimize the rate of spread of gypsy moth, whose caterpillars cause major defoliation of many forest tree species, particularly oaks. Similar to the Slow the Spread Foundation, the Hemlock Woolly Adelgid (HWA) Initiative (https://www.fs.usda.gov/naspf/featured-projects/2017/hemlock-woolly-adelgid-initiative-protecting-hemlock-resource-east-2014) is a collaboration of various federal and state agencies, universities, and private industries formed in 2001 to accelerate the development and implementation of management options to reduce the spread and impact of HWA, which feeds on eastern and Carolina hemlock, causing dieback and mortality. The American Chestnut Foundation (ACF; https://www.acf.org/) is a non-profit organization dedicated to the restoration of the American chestnut, which was devastated by the chestnut blight disease in the mid-1900s, across its native range. The Midwest Invasive Plant Network (MIPN; https://www.mipn.org/) works with many partners across the upper Midwest including Ontario, Canada to develop invasive plant species spread prevention measures, promote early detection and rapid response, promote consistent methods for inventorying and monitoring invasive plants, and facilitate information sharing and education between and by researchers and land managers.

Mined Land Reforestation

More than a million acres in the Appalachian region were surface mined for coal under the Surface Mining Control and Reclamation Act (SMCRA). Much of this land was reclaimed using practices intended to stabilize the surface, prevent erosion, and establish herbaceous vegetation suitable for grazing livestock, but most is not used for grazing. Other areas were reclaimed to post-mining uses such as wildlife habitat or unmanaged forest, but with trees and shrubs able to survive heavy grass cover and compacted mine soils. Today, these lands are mostly covered with persistent herbaceous species, such as grasses and forbs, and a mix of native and non-native woody species with little commercial or ecological value, and most are not used or managed. From an ecological standpoint, these lands are said to be in a state of “arrested succession,” meaning that current conditions hinder recruitment of native forest trees. For these lands to become productive forests, intervention is needed to loosen compacted mine soils, correct

chemical or nutrient deficiencies, and replace the current vegetation. Re-establishing productive forests on otherwise unused and non-productive mined lands will generate economic value for landowners and communities, and will enhance environmental quality by accelerating restoration of ecosystem services such as watershed protection, water quality enhancement, carbon storage, and wildlife habitat that are typically provided by native forests on non-mined landscapes.

Appalachian Regional Reforestation Initiative

The Appalachian Regional Reforestation Initiative (ARRI; https://arri.osmre.gov/) is a coalition of groups, including citizens, the coal industry, and government agencies dedicated to restoring forests on coal mined lands in the Eastern U.S. ARRI was established in early 2004 with the formation of the Core Team and is now active in Kentucky, Maryland, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. The Core Team's responsibilities include outreach, trainings, event planning, and monthly meetings to discuss progress reports and new strategies. A Science Team was created in 2005 comprised of individuals active in forestry research from across the country, including researchers, soil scientists, plant biologists, and foresters, whose function is to improve ARRI's scientific foundation. ARRI advocates using a technique known as the forestry reclamation approach (FRA) to plant trees on reclaimed coal mined lands. Highly productive forestland can be created on reclaimed mine lands under existing laws and regulations by using the FRA. ARRI seeks to change the existing cultural, technical, and regulatory barriers surrounding forest reclamation of coal mined lands and its primary goals are to plant more high-value hardwood trees on reclaimed coal mined lands in Appalachia, increase the survival rates and growth rates of planted trees, and expedite the establishment of forest habitat through natural succession.

Sustainable Forest Management on Private Lands

While timber production is not a priority for most private "nonindustrial" forest landowners in Ohio and the region, many people sell timber at some point during their forest land ownership. Unfortunately, only a small percentage of all timber harvests in Ohio and the region involve the services of a forester or natural resource professional. As a result, landowners often lose income because they sell timber without adequate information and millions of acres of forestland lack ongoing management. Forests are complex natural systems. To manage them sustainably requires a broad understanding of the biological processes involved as well as an appreciation for the economic, social, and personal pressures that influence woodlot management decisions. By practicing sound forest management, landowners can enjoy the great benefits of their forests: clean water, forest products, wildlife, aesthetic enjoyment, and a sense of stewardship.

Call Before You Cut

The Call Before You Cut (CBYC) program (http://callb4ucut.com/ohio/) has been active for over a decade in Ohio with the primary purpose of bringing landowners together with foresters at time of a timber harvest. The program started in Ohio and with the help of a USDA Forest Service funding, in 2008 it expanded to multiple states. Nine states in the Northeast have CBYC programs currently, with Ohio hosting the multi-state website. The CBYC website and phone number direct landowners considering a timber harvest to expert advice and technical guidance from professional foresters and natural resources agencies that can help them conduct proper

silviculture in their woods, ensure environmental sustainability, and achieve their management goals. The program has been highly successful in Ohio through a strong partnership between several organizations and agencies including the ODNR Division of Forestry, cooperative forestry extension, Ohio Soil & Water Conservation Districts, The Nature Conservancy, Rural Action, the Better Business Bureau, the Society of American Foresters, and the Ohio Tree Farm Committee.

Sustaining Oak-Dominated Forests

Oak cover types comprise half of the forestlands in the eastern United States. Oaks are highly valued for their ecological and economic benefits, including wildlife habitat and wood products. Recent data on forest conditions show a lack of young oaks and an overabundance of young maples, leading to concerns about the long-term sustainability of oak-dominated forests in Ohio and the region. Restoring and sustaining oak-dominated forests require active management and long-term commitment. Climate change, high deer populations, invasive pests and diseases, and social constraints can complicate oak management. Despite these challenges, we have sufficient knowledge to be successful in our efforts to improve oak regeneration. Forest landscapes have become more homogenous and this can be a hurdle for oak regeneration as mature forests continue to age. Management is needed to diversify the landscape and create a more balanced age structure that has the capacity to naturally regenerate oak. Landscape diversity is also desired to combat the myriad of forest threats and future uncertainty. Getting private landowners and public managers to manage for oak is key to changing landscapes and ensuring a quality oak resource.

Oak SILVAH

SILVAH (short for Silviculture of Allegheny Hardwoods) is a computer tool for making silvicultural decisions in hardwood stands of the mid-Atlantic and upper Appalachian region. It is an "expert system" in that it recommends appropriate treatments based upon user objectives and overstory, understory, and site data provided by the user. SILVAH also contains a wildlife attributes report, forest stand growth simulator, provides the ability to test alternative cuts, enables development of a forest-wide inventory database, and facilitates other forest management planning functions. SILVAH is the computerized implementation of a systematic approach to silviculture, in which current conditions are identified through a systematic inventory of overstory and understory. These conditions are evaluated using an objective set of research-based standards and the constraints and objectives of the land-manager. Then a prescription is recommended to move the stand closer to the manager's objectives.

The SILVAH-Oak system (https://www.nrs.fs.fed.us/pubs/8561) 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. This effort includes the ODNR Division of Forestry, Wayne National Forest, USDA Natural Resource Conservation Service (NRCS), and Ohio Soil and Water Conservation Districts.

White Oak Initiative

The White Oak Initiative (https://www.whiteoakinitiative.org/) is a collaboration of forest industries, trade associations, conservation organizations, agencies, universities, and non-profit organizations working to ensure the long-term sustainability of America's white oak and the economic, social, and conservation benefits derived from white oak-dominated forests. While current white oak growing stocks are enough to meet demand, forest monitoring and long-term projections indicate problems in maintaining high-quality white oak regeneration. White oak is critical to many game and non-game wildlife species and to forest products industries including furniture, flooring, cabinetry, and barrels for wine and spirits.

Wildfire Risk

The northeastern U.S. (including Ohio) has unique challenges in wildland fire management, particularly in initial attack preparedness and response. With the landownership in the Northeast overwhelmingly in private ownership and the nation's greatest number of both human-caused fires and communities, the Northeast has historically required full suppression as the response to all wildfires. While most state forestry agencies have the legal responsibility for the suppression of wildfires, local fire departments play a key role in initial attack success in the Northeast. Although large, destructive wildfires occur infrequently in the Northeast when compared to other areas of the country, homes and infrastructure can still be lost or damaged in small fires in forest, non-forest, and urban areas. With longer intervals between large wildfire events, investments in preparedness (at least across some parts of the region) are challenged because wildfire management is expensive. Wildfire preparedness at the local fire department level can be overshadowed because of the responsibility of these departments to respond to all-hazard and emergency medical situations.

Middle-Atlantic Interstate Forest Fire Protection Compact (MAIFFPC)

The Middle-Atlantic Interstate Forest Fire Protection Compact (MAIFFPC; http://midatlanticfirecompact.com/home/) is authorized by public law and is composed of seven states and associated partners from the USDA Forest Service, National Park Service, and U.S. Fish and Wildlife Service. The seven states are Ohio, West Virginia, Virginia, Pennsylvania, New Jersey, Delaware, and Maryland. Funding for the compact comes from the USDA Forest Service's State and Private Forestry Program. The compact uses the funding to plan training sessions, cover costs of fire prevention material, and employ one person to administer grants. The purpose of the MAIFFPC is to promote effective fire prevention and the control of wildfires in the Mid-Atlantic region. Collectively, the states are responsible for protecting more than 35,000,000 acres of woodland. The MAIFFPC coordinates the development and integration of forest fire plans, maintenance of adequate fire-fighting services by the member states and provides mutual aid in forest fire fighting. The MAIFFPC has an active fire prevention committee consisting of a member from each state. The committee has developed fire prevention material shared by all the states. Because training is one of the most important objectives of the MAIFFPC, annual training sessions are held annually.

Summary

The Food, Conservation, and Energy Act of 2008 (the 2008 Federal Farm Bill) requires each state to complete a Statewide Forest Resource Assessment and Statewide Forest Resource Strategy to continue to receive funds under the Cooperative Forestry Assistance Act. This Forest Resource Assessment represents the first full update of Ohio's statewide, comprehensive forest resource assessment since 2010. The findings of this document will be integrated into the accompanying Forest Resource Strategy document. The Forest Resource Strategy also considers and complements other existing strategic plans including Ohio's State Wildlife Action Plan (released in 2015), the Statewide Comprehensive Outdoor Recreation Plan (2018), and local community wildfire protection plans. The combined documents, called the Forest Action Plan, can be considered a pilot for this integrated approach to evaluating and managing Ohio's forest resources. The Forest Action Plan will be living documents that will be amended and updated as new data become available, and they have an expected life expectancy of 10 years before the next update. The purpose of the Forest Action Plan is to provide a basis upon which future strategic directions and actions can be evaluated and selected. It is to be used by the ODNR Division of Forestry and its partners to marshal limited resources towards addressing identified forest issues and threats. It will also help ensure that future resources are focused on important landscape areas with the greatest opportunity to address shared management priorities and achieve meaningful outcomes.

Forest Conditions and Trends

Forest conditions and trends for the state of Ohio were assessed using a framework of criteria and indicators that was developed to assess the sustainability of forests in the northeastern United States. The key findings under each criterion follow.

Criterion 1: Conservation of Biological Diversity

Forest land and forest ownership

- The total area of forest land in Ohio has seemingly stabilized over the past three decades and is currently approximately 30% of total land cover.
- Most heavily forested areas are in the unglaciated, southeastern part of the state.
- Eighty-five percent of Ohio's forests are privately owned and 70% are family forests.
- The State of Ohio owns 6.7% of Ohio's forest land, or 572,843 acres, with the Ohio Department of Natural Resources owning the majority of that area.
- A total of 946,944 acres of forests are protected by ownership from land use conversion, including local, state, and federally owned government lands, as well as lands owned by non-governmental conservation organizations such as The Nature Conservancy.
- 80% of Ohioans live in urban areas; Ohio's urban forests provide critical ecosystem services (i.e., improve air quality, reduce energy use and runoff).
- Forest cover is declining in many urban areas and stabilization of urban forest management indicators has occurred in many Ohio communities.

Forest type, structure, and age

- In general, the relative dominance of oaks is decreasing while maples and yellow-poplar are increasing mainly due to altered disturbance regimes (i.e., loss of fire as a landscape-scale disturbance after major fire suppression efforts began in the early 20th century).
- Ohio's forests are becoming denser (majority are moderately to fully stocked)
- Ohio's forests are maturing, with increases in the large diameter size class and decreases in the small diameter size class.
- Eighty-seven percent of Ohio forests are between 20 and 100 years of age. Young forests (less than 20 years of age) and old forests (greater than 100 years of age) are under-represented in the state at 8% and 4%, respectively.

Forest land conversion, fragmentation, and parcelization

- Ohio's forests are fragmented, and additional fragmentation is occurring; the majority of Ohio's high integrity and core forests occur in southern and eastern Ohio, mostly in the unglaciated Appalachian region.
- The rate of conversion of forest land to wildland urban interface (WUI) is greater in Ohio than any other state in the USDA Forest Service's Region 9 (20 Northeastern and Midwestern states); an average of 7.5% of forest land becoming WUI each decade.
- The size of family forests holdings is decreasing (average parcel size decreasing) with most family forests being under 50 acres in size.

Forest-associated plant and animal communities and species of concern

- Many of Ohio's forest-associated wildlife (i.e., wild turkey and bobcat) are doing well and have shown population growth over the past several decades.
- Primary threat to forest wildlife in Ohio is habitat loss due mainly to development, which can fragment contiguous forest and result in conversion of forest to non-forest. Additional threats include invasive species and loss of early-successional forest due to natural succession.
- Most bird species that utilize mid- and late-successional forests appear to have stable or increasing populations, while species that utilize early-successional forests or depend on low-level disturbance (i.e., small canopy gaps in mature forest or open canopy forests with dense understories) are experiencing population declines.
- Detailed trend data are lacking for forest communities. Some important and/or rare communities in need of protection include oak savannas, various wetland communities, and forests with old-growth characteristics. Critical habitat for threatened and endangered plant and animal species are also high priorities for protection.

Criterion 2: Maintenance of Productive Capacity of Forest Ecosystems

- Ohio's forests continue to experience a positive net change in volume (net change of 65 million ft^3 annually; growth outpaces removals); however, this is a 73% decrease from 2011, when net change was 240 million ft^3. The net growth occurring in Ohio's forests

has been on a downward trend since 2010, as the volume of removals and mortality (due in large part to emerald ash borer) have increased.

- Red maple, sugar maple, yellow-poplar, hickories, and northern red oak have the greatest growth to removal ratios (greater than 2:1). The net growth of white oak is concerning, as the volume of removals and mortality annually exceed its volume of growth, with a growth to removal ratio of 0.8:1.

Criterion 3: Maintenance of Forest Ecosystem Health and Vitality

- The current major insect and disease threats to Ohio's forests include emerald ash borer (established statewide), Asian longhorned beetle, gypsy moth, hemlock woolly adelgid, oak wilt, beech leaf disease, white oak mortality (oak decline), and eastern white pine decline. New and emerging insect and disease pests that have not yet been detected in Ohio including spotted lanternfly and laurel wilt.
- Non-native invasive plants are a major threat to forest ecosystems in Ohio. Fragmentation facilities spread of invasive plants, and they often colonize after, and respond positively to, disturbance. Better mapping of the extent of invasive plant distribution in Ohio is needed.
- Wildfire has been mainly an anthropogenic forest disturbance across Ohio for thousands of years but has been greatly reduced since fire suppression efforts increased in the early 1900s.
- From 2000-2019, an average of 580 wildfires occurred annually, burning an average of 3,009 acres, with most wildfire activity occurring in the unglaciated portions of southern and eastern Ohio.
- From 2010-2019, Ohio has seen greater than average precipitation, and over the last few decades, Ohio has experienced a significant warming trend (which is consistent with national and global trends).
- Current and future climate change is likely to have various impacts on Ohio's forests, including shifts in plant hardiness zones and species ranges, changes in seasonality and amount of precipitation, and increased forest productivity which may be offset by increased stressors (i.e., summer droughts, expansion of invasive plants, pests, and diseases, increased wildfire, and decreased air quality).

Criterion 4: Conservation and Maintenance of Soil and Water Resources

- Approximately 12.6% of Ohio's forests have commitments to soil and water conservation; represented in that number are "protected" forest lands held by local, state, or federal governments and non-governmental organizations, as well as private lands enrolled in the Ohio Forest Tax Law program.

- Riparian forest cover is generally stable near intermittent and perennial streams, but of concern is a general decline in forest cover from 2006 to 2016 near large rivers and water bodies statewide.
- Forest cover by watershed has mostly remained stable, with some increases in southern Ohio, and some decreases in northern Ohio.
- Water quality and relative importance of forests to drinking water varies across Ohio's watersheds. The major causes of impairment of Ohio's forested watersheds relate to landscape modification from agricultural land use and urban development.

Criterion 5: Maintenance of Forest Contribution to Global Carbon Cycles

- Mycorrhizal fungal communities are very important in sequestering carbon in forest soils and warrants further study.
- The greatest stores of above- and below-ground carbon in trees are in southeastern Ohio.
- 66% of the forest carbon in live trees occurs in the oak/hickory forest type, with the next most occurring in the maple/beech/birch forest type, at 21%.
- Total forest carbon in Ohio has decreased slightly since 2013.

Criterion 6: Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies

Production and value of wood products

- The gross domestic product (GDP) for wood-related industries in Ohio has been relatively stable over the past decade.
- Ohio remains among the top-15 states for wood product and furniture related manufacturing.
- Timber prices have been relatively stable in Ohio over the past decade, with some species seeing slight increases.
- The majority of harvest removal in Ohio is concentrated within the sawtimber diameter classes, with 50% of the harvested volume coming from the 14- to 20-inch diameter classes.
- Oaks are the dominant species groups harvested, followed by ash and yellow-poplar.
- Since 2014, exports of raw lumber from Ohio have increased, wood products have remained relatively stable, and furniture have decreased.

Non-timber forest products

- Some important non-timber forest products in Ohio are maple syrup, ginseng, and Christmas trees. In recent years, Ohio ranked 8th among states for production of maple syrup and Christmas trees and 3rd for ginseng production (of reporting states).

Outdoor recreation

- Public forest lands in Ohio are used for a variety of recreational activities, including hiking, camping, wildlife watching, and trail riding (horses, mountain bikes, ATVs).

- Outdoor recreation is a significant economic sector in Ohio, valued at over $8 billion in 2017, with forests on public land generating $273 million in recreation benefits annually.

Investments, certification, employment, and wages

- Significant investments are being made in forest health, management, and research in Ohio. One key program that supports forest management on Ohio's private forest lands is the USDA Environmental Quality Incentive Program (EQIP), which invested around $1.4 million in forestry in 2019.
- Third-party certification of sustainable forest management has continued to grow in the United States. The major certification systems include the Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI), American Tree Farm System (ATFS), and Programme for the Endorsement of Forest Certification Systems (PEFC). Ohio's state forest system became dual-certified by FSC and SFI in 2010.
- Since 2010, the employees, wages, and establishments in Ohio's forestry and logging industry have slightly decreased or remained stable; for the wood products manufacturing industry, they have slightly increased or remained stable; and for the furniture industry, they have increased.

Criterion 7: Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

- In general, forest management standards in Ohio are voluntary. Some programs provide incentives for landowners to encourage good management, such as the Ohio Forest Tax Law program and the USDA Environmental Quality Incentives Program.
- Numerous laws and policies guide planning and management in Ohio's forests. Government agencies that manage public forests have protocols for developing and updating management plans. Several statewide committees and advisory councils provide input into planning and forestry program administration.

Data Gaps

As forest conditions and trends were evaluated for this statewide assessment, several gaps in available data were identified. Improving or expanding the available data to fill some of these gaps would facilitate a more comprehensive assessment of forest resources in the future and could lead to increased success in implementing the statewide strategies. A list of some of the data gaps that were encountered during this assessment follows.

- Location of old forests (forests with old growth characteristics) and their land area coverage
- Quantification of outcomes of sustainable forestry and forest pest suppression practices across all lands, especially private lands
- More detailed data on urban forest structure, composition, health, and benefits (USDA Forest Service FIA Program has initiated this)
- Location of conservation easements on private forest lands and their land area coverage
- Statewide maps of critical habitat for threatened and endangered species
- Improved inventory of state and federally listed species and rare biological communities
- Improved mapping of plant communities in forest ecosystems (this has been recently addressed through ecological mapping efforts for southeastern Ohio, but gaps remain elsewhere in the state)
- Improved mapping of invasive plant distributions across the state (this is improving with more attention on standardized mapping through citizen science and efforts of some organizations and agencies with tools such as the Great Lakes Early Detection Network application, supported by Early Detection Distribution and Mapping System; EDDMapS)
- Improved data on the impacts of forest insect and disease pests
- Improved data on harvest and production of ginseng (including information on how crop was grown) and maple syrup
- Data on production or sale of additional non-timber forest products that are not currently tracked, such as berries, mushrooms, nuts (i.e., walnuts), and other medicinals (i.e., black cohosh and bloodroot)
- Data on the economic impact of the urban forest industry (initiated by states in the Northeast-Midwest State Foresters Alliance)
- Improved data on carbon pools and mycorrhizal networks and opportunities for increased carbon storage in the state
- Quantification of ecosystem services that Ohio’s forests provide

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Appendix A

Forest Legacy Program

Forest Legacy Program Requirement	Criterion ("C") & Indicator(s) ("I")	Forest Resource Assessment or Strategy Location
a. Forest resources, including:		
• Aesthetic and scenic values	C6-I13	Pg. 134-140
• Fish and Wildlife Habitat	C1-I4	Pg. 40-54
• Public recreation opportunities	C6-I13	Pg. 134-140
• Soil productivity	C4-I8	Pg. 105-109
• Forest products and timber management opportunities	C6-I12	Pg. 122-134
• Watershed values including water-quality protection	C4-I10	Pg. 114-119
b. The present and future threat – as defined by the state – of conversion of forest areas to non-forest uses	C1-I3	Pg. 30-40
c. Historic or traditional uses of forest areas and trends and projected future uses of forest resources	C2-I5 & 6	Pg. 54-58
d. Current ownership patterns, size of tracts, and trends and projected future uses of forest resources	C1-I1	Pg. 9-16
e. Cultural resources that can be effectively protected	C6-I12	Pg. 130
f. Outstanding geological features	C1-I1	Pg. 5-7
g. Threatened and endangered species	C1-I4	Pg. 44-48
h. Other ecological values	C1-I4	Pg. 40-54
i. Mineral resource potential	C1-I3	Pg. 35-39
j. Protected lands in the state, to the extent practical; including federal, state, municipal, and land trust organization lands	C1-I1	Pg. 14-16
k. Issues identified by the State Forest Stewardship Coordinating Committee (SFSCC) and through the public involvement process	In Strategy	Pg. 33-34

Forest Legacy Program Requirement	Forest Resource Strategy Location
a. Identification of applicable eligibility criteria	Pg. 34-35
b. Identification of specific FLA(s) for designation:	Pg. 37-41
• Location of each geographic area on a map and a written description of the proposed FLA boundary	Pg. 37-41
• Summary of the analysis used to identify the FLA and its consistency with the eligibility criteria	Pg. 37-41
• Identification of important environmental values, and how they will be protected and conserved	Pg. 37-41
• The conservation goals or objectives in each FLA	Pg. 37-41
• List of public benefits that will be derived from establishing each FLA	Pg. 37-41
• Identification of the governmental entity or entities that may hold lands or interests in lands	Pg. 41
• Documentation of the public involvement process and analysis of the issues raised	Pg. 44-45
c. Specific goals and objectives to be accomplished by the FLP;	Pg. 33-34
d. Process to be used by the State lead agency to evaluate and prioritize projects to be considered for inclusion in the FLP	Pg. 41-43

GEORGE V. VOINOVICH
GOVERNOR

STATE OF OHIO
OFFICE OF THE GOVERNOR
COLUMBUS 43266-0601

June 16, 1993

Mr. F. Dale Robertson, Chief
USDA-Forest Service
14th & Independence, S.W.
P.O. Box 96090
Washington, D.C. 20090-6090

Dear Chief Robertson:

Pursuant to the guidelines prepared for the Forest Legacy Program, I am designating Ohio's state forestry agency as the state lead agency for the Forest Legacy Program. Please send any future information pertaining to the Forest Legacy Program to:

Ronald G. Abraham, Chief
ODNR, Division of Forestry
4383 Fountain Square, B-3
Columbus, OH 43224

I believe the Forest Legacy Program and the federal, state, local, and private partnership that this program will promote will complement other programs within the state and will better enable us to protect and manage our valuable forest resources today and in the future.

Sincerely,

George V. Voinovich
Governor

GVV/sas

United States Department of Agriculture

Office of the Secretary
Washington, D.C. 20250

Gonzalez
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The Honorable Bob Taft
Governor
State of Ohio
30th Floor
77 South High Street
Columbus, Ohio 43215-6117

Dear Governor Taft:

I am pleased to inform you that your request for participation in the Forest Legacy Program has been approved pursuant to our authority under Section 7 of the Cooperative Forestry Assistance Act of 1978 (16 U.S.C. 2103c), as amended.

The State of Ohio proposed two Forest Legacy Areas (FLA) to achieve the program's goals. These two FLAs meet eligibility criteria and have public support. The FLAs are described and mapped in the Ohio Assessment of Need (AON). The eligibility criteria and two FLAs as defined in the AON are hereby instituted and approved.

Thank you for your efforts to join the Forest Legacy Program. Please feel free to have your staff contact Mark Rey, Under Secretary for Natural Resources and Environment, telephone: (202) 720-7173; e-mail: Mark.Rey@usda.gov for additional information.

Sincerely,

Mike Johanns
Secretary

An Equal Opportunity Employer

Appendix B

Ohio's Forest Resource Assessment & Strategy: Summary of Stakeholder Input

Regional Stakeholder Meetings

Five regional public stakeholder meetings were held in January and February 2020 at the following locations and dates:

- Columbus, Ohio; ODNR Office-Fountain Square, 2045 Morse Rd., Bldg. E-1, Jan. 22, 2020
- Athens, Ohio; ODNR Office, 360 E. State St., Jan. 28, 2020
- Dayton, Ohio; Wegerzyn Gardens Metropark, 1301 E. Siebenthaler Ave., Feb. 4, 2020
- Findlay, Ohio; ODNR Office, 952 Lima Ave., Feb. 5, 2020
- Akron, Ohio; ODNR Wildlife Office, 912 Portage Lakes Dr., Feb. 12, 2020

The total attendance at the regional stakeholder meetings was 165 people. A variety of affiliations were represented, including Ohio Tree Farm System, National Park Service, U.S. Forest Service-Wayne National Forest, Five Rivers Metroparks, Hamilton County Park District, Hamilton County Soil & Water Conservation District, USDA Natural Resources Conservation Service, Rural Action, OSU Extension, The Nature Conservancy, The Holden Arboretum, The Wilderness Center, Sierra Club, local officials, woodland interest groups, forest landowners, college students and concerned citizens.

Affiliations at Stakeholder Meetings	Number
Governmental natural resources agency	52
None listed	22
Non-governmental natural resources organization	20
Other	19
Citizen/resident	18
Forestry industry	14
College/university	9
Tree commission	8
Environmental group	2
Media	1

At the meetings, participants were divided into small groups of 4 to 8 people, and each group was asked to come up with their top five issues, threats, or opportunities for Ohio's forests. Results of these group discussions are summarized below.

Results from the group discussions at the Regional Stakeholder Meetings:

Group discussions: what are the top 5 issues, threats, or opportunities for Ohio's forests?

Response	Count
Lack of education/public awareness of forest resources and benefits	20
Non-native invasive species	12
Climate change	8
Low incentives for private landowners to retain forest	8
Conservation of biological diversity	7
Forest fragmentation	6
Lack of funding/capacity for conservation	6
Poor logging practices/regulation of logging	6
Loss of early-successional forest/age-class diversity	5
Lack/loss of urban forest cover	4
Loss of riparian forest benefits	3
Decline in oak regeneration	2
Define achievable metrics in Forest Action Plan	1
Forest types not weighted according to respective attributes	1
Fracking & associated impacts (fragmentation & water quality)	1
Lack of access to high-quality forests near urban areas	1
Lack of engagement with agricultural community	1
Lack of loggers	1
Lack of old-growth forest	1
White-tailed deer management	1

Stakeholder Surveys

In addition to the regional meetings, stakeholder input on Ohio's key forest issues was also provided through surveys. A total of 1,108 stakeholder surveys were completed online, mailed in, or submitted at a regional meeting. Results from the two core questions from the surveys are presented on the next few pages.

Question 1: Rate your level of concern for the following:

Issue or Threat	Weighted Average
Fragmentation or loss of forests	5.29
Conservation of soil & water resources	5.2
Conservation of biological diversity	5.14
Insects and diseases	5.11
Wildlife habitat loss	5.07
Parcelization or urbanization	5.02
Protecting public water supplies	4.93
Inadequate funding for conservation	4.88
Invasive plants	4.83
Decline in reforestation	4.62
Low incentives to retain forests	4.62
Climate change	4.59
Lack of funding for land acquisition	4.55
Change in forest species composition	4.52
Sustainable use of forest resources	4.41
Public awareness of forest benefits	4.31
Poor timber harvesting practices	4.11
Lack of adequate forest management	4.08
Availability of land for public recreation	3.73
Public opinion of forest management	3.55
Lack of trained loggers	3.52
Lack of technical support for landowners/communities	3.42
Change/transfer in land ownership	3.34
Loss of fire-dependent species	3.16
Overpopulation of white-tailed deer	3.14
Poor delivery of conservation programs	3.1
Decline in timber quality	2.99
Urban tree management	2.99
Property tax policies/programs	2.97
Timber theft/trespass	2.93
Sustaining forest products industry	2.8
Wildfire suppression	2.75
Uncertainty of credentials of forestry professionals	2.57
Poor timber markets	1.87
Other (please specify)	N/A

Question 2: Please rank the five items that are of greatest concern to you.

Issue or Threat	Score
Conservation of biological diversity	30.8
Climate change	30.33
Conservation of soil & water resources	29.45
Fragmentation of forests and/or loss of forests	29.01
Change in forest species composition	28.43
Decline in reforestation	28.04
Parcelization or urbanization	27.7
Insects and diseases	26.67
Availability of land for public recreation	26.53
Inadequate funding for conservation	25.74
Invasive plants	25.44
Wildfire suppression	24.42
Lack of funding for land acquisition	24.17
Change/transfer in land ownership	23.92
Wildlife habitat loss	22.8
Decline in timber quality	22.74
Low incentives to retain forests	20.45
Protecting public water supplies	20.36
Lack of adequate forest management	20.19
Lack of trained loggers	20.04
Lack of technical support for landowners/communities	19.29
Overpopulation of white-tailed deer	17.78
Loss of fire-dependent species	17.28
Poor timber harvesting practices	16.04
Property tax policies/programs	14.68
Public awareness of forest benefits	14.03
Sustainable use of forest resources	13.17
Poor timber markets	12.24
Public opinion of forest management	10.35
Urban tree management	8.59
Sustaining forest products industry	8.15
Timber theft/trespass	7.72
Poor delivery of conservation programs	6.08
Uncertainty of credentials of forestry professionals	6.05

For the “other” category on Question 1 (140 responses) and “additional comments” (all of which are included below) the most commonly expressed concerns follow.

- Need for increase in public education of forest benefits (in general, as well as for youth and those living in urban areas)

- Timber harvest practices
    - Desire for preservation and management for more old-growth forest
    - Concern with impacts (i.e., soil compaction/erosion, aesthetics)
    - Timber harvest on public land (mainly listed as threat, although some recommend increased harvest for wildlife habitat)
- Wildlife
    - Desire for increased management for early-successional associated wildlife species
    - Desire for protection of mature forests for late-successional associated wildlife species
    - Concern for loss of habitat due to climate change, resource extraction, and agriculture
- Invasive species
    - Need for more management of invasive plants, pests, and diseases
    - Concern for nursery and horticultural practices that promote non-native, invasive plants
    - General concern for presence of invasive species and impacts to wildlife, native ecosystems, and biodiversity
- Fragmentation, Parcelization, and Urbanization
    - General concern for urban sprawl and development and impacts to forests and habitat
    - Need for coordinated forest management across landowner boundaries
    - Need for more incentives for landowners to keep existing forests intact
- Climate change
    - General concern for impacts of climate change (i.e., increased precipitation, seasonal variation affecting wildlife and ecosystem functioning)
    - Desire for increased carbon sequestration through forest management and reforestation
- Urban forestry
    - Desire for additional programs/incentives to benefit urban trees
    - Desire for increased canopy cover in urban areas
    - Concern over right-of-way management/poor pruning practices
- Reforestation
    - Desire to revert farmland to forest cover
    - Desire for plantings when natural regeneration does not occur
- All-purpose vehicle use (concern over impacts including noise pollution, soil erosion, habitat fragmentation, and greenhouse gas emissions)
- Oil & gas extraction hydraulic fracturing concerns over forest fragmentation, water quality, and forest loss

Additional Comments from the Survey:

50% of Ohio land area needs to be set aside for nature (trees, plants, wildlife), untouched by people.
A Committee of Ohio Concerned Woodland Owners have met, and made the following recommendations to The Ohio Division of Forestry. A. Start with a Good Program of NO TAX on Ohio Woodlanhd. Show how this pogram will pay for itself. Show how this will help Clean Up Ohio. Encourage Iowa Forest Reserve Law for Ohio. B. Implement the Simplified PLAN MODEL, "OHIO WOODLAND OWNERS INCENTIVE PLAN" C. A personal report stated Woodland Owners provide $250 per acre, per year on Clean Water and Clean Air for Ohio. D. Give more THANKS to ALL Woodland Owners, who come from all walks of life, for growing trees and keeping their land together. E. "Forest Education Beats Forest Regulation". Create Laws to protect Woodland Owners. F. Omit Soil Types for taxing woodland property. Use One Plan Model for all Woodland Owners. G. Expose how our Ohio Tax Commissioner is mistreating Ohio Woodland Owners. H. Create Laws to stop Forced Manageing and Policing Woodland Owners. Make Woluntary. I. Make it illegal to discriminate against Woodland Owners, especially Senior Citizens, and disabled. J. Make a law for Oil and Gas companies installation of pipelines and pads, to replace trees lost forever, in another area. By Law, in construction, Loss of wetlands, must be replaced. K. Recognize many invasive plants (Muliflora Rose, Autumn Olive, Ailanthus, Honeysuckle), were plants, wrongfully given out by our State Public Employees. One Multiflora Rose plant can have One Million seeds which spread and last a long time in soil. People in public service must be held accountable for these wrongful recommendations. We have fact sheets to prove. L. Be up front on the lack of profit in owning hardwood woodland, which take 60 to 100 years to grow a tree. M. School Taxes: One report stated, Woodland take less than 15 cents per dollar, Farm land 37 cents, cities $.19 per dollar for public service. States have programs for no tax for Seniors, disabled, and Military. How many trees and woodlands send kids to school. N. Never allow "Tier"programs in taxing woodlands. It leads to more Law Enforcement Foresters. O. Remind others, Woodland Owners do pay regular property tax on their homes and buildings. PCreate laws to help protect Woodland Owners on timber pricing. Help get higher pricing on selling timbert. Note: in three timber cuts with foresters, we averaged only $50.50 per tree. A timber cut only helps supplement losses in owning a woodland. Q. Stop one sided surveys, to benefit State employees and organizations. We need more up front "TRUTH IN FORESTRY". R. Treat regular Woodland Owners equal to Farmers, who own woodland and do not manage. S. The Tree Farm program is good for people who have time and can afford to belong. It has been in business since 1945, and has only 1/2 per cent Woodland Owners in Ohio and 1/2 percent members across the US. It is a failed program of individuals who want to control everybody. They throw people out if they get old or disabled, after all they have given. T. The Ohio Forest Tax Law, established in 1923, is a failed program, along with the name. U. Not all State woodlands are being managed, as they say they are. V. Many making Laws for Woodland Owners, do not even have Woodlands. We are not being represented properly. "PLEASE, HELP WOODLAND OWNERS KEEP THEIR LAND"
A continuing coordinated effort by all groups concerned about our woodland resources is very important.
Additional top concerns are Invasive insects/pests and urban tree management.
Again, anything related to the decline of upland and small game numbers.
All above are concerns for me but it's so very important that Ohio's forests and woods provide safe harbors for all forms of biodiversity. All our parks and preserves should be legally protected forever. Places that are not protected will not be here as years go by. I've seen many of Ohio's beautiful country developed (homes, strip malls). Please don't deprive the future generations the beauty of Ohio's forests, woods, fauna and wildlife.
All agencies should work together to plant the best trees to clean up the air and solve the climate change problem. Public road right of ways and all other governmental owned properties are ideal available resources. This is a no brainer. We pollute the air by mowing unnecessary right of ways that could have trees and clean up the air. Trees breathe in CO2 and out O2, really quite simple. I have a degree in agriculture and have formed all of my life of my 215 acres of land, 120 acres are in woodland with 52 acres in CRP. John PS Thanks for sending me the survey.
All are important, but basic to all, are protection of water, soil, forestation and biodiversity. The rest should follow if policies are in place to protect the basis and to protect them from urban/parcelization as developers, as a group, only attend their bottom line, ie., profit without regard to the common good or our planet.
All or most of our state forests should be under conservation easements so they are protected from short term policies such as timber harvesting.
Anything above “5” in the ranking for Question 2 was auto-selected by the quiz. I only ranked my top 5 issues. Thank you.
APV vehicles are soon to be all electric. Greater access to the forest by everyone (especially those with disabilities that cannot hike all day) helps to raise awareness of the importance of the resources and increases stakeholders that have a common interest in preserving the forest.
As a biologist with an understanding of the science of ecology, I feel that the wholesale destruction of forests and all natural habitats in Ohio and world-wide will eventually bring about the demise of our own species-potentially sooner than we think. It's beyond unconscionable and beyond profligate irresponsibility. It is greed and a lack of a basic understanding about the way the world works among those making important decisions about the future of our children and grandchildren. Thank you for asking. It's time we get more active about fixing the obvious problems instead of pretending that they don't exist.
As a land owner that connects to zaleski forest we do not want utilities vehicles destroying the land and noise that will disturb land owners and hunters. We pay for license to hunt state forest and how are we going to hunt with all the riders. Most stupid ideas the state could think of.
As a woodlot owner for the past 44 years of land that is located very near Mohican Memorial State Forest my concerns for our publicly owned forests is based upon the stewardship I have maintained on my own property. I am concerned that forestry management at Mohican contributes to the fragmentation of continuous forest ecosystem that is healthy for diversity of birds and wildlife. I am also deeply concerned about the issue of invasive plant species filling in the canopy gaps and gashes in the forest floor left behind by poorly conducted commercial logging. It is not wise stewardship to focus on promoting one particular species of tree at the expense of other species because that tree species happens to have a market worth in terms of board feet. I wish the forestry management of Mohican and other PUBLICLY owned forests could be a modern vision of future needs in carbon sequestration, Landscape Scale Restoration and modern visions that reflect and protect our historically passed down treasures of water quality and soil conservation.
As an avid hiker and outdoorsman, I frequently visit our Forests and Parks. While it is nice to see the efforts at some. Other are lacking. The fracking issue with Wayne is just disgusting and wrong. We need to protect our forest not monetize them. We once were a sate over 90 percent forested. Now were less than 40. Our forest are the lungs and we being one of the great hunting states of the natives should be more willing and empowered to want to reforest as much of our beautiful land as we can.
As I travel around the state I see so many wood lots littered with the remnants of ash trees. But I do not see any signs of reforestation. Unfortunately so many landowners do not view their wood lots as a valuable resource. I’m not sure they would be receptive to a reforestation effort.
As we face climate change, attention to Ohio's forest land and water resources become more important for the whole nation.

At present, Ohio has a very limited amount of public land devoted exclusively to recreation when compared to that of other states. With regard to Ohio's State Forests, the number is one reflecting a limited (in number) publicly-owned amenity with great potential for use devoted entirely for public recreation. With climate change an established fact, and demand for additional public recreation space at an all-time high, there is no justification in continuing to commercially exploit a limited and precious public resource that could otherwise be employed in carbon storage and economically viable public recreation space (see the recently completed study by Ohio State University on the recreational economic value of public lands on Ohio). Additionally, the state of Ohio has not formulated ANY response to the fact of climate upheaval. As a beginning step to devising such plan/response, the state should immediately cease commercial logging of its (publicly owned) state forests and begin addressing a no-cost approach to addressing climate change in Ohio.
ATVs and vandalism, along with too much logging, are causing too much damage to Ohio forests.
ATV's on the walking paths need to be controlled and limited to where they are wanted.
be a part of the trillion trees idea
Beach tree disease is frightening and we must find a cure for this and or plan for replacement tree planting. White tail deer overpopulation will begin to threaten human health and we must address the threat.
Biggest threat Imo is urban sprawl and loss of habitat for many species. Greed will get us all
Both private and public mineral holders should be able to develop their oil and gas
CAUV needs to treat timber as a crop.
Clear cut logging in state forests increases invasive species, leads to ecosystem degradation, decreases biodiversity, decreases CO2 sequestration ability of forests.
Clearcutting for timber harvesting should not be carried out, moving forward. It also seems counterintuitive to remove healthy, mast-producing oaks from the canopy when the decline in natural oak regeneration is so well known.
Climate change, if it progresses as predicted and at the current rate, will render all other concerns moot. The most simple and available action we can take is to reforest as much area as possible. And yet, I have read recently that $0 were spent by the state of Ohio on any landscape-wide reforestation in 2018.
Concerned about continuing subruban sprawl and the individual micro-loss of the tree cover in those areas. Paving of land area resulting in increased rainwater runoff.
Concerned about increased pesticide use. Concerned about confusing invertebrates, fungi and other biodiversity for "pests". Concerned about focus on timber and oak over biodiversity and conservation.
Concerned about increasing incompatible uses, such as previous proposals to further fragment the forests with additional APV trails.
Concerned land development projects are not required to incorporate /maintain trees. Concerned utility easement are not required to incorporate trees.
Concerned with attempts to allow APV trails into Zaleski State Forest and Zaleski Experimental Forest. It is displacement of one activity for another. And would be detrimental to wildlife species and surrounding areas.
Convert forest lands to permanently protected parks, nature preserves. Think to the future, not quick revenues.
Convert state forests to parks and to permanently protected preserves.
Credentials in addition to a college degree is a slap in the face to the school.
Current laws aren't being enforced regarding felling of trees during Indiana bat breeding season.
Cut more trees! A clear lack of young forest regeneration are leading to overly mature forest deserts. Many wildlife species are dependent on young forests to flourish. Cut the trees please!
Decline of birds
difficult to rank these things.. but loss of forests and it's effect on water and wild life and soil is a big deal. We need more forests that are Less managed for forest products
Don't get crazy about white tail deer populations. Do not bring coyotes in to kill young deer. This is not the answer! Longer hunting seasons and either sex. Able to kill more.
Educate Private landowners . Great Investment healthy timber increases in value 10-15%, healthy forest = healthy wildlife
Education, community-based conservation action is key to establishing an understanding of how human life is dependent on ecosystem services provided by our forests
Everyone with a yard can plant a tree or set aside part of their lawn for natural vegetation. Through individual effort, we would save energy and improve the overall environment.
Extremely concerned about the forestry practices I see used in Southern Ohio specifically Scioto, Adams and Pike Counties. Extremely erodable land that is being heavily cut including clear cuts that are causing erosion and siltation of in our streams which are home to endangered species such as the Eastern hellbender, fresh water mussels etc. I have seen some extremely poor forestry practices used by private loggers and wonder if any agency is inspecting their work. I see no replanting of the highly erodable soils after such logging on private and state lands. Shawnee State Forest have been subject to many more cuts in the past 10 years and some look like moonscapes when the logging is finished. Invasive species such as paulownia are moving into the cut areas. I know that some selective cutting is benificial as are burns to both wildlife and some species of trees/plants however large timber is also important and should be protected. I have traveled to Michigan and have seen their forest management practices and I have been impressed with both their state and private logging practices. Perhaps Ohio can encourage and enforce more best management practices. Thank you for allowing the public the opportunity to have input.
Feels a little like a push poll. Ex. I'm not so much concerned about less "oak" as about other species
Find a way for more prescribed fire on private land. Fund RX teams? Hire contractors? Reduce permitting. Need more early successional habitat
For question #2 I only ranked the top 5. " Please rank the five items that are of greatest concern to you" The rest I left in random order.
Forestry management and increase of forested lands is an easy way to address climate change. Our forests, as well as our geographical location, are protecting us from extreme weather other communities face just north and south of us. We need more. The Federal forests need to be on board with State forests as well a privately-owned practices. And landowners who protect wildlife habitat and forests should be compensated for their efforts to a much greater degree. We are moderating temperatures and protecting the water table, as well as preventing extreme flooding, which benefits communities far from us, as well as our own. Those who clear-cut and drastically select-cut should be fined heavily to make bad forestry practices financially unattractive.

Forestry Service actions should be science-based rather than financially-based. Timbering should be done only when dictated by a rational, science-based purpose.
Forestry should be considered an agricultural practice equal to farming, and timber a long term crop equal to corn and beans. We need more service foresters, equal i to ag. agents.
Forests are being cut down all over, not many true forests even exist. Please stop all logging on/in our public lands!
Fracking will provide 20 years of fuel and profits for distant investors. The locals will have toxin induced diseases for centuries.
FSA - USDA SWCD nees funds to give landowners funds to improve their forest lands, manage and control pests and invasive species.
Great resource
Healthy forests benefit everyone.
High impact of specialized user groups (mountain bikers) that want their own trails etc to use. State forests are not maintained for uncontrolled recreational use by high impact users.Horse back riders are another high impact user group. Our state forests are our last remaining WILD places we have left and we need to protect them at all cost.
High quality native forests are far more precious than we realize and we do not even know all of the costs of destroying and/or damaging intact forest at our current rate.
Hocking Hills SF area- best use for future users is non-timber harvest uses.
honeysuckle proliferation is a crisis in my opinion and deserves more attention and efforts to control it
I am a Midwesterner by birth and forests and associated wetlands and rivers are my lifeblood. The continual harvesting of trees just getting to adulthood or clear cutting in large sections of unbroken forest are unjustified and unforgivable, especially with consideration of the next generation. Visiting true old growth forests like Pioneer Mothers in Indiana gives me such insight into what we lost and such anger towards those who preceded me and did not realize or care about the magnificence of these forests. To take that away from other life, including mine, is not anyone's right to take. Let's think bigger and broader and return large tracts of forest to the Midwest again so we can become known for biodiversity and a place to visit and to LOVE.
I am a private landowner concerned mostly about habitat loss and invasive species. Please conserve our forests.
I am concerned with the overpopulation of deer section. I hunt in a county in S.E. Ohio and have seen a large decline in deer population over the past 10 years. I hear ODNR saying they have the numbers where they want it, but I know people giving up on hunting due to the low population. I know a lot goes into these decisions, but I caution the decision makers in Forestry and Ag to consider the hunting industry as well.
I am very much against the expansion of more ATV trails and horse trails due to the erosive damage, the litter, the noise, and the general disruption of all other activities caused by these "sports".
I answered these as a tree commissioner for urban forests. persons with a different outlook might have differing opinions
I appreciate the efforts of the State Foresters to provide information and support to landowners who have property that includes forests.
I appreciate the ODNR performing this survey
I assume above ranking is 1 most important and 5 least important!
I believe that the ORV community is a much needed life line for certain parts of OHIO, and with expanded opportunities to expand our trail system to improve the overall economy in the southern region of Ohio
I believe that the quarantine on Black Walnut in Butler County should be lifted. The quarantine is currently making it difficult to manage many of the woods in Butler County properly. Black Walnut is an important species for the hardwood timber industry and currently Butler County landowners and forest managers are feeling frustrated with the quarantine. All evidence points to limited spread of TCD in Black Walnut. The quarantine was necessary at the time TCD was introduced to research and prevent spread. It is now preventing sustainable use of forest resources.
I believe we need to preserve all existing forested land and protect our water supply from farm run off pollution.
I do not support fracking being done on state, federal, or any public land.
I do not want to see ATV trails in our state parks and forests.
I have a personal and professional concern about the disconnect between public officials who promote the plantings of Bradford Pear Trees without understanding the impact nor the value of planting native beautiful trees like Redbud. A statement from the Forest Service to address this issue would help and should be sent out statewide.
I have picked the five topics because they all get back to my main concern, which is fighting climate change by stopping any future lumbering or logging operations. I am a scientist who is not in favor of a strictly hands-off approach-- we should continue to destroy invasive plants and allow hunting to reduce deer populations-- but we should stop timber operations entirely.
I know that in my area, we have a native timber reserve and we also have people who are given permission (they say when I ask them) by owners to take all of the mature trees in a small forest in my neighborhood. I cannot answer this survey with much confidence in my knowledge.
I live in an area where Invasive honey suckle and deer are decimating the under story and see a decline in bird numbers and diversity. So that is a huge concern for me. Unfortunately, many forestry practices that increase value also decrease diversity. For example, cutting of beech that are not timber quality also reduces the number of nesting holes for certain species.
I proud to be a part of landscape stewardship in northeast Ohio. I think the greatest challenge for landscape stewardship (in Ohio and other states) is people's view of money and how they handle it.
I ranked 10 because they are interrelated and important. Thank you for your work!
I read the assessment and strategy data that yo usent me. It is appalling to me to find my taxpayer dollars are used to create a report that says only the ODNR knows forestry and the landowners need to be controlled by this knowledge. I t also recommends or suggests writing laws to grant public access to private landowner areas.
I think it would be beneficial to encourage rural and urban landowners/developers to find ways to include trees but also planning for that tree's growth in the next 200 hundred years. And CAUV programs to encourage reforestation of properties when not being farmed any longer
I think that Shawnee state forest is under utilized for recreation. There is potential for a great multi use trail system. Seems like the entire focus of this large forest is to just take the timber and not invest anything back into it.
I think there is far too much emphasis on maintaining timber resources only for potential harvest. The natural lifespan of some species is 400-500 years, longer than Europeans have even been here. Why do forestry 'experts' think they understand forest ecology? They haven't even been studying

them through one tree's lifespan. Need to set aside much more forest lands for return to old growth. Maintenance should only involve invasive removal and fire control.
I think this would be a good time to investigate the Black Walnut quarantine in Butler County. It has been monitored closely for some time now and there have not been any reports of spread or even any more incidents. I believe that, with all this being true, the quarantine of Black Walnut in Butler County should be uplifted. With this quarantine in place, land managers are limited in how they can implement management plans and this resource is being left improperly managed and possibly wasted. Thanks.
I volunteer over 1,200 hours per year dealing with reforestation in both our parks and in Cuyahoga County's urban environments.
I want logging on public lands to stop
I want to convert state forests to permanently protected and managed parks and preserves. Forests and woods provide safe harbor for biodiversity in all its forms. They must be protected.
I want to see forest management based on evidence, and to do that we need to support science-- scientific studies of Ohio's forests!
I was not aware that Ohio has only 30% of Forest Land. I live in Lake County Ohio and it seems there is more than that but I am not the expert. This to me is alarming as where I live in Concord Township Ohio more Developers are buying land for Developments and the loss of wildlife habitat and trees is alarming. Growth cannot be stopped but it needs to be controlled.
i was walking in the small urban forest area today and noticed that as i walked closer to the noisy highway it was adjacent to, the quieter it became. the birds were only active in the center where the urban traffic noise was less. this tells me we need larger stands on undisturbed woods to provide habitat conducive to wildlife.
I wish you had asked what region of Ohio we are coming from, even a map with 5-7 zones would give you much more useful information.
I would encourage you to convert the state forest land in Mohican to the state parks and preserves.
I would like Ohio t have a "Community forest" program paid for in part with Clean Ohio Funds or other funds that match public investment (like $100 per tree planted) to reforest. Ohio needs to designate land to it to help with fragmentation (to reconnect forest lands).
I would like the focus to be on finding a healthy balance of recreational opportunities within Ohio forest lands while maintaining a healthy forest for generations to come. Too much recreation (especially involving motorized vehicles like ATVs) is a concern as I worry the damage they can potentially do to the land may be hard (or impossible) to recover from in the future. Also, I hope that Ohio would work to protect more forest lands and work to purchase tracts of property that can help fill in the gaps in the already developed forests. Last, but not least, I think it is important that reforestation projects also be considered, especially in areas that are currently without much forested land. Urbanization and the spread of commercial buildings into previously natural areas is not sustainable and does not benefit our area in my opinion.
I would like to see FMPS cost shared by the USDA-NRCS move to 15 year plans instead of 10 year plans. NY has moved to this criteria and other states are looking at standard templates that will do the job. This will allow more money and resources dedicated to the landowners and actual projects on the ground rather than a bunch of FMPs generated repeatedly ending up sitting on the bottom of the pile on top of the refrigerator. A good TSP can certainly do a plan for 15 years in SE Ohio and the money saved can than be used to better fund incentives to the landowners so that the work can actually be accomplished rather than just be recommended.
I would like to see more discussion of urban food forests as well as the need for more policy around re-establishment of hedges and forests on and in-between farms to help with agricultural runoff issues
I would like to see more forest land in some of nicer parks with adjoining state forest converted to State Park designation.
I would like to see more land put into permanent trusts.
I would like to see our state forests permanently protected like parks. Help private landowners to manage their woods more sustainably.
I would love to see local programs that actively monitor deforestation and promote responsible practices in farming, development and timber harvesting.
Iam concerned about fracking and the effects it has on water and on forest continuity. Note the fracking wells just north of Mohican or the the NE portion of the Allegheny NF (PA). You can see these easily from satellite images. Cutting roads to these numerous fracking pads creates fragmentation issues. It increases penetration of invasives into otherwise continuous forest. This seems extremely shortsighted. It seems to benefit a very few individuals at the expense of an important resource (intact forests).
If there are volunteer opportunities for any of my "top 5" issues, please contact me
I'm also concerned about pollution and it's effect on water, trees, and wildlife. I've had dozens of trees die on my property with pine trees seeming to be the most suseptable. It's unclear what is causing large seemingly healthy trees to die over the course of a few years but I wonder if it has anything to do with all the natural gas wells and continued fracking in my area. (eastern Ohio)
I'm very aware of how beneficial trees and forested lands are to our health and for wildlife habitat and protecting water resources. I'm very discouraged seeing every last parcel of wooded lots be up for sale for another housing development or grocery store for our convenience and wish I could do more to keep the destruction from occurring. Unfortunately unless the population growth reverses I don't see an end in sight. It's a depressing fact.
Important factors to take into consideration for forest health: planning for the future (generally) which includes climate change, sustainable use and conservation of natural resources, and protecting biodiversity across taxonomic groups. Since most of forested land in Ohio is private, only so much contribution can be made from governments; private citizens must be thoroughly engaged and understand the impacts on forest health, wildlife, and human health.
In regards to Hocking State Forest - the County is a tourism Mecca and no commercial forestry should take place. The existing older growth trees once cut will never return because of timber cutting cycles. Also, the Hocking County streams are too important and valuable to allow commercial tree cutting. Also, never any clear cutting of forests.
In the future less land will be available for forests and wildlife. We must preserve what is left for posterity. Money is a transitory thing and only has the value we give it. Forests have an intrinsic value all of their own and it is the forests and all it contains that gives value to us.
Inter agency public education on protecting the states natural resources. Bring together water recreational users, hikers, bikers, bird watchers hunters, and fishermen do everybody buys into sustainability and understands the urgency.
Invasive species include more than just Ailanthus, many herbaceous invasives are more detrimental.
Invasives and overpopulation of deer in urban areas like Worthington are devastating the local forests.
Invest into technology that will make it easier to communicate with all of us. Update the websites, more social media presence. Make the woods fun again.

It is vitally important that we save our forests and wildlife from threats of climate change and manmade destruction.
It would be great if more and more land was procured by the State Parks or gifted to the State to preserve habitat and forests. So many people enjoy the parks. I see so many people use them and enjoy the beauty and tranquility they provide. Protect more habitat, land and trees with more strict zoning laws.
It would be great if Ohio could regain some of its forest heritage. Conservation at scale would go a long way.
It would be nice to hear more about what our regional foresters (urban and non) actually do...
It would be nice to see additional educational oppertunities for woodland land owners that are more regional besides Columbus and Mansfield Ohio. A tri-county location would be helpful in NE Ohio(Lake, Geauga, Ashtabula, Portage, Trumbull have bad harvests taking place). Landowners need education on timber harvesting approaches and loggers need to be better trained on BMP's.
its very hard to narrow it down to 5
It's vital to keep ODNR Forestry on the forefront of all these issues and keep us informed as to what we can do. Working with your Urban Forestry Program continues to be a welcome partnership. Great Folks, especially Stephanie Miller in Findlay.
Keep the politicians and bureaucrats out of the equation. God will do quite nicely without them.
Knowing that the forest's need to be managed, but to go in and completely clear cut the whole area doesn't seem like management to me, it seems like destruction.
Lack of invasive species control in State Parks & missed opportunities by State Parks to educate the community.
lack of oversight for oil/gas industry resulting in landowners being defrauded (especially the elderly). no standardized royalty reporting requirements.
Landowners have little to no access to awareness (perhaps ameliorated by signage in public spaces, fliers in the mail, workshops and community activities that bring people together through nature— regreening condemned lots, flower planting, bird IDing, composting initiatives/setup, community garden building, etc...). Native plants are not celebrated the way exotic plants and manicured lawns are (made obvious by legal cases against homeowners who allow their lawn to return to the natural and native and healthy state). Forests do not need to be 'managed'— they need to be protected.
Landowners with forested area should be given a tax credit not taxed for land that once every 20 years provides a little income. The incentive to retain the ground in a woodland setting is very low, especially in areas that have urban growth around it!
Last question is set to rig the survey as I have to rank items of no concern and a ranking is already populated
Learning to live sustainably on our planet and maintaining ecosystems to provide ecosystem services is critical. Providing real financial incentives to private landowners to maintain forest habitat is important long range thinking/action.
Lindera Benzoin is a vital native plant for the spicebush butterfly! Invasive honeysuckle should be removed.
Looking forward, my current focus is on ecosystem fragmentation and that we are best served developing resources to reconnect ecosystems. Water being the other concern, my focus is towards programs that protect H2O resources by minimizing their use and improving the quality of what we have.
loss of sugar bushes
Loss of the urban tree canopy is alarming as cities see trees as a liability. In tree issues the first impulse and action is to remove the tree.
Lots of Urban Folk would like to PLANT TREES. They don't have sites and need a little training. Many landowners want forests and have sites, but need help/labor. ODNR can facilitate training and connect volunteers with landowners.
Love what you are doing here!! Thank you for the opportunity to be heard!!
Make decisions to Preserve Ohio's forests and wildlife. If opening to public, make it hiking accessible not Atvs. Keep out the timber industry and expand and grow more forests and trees.
Making mountain biking trails in Shawnee forest. Make use of the land other then selling timber.
Managing for threatened/endangered species Managing for game More prescribed fire
Managing State Forests should be a priority of ODNR Forestry. Some of the proceeds from harvests should go to replant tracts that have been clearcut. Management should include invasive vegetation control until newly planted trees canopy. Ohio has a good landowner educational delivery system in OSU Extension that provides forest management information.
Many of the concerns are interdependent so holistic approach is really needed
Many of these issues are interdependent, so it's difficult to prioritize them. Also, this survey asks only if one is concerned about an issue, not whether one is for or against ODNR's practices regarding the issue.
Mining and pipelines underground negatively impact far more area than their locations in the landscape.
Mohican State Park has been a big part of my life for decades. It breaks my heart every time a tree is cut down for profit. Some things are more valuable than money.
More burning
More dirtbike single track mileage. More invasive species management. Thank you.
More emphasis placed on bmps for harvest (single tree selection, crop tree, shelterwood). Too often forests are stripped of all trees with no thought of the future.
More forests need to become preserves safe from timbering or fracking
My biggest concern is that our children and grand children need a place to hunt and fish. We can not let these children grow up thinking food is made in the back of the grocery stores. Also, these kids need a place to ride off road motorcycles. I'd rather have my kids learn about balance and traction on a dirt bike before we hand them the keys to a car to go drive inn public. It certainly helped me.
NEED STATE ASSISTANCE IN ELIMINATING EUROPEAN BITTERSWEET SUCH AS MASS SPRAYING FROM AIR
NO FRACKING IN OUR FORESTS!!! NO DRILLING FOR OIL OR GAS IN OUR FORESTS! NO MINING IN OUR FORESTS!
NO fracking on these lands!
No leasing public lands for fracking, timbering, or storage wells.
No mention made of sustainably developing and managing mineral (Oil & Gas) resources to create income, like the Muskingum Watershed Conservancy District, to financially support the state, the parks and local governments - if it's good enough to mention in your Draft Assessment, then surely it merits mentions in Sections 1 & 2 - I'd make it #1 on my list in question 2 if it was offered - rather blatant disingenuousness/bias not to include it - development can and is being successfully done so that there is no surface disturbance - be a good neighbor.
no more ATV trails! noisy, awful, degrade the land .... a few is ok, but not any more... minimal to no logging in state forests. can log other places....

No reason private timber can't be properly managed with the help of governmental foresters. Clear cutting is ridiculous
Not all forest supports biological diversity equally. We need an efficient way to identify and protect high-diversity stands. This means recognizing the complex management history of Ohio forests.
Not enough forestry and conservations programs in junior high school - field trips are. Ritical
numbers erase themselves
Obviously these details are intertwined. We need trees because they work hard!
ODNR Division of Forestry needs to designate areas of no-harvest, future old-growth to conserve biodiversity and prevent loss of species that require old-growth character
ODNR should beef up its programs for educating suburban citizens on converting potions of their yards to native ecosystems, forests, and prairies.
Ohio currently has 7.9 million acres of forestland; 88% of that forestland is privately owned with the remaining 12% owned by local, state, and federal governments. The DOF plan addresses all of these forests. The 2020 DOF Resource Assessment, found on the DOF's webpage, has several alarming pieces of data. A chart shows that in the early 1800s, Ohio had 25 million acres of forests. By 1940, we had cut down more than 85% of our forests and had less than four million acres of intact forests remaining. By 1990, that amount of acreage had inched up to about eight million acres, but sadly, the amount has remained constant at this level for over thirty years. Most of these forested areas are in counties located in the Southeastern portion of the state. A recent fact sheet from DOF states that Ohio has spent "$0 - zero dollars on landscape scale restoration." The last time Ohio witnessed any real attempt at planting new trees was during the 1940s when the Civilian Conservation Corps (CCC) helped restore forests with massive plantings around the state. This project was responsible for restoring a barren area we now know as the Wayne National Forest. About 70 percent of our forests are owned by families and a survey showed: "the primary reasons for owning forest land are related to beauty, wildlife, and nature; the most common activities on their land are personal recreation, such as hunting and hiking, and cutting trees for personal use, such as firewood; and most family forest ownerships have not participated in traditional forestry management and assistance programs in the past five years." The state owns less than seven percent of Ohio's forested land and data shows, as the population of the state has grown, our forested acreages have not. There are about 0.68 acres of forests per person in the state and only 3.6 percent of our forests are protected to "preclude timber utilization." Ohio has 220 million urban trees or about 38% urban tree cover. These trees are especially important in that they "moderate climate, reduce building energy use and atmospheric carbon dioxide, improve both air and water quality, mitigate rainfall runoff and flooding, enhance human health, and social well-being, and lower noise impacts." The annual benefits from urban forests in the U.S. are estimated at $18.3 billion. Ohio's forests sequester 1.2 million tons of carbon dioxide a year. Unfortunately, invasive insect species like the emerald ash borer have severely impacted many of our urban forests. Ohio's forests are also impacted by invasive tree species and other herbaceous plants which move into an area especially when clear-cutting techniques are used. The species of trees dominating the forests have changed, with oaks declining and maples increasing. Anyone who lives in rural Ohio can tell you, the deer population makes it nearly impossible to grow hardwoods without some type of protective fencing. The DOF report claims we have enough mature trees to justify the "opportunities for stand improvement activities to be funded by a removal of a portion of available sawtimber in fully and overstocked stands." DOF refers to mature trees as those being between 60 and 100 years old, but in actuality many of Ohio's Oaks (white, black, burr) can live at least twice as long, 200 years, and in some cases up to 400 years. Why are we cutting trees down before they can reach their maximum carbon storage ability? These mature trees create the shaded canopy that non-timber forest products like ginseng, a long-lived perennial plant, requires to grow. When I did my doctorate research, I found that ginseng harvests netted more income in forested regions than logging operations. We should be encouraging and assisting private forest owners to keep their forests intact and to cultivate valuable medicinal plants such as ginseng and goldenseal. We also need to protect second-growth forests so they might one day become old growth forests. Basically, we need trees. We need them for carbon sequestration, for water and air quality, for habitat, for watershed protection, as riparian buffer zones, for their beauty, and for our future. We need to protect the symbiotic relationships between fungi and plant roots, which are the mycorrhizal fungal networks. These networks are especially sensitive to "intensive harvesting". Scientific studies show that harvesting "disrupts soil carbon storage and causes significant carbon emissions." What we don't need are poorly conducted timber harvests by unregulated and unlicensed loggers. We don't need prescribed burns, as fire is not a common natural occurrence in Ohio. These fires kill turtles, snakes, herbaceous plants, fungi and other microorganisms. We don't need more oil and gas development which leads to fragmentation, the spread of invasive species, radioactive contamination, light pollution, and air and water pollution. We don't need to use our forests for unsustainable biomass energy. We don't need to open our forests to indiscriminate use by ATV enthusiasts. We don't need to cut down old forests to provide areas for the development of "young forests." This false narrative has been used to justify logging, when in reality, we can easily create "young forests" without sacrificing mature forests. Ohio's mixed mesophytic forests represents one of the most biologically diverse regions of the world. Sadly only a few small stands of undisturbed old-growth forest remain in the state and "less than 0.4 percent of all forest stands in the state of Ohio are at least 140 years old." Research shows that "old-growth are superior to all forest age classes for both carbon sequestration and carbon storage." We have to make a commitment to the future to greatly expand forests in our state and to protect the forested areas that remain.
Ohio forestry needs to get away from managing our forests for money rather than protecting the species that need the forests, good biodiverse forests, with excellent water quality and the ability to withstand the onslaught of future climate change ravages.
Ohio has very little public land per capita. We need more, and we need to manage it for biodiversity and resiliency to prepare for a changing climate.
Ohio needs more hiking and backpacking opportunities with dispersed camping. I'm tired of driving to Michigan for long overnight trails. Zaleski is great but can only be done so many times. Also, if you could teach more leave no trace. It's so sad when I get to a site and it's loaded with trash.
Ohio needs to convert state forests to permanently protected parks and preserves. They should manage ginseng crops for the state since it is a high value forest crop. Manage the forest for eco-tourism, so people will travel to Ohio to have a great forest experience. Do not allow 4-wheel vehicles on the the forest trails/roads. They should be on reclaimed mine land. Encourage growth of native shrubs/forbs in the understory and stop mowing the road edges in the forest so native wildflowers can flourish. Our foresters should become the guardians of the forests!
Ohio needs to replant forests and encourage sustainable forest farming and multi use development from recreation to food, to living (treehouses). Programs should be implemented to incentivize dairy farmers and other monoculture crops into replanting forests. The new genetically modified American chestnut is a great opportunity for Ohio to replant a species that is critical for healthy forests
Ohio should require mineral extraction companies to purchase insurance policies that guarantee public forest and prairie lands they access will be restored in the event of a bankruptcy.
Old growth forests should be preserved at all costs. Conservation of remaining forests should be a priority. NOT logging for profit and atv trails.

Ongoing loss of trees with reduction in ability to sequestrate carbon without adequate controls to reduce clear felling and replace trees with the same species to retain structure and composition of forests. Not enough Cities with ordinances to protect trees and trained staff to implement legislation. Not sufficient funds to enact enforcement and education of public and administrators.
Our forests are laborious to maintain, and there is little support for land owners to enact needed practices.
Our forests need to be managed for a diverse mix of tree species considering the threat from various insects, diseases and plants.
Our forests, along with most other natural resources, can only be ruined once. Responsible government and citizenry will carefully guard what's left and appropriately fund that stewardship. Start now--we plead with you.
Our public forests should be managed as tree reserves and not commercial timber sales. Low impact recreation and bird habitat is important. There is enough private land to supply the states timber needs. We need large tracks of undisturbed forest with only the State can provide to the public. Forestry should manage invasive species which basically have gotten a stronghold from all the disturbance of logging.
Our state and national forests are essential as natural areas. Any reduction in them is a theft from present and future generations.
Our state forests are funded with public tax money. As such, we should always have a say in how they are managed. I believe any changes should be put on a ballot to vote on.
Our state needs to focus MUCH MORE on conservation and reforestation, rather than a "resource" model. Why are we not planting trees?
Over population of wild turkey and especially coyotes!! Becoming a danger to domestic animals in rural neighborhoods. Need to thin these populations!
Over the years I have considered the forest management field days sponsored by our county SWCD to be very informative. They have been probably my greatest resource for managing our 30+ acres of woodland.
Over use by high impact special interest groups on state forest properties, i.e. mountain bikers, horse back riders and ATVs. Wild places need to stay wild places.
Parcelization/ Urbanization was not included on the top five list choices. It would be my top choice.
Perhaps the greatest challenges to OH forest resources in introductions of invasive species and the large numbers of different forest owners and the challenges of coordinating responses to threats to forest health across these many owners.
Plant more native trees!!!
Please consider overall impacts as it pertains to forest management - for example, if nearly all of NE OH is clearcut in the same year the wildlife which depends on larger trees had their habitat decimated.
Please continue. looking into the Carbon Credit Market and how the state might become a part of the program if possible. Please consider doing more comprehensive assessments of state forests that might qualify for more areas which qualify for FSC-HCVF protected status. I believe that there is movement within the ODNR and DOF towards recognizing that there are drastic changes happening on our fragile planet in relation to the world-wide complex of climates. From individual adjustments to to the extremely important adjustments at the state and federal levels , the future life as we know it on this planet is dependent on the changes and sacrifices which should have begun in ernest 50 years ago. We're now feeling the effects of not responding when we still had a better chance to slow the huge flywheel of irrepairable damage to the sustaining systems which keep this planet in balance. The changes which are needed now are drastic and immediate!!! Please put the highest priority on what our state DNR and DOF can do to protect instead of exploiting our valuable forests. The value of State forests should not be valued in dollar signs. The integrity of these large forests play an impotant mitigating part of what our State can contribute to the children's quality of life on this planet in the future!
Please disregard my ranking. Couldn't get the numbers to stick
please keep doing good work
Please keep the forests intact. Thank you.
Please manage our forests with Ruffed Grouse in mind. As a lifelong resident I dream of not driving to Michigan to hunt my favorite species. I flush but will not shoot in Ohio due to the fear we will lose these birds. Ultra habitat sensitive and we can help them...
Please no fracking either.
Please promote as much unspoiled forest land as possible.
Please remember that state forests belong to the people of Ohio and are not just a revenue stream from logging. Please be sensitive to the interests of hikers, hunters, horse riders, mountain bikers, and trail runners.
Please save our wild areas. There are becoming less and less places. Thank you for the work you do.
Please STOP CRUEL YEAR ROUND hunting of INNOCENT COYOTE families! We need LESS hunting and MORE HUMANE methods of controlling deer like birth control or reintroduce NATURAL PREDATORS like wolves!
Please use your talents to benefit all of us. Thank you for asking.
Preserve backcountry trails for hiking.
Preventing habitat loss and fragmentation is obviously my greatest concern during an era of mass extinction. (We also need to restore the wetlands, especially in northeast Ohio.) Any loss of forest is tragic, selling out forests to oil and gas industries is doubly so in an era of climate change. I also greatly value the available public recreation including hiking, backpacking, camping, hunting, fishing, and birdwatching, and consider such recreation essential to allow humans to connect with the natural world. However, I am very concerned about ATV trails in Ohio's forests. ATVs create noise disturbance to both humans and wildlife, and damage vegetation and soil. ATV trails are NOT valuable outdoor recreation!
Prioritize historically native, bio diverse land that will also be resilient to climate change, and invasive species
Proactive Oil and Gas development needs to be addressed and included - this has been stalled for way to long! - please make this a win-win for your neighbors
property tax policy
Protect our forests.
Protecting our forests is critical to slowing down climate change. The USA must stop procrastinating! Since our ignorant president won't take action, states must. With additional funding and conservation practices, many of these issues would be addressed.
Public education of forestry management and resource issues
Question 2 -- needed more instruction on how to choose/rank.
Quit taking lumber from our forests & start major reforestation!
Ranking too difficult

Recreational through protection of our streams, wetlands, and forests is my main concern. Loss of habitat, species decline. Maintain our forests to these ends.
Reduce logging and let our current forests regenerate and spread out across more acerage. Make loggers, timber companies create their own sustainable "tree farms"
Ron Ott Ott's Lost Forest
See above re: ranking numbers
Set aside areas of old growth management as a % of the total stand, including roadless areas.
Several of the above items are so related to each other it makes it hard to rank them properly. For instance, if the overpopulation of deer are addressed, native vegatation will have a greater survival therefore decreasing invasive species advacement and protecting water quality. Addressing disease and insects with regards to the forest, will also help increase water quality.
Should we be trying to tie these forestland/urban forests together?
Small game hunting has gone away because of a loss of availability of hunting land. Private land owners are of a new generation and do not understand or care about our heritage of the outdoors .
So many private owners do not know the impact they have when they try to make their wooded areas pristine, grassy and full of non-native flowering plants. We need to educate!
Some forests need to be managed for timber but there needs to be forests managed for wildlife.
Some of the questions are too vague or broad to answer. For example, wildlife habitat loss could refer to very different habitats depending on whether the wildlife one is concerned about are species that need young woods (e.g., Ruffed Grouse) or species that need unfragmented old forest (e.g., Parula Warbler).
Some sort of legislation to make Mohican permanently protected would be wonderful.
Some wooded areas were 70 to 80 per cent ash. Now that they are gone, replacement species are needed. Otherwise, honey suckle, Russian olive and multi flora will take over the area.
State forests and wildlife areas should retain income from forest management to reinvest in their properties.
State forests should be used for recreation and not to harvest trees.
State forests with State mineral ownership should be leased with no occupancy so income can be dedicated to State forest and parks management! Look at Fernwood State Forest!
Stop all logging on state lands!
stop all lumbering in state and federal forests, we have so little left and need to restore old growth habitat
Strong State and Federal cross-sector policy is essential. Funding stability for conservation actions will allow long term solutions and growth.
Strongly support efforts: - maintaining large tracts of unfragmented forest (reducing non-science based cutting) - performing reforestation by planting trees in tracts not cut for wildlife benefit - making decisions based on improving water quality - increasing forest health education for Ohioans - continuing emphasis on work to address invasive pest and disease (including education programs) - supporting state leaders and representatives committed to adequately funding our state forests
Survey too long! Numbering the items by importance was confusing. My numbers are not correct. Sorry.
Thank you for asking for the public's input!
Thank you for doing this survey! I think it's important to expand this type of outreach to people beyond landowners, too.
Thank you for the info, now go camping or take a vacation (retire?) and take a break from the numbers :) -from an ex-engineer P.S. I have 5 kids. I hope they get to enjoy the woods in 30 years.
Thank you for this opportunity. Unfortunately I feel my viewpoint is in the minority. While I have several hundred acres of forest I have no interest in managing them in the traditional way. An ethic of invasive control and allowing natural regeneration should be part of the discussion. Our belief is humans have done significant damage to the environment by well-meaning practices and our forest are all the more poor for it. Ohio has approximately 2 square miles of old growth forest remaining out of an initial 46,000 square miles. Can't we adjust our thinking and laws to promote at least some regeneration of old growth forests? I do not want money from anyone but I don't want my conservation projects taxed out of existence either. I submit the productively of land can be measured in the aesthetic value of a relatively hands off ecosystem. I am perfectly content to allow all of my trees to die of old age and in doing so provide the restoration that is needed in old growth forests. I would be happy to discuss this further as I do not what to be a whiner but rather a voice to help move us beyond a relatively exclusive consumptive attitude of our natural areas.
Thank you!
thanks for asking my opinion!
Thanks for asking. The apparently unstoppable waves of invasive species is my biggest concern for the long-term health of Ohio forests.
Thanks for asking. I hope that I will be able to pass ownership of our forest property to children and grandchildren, and that ownership continues to be affordable (thru CAUV or OFTL) without resorting to large scale harvest or sale of portions of property.
Thanks to the ODNR for this survey. Hope many respond.
The current woeful state of Ohio forests and American forests generally could be attributed to "management". Much of what is labeled "forest" in Ohio should not be considered as such, because forests are ecosystems, not simply contiguous stands of trees. Forests should have a great diversity of plant, animal, and fungal life, and the so-called forests remaining in Ohio largely don't exhibit this any longer, because of the devastation from logging, burning, and the invasive, non-native species of insects and plants that seem to inevitably follow from such"management" practices. The effects of climate change, which itself is partly caused by global deforestation, could be the final blow to healthy, living forests in Ohio. If the Ohio Division of Forestry exists to preserve forests in Ohio for commercial and recreational purposes, for wildlife habitat, and for soil and water protection, then it's imperative that a new 10-year plan completely readjusts existing management practices, because it appears like the current ones are not working.
The fragmentation and loss of Ohio's forests, and the declining health of these ecosystems due to species imbalance and invasives, need 1. FUNDING for: 2. PUBLIC AWARENESS CAMPAIGNS; 3. RESTORATION via removal of invasives and replanting with natives, and scientific surveys of native flora and fauna. And, 4. STRICTER LAWS ON DEVELOPMENT. Ohio is becoming one giant strip mall/subdivisions. Thank you for reading my comments.
The invasive fish species is very concerning. It's killing off ducks and other animals and upsetting the balance of nature. Invasive trees should not be sold at local nurseries. We need more parks not parking lots
The list above is too long and almost impossible to prioritize. Too many items have to be addressed very soon.

The ODNR and DOF should prioritize public land conservation and low-impact recreation, and finally put an end to the harmful ecological management practices involving logging, oil& gas exploration, and mining on all public lands in Ohio.
The ODNR Division of Forestry needs a more robust and better funded Forest Health Program. Funding to fight pests and pathogens, to restore fire-dependent forest types, and to improve over-all forest health should equal or exceed that spent on commercial harvests. Increasing and maintaining low-impact recreational facilities such as hiking trails, biking, and primitive camping, on state forest lands should be a priority as the demand for these multiple-use activities is increasing. Increased funding for service foresters should also be a priority as private forest land owners are in need of professional advice and assistance.
The public is generally misinformed about what a healthy forest should look like. Timber harvesting is important in order to maintain a diverse and healthy forest and to support a variety of wildlife. Educating the public should be an important aspect of your forest action plan, as well as encouraging timber harvest on private lands, discouraging the fracture of large blocks of timber through replanting of harvested areas, and adequate timber harvesting across public lands throughout the state, but especially in southern and southeastern Ohio.
The public, especially in areas away from forests, needs more education. There are many poor management ideas being promoted by non-foresters.
The question "loss of fire-dependent species" is misleading. We don't have any fire adapted species. We have fire tolerant species (in that, some do OK with fire) but we don't have any that actually NEED fire (e.g., pines with serotinous cones).
The recently shelved proposals to build APV trails in Shawnee, Vinton Furnace, and Zaleski state forests are examples of the potential for mismanagement of Ohio's state forests. This destructive use of land is contrary to the stated mission of DOF.
The revenue from timber sales does not justify the clear cutting of forests and destruction of scenic assets, habitat, biodiversity.
The State of Ohio is already overtaken by low-density homes, creating habitat fragmentation that continues to grow. As public awareness grows regarding climate change I hope that we can be leaders in sustainable forestry. Having lived in many parts of the country, I see Ohio's potential but also see how far behind it is in far-reaching resource management. I hope that you are able to coordinate efforts to preserve and grow this asset. Thank you for your efforts.
The top concerns are: maintaining habitat and climate change impacts
The two biggest issues for Ohio's forest is the lack of forest management and the loss of oak. The major threat to reaching to these issues ; the biggest hurdle is environmentalism.
There is a great need for educating land owners about invasive plant identification and control and include suggestions for native replacement plants, shrubs and trees.
There is no longer an economic justification for commercial logging (or any other extractive activities) in Ohio's public forests. Despite ample evidence that taxpayers dk approve of these practices, the Ohio Department of Natural Resources and Division of Forestry patently ignore such concern and disapproval. With public recreation land in short supply, and climate change a blatant fact, Ohio' public forests must be transitiined, as soon as possible, to public parks. Failure to do so is a betrayal of a public trust.
There is plenty of state owned public lands, however, there never seems to be enough workers to be able to do the ecological work needed. Instead of more land acquisitions why not acquire more reliable workers to assist in managing the ecosystems already under state ownership.
There needs to be greater focus on the contributions of NTFP's to sustainable economies and forest management. Timber is important but currently, Ohio Forest Tax Law and similar programs are hyper focused to a fault. We need a broader understanding of the economic and environmental contributions of NTFP management. Turning more focus to NTFP's tends to provide benefits to biodiversity, forest management, and conservation.
There needs to be more education about the need to clearcut to encourage biodiversity and to protect species like the ruffed grouse.
There should be agricultural programs for forestry. I have twenty acres id love to put in Forest but can't because it doesn't pay. Soy/corn pay the bills. Forestry benefits for PRIVATELY OWNED FAMILY FARMS needed!
There's a lot of poor forest management / timber harvesting in NE Ohio. There's an associated poor opinion / lack of understanding of what forestry and good forest management is. The good guys get lumped in with the bad. Educated people and farmers are the worst. Tree cutting is seen as bad no matter what by educated people and farmers don't think they need help managing their timber. Proactive, sustainable management is not understood and people don't know enough to distinguish between good advice from a qualified forester and bad advice from wood butcher. It's difficult to champion sustainable management due to the lack of understanding and disconnection from the natural world and general distrust of anyone advocating tree cutting.
These are such vague terms to use in an effective survey. Data can be interpreted however you want it. No ATVs for "availability of land for public recreation". We must stop viewing forests as "timber products" and profits for the timber industry. Our forests are essential for the health of all living tings, especially with the impacts of climate change! We must completely rethink of management of a forest as dealing with the invasive plants and trees and the looming loss of many more tree species due to disease and insects (beech, hemlock, oak...) our management plans and lawns need to grant incentives for carbon sequestration and air pollution/air purification with allowing more preservation of forest land. Mature forests store much more carbon than damaged logged forests with young trees remaining. Habiat loss and biological diversity are also topics that must top forest management discussion and plans...NOT just logging!
These ranking items can be combined as TOP Priority!!! Sustainability is critical!!! Development sprawl needs to be controlled and stopped. Tax incentives for land owners to save Tree stands and sustainable management of timber !!! Harvest wisely!!! Since we all live in wood homes...
This ranking is not user friendly

This survey is inherently biases toward timber industry goals. Why do you ask about conserving fire-dependent species rather than fire-intolerant species when our native deciduous woods are largely fire intolerant? Only upper forest slopes host fire-tolerant species. Yet DOF prescribed burn plans include coves and mesic areas, which have been destroyed by fire and bad logging. They also cause wildfire, not a natural phenomenon in our moist forests. The almost 3000 acres that burned in Shawnee State Forest in 2009 as a result of a DOF prescribed burn that got out of control on a day of intense heat and high winds is an example of the horrible unforeseen consequences of such wanton "management" by our forest guardians. Your goals should be to protect our native forests, and our old forests especially, which are much more important than young forests for rare biodiversity not widely available on fragmented private lands, air purification, and carbon sequestration (Stephenson, N., et al., Rate of tree carbon accumulation increases continuously with tree size. Nature 507, 90–93, 2014; James A. Lutz et al. Global importance of large-diameter trees. Global ecology and Biogeography, 2018.) It is outrageous that the State and feds talk about our 40-80 year old forest being old when many species live 200-400 years or more. This is pure timber industry spin and not scientific or true. Furthermore, logging causes soil to become a source of carbon emissions for decades, thus dealing a double whammy to climate – from lost sequestration capacity of trees removed and destruction of the forest soil as a carbon pool. The state's promotion of fire at the expense of our climate and most of the inhabitants of our forests other than oak is based on shoddy science. (eg. Matlack, G. Managing fire in the mesic deciduous forest when fire history is unknown, Conservation Biology 29, 3, 2015.) It is highly questionable whether there was extensive fire in SE Ohio and southern Ohio, where most DOF forests are, in pre-European-conquest times. (Eg. R. McEwan et al. Multiple interacting ecosystem drivers: toward an encompassing hypothesis of oak forest dynamics across eastern North America, Ecography 34: 244_256, 2011.) The state's promotion of biomass as an energy source is highly problematic, since burning wood to produce electricity is less efficient and produces more CO2 than coal per unit of energy produced. (pfpi.net/wp-content/uploads/2014/04/PFPI-Biomass-is-the-New-Coal-April-2-2014.pdf and other references at pfpi.net). Only the subsidization of this industry with renewable energy credits makes this industry profitable at the expense of our climate, our air quality, and our native forests, which lose the important carbon matter that makes forests healthy and protective of climate. In a time of melting ice caps and climate tipping points already met or imminent, the State has an obligation to the people and land of Ohio to do all it can to protect climate, air quality, water resources, our native forests, and the biodiversity that only large tracts in protected status can host. Stop the logging and burning, both poorly disguised as based on science. Protect our forests and our futures.
Tim and Stephanie Stover Morgan County Tree Farm Owners in the family 51 years.
To enhance the economic impact of forest lands to local, regional and state economies, please consider including those with outdoor recreation and tourism/travel development in your action planning. If we work together, we can create sustainable access and experiences while boosting the economy. This will help with so many of your other priorities.
To maintain and improve sustainable timber resources, wildlife diversity, air quality, protection of our waterways, and recreational opportunities for our citizens, it is critical that we have a well funded, well managed Division of Forestry. The Division of Forestry is integral to the success of ODNR and must be adequately funded to carry out its mission. If 80% of Ohio's forestland is owned by private citizens, education, guidance and enforcement must be the priority of the DOF. Their ability to demonstrate such leadership is reflected in their proficient management of the timber resources of our 200,000+ acres in Ohio's State Forests.
Too many items to effectively prioritize
Top priority should be protection of old growth forests and older growth forests that could become old growth forests. It's awful how few of these exist in the state and many Rare to state plants need them and it also makes for a much better habitat for native wildlife.
Trees sequester carbon. We must do all that we can to reduce the amount of carbon dioxide in the atmosphere in order to combat climate change. This is a fact. There is no more room for denial. It is very important that we retain as many mature trees as we can, especially on public land. Also, the destructive process of timbering opens land to invasive species that crowd out our native plants. Native wildlife depends on native plants. I have seen clear cuts in Shawnee State Forest. These clear cuts ravage the land and lead to sediment run-off. No good comes from these clear cuts. They are done for short term financial profits. I don't buy the grasslands-for-grouse story that was put forth by DOF. Precious ecosystems that have developed over years are destroyed by heavy equipment and chain saws. The trees that were sequestering carbon were gone in the blink of an eye. People need intact, undisturbed forests for relaxation and recreation. Quality recreational areas attract tourism. I no longer go to the Shawnee State Forest due to the destruction wrought by the Ohio Division of Forestry. I had previously enjoyed vacations there, but I started to notice that every time I went there was more and more destruction of an important Ohio area of rich biodiversity. Please protect our remaining mature forests. Thank you.
Trees/forests need to be conserved in rezoning decisions. Climate change is here, conserve what exists, mitigation is too late.
Tried to put in order of personal importance but this was difficult for me
Trump & his supporters are a national disgrace....
Urban forestry issues are not represented well in this list of items.
Urban forestry suffers from multiple jurisdictions, shifting ownership.
Urban Program should consider tracking how to increase number of communities with an urban program. Reactivate and improve the Ohio Urban forestry Administration.
Urban sprawl is a great concern to me.
Urban tree management in Worthington and other suburbs is deplorable. How Asplundh is allowed to do what they do for AEP is mind-boggling. Their work is a death sentence to most trees they butcher.
Very concerned for planning for Climate Change. Climate Change will happen even if we do not exactly know the schedule. Would be good to have good recommendations now for what species will be doing the best 100 years from now because those are the trees that we will bee planting today.
very difficult to rank :)
we are at a critical stage and we need to manage our irreplaceable Mohican forest very wisely.
We are very concerned about the continued destruction of our public forests that are essential for the health of our environment. We have to completely rethink the "management" of our forests, as it is clearly evident the impact that climate change is having on our public health and the health of all living things on our planet. It is very simple, we need our forests to help mitigate the impacts of climate change. The time is NOW to fully consider global warming and climate change. Therefore, a reexamination of all current practices is imperative. This is unavoidable as a global priority. The priority can not be profit and monetary gain above all else. We must look at what how each decision concerning our public forests and how it impacts erosion, allowing invasion of invasive species, loss of air quality, wildlife impact loss, and all the other positive impacts (that you trained professional) already know about why we need our forests and trees.
We can't breath/eat/drink money. We need to be careful stewards of the world we're handing off to our children.

We have had a tx reduction plan done, and would like to harvest our timber - we cannot locate anyone on the approved list to take our job. We only have 48 acres, and believe we are too small for the certified foresters to deal with. Very frustrating when we are trying to manage our land correctly, but can't get a timber sale performed.
We love spending time in Mohican Forest, and it is disheartening to see areas ravaged that will not recover within our lifetime.
We must preserve our forests as habitat for native plants and animals and greatly limit human recreation.
We need conservation and preservation not logging.
We need early forest types to support upland/song birds.
we need more education for people about how to work together to have an earth where people and other animals and plants live in harmony with nature in ways that allow for live on earth to continue.
We need more prescribed burns in standing timber
We.need clean water, trees and forests to sustain wildlife and climate change.
Went to your Columbus presentation. Went well. General Statement: When making decisions, please keep in mind the concept of the land ethic (Aldo Leopold). It is my belief that this concept is a part of the foundation of our North American Model of Wildlife Conservation. It all starts at the habitat and the sustainable use of the habitat. With out a properly managed habitat, the whole biota system will fail. Keep on doing good work. Thanks for all you do.
Wet woods with vernal pool communities are often timbered without regard to the biodiversity that is dependent on these seasonal wetlands. Buffers are needed, surveys made and restrictions of heavy equipment for protection of sensitive and often declining biotic communities.
while there is one question lumping all under soil and water resource management, there are separate water questions -- where are the soil/fracking questions???
Who do I contact if I see tree poachers? I have seen this many times and no one will help! Not just forest, city parks and county.
Wish Ohio still had a tree seedling nursery(s)
With the effects of climate change accelerating, it would be either arrogant or foolhardy for those charged with managing our public forests to believe that the best course of management for many decades into the future would be to do anything other than let all public forests continue to grow, not logged and not burned, so that they can sequester carbon in the largest capacity and to be a healthy, abundant resource to future generations. The only management that our forests need for the foreseeable future is to monitor and control non-native, invasive species and to allow our forests to heal from the cutting and burning that has left our current Ohio forests in such a poor state of health. Old-growth forests are a miniscule portion of our existing forestland. They should be predominant.
Woodland landowners need strong incentives to develop and maintain woodland management plans. Then, we need professional foresters available and trained to develop those management plans.
Would like more participation in Timber Harvest Planning program by loggers/landowners. Loggers/Foresters need additional training in how sediment effects water quality. Training should include how to identify vernal pools. BMPs should do a better job of protecting vernal pools/wooded wetlands and ephemeral/intermittent streams. Provide training to SWCD staff on portable mills and effects on WQ. Are there beneficial uses for green/wet sawdust? How should sawdust piles be managed if being left on-site?
would like Ohio tree nursery to resume
Would like to see an emphasis on conserving forests in a way that promotes large contiguous areas of late successional forests. Management that promotes stable ecosystems in a rapidly changing environment, including eliminating commercial logging in state forests.
Would like to see better communication and/or partnering with ODOT.
Would like to see continued cooperation between DOF and other public entities @ the state, county, and municipal level. There is a high level of need for professional forest management guidance at Ohio's state and local parks. Urban forstry program should continue to be a priority as our state becomes further. There is a need to more actively protect and manage forest land owned by ODNR outside of DOF. Primarily parka and wildlife land. Most of this land does not have an active management plan.
Would like to see more effort to help birds and improve habitats
Would love to be able to see growth and expansion of protected forest/timber of native species. White pine stands are fun and beautiful for public use but would love to have more reclaimed areas of native timber. Protection of Eastern Hemlock from Hemlock woolly adelgid. Would like more land conserved and reclaimed back to forests of native trees if logging occurs. Would appreciate more education and advocacy for the public on forest benefits. We need more trees not less. Mohican has too much development as it is. Limit logging of native trees, focus on white pines, reclaim logged areas to native species, prevent further exploitation of natural gas. Expand trail options in certain areas but think about spread of invasive plants (garlic mustard). Educate and advocate for more public involvement of conservation assistance. Conserve what we have and expand the forest if possible. Mohican's trees and forests are too valuable for exploitation in a large fashion. Keep it small, sustainable, and regrow what is taken away. Hold timber operations to high standards, they represent you in the public eye. Plant more, cut less.
You are not forthright in the survey about prescribed burns (there are other ways to manage for oak) and there are many ways to "manage forest" and various definitions of "sustainable forestry" depending on if you are a logger or are interested in maintaining biodiversity.
Your survey ranking list was cumbersome to sort. Too many choices to go through.

Meetings with Key Partners & Statewide Committees

In gathering input from stakeholders for the statewide forest resource assessment and strategy, the previously described regional meetings and stakeholder surveys had diverse representation from across the state on key forest issues. However, the Ohio Division of Forestry also held separate discussions on the assessment and strategy at meetings with a few key partner organizations and at several statewide committees with a natural resource or forestry focus (list follows). Many of the Division's key partners are represented on the various statewide

committees. Discussions at these meetings covered various topics related to the statewide forest assessment and strategic planning, but they focused on the following: 1) ensuring accurate and current data in the assessment, 2) identifying key forest issues and statewide strategies, and 3) identifying or expanding partnerships to implement those strategies.

Meeting Dates and Organizations Represented:

- January 9, 2020: Ohio Forestry Coalition
- February 7, 2020: Ohio Conservation Federation
- February 18, 2020: Federal Partners Meeting – USDA Animal & Plant Health Inspection Service, USDA Forest Service (Wayne National Forest, Northern Research Station, and State & Private Forestry), U.S. Fish & Wildlife Service, USDA Natural Resources Conservation Service, U.S. Air Force (Wright Patterson Air Force Base)
- February 25, 2020: Ohio DNR Division of Wildlife
- February 28, 2020: The Nature Conservancy
- March 13, 2020: conservation partners meeting – Association of Consulting Foresters, Ohio Farm Bureau, National Wild Turkey Federation, Ohio Chapter of American Tree Farm System, Ohio Forestry Association, Ohio Department of Agriculture

Statewide Committees and Dates When Assessment and Strategy Discussed:

- Ohio Forest Stewardship Committee: October 4, 2019
- Urban Forestry Advisory Committee: November 1, 2019
- Forestry Advisory Committee: March 4, 2020
- State Technical Committee: March 12, 2020

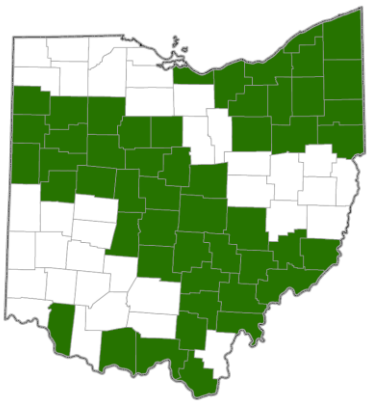
Appendix C

Geospatial Analysis: Rural Lands Methodology

Analysis Process

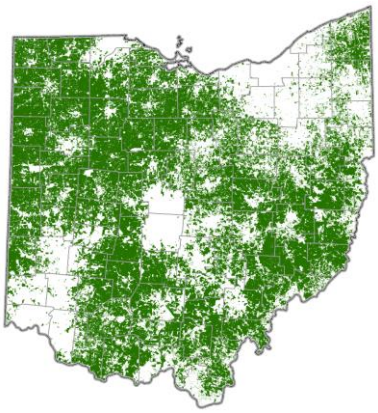
All analyses were completed by the ODNR Division of Forestry using ArcGIS 10.7.1 (ArcView license level) and Spatial Analysis Extension tools. Data used in analyses were acquired from multiple sources (see Table 30). After acquisition, each data set needed to be prepared in some way. Some final datasets used in the analysis were derived from original datasets. A complete discussion of each dataset follows.

Forest Pest



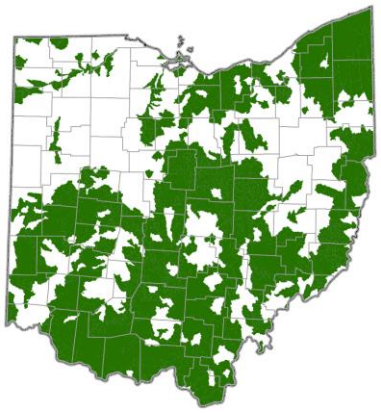
This layer depicts areas of concern regarding forest pests in Ohio. This layer was constructed using Ohio Department of Agriculture gypsy moth and Asian longhorned beetle data and ODNR hemlock woolly adelgid and beech leaf disease data. For gypsy moth data, those counties at least 50% within the "Slow the Spread" action area (the area of the "advancing front" of gypsy moth infestation) were included. For the other forest pests (Asian longhorned beetle, beech leaf disease, and hemlock woolly adelgid), county-level data for known occurrences were included. For analysis, this layer was converted to a raster and all cells within the area of concern were assigned a value of 1 and all other cells were assigned a value of 0.

Housing Change



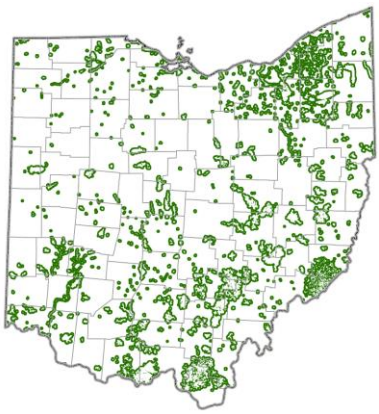
The housing change layer used was obtained from the U.S. EPA's Integrated Climate and Land-Use (ICLUS) dataset. This dataset contains projections for changes in human population, housing density, impervious surface, and land use for the United States, stemming from global population and urbanization assumptions underlying various future trajectories. Input data for these models includes census data, fertility, mortality, and immigration rates, which are all used as inputs to a land use model, which spatially allocated five residential land uses (exurban-low, exurban-high, suburban, urban-low, and urban-high). For this analysis, the "base case" (BC) data, projected for change in land use from 2010-2040 was used. The areas projected to remain rural in the year 2040 were selected as the priority areas and assigned a value of 1 and all other cells were assigned a value of 0.

Priority Watersheds



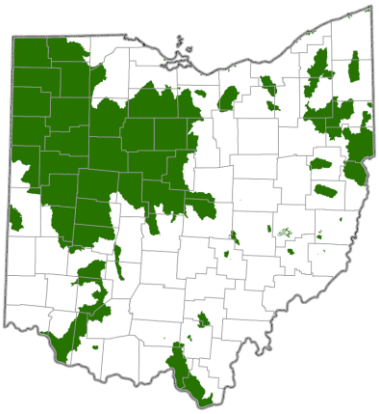
The priority watershed layer is composed of two components: 401 water quality certification "ineligible" and "possibly eligible" watersheds as defined by the Ohio EPA, and watersheds having a relative risk to water yield greater than 80 (on a 0-100 scale, 0 being lowest risk), as defined by the USDA Forest Service "Forests 2 Faucets 2.0" data. For this analysis, these areas were combined, converted to a raster, and all cells within the areas of concern were assigned a value of 1 and all other cells were assigned a value of 0.

Proximity to Protected Land



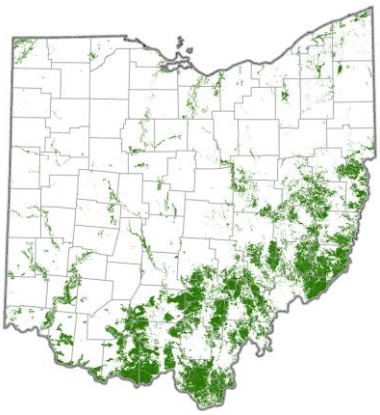
The proximity to protected land layer is considered important as government and conservation organizations already have an investment in the public and protected lands and management of these adjacent private lands can have an influence on the public and protected lands. A private land holding was considered adjacent if it was within one mile of a public land holding or privately owned protected conservation land holding. For this analysis, a protected land vector layer was established and buffered by a one-mile distance and converted to a raster with all the cells in the buffer area given a value of 1 and all other cells assigned a value of 0. The data was acquired from the USGS Protected Areas Database of the United States (PAD-US 2.0) and all public land and private conservation land was used in the analysis.

Public Water Supply



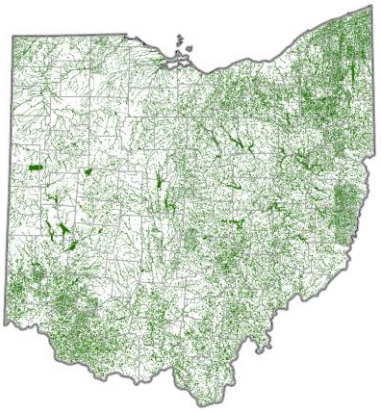
Public water supply is intended to give added weight to areas that surround surface water intakes. Forests in these areas can positively influence water quality through their filtration and uptake of pollutants. Sub-watersheds were selected that contain surface water intakes. This dataset was obtained from the Ohio EPA. Watersheds were intersected with point and polygon layers and the resultant watersheds were converted to a raster with the intersecting watersheds receiving a value of 1 and all others receiving a value of 0.

Resilient and Connected Landscapes



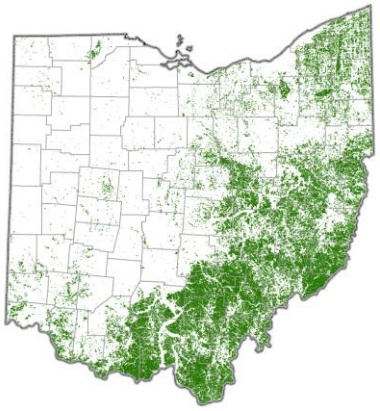
The resilient and connected landscape areas data were acquired from The Nature Conservancy, which identify areas that may have habitats with relatively greater resilience to a changing climate based on microclimates or highly connected lands and corridors where species are most likely to persist and/or move. For this analysis, all areas identified as resilient or connected landscapes were given a value of 1 and all other cells assigned a value of 0.

Riparian



Riparian corridors are high-priority forests for proper management because of the important role that they play in water quality and wildlife habitat, both in-stream and near-stream. A priority area for riparian forests was derived from the USGS's National Hydrography Dataset. The value area shown consists of a 300-foot buffer around all perennial streams and water body shorelines. For analysis, the layer was converted to a raster and all cells within the 300-foot buffer were assigned a value of 1 and all other cells were assigned a value of 0.

Spatial Integrity Index



Spatial integrity index (SII) was developed by the USDA Forest Service and integrates three important facets of forest fragmentation that can affect forest ecosystem functions–patch size, local forest density, and patch connectivity to core forest areas–into one metric. Spatial integrity index ranges from 1 (indicating a highly fragmented forest) to 10, representing the highest forest spatial integrity. For this analysis, SII classes 8-10 were considered "high spatial integrity" or "core forest," and those cells were assigned a value of 1 and all other cells were assigned a value of 0.

Threatened and Endangered Species

Recorded occurrences of threatened and endangered plant and animal species that fell within the forested area of the state (based on 2016 National Land Cover Database data) were extracted from the ODNR's Natural Heritage Database. All occurrences (both point and polygon features) were buffered by 3-mile wide hexagons. For this analysis, the layer was converted to a raster and all cells within the hexagons were assigned a value of 1 and all other cells were assigned a value of 0.

RESTRICTED DATASET – NO IMAGE

Wetlands

The wetlands layer is comprised of spatial data obtained from the U.S. Fish & Wildlife Service's National Wetland Inventory (those areas defined as "freshwater emergent wetland" and "freshwater forest/shrub wetland" types and the USGS's Gap Analysis Project (those areas defined as "north central interior & Appalachian rich swamp," "Laurentian-Acadian swamp systems," "central interior & Appalachian shrub-herbaceous wetland systems," "Great Lakes coastal marsh systems," and "Great Plains prairie pothole" cover types). These areas were combined, converted to a raster, and all cells within identified wetlands were assigned a value of 1 and all other cells were assigned a value of 0.

Spatial Overlay Analysis

All datasets described above were clipped by the state of Ohio prior to spatial analysis. A weighted sum analysis was performed in ArcGIS 10.7.1 Model Builder. Table 31 provides weighted value information. Three additional operations were performed within the model (Figure 106). Before running the weighted sum analysis, protected lands were masked out of all datasets. After running the weighted sum analysis, the copy raster tool was used to convert pixels to 4-bit unsigned integers and a second extract operation masked out all land not classified as forested in the 2016 NLCD dataset.

Table 31. Criteria used in the geospatial analysis to identify high-priority rural forest landscapes in Ohio and weighting value.

Criteria	Value
Spatial integrity index	1.6
Priority watersheds	1.1
Public water supply	1.1
Riparian	1.1
Housing change	0.9
Proximity to protected land	0.9
Resilient and connected landscapes	0.9
Threatened and endangered species	0.9
Wetlands	0.9
Forest pest	0.6

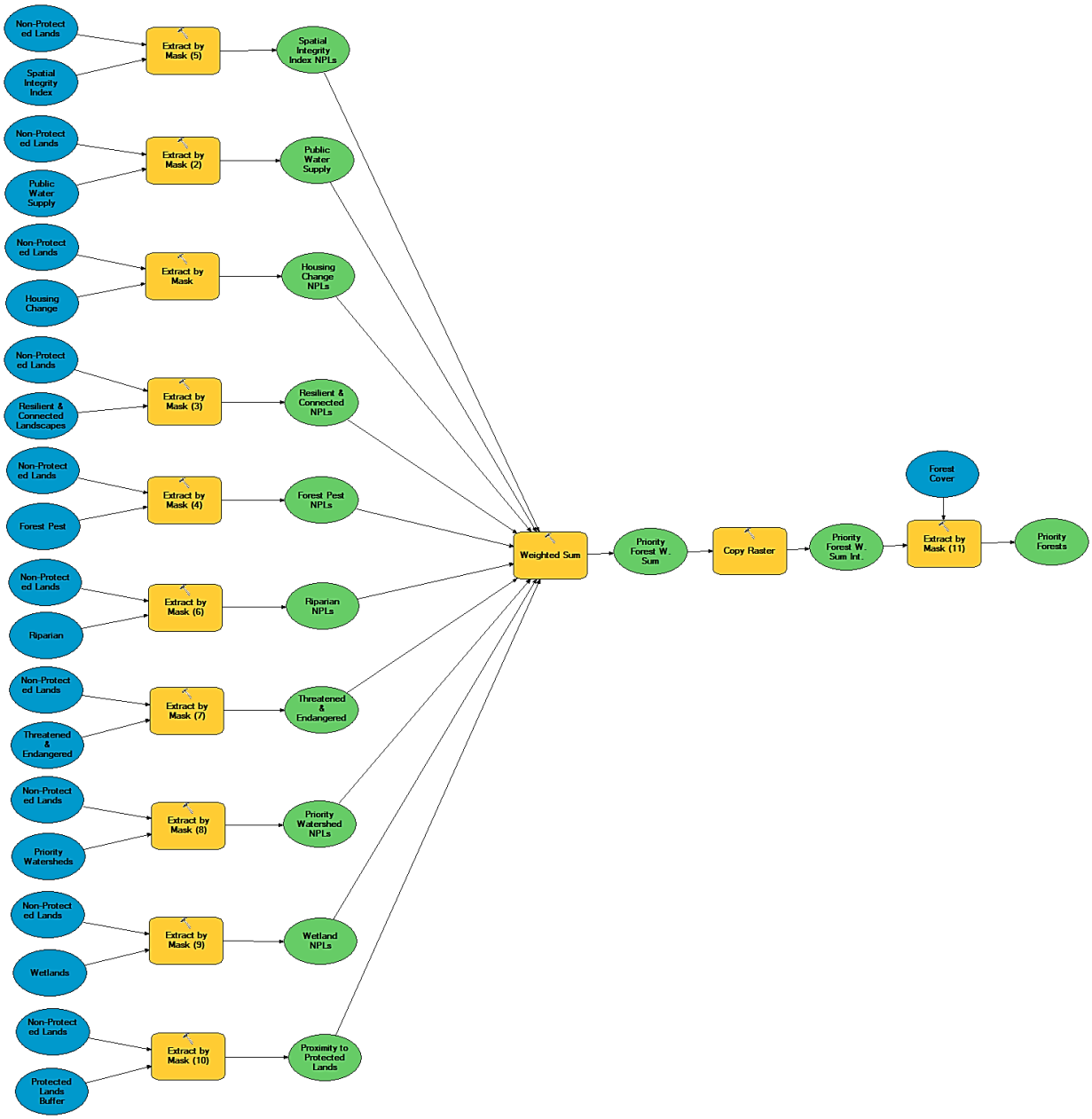


Figure 106. Steps used in weighted sum analysis performed in ArcGIS 10.7.1 Model Builder for Ohio private rural forest land prioritization.

Appendix D

Chronology of the Ohio Forest Tax Law Program

1. The 1912 amendments to the Ohio Constitution (which were substantial) included the conservation language and took effect 1/1/1913.

   The constitutional amendment of 1912 (Section 36, Article II), reads as follows:

   "Laws may be passed to encourage forestry, and to that end areas devoted exclusively to forestry may be exempted, in whole or in part, from taxation. Laws may also be passed to provide for converting into forest reserves such lands or parts of lands as have been or may be forfeited to the state, and to authorize the acquiring of other lands for that purpose; also, to provide for the conservation of the natural resources of the state, including streams, lakes, submerged and swamp lands and the development and regulation of water power and the formation of drainage and conservation districts; and to provide for the regulation of methods of mining, weighing, measuring and marketing coal, oil, gas and all other minerals."

2. In 1925, Amended Senate Bill 186 passed a law to implement this authority. The act was titled, “To provide for the taxation of forest lands, to promote the production of timber, provide for the utilization of idle and low-grade agricultural lands, and to encourage the general practice of forestry among private owners.” The law included property taxed at 50% of the actual local values of the land and a recoupment of up to 10 years of forgone taxes except that property that was enrolled for 25 years or more would be exempted from recoupment.

3. By 1937, the law included a severance tax for timber or 5% and the recoupment was for 5 to 10 years but again except that property that was enrolled for 25 years or more would be exempted from recoupment.

4. By 1939, the law was amended and the recoupment and severance tax were eliminated. The law took on the elements of the “rules” that governed the program until the promulgation of rules in 1993.
   “In order that the owner may receive this reduction in his forest taxes he must:
   1. Protect his forest from livestock.
   2. Protect the forest from fires.
   3. Maintain a crop of valuable timber trees on the land.
   4. When trees are destroyed or removed from the woods, young trees must be planted, unless provision is made for natural regeneration.
   5. Post at least two signs which state that the woods has been classified under the tax law, and explain what the owner is doing to receive this consideration. These signs may be obtained from the State Forester at a small cost, or must be similar to them.

6. File an agreement with the State Forester, stating that it is the owner's intention to practice forestry on the area."

5. In 1993 (effective 2/26/1993), the first rules were passed to govern the FTL. Prior to 1993, there were no formal rules in place; only an agreement form was signed by the landowner that outlined the basic rules. The balance of the program was governed by policy.

   The 1993 rules established (fundamental points that may be at issue):

   Definitions
   Eligibility
   Lands certified prior to the implementation of rules were to "remain certified as long as those lands comply with the regulations under which they became eligible for certification."
   10 acres minimum
   Building exclusions
   Property line marking
   Application process
   Forest management plan requirement
   Violations/withdrawals
   Notification
   Conversion
   Failure to comply with mgt. Plan
   Conversion of Ownership that included cancellation for any ownership change.

6. In 1994, (effective 11/7/1994) the rules were amended to allow forest land acreage to be added without application.

7. In 2004 (effective 1/9/2004) the rules were modified:
   Definitions were added and some modified.
   Lands certified prior to 11/7/1994 were given the pass to remain certified as long as those lands comply with a new rule 1501:3-10-7.
   Landowners were required to attend training.
   Added an appeal process.
   Required the use of a master logger to perform harvests.
   Notice of violation for conversion of land.
   Cancellation of certification if owner authorizes a lessee or other to manage the property inconsistent with the management plan.
   Added the special provisions for property certified prior to 11/7/1994.

8. In 2009 (effective 6/11/2009) rules were modified:
   Can use topographic map in addition to aerial or plat maps for the OFTL forest map included in plan
   Forest plantations eligible for consideration for certification as forest land one calendar year after trees planted (versus prior one planting season)

Old law cancellation exclusion for transfers to surviving spouse, upon affirmation of surviving spouse to the original agreement terms (FT-7) and forest mgt plan (if there was one).

9. In 2019 (effective 1/28/2019) the rules were modified:
   One-time application fee was increased to $75
   Definition of family members was expanded to include trusts, LLCs, and other organizations that include original family members from deed
   No automatic cancellations for transfers to any family member (under expanded definition)
   Eligible acreage adjusted to include non-contiguous forest land >120 feet wide
   Language added that commercial timber harvests must be under the advice of a forester
   Added ability of Chief to maintain list of qualified professional foresters for program implementation/plan writing
   Expanded allowable distance between boundary markings to 100 feet
   Removed education requirement
   Removed required “intent to manage” practice prior to classification into program
   Loosened timing requirements for completing management practices to a more “work at it” approach for added flexibility to landowners