Landscape Stewardship Plan for

Washtenaw County, Michigan

March 2017 Version

Landscape Stewardship Plan for Washtenaw County, Michigan

March 2017

Written by Jacqueline Corteau

This Landscape Stewardship Plan is funded in part through a Fiscal Year 2015 Landscape Scale Restoration grant for "Developing Nine Landscape Stewardship Plans in Michigan" (15-DG-11420004-175). The United States Forest Service, State and Private Forestry granted $336,347 in federal funds to the Michigan Department of Natural Resources, Forest Resources Division which along with its partners provided $337,113 in matching non-federal funds. The Department of Natural Resources administered the grant in partnership with The Nature Conservancy, Huron Pines, The Stewardship Network and the Remote Environmental Assessment Laboratory.

The Stewardship Network
Connect to Conserve

Table of Contents

1. Executive Summary

This Landscape Stewardship Plan, covering Washtenaw County and adjacent areas within the Huron River watershed in Southeastern Lower Michigan (The Stewardship Network's Huron Arbor Cluster area), is one of nine such plans developed through a grant project funded by United States Forest Service (USFS) and administered by the Michigan Department of Natural Resources (MDNR). The intent of developing this plan was to connect people and organizations to each other and to forest stewardship information, resources and assistance programs, in hopes of increasing our collective capacity to protect and maintain the forest products, services, and values upon which this region depends. Only by working collaboratively at the landscape scale we can better address the expansive challenges that threaten the health and sustainability of our forests and other natural resources.

In Washtenaw County, as in much of the Southeastern Lower Peninsula, old-growth forests were cut over during the middle of the 19th century. Since then, forests have gone through periods of expansion (establishment of second-growth forests) and contraction linked to drought and agricultural use and policy, followed by increasing development following World War II, and accelerating suburban and exurban expansion since the 1970s.

Agriculture and development have created a highly fragmented landscape in which forests exist mostly in small patches in regional, county, and city parks or private woodlands, rather than in large parcels of publicly managed land. At the same time, these forests provide important wildlife habitat and are home to over 150 rare species that are considered endangered, threatened, or of special concern at the state level, 8 of which are Federally listed as threatened or endangered and at least 2/3 of these species depend fully or partly on healthy forest communities for habitat.

Woodlands are increasingly valued in this highly fragmented landscape for providing important ecosystem services, such as aiding water quality and storing carbon to help mitigate climate change, as well as for recreational and educational opportunities and nature connection. Even urban trees can provide important ecological and economically valuable benefits, as cities such as Ann Arbor have reported.

Washtenaw County's various park systems, land conservancies, and many small private land-owners are deeply committed to preserving and protecting their woodlands for their many values. But the maintenance of healthy and productive forests, protection of rare species, and preservation of high quality water resources takes work. Many land managers and owners voiced concerns about the difficulty of caring for their forests with a continuing onslaught of invasive species and with increasing deer damage over the past decade (especially in urban and suburban areas). Forests have been fragmented into small parcels—an intertwining process of *parcellation* and *fragmentation*, often increasing edge habitat and invasibility, and also increasing the challenge and need for coordinated management across many owners, both public and private. Factors such as climate change, tree diseases and insect pests, habitat fragmentation, nonpoint source pollution, limited financial resources, and sometimes and lack of awareness

further complicate sustainable stewardship. A major goal of this Landscape Stewardship Plan is to increase interest, awareness, and participation in active land stewardship opportunities throughout the Southern Lower Peninsula, including Washtenaw County, in order to foster active and collaborative stewardship of private and public woodlands and landscapes.

The Michigan Department of Natural Resources offers information and small grants to landowners to develop customized Forest Stewardship Plans, which characterize existing resource features found on a particular property and identify strategies for meeting each landowner's goals through on-the-ground stewardship activities that also yield public benefits such as protection of clean water, provision of wildlife habitat and mitigation of various negative factors acting on the landscape scale. In fact, the idea for the Landscape Stewardship Plans project was based on the idea of these individual Forest Stewardship Plans, which, due to their limited geographic scope, fail to fully address some of the biggest challenges the ecosystems of Michigan are facing. While a collaborative landscape-scale approach to stewardship is therefore critical, success ultimately still depends on the participation of individuals.

Each of the nine Landscape Stewardship Plans characterizes the focal ecosystem's physical, biological and cultural resources, including a summary of existing resource assessments and stewardship plans. Theprocess of developing each Landscape Stewardship Plan has brought resource professionals and other stakeholders closer together, and the plans serve to connect landowners and land managers with information about practices and programs that will help people take the next step toward becoming more engaged land managers.

A key element of each Landscape Stewardship Plan is the collection of inspirational stewardship stories told by the people living and working within each of the focal landscapes. Through these stories, local landowners and land managers share why and how they are active stewards of their own forests. Whether that means a small private property or a vast area of public land, these stories are told with the hope of inspiring other landowners and land managers to join in and become actively involved in the stewardship of our collective forest resources. Our forests are, after all, interconnected with all of the other physical, ecological, and cultural elements of the landscape we call home.

2. Project Introduction

This Landscape Stewardship Plan focuses on the Stewardship Network's Huron-Arbor Cluster in the southern Lower Peninsula, with emphasis on Washtenaw County but also covering some adjacent areas within the Middle Huron River Watershed. This plan was developed by The Stewardship Network as part of a larger collaboration to promote sustainable stewardship of private and public forest land across the state of Michigan. The larger project began in 2015 when the Michigan Department of Natural Resources (MDNR) received a grant from the United State Forest Service (USFS) to partner with The Stewardship Network (TSN), The Nature Conservancy (TNC), and Huron Pines (HP)—all of which are 501(c)(3) nonprofit and non-governmental conservation organizations—to develop nine landscape forest stewardship plans, each covering unique Michigan ecosystems (Figure 2.1).

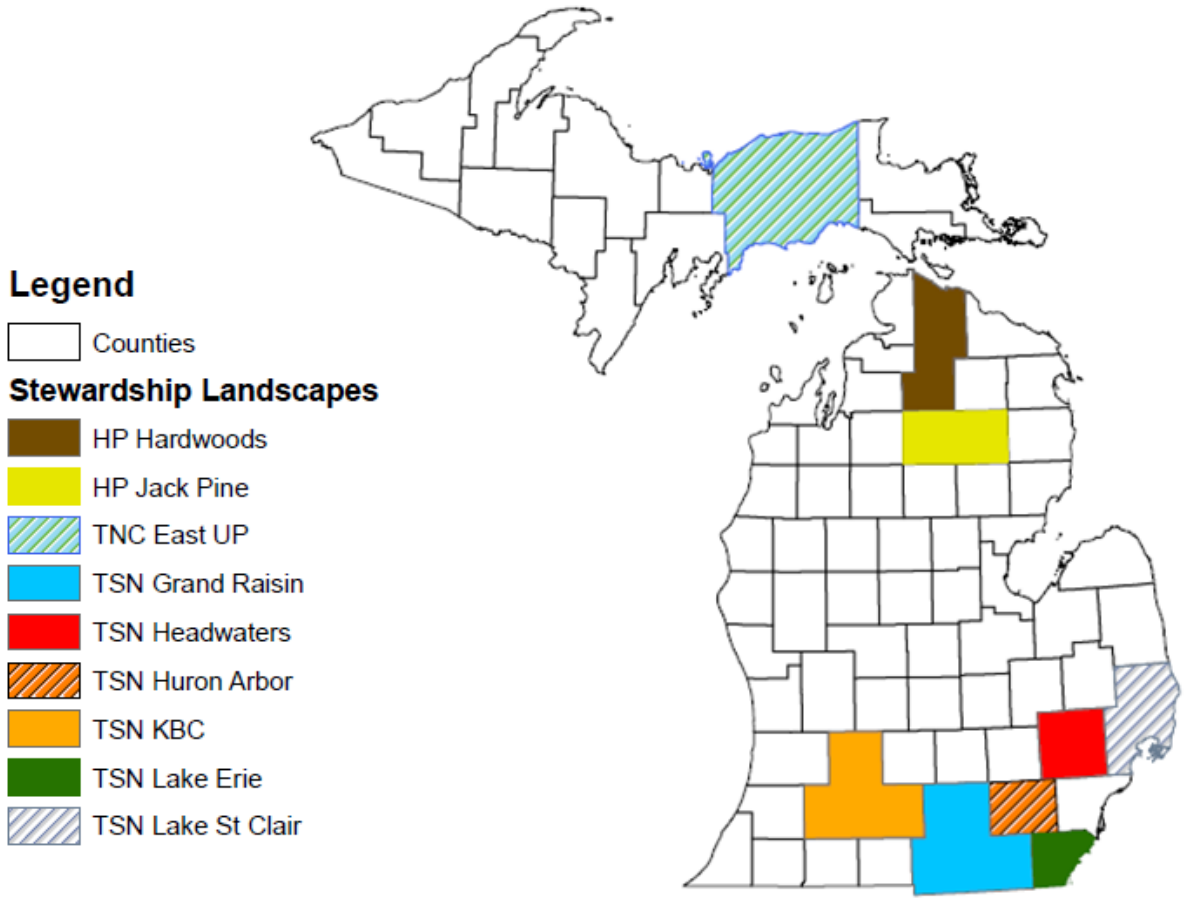


Figure 2.1 The nine Landscape Stewardship Plan areas. This report focuses on TSN Huron-Arbor.

Each plan covers a one to four county area in Michigan, characterizes the physical and cultural context of the focal landscape, and connects landowners to assistance programs by summarizing available opportunities and providing program contact information. Each Landscape Stewardship Plan also includes a collection of stewardship stories told by the local landowners and land managers working within it. Rather than simply listing recommended land management practices, these stories let real people tell, in their own words, how and why they choose to actively and sustainably manage their land, the challenges they face, and the resources they have found helpful.

These Landscape Stewardship Plans aim to inspire people to become more active land stewards by showcasing opportunities through stories and by connecting people with resources for woodland management. By increasing voluntary participation in land stewardship activities, we are ultimately working to protect and preserve Michigan's unique natural resources through collective impact. This can only be achieved at the landscape scale—with private and public land managers working together to maintain healthy forests, clean water, and other natural resources for the use and enjoyment of current and future generations.

The Stewardship Network developed six Landscape Stewardship Plans covering a large swath of the southern Lower Peninsula of Michigan. This region is a mosaic of urban areas, agricultural lands and small private forests. There is comparatively little forest land under public ownership in southern Michigan, where 75% of Michigan's 10 million residents live, but deliberate and responsible land management activities here have the potential to affect a large number of people.

The Nature Conservancy developed one Landscape Stewardship Plan for the eastern Upper Peninsula, which covers parts of Alger, Luce, Mackinac, and Schoolcraft counties—an area dominated by large blocks of both public and private forest land.

Huron Pines developed two Landscape Stewardship Plans, one focusing on the Jack Pines Ecosystem plan and one featuring Michigan's Northern Hardwoods in Cheboygan and Otsego counties.

These Upper Peninsula and northern Lower Peninsula landscapes contain fairly large tracts of forest land under a mixture of private, state and federal ownership. This rural area contains intact and functional forests, but long-term protection of these resources faces many challenges.

While the lead organizations were responsible for developing their respective Landscape Stewardship Plans, the content of each plan was generated with substantial input from other resource professionals, the landowners, and land managers willing to tell their stories, and based on existing resource assessments, stewardship plans, and other available literature.

Project partners also worked with Dr. Stuart Gage, Michigan State University professor emeritus, to install acoustic monitoring devices to capture the "soundscape" of each landscape. The sounds of the forest tell their own story. An interactive website to be developed will allow people to view stories in their region, share their own stories, and listen to the sound stories.

Finally, a portion of the grant funding will be administered by the MDNR to provide cost-share to landowners within the nine landscape focus areas for developing and implementing unique Forest Stewardship Plans for their properties.

2.1 Project Goals and Objectives

Michigan's forests face myriad threats—invasive species, tree diseases, habitat fragmentation, overbrowsing by deer in some areas, financial challenges—that sometimes make it difficult to achieve forest stewardship goals. A recent study estimated that only 20% of Michigan's 11 million non-industrial private forest lands are being actively managed, yet active stewardship of private forest land is vital to the long-term health and productivity of the forest resources (including soil, water and wildlife) on which our local economies and communities depend. Therefore, the overarching goal of this project is to increase interest, awareness and participation in active forest stewardship opportunities through the development of nine landscape stewardship plans covering strategic and unique forest ecosystems throughout the state of Michigan.

Specific objectives that the we seek to accomplish in order to achieve that goal include:

- Objective 1: Describe the physical, cultural and resource management context of each of the nine landscapes to serve as a comprehensive reference for landowners and land managers.
- Objective 2: Facilitate collaborative management of multi-county areas by state, federal and local resource agencies, nonprofit conservation organizations, private sector professionals and individual landowners.
- Objective 3: Promote sustainable forest management practices and encourage people to be more active stewards of their land (e.g., develop and implement a Forest Stewardship Plan).
- Objective 4: Connect people with tools, resources and programs to help them take the next steps toward achieving their personal land management goals and increase our collective capacity to manage forest resources at the landscape scale.

These Landscape Stewardship Plans also aim to support and inform strategies for addressing national priorities and state-level issues identified in "Michigan Forest Resource Assessment and Strategy," which was completed by the MDNR in 2010. These priorities and issues are:

- National Priority 1: Conserve Working Forest Landscapes
  - Issue 1.1: Promote Sustainable Active Management of Private Forests
  - Issue 1.2: Reduce Divestiture, Parcellization and Conversion of Private Forestlands
  - Issue 1.3: Reduce the High Cost of Owning Private Forestland

- National Priority 2: Protect Forests from Threats
  - Issue 2.1: Maintain and Restore Aquatic Ecosystems and Watersheds
  - Issue 2.2: Reduce Threats from Invasive Species, Pests and Disease
  - Issue 2.3: Reduce Impact of Recreational Activities on Forest Resources

- National Priority 3: Enhance Public Benefits from Forests
    - Issue 3.1: Maintain Markets for Utilization of Forest Products
    - Issue 3.2: Maintain Ecosystem Services from Private Forestlands
    - Issue 3.3: Provide Effective Conservation Outreach for Private Forestlands
    - Issue 3.4: Maintain Community Quality of Life and Economic Resiliency
    - Issue 3.5: Maintain and Enhance Scenic and Cultural Quality on Private Forestland
    - Issue 3.6: Maintain Forested Ecosystems for Biodiversity and for Wildlife Habitat
    - Issue 3.7: Maintain and Enhance Access to Recreational Activities on Private Forestlands

2.2 The Need for Active Forest Stewardship

Forest land accounts for 55% of Michigan's total land area, and of Michigan's 20 million acres of forests, 12 million (60%) are privately owned. State and federal agencies are responsible for managing our public lands, but the overall health of Michigan's unique forest, water and wildlife resources ultimately depends on the collective management activities of all landowners. Unfortunately, a survey conducted by Michigan State University revealed that only about 20% of Michigan's non-industrial private forest lands are currently under active management.

The condition of a particular forest property is highly dependent on the condition of other forest lands throughout the landscape. Conversely, the management actions (or lack of active forest management) on a single property can impact forests, rivers, wildlife, property and people far beyond the boundary of that individual piece of land. Native wildlife, forest fires, harmful invasive species, tree diseases and insect pests all move freely among private and public land—they do not recognize property boundaries. Likewise, rivers and streams flowing from one property to the next carry the effects of poor land management activities downstream (or even upstream, as is the case with dams or poorly designed road crossings that block fish passage).

Maintenance of healthy forest landscapes is also important at the regional and global scale. We depend on our forests for timber and other forest products, to provide wildlife habitat, to help mitigate climate change, to protect the quality and quantity of our water resources and for the myriad aesthetic, recreational and spiritual values they provide. Protecting our forest products, services and values starts with active stewardship of individual properties by landowners and land managers. Because widespread threats to forest health act scales larger than single parcels, our approach to maintaining healthy, functional and sustainable forests must also incorporate landscape-scale considerations. The purpose of this project is encourage and inspire people to actively manage their forests to realize benefits for both individual landowners and the larger community. The next section describes our methodology for doing so.

2.3 Methodology: A Landscape Approach to Natural Resource Conservation

The Michigan DNR applied for and was awarded funding by the USFS in 2015 to coordinate with The Stewardship Network, The Nature Conservancy, and Huron Pines to develop nine Landscape Stewardship Plans. These partners strategically identified landscape types containing a set of unique physical and cultural features that help define each landscape area while also distinguishing them from other landscapes. Of course, ecological landscapes do not adhere to our political boundaries and tend to transition gradually and unevenly from one landscape type to another. However, for the purpose of managing landscape-scale issues and challenges while also keeping the project areas manageable and relevant to local landowners and land managers, we've defined each landscape area as ranging from one to four counties in geographic scope. One advantage of defining the project area based on county boundaries is that these align with jurisdictional areas of different resource agencies and nonprofit organizations. Therefore, the assistance programs, resources and opportunities offered within each landscape project area are generally consistent and the background information and stewardship stories are tailored to a particular local audience. Nevertheless, people in surrounding counties or other areas with similar characteristics will generally also find that these landscape stewardship plans are useful.

The Stewardship Network's Huron-Arbor area, comprising Washtenaw County and immediately adjacent areas, lies in the Huron River Watershed in Southern Lower Michigan in the Greater Detroit Metropolitan area—the most heavily populated part of the state. This region is a mosaic of urban areas, agricultural lands and small private forests. There is comparatively little forest land under public ownership in southern Michigan, so effective forest stewardship requires engaging interest and coordinating efforts among park systems, land conservancies, and many small private landowners. While coordinated and collaborative land management poses many challenges, it can have many benefits: 75% of Michigan's 10 million residents live in this region, so land management activities can affect a large number of people.

The Stewardship Network coordinated with the landscape stewardship project partners to develop the text in Section 2, including the project background and project goals, objectives and methodology. To complete Section 3: Landscape Context, The Stewardship Network reviewed existing resource assessments and management plans/strategies. We also met with government agencies, private resource providers and nonprofit organizations to collect information on the various assistance programs and opportunities that are available, with a focus on forest stewardship. Contacts for each program are included as a resource for property owners and land manager.

A key focus has been to collect stewardship stories, told by local landowners and land managers, illustrate opportunities and practices in the area (Section 4). Rather than simply providing a list of forest recommendations for property owners, we offer these stories to inspire others to learn more and to take advantage of resources and programs that have been useful to Washtenaw County residents. The Stewardship Network and our partners identified people who are actively stewarding their land and who want to tell their stories. We had conversations

with individual and institutional land owners and managers (including parks, land conservancies, and the University of Michigan) to hear about the many ways people are caring for the woodlands. All landowner stories were provided voluntarily for inclusion in this plan and with permission to distribute in the hopes of encouraging other landowners to become active land stewards.

Forests also tell their own stories through sound, and this project has included an acoustic monitoring component to record "soundscapes" as part of two "song stories" that offer another perspective on what is happening in Washtenaw woodlands.

1. Sounds of small woodlots vs. larger forests. Because habitat fragmentation and land parcelation is a major issue in this landscape, and because various conservation land acquisition efforts have focused on purchasing parcels or conservation easements adjacent to existing preserved land to create larger contiguous areas for wildlife habitat, we wanted to hear how forests of different sizes sound. During June 2016, we placed one acoustic monitoring device was in a 10-acre mature oak forest in a suburban Ann Arbor park, and a second device in a similar forest in nearby park 2 miles east that lies in a mosaic of 250 acres of mostly wooded areas with a mix of public ownership (city and county parks and university land), with 50-100 additional acres in low-density housing with large woodlots. Acoustic monitors recorded sound for one minute every thirty minutes. Both parks were close to highways, so human-generated noise ("homophony") often dominates over nature's sounds ("biophony"). We placed the devices similar distances to major highways traveling both east/west (M-14) and north/south (US-23), although prevailing winds may have led to differences in highway noise volume between the smaller parcel west of US-23 and the larger parcel on the east.

2. Before and after highway noise. Ann Arbor is tightly ringed by interstates (I–94, US–23, and M14), and many parks and conservation lands in the area are flooded with highway noise. Bird Hills Nature Area, the biggest city-owned natural area in Ann Arbor (124 acres of forest, including mature oak-hickory stands, conifer plantations, and younger post-agricultural woodlands) lies adjacent to a heavily travelled section of M-14 that was closed for construction during Summer of 2016. To compare the soundscape during the relative quiet of construction (some noisy trucks and equipment, but far less traffic overall), we placed an acoustic monitor in the park during August 2016, two weeks before the estimated date the road would reopen, and we recorded for several weeks after traffic resumed. A future comparison could look at the comparable period in August 2017, so that the recording season would be the same and only the highways noise would differ. As it is, even with seasonal differences, this song story should reveal much about technophony vs. biophony.

Similar acoustic monitoring devices were deployed in several other landscapes throughout the state of Michigan. Additional information and sound clips from all landscape stewardship projects can be found on the Michigan State University Remote Environmental Sensing Laboratory (REAL) website: Details can be found on http://www.real.msu.edu/projects/one_proj.php?proj=ls.

In addition to the song stories, Michigan DNR is hosting an online story map where people can read the stewardship stories collected through this project, submit their own stories, view images and listen to sounds of our forests.

For your convenience, a summary of the available assistance programs, additional resources and contacts is included at the end of the plan to guide you to becoming an active land steward.

3. Landscape Context

The mention of southeast Michigan and Washtenaw County likely calls to mind various images unrelated to forests: Ann Arbor and the University of Michigan (UM) in its many roles as a top-tier research university, regional medical center, and sports powerhouse; a location in the outer suburbs of the Detroit Metropolitan area; Eastern Michigan University with its historic and continued strengths in education.

But while forests may not be first in mind, they are interwoven into our sense of place. After all, Ann Arbor is nicknamed "Tree Town" and is famously named after the bur oak arbor where the wives of the town's two founders, both named Anne, would meet. The Huron River—the only state-designated scenic river in southeastern Michigan—runs through Washtenaw County, its most scenic stretches the tree-lined banks of floodplain forests and riverside parks, where thousands of residents paddle and play. Greenbelt initiatives in Ann Arbor and Washtenaw County, along with two active land conservancies, support land preservation in the area through outright purchase, conservation easements, and the purchase of development rights; although some funding from these efforts is directed at farmland and open space preservation, many preserved areas are partly or entirely forested. The intertwining Potawotami and Waterloo-Pinckney Trails offer thousands of recreational bikers and hikers scenic landscapes of forests pockmarked with kettle lakes, bogs, open wetlands, and fields. The City of Ann Arbor, the County, and the regional Huron-Clinton Metropolitan Authority manage numerous natural areas within their parks, including thousands of acres of forest, with the specific goals of preserving biodiversity and promoting healthy ecosystems, as well as offering natural places for people to learn from, work in, and enjoy.

The use and management of Washtenaw woodlands has changed over time in response to agriculture and development. The following sections of this report details past and present land use and describe the full range of natural resources found here. Although the primary focus is on forests, healthy forests occur as part of a mosaic of wetlands, grasslands, riparian areas, streams, rivers, and lakes within the same landscape.

3.1 The Physical, Ecological and Cultural Landscape

Recent reports by Washtenaw County institutional stakeholders have compiled descriptions of the physical and ecological landscape of Washtenaw County:

- **Washtenaw County Parks & Recreation Commission**, *2015-2019 Washtenaw County Parks & Recreation Master Plan* (August 2014) has a comprehensive description of the physical and ecological features of the county, and was the primary source for several sections of this report.
- **Washtenaw County Conservation District**, *Washtenaw County Resource Assessment* (September 2016) includes briefer descriptions of key landscape components, which were incorporated into sections on climate and soils.

- **Southeast Michigan Council of Governments**, *Green Infrastructure Vision for Southeast Michigan* (2014), provides information on land use and land use planning, looking at the role trees and tree canopy in terms of the larger urban and suburban regional landscapes (www.semcog.org).
- **Washtenaw County Department of Planning and Environment,** *A Comprehensive Plan for Washtenaw County Land Use, Infrastructure, Natural Resources* (September 2004) is more than a decade old but still provides useful perspectives and visions for past and future land use and landscapes.

3.1.1 Geographic Scope

This Landscape Stewardship Plan focuses on Washtenaw County, although the issues and stories arise from and apply to adjacent areas as well. Washtenaw County covers roughly 722 square miles in Southeast Michigan and includes the Ann Arbor, MI Metropolitan Statistical Area; it is also included in the Detroit-Warren-Ann Arbor, MI Combined Statistical Area (Figure 3.1). MDNR sources list the County's acreage as 421,889, whereas the Southeast Michigan Council of Governments, SEMCOG, shows a total of 462,247 acres.

The County, which was first platted as a county by the Michigan Territory Legislative Council in 1822 and formally organized as an administrative unit in 1826, is home to six cities (Ann Arbor, which is the County seat, Chelsea, Dexter, Milan, Saline, and Ypsilanti), two incorporated villages (Barton Hills and Manchester), and 20 townships (Figure 3.2). The population doubled between 1960 and 2010, increasing from 172,440 to 344,791 (U.S. Census). According to the Southeast Michigan Council of Governments (SEMCOG), the County population was expected to grow to 350,781 by 2015, and to 386,235 in 2040—an increase of 12%. Population is concentrated in cities but also in some of the heavily suburbanized townships (Figure 3.3). The County spans urban, suburban, and rural settings, and is home to two major universities (University of Michigan and Eastern Michigan University), two major rivers (the Huron River and River Raisin), and dozens of lakes.

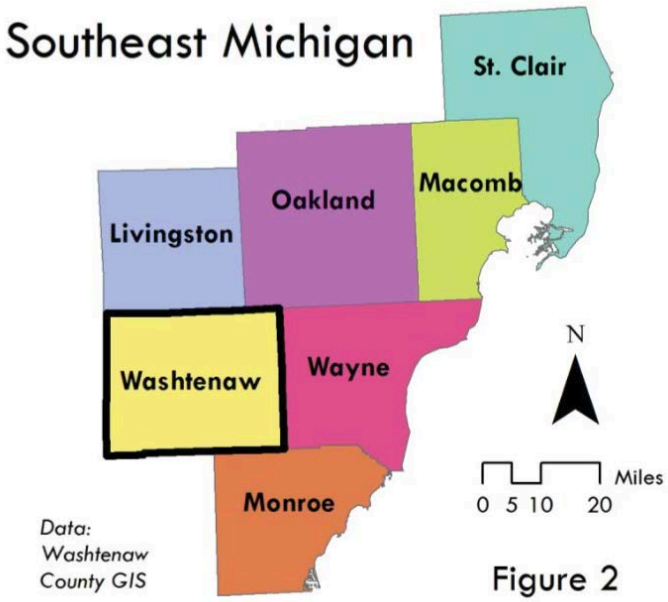


Figure 3.1. General map of Washtenaw County's location within the southeast Michigan region.

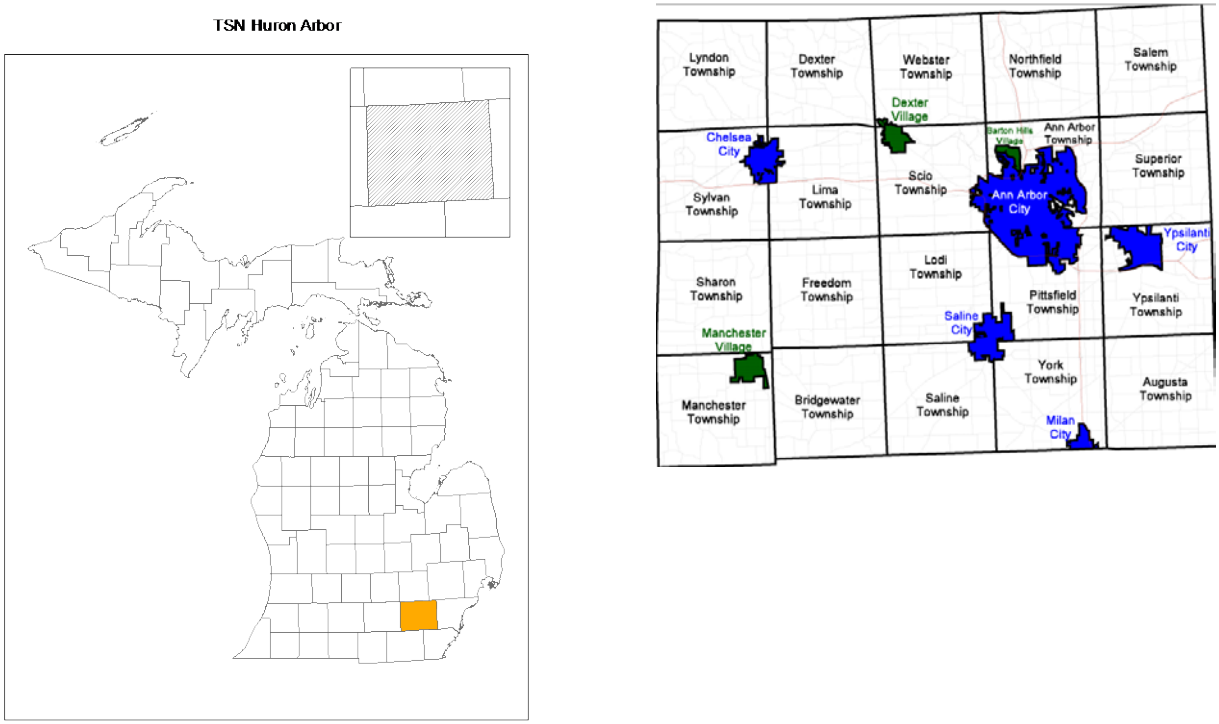


Figure 3.2. Left: TSN's Huron Arbor cluster area (also shown in Figure 2.1) covers Washtenaw County, the primary focus of this report. Right: Townships, cities, and villages in Washtenaw County. Dexter appears as a Village in this map, but became a City in 2014.

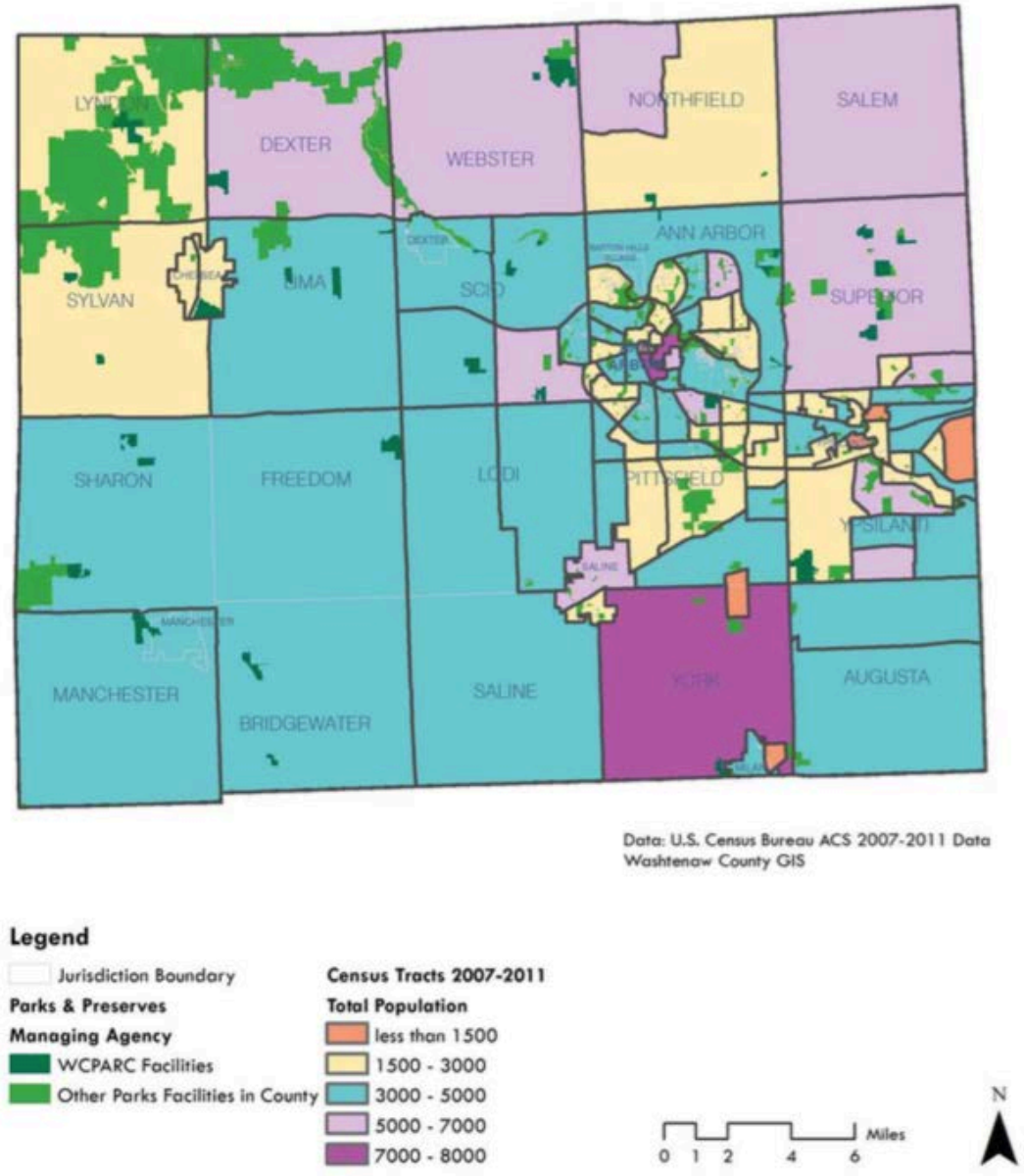


Figure 3.3. Population density and distribution in Washtenaw County, compared to parks and preserves owned and operated by Washtenaw County parks and other organizations.

Although this plan has been specifically tailored for the landowners and land managers living or working in Washtenaw County, most of its information and many of the listed resources, assistance programs, and Best Management Practices (BMPs) contained within this plan are applicable to adjacent areas in Livingston County, to the north, and Jackson and Lenawee Counties, to the west and south—which are covered, along with Hillsdale County, in the TSN Grand Raisin Landscape Stewardship Plan. Furthermore, many of the issues confronting Washtenaw County woodlands are similar to those in other Detroit Metro area counties, which

are covered in landscape forest stewardship plans that TSN is doing for neighboring cluster areas (Figure 3.2, above)

- Lake St. Clair (St Clair and Macomb Counties)
- Headwaters (Oakland County)
- Lake Erie (Monroe County).

3.1.2 Cultural Landscape and Land Use

Many know that Ann Arbor's name relates to trees. But fewer know that the University of Michigan developed one of the early forestry departments in the U.S. in 1903 (which became a full-fledged School of Forestry in 1925), just a few years after the founding of the nation's first forestry schools (Biltmore Forest School in Asheville, NC, and New York State College of Forestry at Cornell in Ithaca started in 1898; Yale School of Forestry started in 1900). UM's Saginaw Forest was one of the earliest experimental forests in the state. Originally known as Saginaw Forestry Farm and briefly designated by the U.S. Forest Service as the "Ann Arbor Forest Experiment Station," the Forest was planted with 40 species (mostly conifers) in one-two acre plots during 1904–1915 to assess which species might be most suitable to plant in the cut-over agricultural fields that dominated southern Michigan at the time.

For indeed, southern Michigan's 19th century forests were largely cut and converted to agriculture—after hundreds of years of more or less active management by Native Americans had fostered the open woodlands encountered by early settlers. By the early 1900s, the area was largely deforested, leading to serious soil erosion in some areas, including the farm that eventually became Saginaw Forest. The early decades of the 20th century brought a series of droughts and then economic depression, leading to abandonment of less productive land. (Some lands in the hilly and swampy northern and western parts of the county were purchased by or reclaimed for back-taxes by the state, to form the Waterloo and Pinckney State Recreation Areas, and Brighton State Recreation Area to the north in Livingston County.)

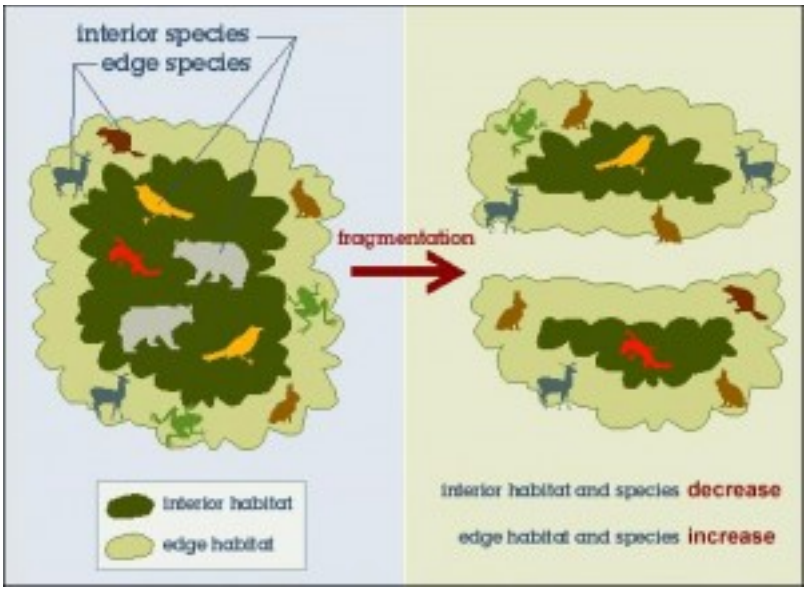
Second-growth forest expanded during the middle of the 20th century to reclaim marginal lands that had been formerly tilled or grazed. During that time, soil conservation programs promoted reforestation, often with fast-growing conifer species selected for timber production and commercial harvest; these species were often non-native, or species native to Michigan but not typical in this ecoregion. The legacy of this previous conservation approach remains in patches of aging conifer plantations that still dot the landscape although stands that haven't been harvested are maturing and starting to decline or succeeding to more characteristic hardwood tree species (sometimes mixed with invasive shrubs).

Land use in the County has been shaped by interconnected trends in agriculture and residential development. Starting after World War I and increasing after World War II, a complex network of agricultural programs sought to stabilize crop prices, promoting production of commodity crops or curbing production by supporting land set-aside programs for conservation. Agricultural programs and economic trends have affected the amount of land in active agriculture, which in turn affected the amount of land left fallow to be reclaimed by early-

successional tree species. In the 1970s, the Department of Agriculture Secretary Earl Butz promoted a "fencerow to fencerow" approach to agriculture, encouraging farmers to put more land under cultivation and increase production of commodities including soybeans and corn. Then a combination of agricultural surpluses and concerns about environmental degradation led to the establishment of the Conservation Reserve Program in 1985 and the Wetlands Reserve Program in 1990, in which farmers could receive payments to leave land out of cultivation, with some programs promoting prairie and even forest plantings.

While agricultural land moved into and out of production, the trend of second-growth forests reclaiming previously cleared farmlands continued into the 21st century. A 1977 report estimates that there were 83,500 acres of forest in Washtenaw County, while MDNR land cover data from 2010 show 137,482 acres of woodland categories (deciduous, coniferous, and mixed forest and woody wetlands). But while the total number of forested acres increased, forests were increasingly fragmented into patches of woodlands by development as Ann Arbor grew and suburbanized, and suburbs and exurbs expanding outward from Detroit pushed into Washtenaw and even farther north and west to Livingston and Jackson Counties. Pressure for residential development has led to subdivision of land from larger parcels of 40–160 acres or more (typical for farmsteads) into increasingly smaller parcels, 2.5 to 10-acre lots, that could be sold for low-density housing developments. This process, known as parcelization (Stein et al. 2005), has resulted in a division of ownership: Not only are forests divided into relatively small patches in the landscape (a process known as fragmentation), but those patches often have multiple owners.

Forest fragmentation has ecological consequences. Since the 1980's, an increasing body of research has documented an array of edge effects: edges are warmer and drier, with more potential for drought stress; higher susceptibility to wind damage; and greater potential for species invasions, both by non-native plants and by birds that are nest predators (http://northernwoodlands.org/articles/article/forest-fragmentation). Many species, including birds and other animal, will dwell or thrive only within forest interiors (Figure 3.4). Fragmentation increases edge effects by increasing the total amount of edges (where more disturbance occurs) and increasing the ratio of edge to forest interior (which tends to undergo less disturbance).



Graphic care of Benjamin Pennington, 1000 Friends of Florida

Figure 3.4. Edge effects and forest fragmentation**.** Sources: sustainablelinfield.edublogs.org; http://www.ncwildlife.org/Conserving/Programs/Green-Growth-Toolbox/Conservation-Recommendations.

Even within seemingly large forest patches, roads and home sites can cause a significant increase in edge effects. Snyder (2014) notes that a 14-acre circular forest patch is needed to get one acre of interior habitat (at least 300 feet of edges on every side), and that "the negative habitat effects of each residential building pocket within a forest radiate outward, affecting up to 30 additional acres with increased disturbance, predation, and competition from edge-dwellers" (http://northernwoodlands.org/articles/article/forest-fragmentation).

The landscape mosaic that has evolved in Washtenaw County from the processes of fragmentation and parcelization is broadly characterized by a patchwork of woodlands (often in steep or drought-prone areas, or low-lying wet areas), which cover just under one third of the

land (cover estimates range from 30–32%), interspersed with agricultural fields and low-density residential housing (1- to 5-acre lots) and subdivisions. Forest ownership is parcellated, with few stands of large contiguous forest managed by individual institutions or private owners (Figure 3.5). Instead, the larger forests areas are often divided among many land-owners, private and public, posing challenges for coordinated management.

An analysis conducted by the Huron River Watershed Council (HRWC) for this project shows how natural areas in general, and forests in particular, are fragmented into relatively small patches in the Washtenaw County landscape (Table 3.1). There are few forest patches—that is, contiguous areas—of 1,000 acres or more of natural vegetation, and only 1 of those is within single ownership.[1] However, the issue is even more striking for the 243 patches in the 125–1000 acre size range. Those patches are mostly divided into smaller parcels, because only 51 parcels actually contain forests that size. Instead, although 70% of the County's forested land occur in patches of 75 acres or larger, those patches have been carved into smaller parcels, with 59% occurring on parcels of 20 acres or less. A comparison of maps showing patch vs. parcel size illustrates the issue. Figure 3.5 illustrates fragmentation and parcelization by showing patch vs. parcel size for forest lands. Figure 3.6 shows the numbers and total acreages in different patch and parcel size classes.

Acres	# Patches	Total acres	Cumulative Acres	Parcels	Total Acres	Cumulative Acres
>1000	9	12,678	12,678	1	1,068	1,068
250-1000	107	44,806	57,484	20	9,846	10,914
125-249	136	24,080	81,564	31	5,240	16,154
75-125	154	14,846	96,409	82	7,608	23,762
50-75	140	8,566	104,975	154	9,478	33,240
20-50	422	13,288	118,263	596	20,641	53,882
10–20	450	6,325	124,587	1569	21,794	75,676
5–10	614	4,318	128,906	3026	21,740	97,416
1–5	2,845	6,130	135,035	11079	25,334	122,750
<1	9,729	2,929	137,964	37374	9,138	131,887

Table 3.1. Acres in forest vegetation (deciduous forest, conifer forest, mixed forest, and woody wetlands) based on data from the National Land Cover Database 2011. ***Patches*** are contiguous areas of natural vegetation. ***Parcels*** show property ownership.

[1] For the largest size class, the division into smaller parcels may be an artifact of many ways that MDNR was listed as the land-owner on deeds over the years. However, fewer parcels in the 250–1000 acre list MDNR as the owner with any permutation of names, and none in lower size classes.

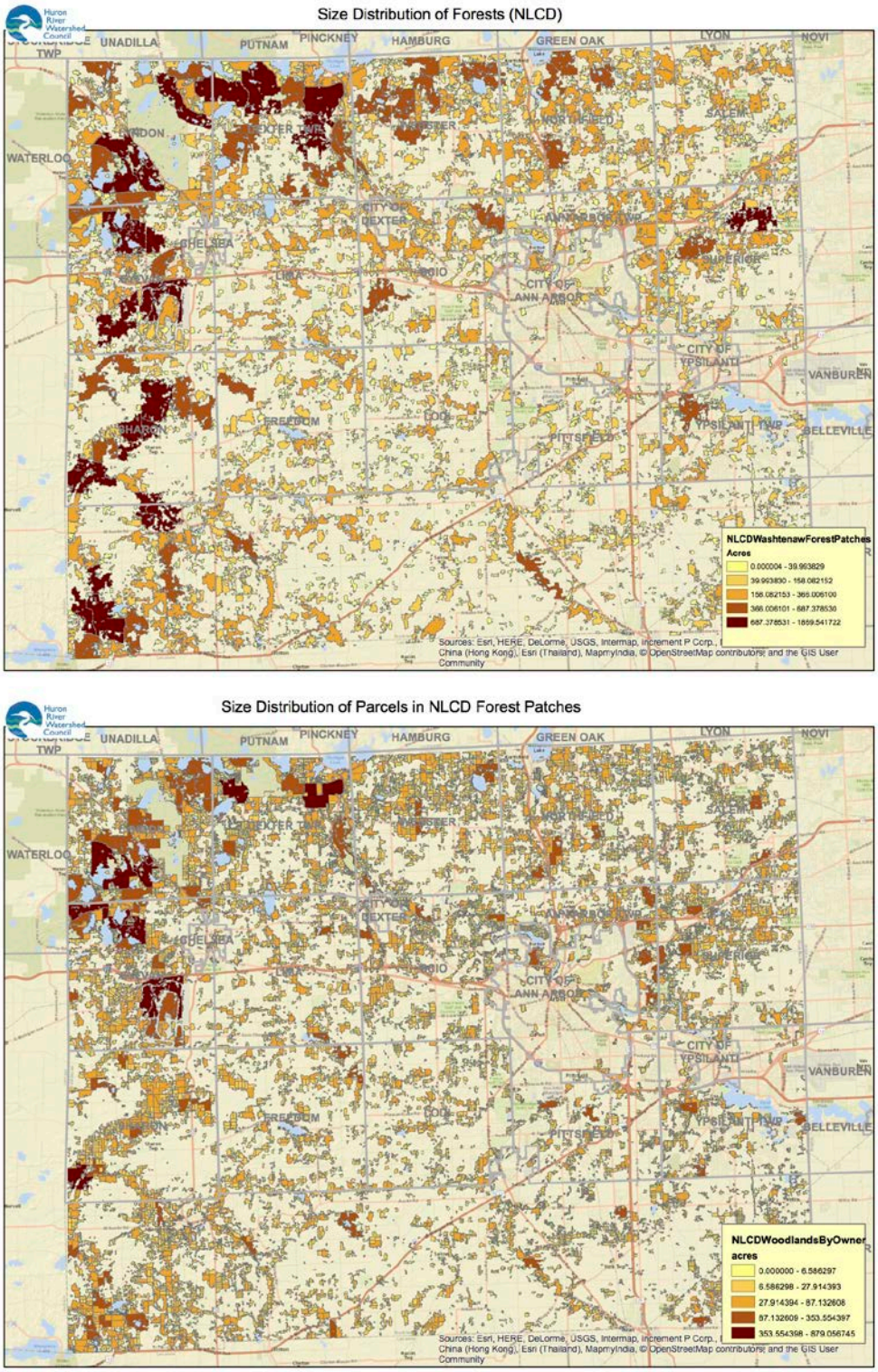
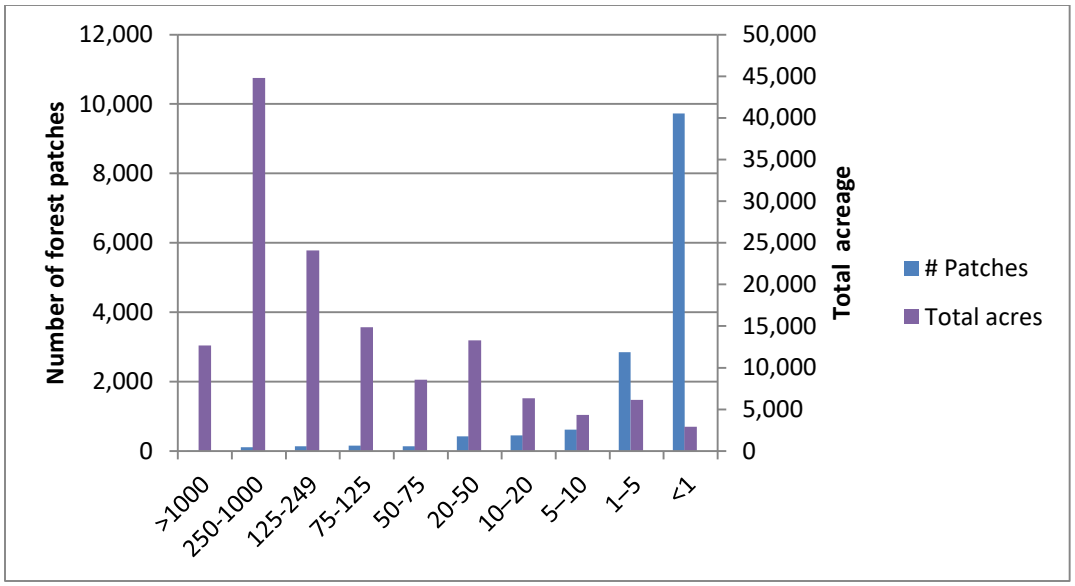


Figure 3.5. Forest fragmentation in Washtenaw County. Patch size (above) vs. parcel size (below) for forest cover classes from the National Land Cover Database 2010 (deciduous-, conifer-, mixed-forest, and woody wetlands). Most forest patches are divided into multiple parcels with different owners. GIS analysis and map: Huron River Watershed Council.



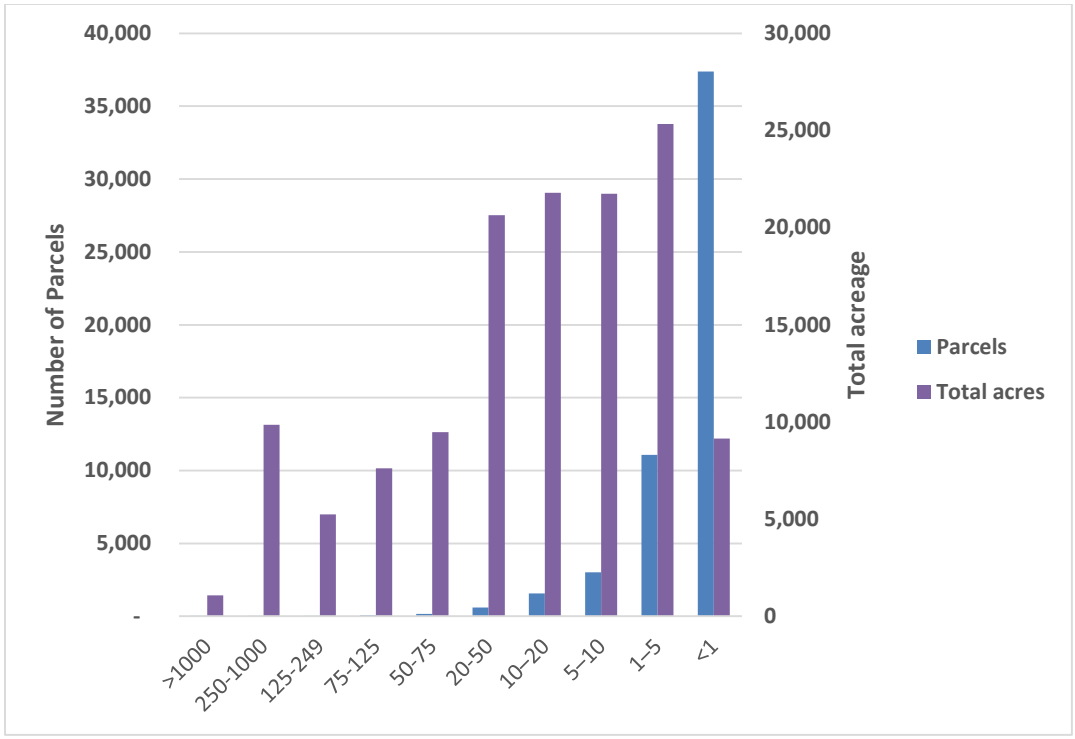


Figure 3.6. Fragmentation and parcelization. Numbers and total acreages of forested land in different patch and parcel size classes in Washtenaw County. Although the largest total acreage of forest occurs in patches that range from 250–100 acres, the majority of forest fragments are divided into parcels ranging from 1–50 acres in size. GIS analysis and map: HRWC, based on NLCD 2011.

Fragmentation and parcelization in Washtenaw County mean that forest holdings are typically small and are divided across many different private land-owners, posing challenges for

coordinated forest management. Relatively little land is in public ownership (Figure 3.7). There are no Federally owned lands, and state holdings, in Michigan DNR recreation and game areas in the northwestern corner and western edge of the county, comprise under 8% (35,904 acres) of the County's area. A majority of that MDNR land, in the Waterloo and Pinckney Recreation Areas, is forested, along with some wetlands, grasslands, and lakes.

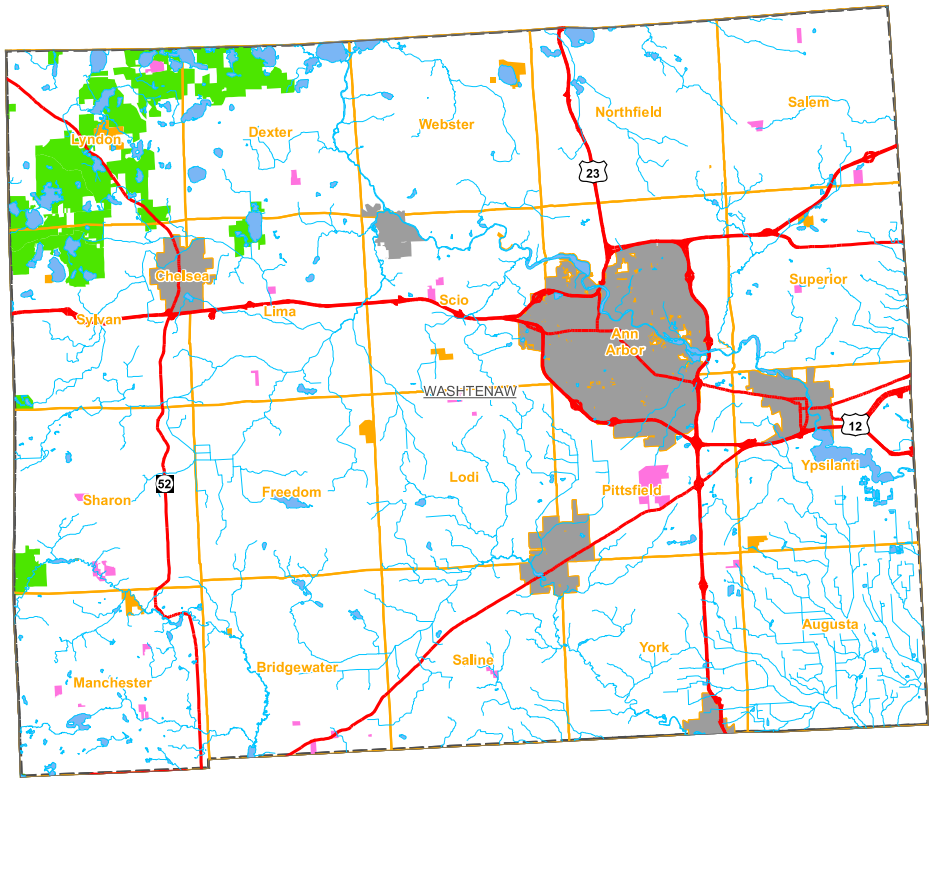


Figure 3.7. Land ownership in Washtenaw County. This map shows public land (state DNR land and county-owned parks and preserves) as well as private holdings areas covered by Forest Stewardship plans, but does not show forested research properties owned by the University of Michigan, nor city and township parks or preserves owned by land conservancies.

Woodlands also occupy significant portions of land owned and operated by various public park systems within Washtenaw County, as well as University of Michigan research properties.

- The regional Huron-Clinton Metropolitan Authority owns and manages three Metroparks totaling more than 1,600 acres.

- Washtenaw County Parks operates 13 County Parks, at least 4 of which have significant natural areas in addition to recreational land (golf courses, sports fields, etc.), totaling 1,124

acres. In addition, the County has 24 Nature Preserves (3,334 acres), many forested or featuring a mix of woodlands, wetlands, and grasslands.

- UM owns 1,804 acres, including significant forest tracts, within the Matthaei Botanical Gardens/Nichols Arboretum and various research properties and preserves within the county (Horner-McLaughlin Woods, Mud Lake Bog, the Newcomb Tract, Radrick Forest, Saginaw Forest, Stinchfield Wood), as well as a 1,300 acres mostly wooded research property (E.S. George Reserve) just north of the Washtenaw County line in Livingston County.

- The City of Ann Arbor has a large park system with 159 parks, totaling over 2,100 acres. Around one third of these parks have natural areas, managed by Natural Area Preservation, with over 500 mostly forested acres.

- Public school districts control about 2,100 acres developed primarily for playgrounds and playfields; some districts have also made provision for nature study areas, including around 100 acres of mature forested areas in Ann Arbor (Eberwhite Woods, Lakewood, Pioneer Woods, Scarlett Mitchell, and Skyline High).

- Legacy Land Conservancy has worked with private landowners to preserve land through conservation easements in Washtenaw County and adjacent counties. To date, Legacy has preserved 110 properties with a total of 6,858 acres. Exact cover estimates aren't available, but 78 of those properties are identified as having at least some woodlands, with an estimated 971 acres of forest.

- Southeast Michigan Land Conservancy (SMLC) has protected over 3,400 acres of natural and agricultural lands, preserving open space through conservation easements or purchases in a 7-county area of southeast Michigan, including Washtenaw. SMLC operates 5 preserves within Washtenaw County, totaling 580 acres of forests, fields (some fallow, some still farmed), and wetlands, including 325-acre LeFurge Woods Nature Preserve. In addition to its own holdings, SMLC has collaborated with Washtenaw County Parks and Superior Township on the Superior Greenway project, which has protected 2,007 acres to create a wildlife corridor that protects open space in rapidly developing Superior Township (http://smlcland.org/superior_greenway.php).

Altogether, these six institutions manage around 18,000 acres in Washtenaw County, around 4% of all land in the county. However, although many of these organizations are active in forest stewardship, it is challenging to piece together their different records to estimate how much of that land is forested. If half of that land is forested, these institutions own or operate around 7% of the forested land in the county.

Finally, under the leadership of the MDNR's Forest Stewardship program, private landowners have developed 27 Forest Stewardship Plans outlining active management of 2,075 acres of forests (1.5% of the forested land in the county).

3.1.3 Climate, Geology, Topography and Land Cover

Climate

The inland location of Washtenaw County in southeast Michigan minimizes the influence of the Great Lakes on the county climate, most noticeably in increased cloudiness. Cloudy days are most common in late fall and winter and least common in late spring and summer. Because day-to-day weather is controlled chiefly by the movement of pressure systems across the nation, there are seldom prolonged periods of either hot, humid weather in summer or extreme cold weather during the winter. The area receives 53% of the annual average possible sunshine.

The average daily maximum temperature in summer is 82° and in winter 34°. The average annual total precipitation is 30.48 inches, 56% of which typically falls during the growing season from May through October (over 17 inches), although this can include prolonged dry periods alternating with heavy rains. The growing season averages 172 days. Average seasonal snowfall is 29.5 inches.

Changes in local climate, including an increase in heavy rainfall events and more hot days in summer, have already been noted in Ann Arbor and throughout southeast Michigan (GLISA 2015). These changes and their implications for forests are described in section 3.1.9.

Geology and Ecoregions

Glaciers covered Washtenaw County during several glacial episodes over the past hundred thousand years, and the action of these glaciers created most of the varied physical terrain of the county: rolling hills in the north and center; steeper hills in the west and gently rolling areas in the southern portions of the county, ranging from 325 to 1,096 feet in elevation. An ancient inland lake, extending northeast from present Lake Erie, formed the flat areas in southeastern Washtenaw County. As the glaciers that covered Michigan thousands of years ago melted and receded, they left the landforms we see today and that remain significant to current land use. Washtenaw County was crossed by glacial lobes, which formed approximately 13,000 to 16,000 years ago during the Wisconsin Period. Figure 3.8 shows the quaternary geology of Washtenaw County using the U.S. Geological Survey (USGS) classification system, and Figure 3.9 shows the landscape ecosystems in the state and county, which are closely linked to glacial landforms.

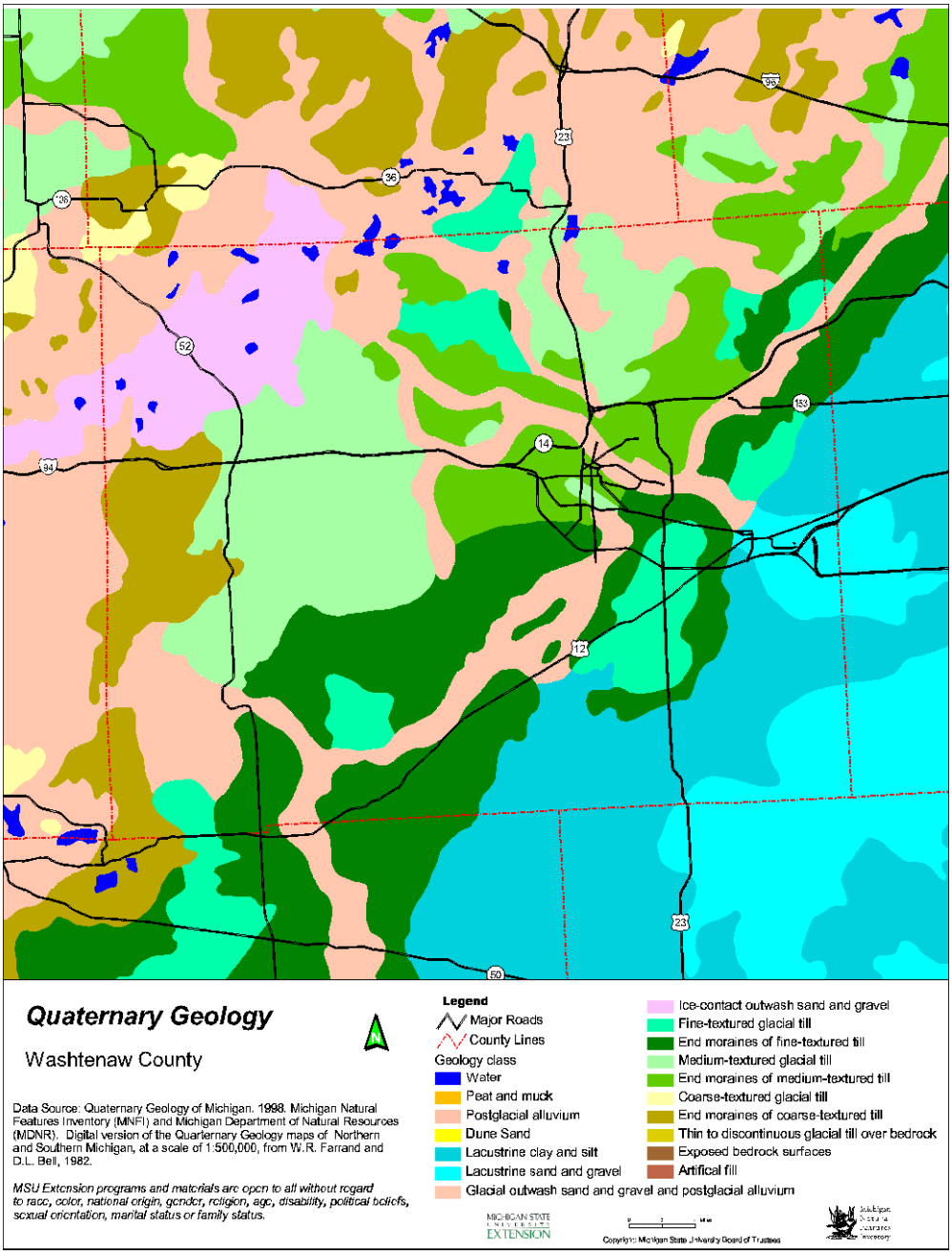


Figure 3.8. Quaternary geology of Washtenaw County. The glaciers that covered the County 13,000 to 16,000 years ago left characteristic landforms and soils, which in turn led to characteristic plant communities, and continues to shape current patterns of agriculture and residential development.

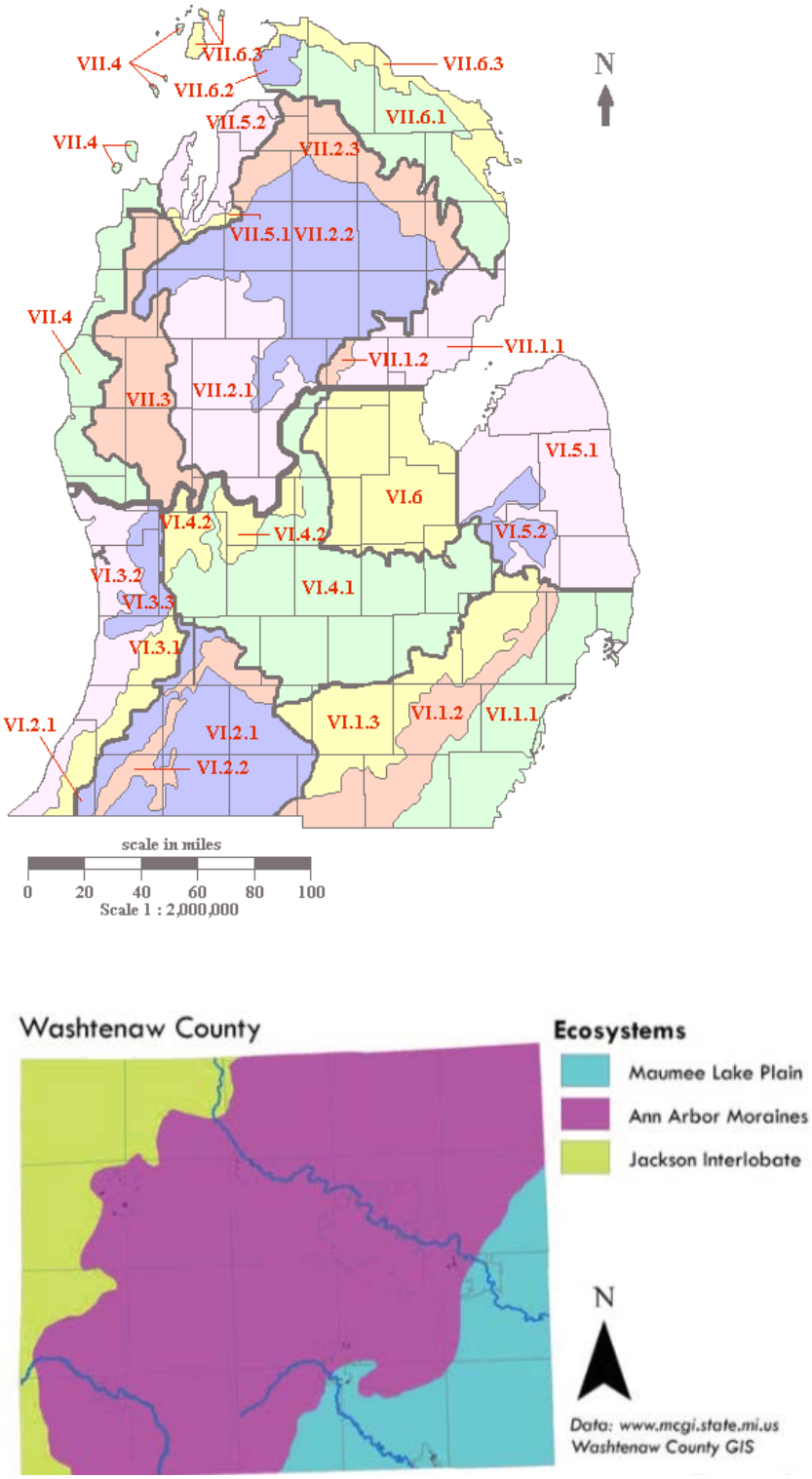


Figure 3.9. Landscape ecosystems of Michigan and of Washtenaw County. Ecosystem types are closely linked to glacial history. Washtenaw County includes types VI.1.1 (Maumee Lake Plain), VI.1.2 (Ann Arbor Moraines), and VI.1.3 (Jackson Interlobate).

Glacial landforms, together with data on soils, climate, and topography, formed the basis of an ecoregional or landscape ecosystem classification of Michigan developed by Dennis Albert and others at the Michigan Natural Features Inventory (Albert 1995). Washtenaw County falls into three different landscape ecosystems corresponding to glacial topography (Figure 3.8, above), including sub-subsections known as the Jackson Interlobate, Ann Arbor Moraines, and Maumee Lake Plain.

Western Portion—Jackson Interlobate. This area lies between three glacial lobes, formed when the glaciers receded, in the western and northwestern portions of the County. It contains wide spans of outwash sands that surround sandy and gravelly end moraines and ground moraines. Hills of end and ground moraines are surrounded by flat outwash. Large linear segments of end moraine, broken by narrow outwash channels—sometimes with steep and erosion-prone slopes—are typically located along the margins of this area. Also included are areas of ice-contact topography, with kettle lakes, kames, eskers, and segments of outwash channel as characteristic features.

Central Portion—Ann Arbor Moraines. This is the largest section in the County, extending from Salem Township southwest to Ann Arbor and Dexter, down to Saline and Manchester. It is made up of narrow parallel bands of both end moraine and ground moraines. The topography of the end moraines is rolling and hilly, but less than 1% of the end moraines have slopes greater than 15 percent. End-moraine ridges can be individual ridges one or more miles across and several miles long, or they can be broken into several smaller ridges separated by glacial outwash channel and postglacial drainages. Ground moraine is mostly flat or gently sloping. Ground moraine forms an expansive plain, and although individual hills may be several miles in area they are seldom higher than 80 feet.

Southeastern Portion—Maumee Lake Plain. This subsection encompasses Ypsilanti southwest to Saline, and the rest of the County to the southeast. It is made up of clay lake plain and sand lake plain that extends to Lake Erie, with several broad channels of lacustrine sand. Small sand dunes are common on the sand channels. Topography is generally broad and flat. Clay lake-plain soils may be poorly drained and tend to be characterized by wetlands or mesic (moist) beech-maple forests.

Vegetation circa 1800

Soon after the glaciers melted and retreated, and their floodwaters receded, plants started to grow on the newly surfacing soils, and over thousands of years, developed into the diverse plant communities that we know today. Early plant colonizers were tundra species and conifers. Oaks and associated species started to become more prominent 11,000 years ago, and become dominant by 9,000 years ago, while maples were also increasing in abundance. The current mosaic of oak-dominated (with hickory and walnut) and maple-dominated forests (with beech, basswood, and elm) emerged around 7,000 years ago (Hupy and Yansa 2009). The mosaic has changed with climatic fluctuations (oaks expanded in warmer, drier times, while

maples were abundant when climate was cooler and moister) but also in response to Native American land management.

While it is beyond the scope of this report to assess the history and practices of Native Americans in Southeastern Michigan and Washtenaw County, archaeological finds along the Huron River and along several documented trails in the area suggest a combination of hunting, fishing, and cultivation. But perhaps more important for forests, there is ample evidence that Native Americans actively managed landscapes using fire as a tool to clear land for hunting, agriculture, and defensive purposes. Use of fire likely helped to maintain open woodlands, including oak savannas and oak openings. Reports by early settlers noted the open park-like stands, and also observed the smoke of distant fires set by Indians almost yearly. Therefore, when interpreting maps that reconstruct "pre-settlement" vegetation, it is important to keep in mind that Washtenaw County forests had already been managed by the time European settlers moved into the area in the early 1800s—thus, it is more useful to consider these vegetation maps as "*circa* 1800" than as "pre-settlement." Even then, wars and European introduced diseases had ravaged Native American populations, so their communities—and the forested landscapes they managed—may have already been changing rapidly during the era when surveyors spread across the land and recorded early notes on vegetation.

Those early survey notes from the General Land Office included more or less detailed observations about trees and other vegetation at each survey point. At a minimum, surveyors marked witness trees at section corners and were supposed to record notes on the species and size, often with notes about other vegetation (especially merchantable timber), signs of recent fire, and general tree density. Based on a comprehensive review of these notes, Michigan Natural Features Inventory has developed a map of the "pre-settlement" or *circa* 1800 vegetation for the state. Figure 3.10 shows that Washtenaw County was dominated by woodlands, ranging from oak-hickory forests (>50% tree cover) to oak savannas (open woodlands with 25–50% tree cover) and oak barrens (10–25% tree cover), beech-maple forests, and hardwood and conifer swamps (wooded wetlands). Forest cover for the county as a whole was likely in the range of 75–90%, and much of the remaining area was open wetlands.

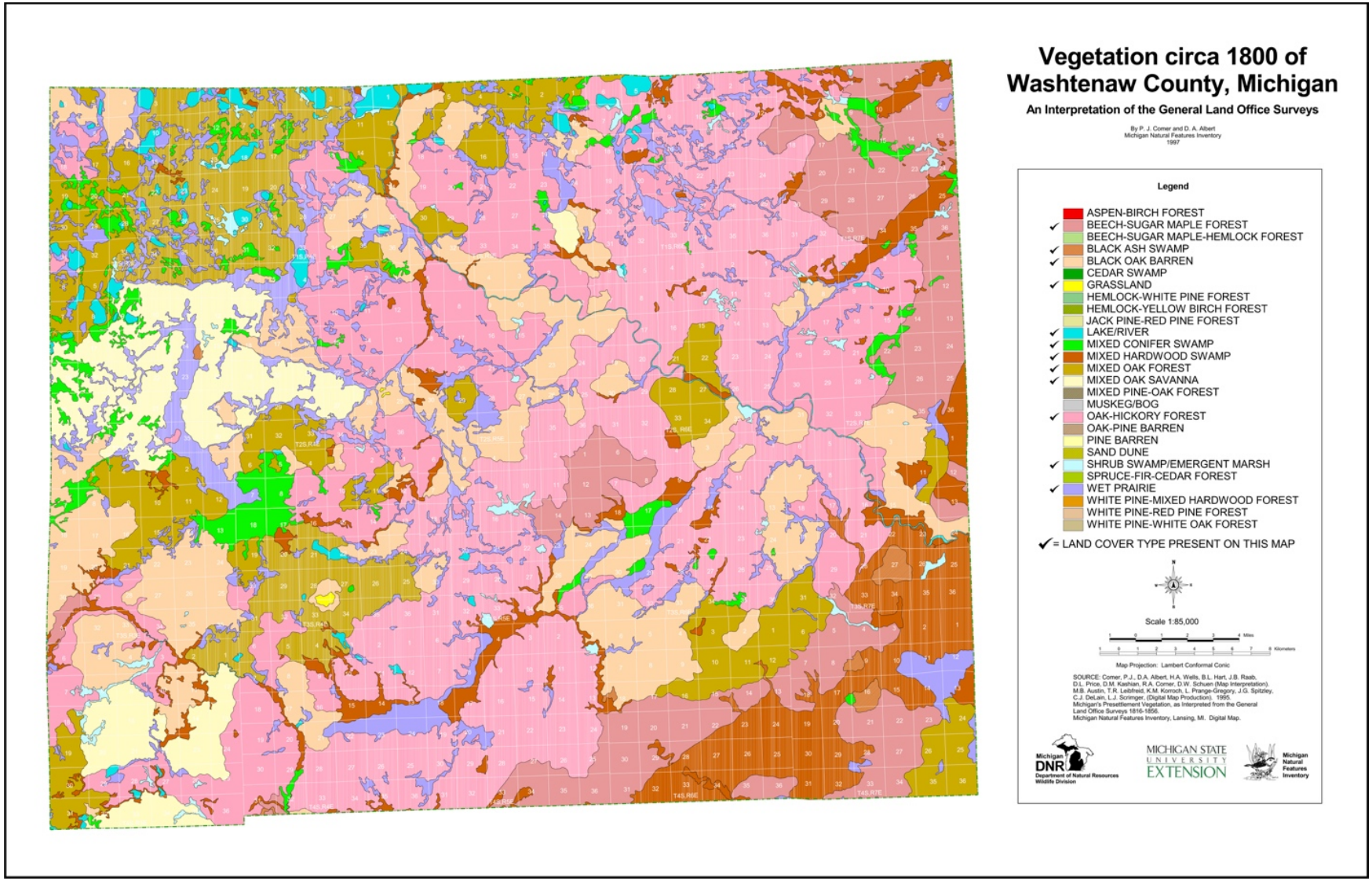


Figure 3.10. Vegetation of Washtenaw County, circa 1800.

Western Portion. Open savannas of black oak, white oak, and hickory were common on the sandy moraines. Most of the wetlands on the end moraines were scrub-shrub or forested swamps located in lower slope positions or in small depressions. Hardwood swamps were the dominant wetland on the lower slopes. Kettle lakes and swampy depressions on the moraines typically supported scrub-shrub swamp, hardwood swamp, or tamarack swamp. Several types of wetlands occurred in the outwash channels.

At the margins between the uplands and the outwash, calcareous seepages often supported fens, with tamarack growing near the upland margins of the fens. Grass and sedge meadows were found growing adjacent to streams on large areas of the outwash channels. Forested wetlands were most common along margins of major streams on the outwash, while tamarack was more common along lake edges and in kettles or depressions in the outwash.

In areas of ice-contact topography, wetlands were commonly restricted to narrow belts surrounding kettle lakes and consisted of scrub-shrub, hardwood, or conifer swamps. Kettles were sometimes completely occupied by either swamp or bog vegetation.
On dry, well-drained ice-contact topography, black oak (probably including some northern pin oak) was typically the dominant forest species. White oak and hickory were also common on slightly moister ice-contact sites, with red oak occupying moist foot slopes.

Central Portion. Oak and oak-hickory forests dominated the well-drained soils found in this portion of the County, with white oak the dominant species. Black oak was typical on the drier ridge tops, and red oak was more common on lower slopes. Oak savannas, dominated by white oak and black oak, could have occurred in this section, especially along the western edge, where fires from the Jackson Interlobate were carried by winds from the west. Beech and sugar maple were found on the silt loams and clay loams, although occurrence of these species was unusual. These occurred in the relatively flat and wet areas of ground moraines and on well-drained, irregular end moraines further north. Forested wetlands were common in lower slope areas on both ground and end moraines. Common species included black ash, red maple, American elm, swamp white oak, bur oak, and basswood. On the floodplain, hackberry, red elm, red ash, and American elm were common.

Southeastern Portion. The *circa* 1800 vegetation of the clay lakeplain contained forest, either upland or wetland, and in some areas wet prairie. The forests varied with the differences in slope class and drainage. On flatter portions (10 feet per mile slope or less) of the lakeplain or in shallow basins or depressions, lowland hardwoods dominated. In closed canopy depressions, black ash was dominant. Black ash also dominated flat or gradually sloping areas, but American elm and basswood were also typical co-dominants. Beech, white oak, white ash, and hickory became more common as slopes steepened and drainage conditions improved, but still were less common than black ash and elm. Common wetland species of the clay lakeplain included cottonwood, sycamore, trembling aspen, and red/silver maple. Where rivers and streams improved drainage conditions, mesic forests were dominated by beech, sugar maple, white oak, American elm, and hickory.

Present land use, land cover, and forest communities

Washtenaw County contains just under 1% of the land area in the State of Michigan, and just over 1% of its forests. Almost one third of the County is covered by trees (Figure 3.11). The County contains roughly 137,500 acres of woodlands (including deciduous forest, conifer forest, mixed forest, and woody wetlands), according to a 2016 MDNR analysis of National Land Cover Database data from 2011.

Vegetation in Washtenaw has changed dramatically since the 1800s (compare Figures 3.9 and 3.10): there is now virtually no old-growth forest; the total amount of forest covers less than half of its former extent; and remaining forests are second growth, generally ranging in age from 20 to 120 years (although individual trees that were left in pastures, fence rows, or steep slopes are older—some estimated to be up to 300 years old).

Land cover can be categorized in different ways, by types of vegetation and development, or by categories of land uses; at an even broader scale, one can simply compare the area covered by trees vs. impervious surfaces (buildings and roads). Table 3.1 (below) shows MDNR land cover estimates for Washtenaw County compared to data compiled by the Southeast Michigan Council of Governments (SEMCOG) for 2008 (which shows only land use based on property classes used for tax assessment) and for 2010 (which groups land cover and land use into broad categories). The comparison is instructive: although the MDNR land cover data shows that roughly 30% of Washtenaw County is covered by different forest types (deciduous forest, evergreen forest, mixed forest, and woody wetlands) or trees (SEMCOG's 2010 data), only 7% of all land is categorized as Park/Recreation/Open Space, which includes most publicly managed lands. Most of the County's woodlands fall into the category of Single-Family Residential land use, although some are on lands classified as Agricultural.

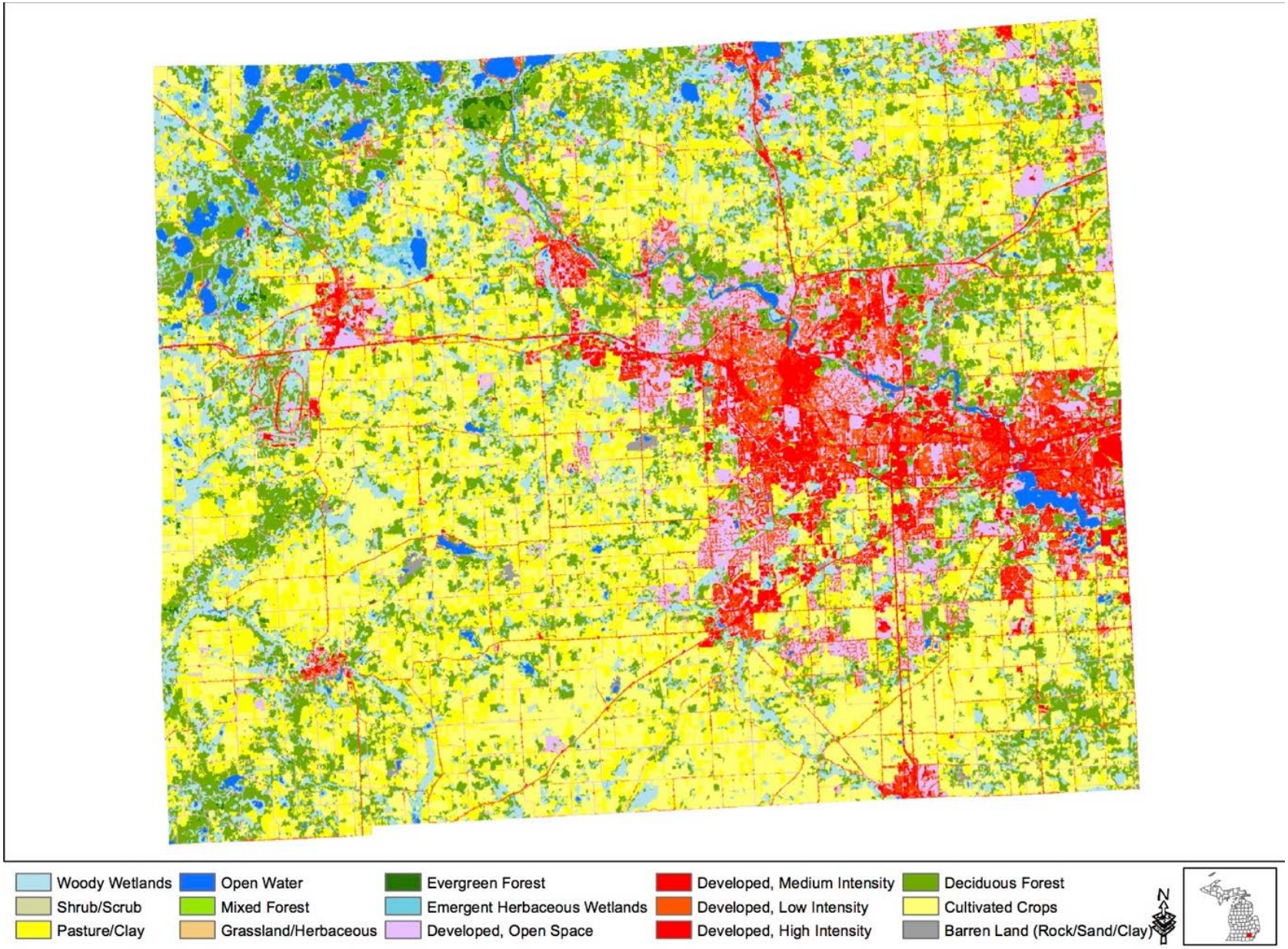


Figure 3.11. Land cover of Washtenaw County. Cover classes based on aerial imagery and interpretation from the Michigan Department of Natural Resources, Michigan Resources Inventory System/National Land Cover Database 2011.

Table. 3.1. Land Cover and Land Use in Washtenaw County: 3 Classifications. MDNR Covertype shows general land cover categories based on National Land Cover Data from 2010. SEMCOG 2008 data shows land use by assessed property classifications rather than aerial images of building or vegetation cover types. SEMCOG 2010 data shows broad categories that combine land cover and land use.

MDNR COVERTYPE	Acres	Percent
Barren Land (Rock/Sand/Clay)	1,876	0.41%
Cultivated Crops	112,942	24.45%
Deciduous Forest	85,570	18.53%
Developed, High Intensity	5,591	1.21%
Developed, Low Intensity	32,472	7.03%
Developed, Medium Intensity	14,909	3.23%
Developed, Open Space	45,346	9.82%
Emergent Herbaceous Wetlands	6,050	1.31%
Evergreen Forest	1,934	0.42%
Grassland/Herbaceous	3,907	0.85%
Mixed Forest	1,725	0.37%
Open Water	8,750	1.89%
Pasture/Clay	91,566	19.82%
Shrub/Scrub	997	0.22%
Woody Wetlands	48,254	10.45%
Total	**461,889**	**100.00%**

SEMCOG Land Use (2008)	Acres	Percent
Agricultural	165,587	35.80%
Single-family residential	189,513	41.00%
Multiple-family residential	2,897	0.60%
Commercial	9,981	2.20%
Industrial	15,317	3.30%
Governmental/Institutional	13,560	2.90%
Park, recreation, and open space	35,031	7.60%
Airport	649	0.10%
Transportation, Communication, and Utility	19,105	4.10%
Water	10,608	2.30%
Total	**462,248**	**99.90%**

SEMCOG General Cover (2010)			
Type	**Description**	**Acres**	**Percent**
Impervious	buildings, roads, driveways, parking lots	35,117	7.60%
Trees	woody vegetation, trees	146,278	31.60%
Open Space	agricultural fields, grasslands, turfgrass	263,712	57.00%
Bare	soil, aggregate piles, unplanted fields	2,657	0.60%
Water	rivers, lakes, drains, ponds	14,557	3.10%
Total		**462,321**	**99.90%**

The land cover classes in MDNR's analysis shown in Figure 3.11 classify forests in broad categories: Deciduous Forest; Mixed Forest; Evergreen Forest; and Woody Wetlands. Other classifications make finer distinctions among different forest types, based on characteristic soils and species. Donald Dickmann (2004) offers a more detailed classification in *The Michigan Forest Communities Guide* from a forestry perspective—including human-created plantation forests—while Michigan Natural Features Inventory (MNFI, https://mnfi.anr.msu.edu/communities/), which surveys plant and animal species and habitats throughout the state, offers an ecological view. MNFI classifies Washtenaw woodlands into 12 types of natural forest communities that presently occur or likely occurred before European settlement in the County, plus an additional 2 types of shrub wetlands (intermediate between forested and more open wetlands dominated by *graminoids*—grasses and sedges). Table 3.2 (next page) shows how these classifications compare, to aid interpretation of maps using different classifications. Forest community types are described in more detail in section 3.1.7, on biodiversity, below.

Other technical vegetation classifications, including the Forest Habitat Type Classification (Burger and Kotar 2003) and the National Vegetation Classification Standard (USNVC 2016, http://usnvc.org) offer even greater detail about and finer categories of forests and vegetation associations in general. These can be quite specialized and are generally more useful in landscapes with larger contiguous tracts of forest or natural areas, rather than in the highly fragmented and often disturbed landscapes of southeast Michigan.

Table 3.2. Land cover and forest community classes.

General forest community types (Dickmann)	MDNR cover classes	circa 1800 vegetation classes	Dickmann's Forest Communities	MNFI Natural Communities
Wetland forest	Woody wetlands	Mixed conifer swamp		Poor conifer swamp
				Rich conifer swamp
			Southern relict tamarack swamp	Rich tamarack swamp
		Mixed hardwood swamp		Hardwood conifer swamp
		Black ash swamp	Southern deciduous hardwood swamps and floodplain forests	Southern hardwood swamp
				Floodplain forest
				Wet-mesic flatwoods
	Shrub/scrub	Shrub swamp/emergent marsh		Southern shrub carr
				Inundated shrub swamp
Upland closed-canopy forest	Deciduous forest	Beech-sugar maple forest	Southern mesic deciduous (maple-beech) forests	Mesic southern forest
	Mixed forest	Mixed oak forest	Southern dry-mesic (oak-mixed hardwood) forests	Dry-mesic southern forest
			Southern dry (dry oak) forests	Dry southern forest
	Evergreen forest	[none]	Plantations	[Rich and poor conifer swamps]
Upland open-canopy forest		Black oak barren		Oak barrens
		Mixed oak savanna		Oak openings
				Bur oak plains

3.1.4 Soils

There are 83 distinct types of soils in Washtenaw County that can be grouped into 49 different soil series (*Soil Survey of Washtenaw County*). These soils range widely in texture (the mix of particle sizes or hydrologic types), natural drainage capacity, slope, and other characteristics. Well-drained to moderately well-drained soils make up 35% of the county soils; somewhat poorly drained soils, 24%; poorly drained to very poorly drained soils, 37%; with fill and made land compromising the remaining 4% of soils. Figure 3.12, below, shows soils as classified into hydrologic characteristics based on soil particle size and texture.

Soils largely correspond with the glacial landforms and landscape ecosystems described above, and are a large factor in determining forest and other vegetation, including which species of trees grow and where (as can be seen in comparing maps of circa 1800 vegetation and present land cover with soil maps). They have also shaped the land use history of the region, with agriculture still dominating on level to moderately sloped loamy soils that hold nutrients and moisture, while recreation areas are found on hilly and drought-prone soils. Residential development and suburbanization have occurred across a range of well-drained to somewhat poorly drained soils, but is less likely very poorly drained soils outside of areas served by city water due to soil percolation requirements for septic systems.

Western Portion. Soil textures range from sand to clay; the most common soil texture is sandy loam on the moraine ridges and sand on the outwash plains, which are very well-drained. On ice-contact topography, soils are typically excessively drained sands and gravels on the upland kames and eskers, and poorly or very poorly drained in the kettles and outwash channels.

Central Portion. Soil textures in this portion of the County are typically loam and sandy loams. Finer textured soils of silt loams and clay loams are more common on the eastern edge of this area. Poorly drained mineral soils are common on lower slopes of the ground moraine. Organic soils are found on outwash channels.

Southeastern Portion. This area is dominated by wet sandy loam and clayey soils. Soil permeability is typically low, so drainage systems (tiling and channeling) are generally required for agricultural use. Soils are calcareous at shallow depth. Soils are poorly or very poorly drained in sand channel depressions and excessively drained on dunes.

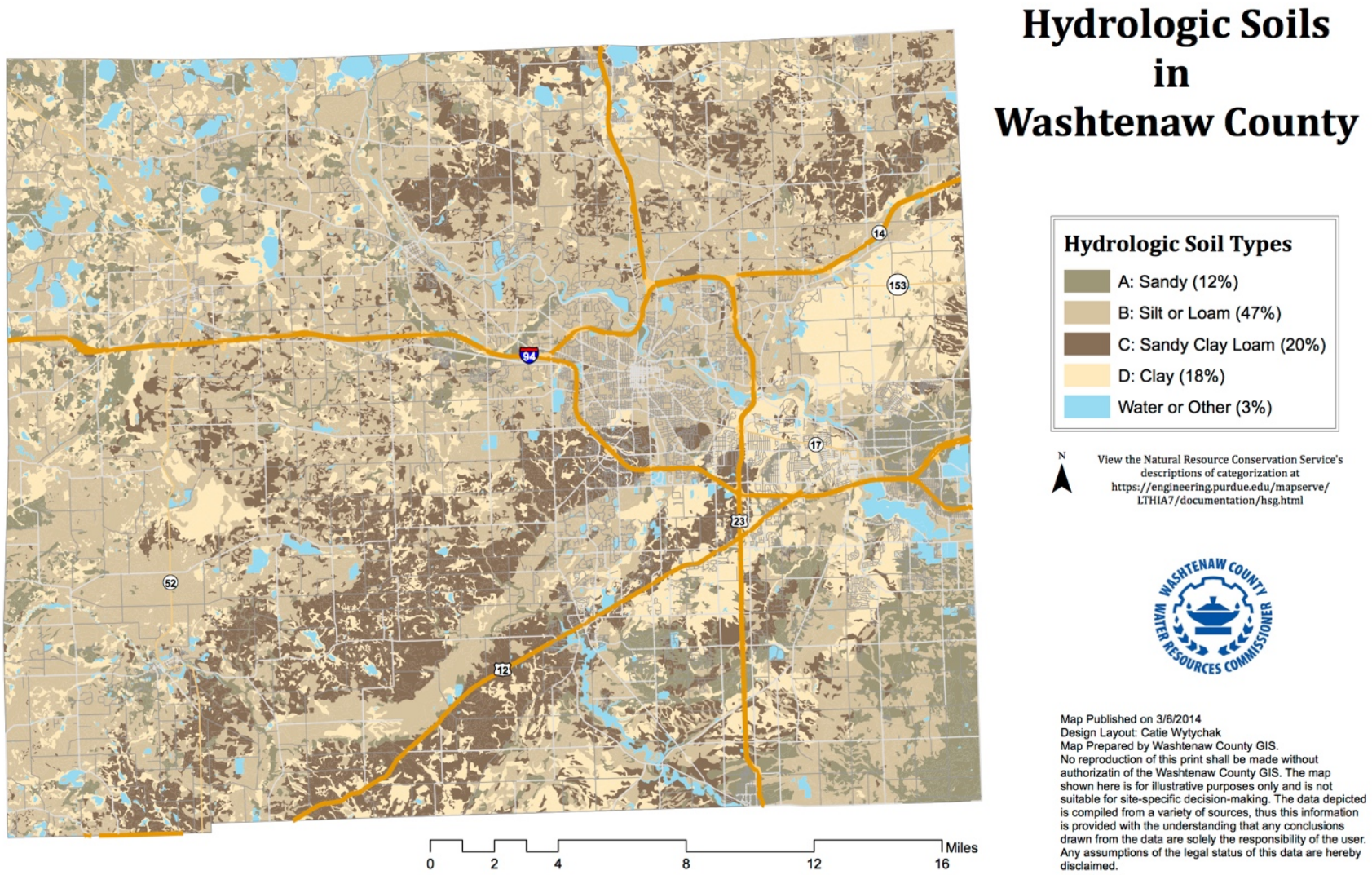


Figure 3.12. Washtenaw County hydrologic soil types. Soil texture and particle size largely determines moisture holding capacity.

Detailed soil information is provided by the USDA Natural Resources Conservation Service though printed soil surveys (available from County Conservation District Offices) and Web Soil Survey (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm), an Internet site that shows recent aerial imagery and allows the user to select an area of interest to assess the soil map units present and search interpretations such as suitability for paths and trails. The print versions of Soil Survey show appropriate trees to plant on different soil types and the site index for a few of the most common trees that are adapted to the soil characteristics (drainage, depth, etc.) for the mapped area.

Smart phone users can take advantage of the SoilWeb app which uses the device's GPS location to display the most common one or two soils at that site. It has basic information that includes a soil profile, landscape position, and simple graphs that display sand, silt, clay, organic matter, and pH with depth.

Michigan State University houses the Soil and Plant Nutrient Laboratory (http://www.spnl.msu.edu/), which offers a variety of analytical services on samples of soil, compost, plant tissue, water, and other materials related to the growing of plants. Determining pH and nutrient status of soil by soil testing is a key method of determining which amendments (lime and fertilizer) to add for optimal plant growth.

For more detailed understanding of the soils on a particular site, contact the Natural Resources Conservation Service or Michigan State University Extension (see Appendix).

3.1.5 Water and Hydrology

Two major rivers run through Washtenaw—the Huron River, which drains most of the northern half of the county, and the River Raisin (with the Saline River), which drains around 2/3 of the southern portion (Figure 3.13). The majority of the County drains to Lake Erie through these and three additional watersheds: Paint-Stony Creek, Rouge River, and Swan Creek. A small portion of northwest Washtenaw County drains to Lake Michigan through the Grand River basin.

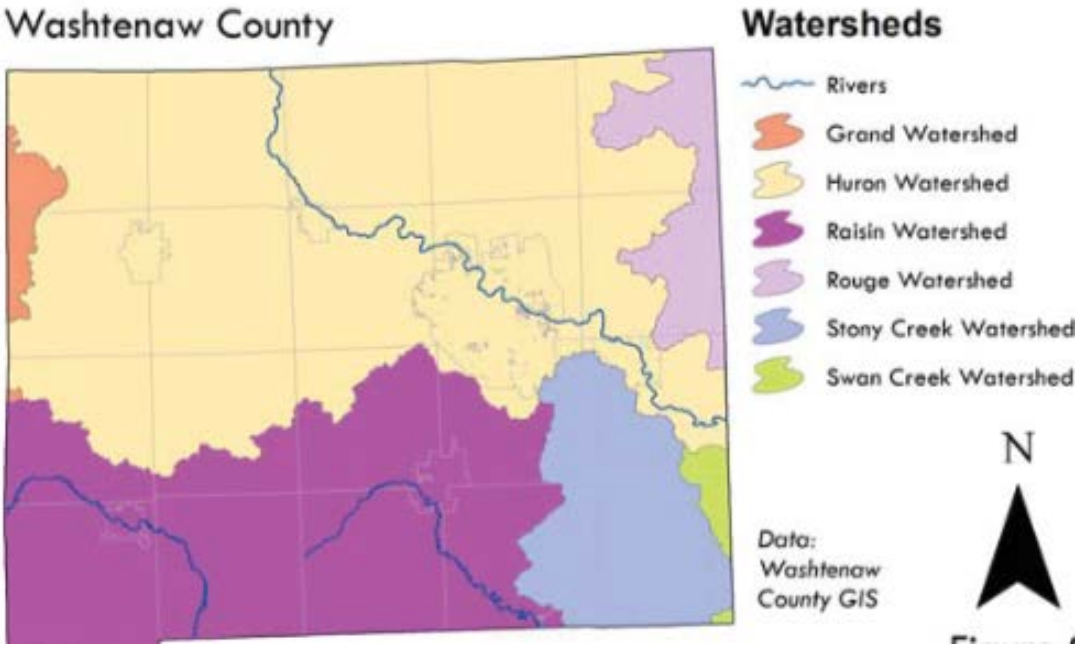


Figure 3.13. Washtenaw County watersheds.

In addition to natural watershed, a large number of streams have been channelized and ditches constructed to drain agricultural land and manage stormwater. The Washtenaw County Water Resources Commission oversees management and maintenance of this extensive drain system (Figure 3.14).

The Huron River provides 85% of the drinking water to approximately 125,000 Ann Arbor residents connected to the municipal water system (http://www.a2gov.org/departments/water-treatment). The Huron River Watershed Council (hrwc.org) has been active in efforts to protect water quality, with recent efforts focused on maintaining natural vegetation (including woodlands and floodplain forests) throughout the watershed. In addition, the HRWC along with 5 other area conservation organizations received a $1.8 million grant in January 2017 under the Regional Conservation Partnership Program (part of the 2014 Farm Bill) to focus on protecting water quality upstream of Ann Arbor through promoting agricultural best management practices and funding riparian land conservation efforts (Stanton 2017). These efforts are described in more detail in section 3.2.2, below. The Huron River is the only state-designated Country-Scenic Natural River in southeast Michigan. It is also designated as the Huron River Water Trail, part of the National Water Trails System administered by the National Park Service (https://www.nps.gov/WaterTrails/Trail/Info/53). The Huron is popular with paddlers, floaters, and anglers, as are parts of the River Raisin (see Section 3.1.10 on recreation, below).

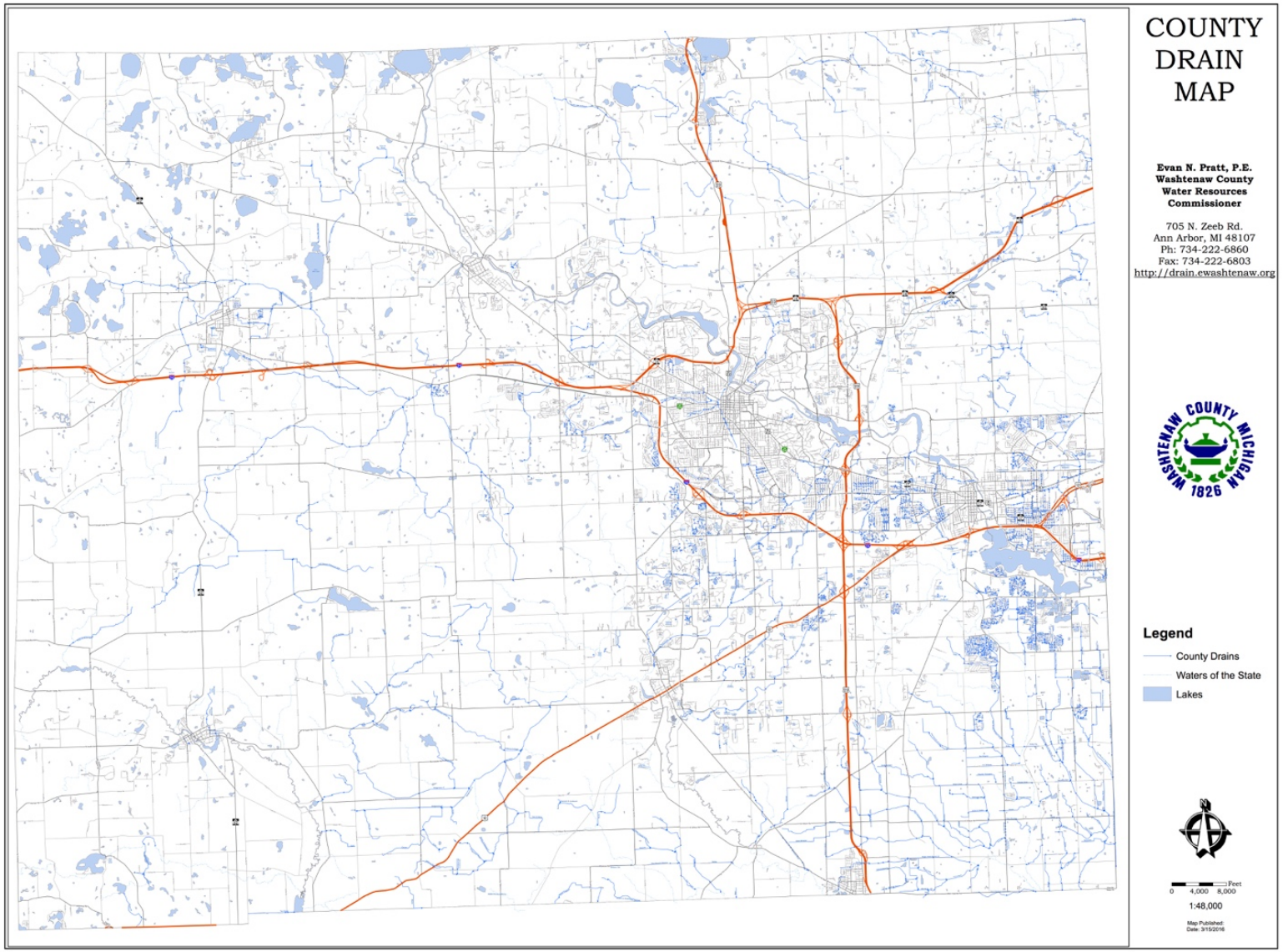


Figure 3.14. Washtenaw County rivers, lakes, and drains. The Water Resources Commission manages drainage ditches and channelized streams.

Lakes

There are more than 300 natural lakes and ponds, and more than 150 artificial lakes, ponds, or reservoirs in the County, covering approximately 11,000 acres. Although many are unnamed, at least 93 lakes are named, including roughly 80 glacier-created lakes that are more than a mile in diameter. Some of the larger lakes (greater than 200 acres) include Ford Lake, Barton Pond, and Geddes Pond (all created by dams on the Huron River); Four Mile Lake, Independence Lake, and Whitmore Lake (in the northern and eastern part of the county); Pleasant Lake (in the southwestern corner); and Portage and Silver Lakes (part of the Huron Chain of Lakes area that lies mostly in Livingston County to the north).

Shoreline vegetation, including trees and woodlands, play an important role in lake ecosystems and water quality. The Department of Environmental Quality's Inland Lakes and Streams program has been participating in the Michigan Natural Shoreline Partnership (http://www.mishorelinepartnership.org/) to promote natural shoreline landscaping to protect Michigan's Inland Lakes and to educate property owners about using native plants and technologies that benefit lake ecosystems.

3.1.6 Wetlands

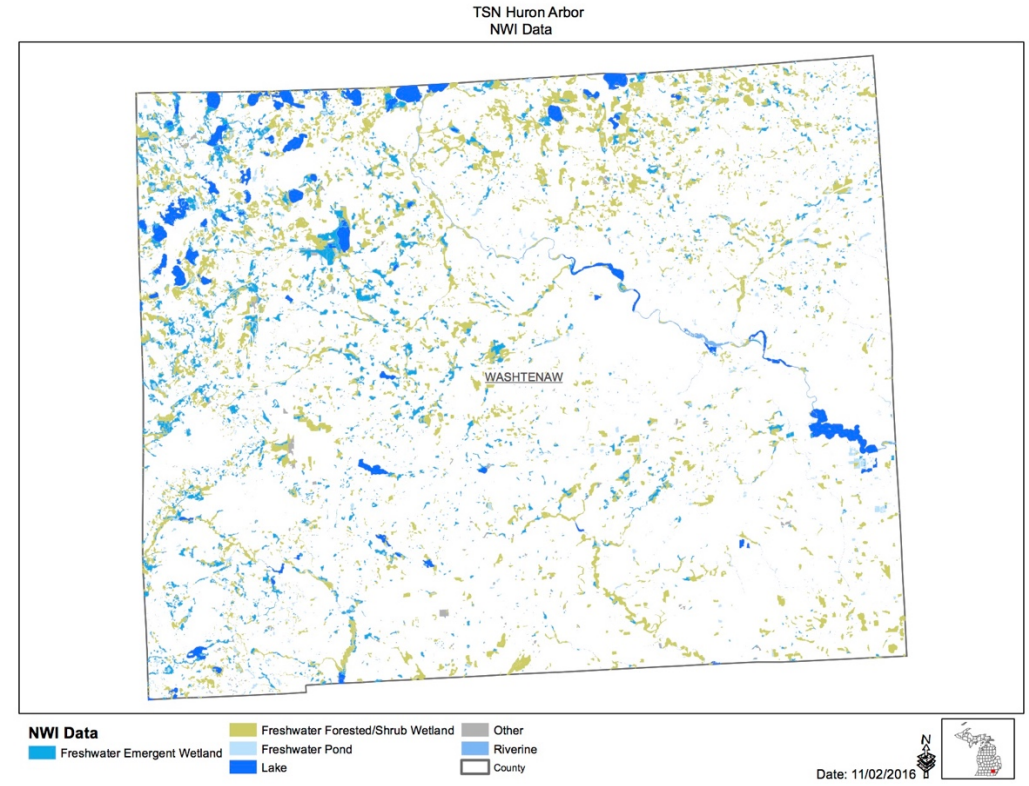
Wetlands are defined as areas with 3 key characteristics, which together form not only an ecological description but also the necessary conditions for various wetland regulations:

1. Wetland vegetation or hydrophytes: plants that rely on standing water or saturated soil for at least part of the growing season;
2. Hydric soils, defined as "as a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part" (USDA 2016); and
3. Wetland hydrology, the movement of water into, through, and out of a wetland that typically leads to soil saturation during some part of the growing season, and to the development of characteristic soils and plant communities (http://www.wetlandsforum.org/faqhydrology.htm).

Wetland vegetation may be dominated by graminoids (grasses and sedges) or trees. According to the MDNR's analysis, woody wetlands (including deciduous swamps, floodplain forests, hardwood conifer swamps, and tamarack fens) occupy just over 10% of the land area of Washtenaw County. Another 1.3% is occupied by emergent herbaceous wetlands (wet prairies and fens), and a small portion (0.22%) is classified as shrub/scrub, which may include shrub-dominated wetlands (inundated shrub swamp communities, dominated by buttonbush)—see Figure 3.11 and Table 3.1, above. In all, wetlands occupy around 55,000 of the County's 461,889 acres (Figure 3.15). Woody wetlands account for 87% of all wetlands in the county (48,254 acres).

Trees in woody wetlands can consist of deciduous floodplain species such as silver maple and cottonwood, or swamp species, including black ash, red maple, swamp white oak, yellow birch,

and others. Hardwood conifer swamps have a mix of deciduous trees and conifers, which typically include northern white cedar, tamarack, and hemlock, and may also include white and black spruce. Shrubby wetlands—which often occur in transitional zones between herbaceous and forested wetlands and may be included in MDNR's shrub/scrub category, include buttonbush, red-osier and silky dogwoods, and several species of shrub willows. Detailed information about natural communities, including species characteristic of various types of woody wetlands, is described briefly below (section 3.1.8) and detailed in the Michigan Natural Features Inventory website and publications (Cohen et al. 2015, https://mnfi.anr.msu.edu/pub/abstracts.cfm#Communities).



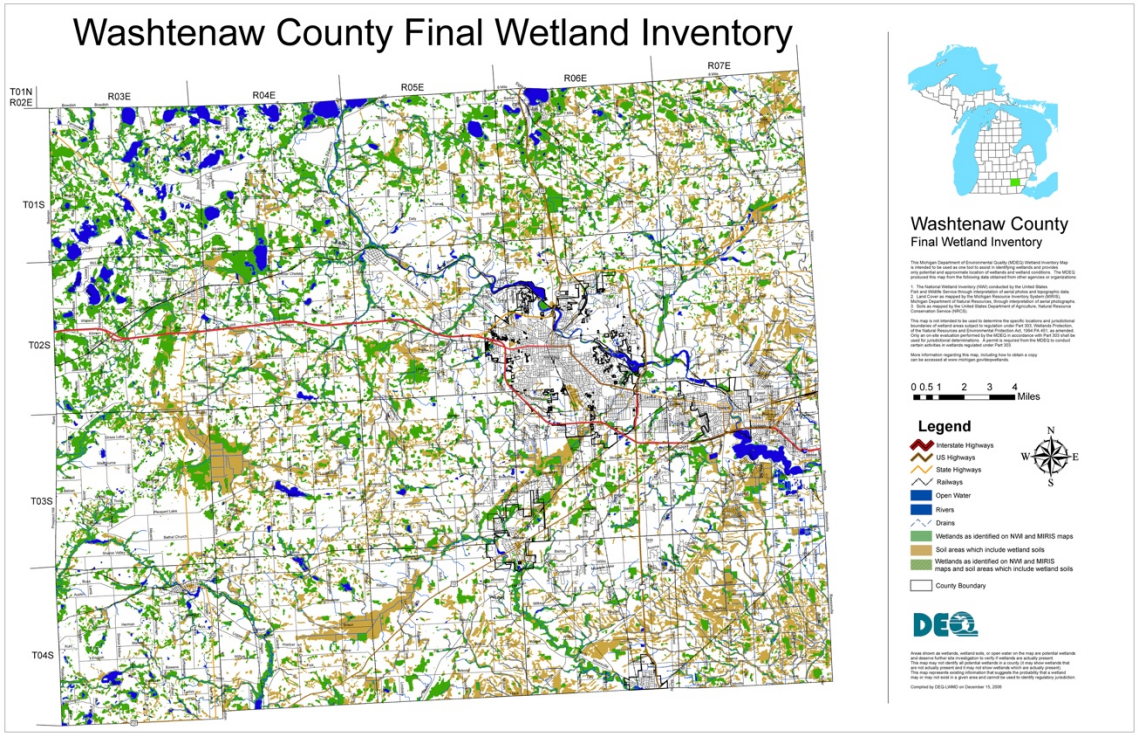


Figure 3.15. Washtenaw County wetlands. A large proportion of wetlands (87%) are forested or shrubby, as shown in the MDNR analysis (top) using National Wetland Inventory data as of 2007. The MDEQ map (lower) uses the NWI map with additional data on land cover and soils.

Wetland losses

Many wetlands throughout Michigan have been ditched, channeled, and drained for agricultural use. Although Michigan's wetland protection law (enacted in 1979) and subsequent regulations put in place in the 1980s and 1990s sought to limit wetland destruction and loss, the Michigan Department of Environmental Quality (MDEQ) estimates that 53% of the wetlands that existed in Washtenaw County at the time of European settlement were destroyed by 2005, dropping from an estimated 107,447 acres circa 1800 to 50,441 acres in 2005 (Fizzell 2014, http://www.michigan.gov/documents/deq/DEQ-Water-Wetlands_Status_and_trends_498644_7.pdf).

Even with laws and regulations in place, wetland losses continued between 1978 and 2005, although at a slowing rate. Washtenaw's wetland acreage was estimated at 51,991 acres in 1978 by the National Wetland Inventory (https://www.fws.gov/wetlands/) but dropped to 50,668 in 1998 and 50,441 in 2005, a loss of 3% (Fizzell 2014).

Remaining wetlands are usually affected by altered hydrology (drainage by tiles and ditches or increased surface water inputs because of dams or additional runoff in the wetland's watershed), changes in water quality (nutrients, pesticides, salts, etc.), and introduction of invasive species (phragmites, reed canary grass, non-native cattails, purple loosestrife, and others).

Wetland losses are of concern because of the many ecological functions and values of wetlands—the ecological or ecosystem services they provide. Wetlands act in many ways to safeguard water quality in surface water (rivers and lakes) and they serve as groundwater recharge areas to fill aquifers (Figure 3.16). They can slow runoff water, improving water quality and reducing sedimentation in streams and rivers. They serve as a buffer to reduce flooding in downstream or adjacent areas. They can absorb excess nutrients (from fertilizers applied in nearby agricultural fields), slowing or preventing eutrophication of lakes and pond (a process that occurs when high nutrient levels lead to dense aquatic vegetation that eventually dies and decomposes, reducing oxygen levels). They also filter pollutants out of runoff water and can bind to (or in some cases break down) toxic pollutants.

In addition to their many water quality benefits, wetlands provide habitat for diverse species, from waterfowl to wildflowers, and including fish, frogs, and other amphibian species. Even small seasonal wetlands, such as vernal pools or ponds (areas that have standing water for several weeks in the spring but not for the rest of the year), benefit biodiversity, often serving as key breeding areas for amphibians and reptiles, snails and mussels, dragonflies and damselflies, and providing resources for numerous bird species (Thomas et al. 2010, MNFI).

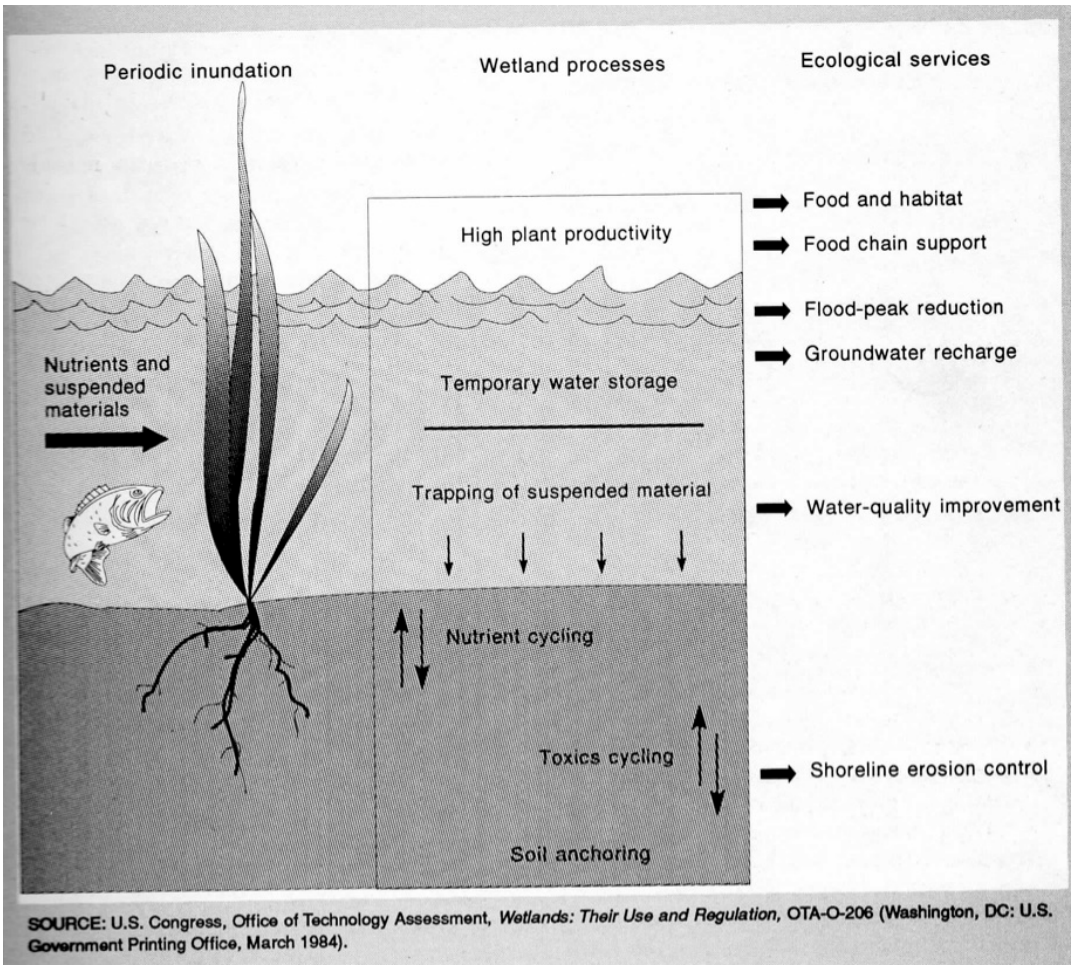


Figure 3.16. Relationship between wetland uses and values.

Because wetlands are often hotspots of biodiversity and are important to maintaining water quality, they are considered high priority for conservation by many stakeholders in Washtenaw County (section 3.2, below).

The Department of Environmental Quality's wetlands program is using geographic information technology to improve the evaluation of wetlands on a watershed scale in a Landscape Level Assessment. The assessment uses a computer model to integrate wetland maps with hydrologic data, site topography, and other ecological information to provide a generalized map of current wetland functions within a watershed, the loss of wetland function associated with past land use changes, and potential wetland restoration areas. This wetland assessment can be used to support watershed planning, zoning decisions, and defining wetland restoration/protection priorities at the local or regional level. Wetlands play a critical role in maintenance of water quality and quantity, and wetland protection and restoration should be an integral component of watershed planning.

Wetlands have been mapped by the US Fish and Wildlife Service in a program called National Wetland Inventory (https://www.fws.gov/wetlands/Data/Mapper.html). That mapping uses the Cowardin System of Classification with distinctions among palustrine (inland wetland which lacks flowing water), lacustrine (associated with lakes), and riverine systems. The Wetlands mapper integrates digital map data along with other resource information to display wetland type and extent using a biological definition of wetlands (Figure 3.14, above).

Wetlands mapper does not define the limits of proprietary jurisdiction of any federal, state, or local government, so landowners should consult with appropriate agencies (Michigan DEQ and USDA) before conducting clearing, earth moving, or other operations in potential wetlands. http://www.michigan.gov/deq/0,4561,7-135-3313_3687-10801--,00.html

The main state regulation that affects wetland use and alteration is Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, which is administered by the Department of Environmental Quality (DEQ). In Michigan, the Section 404 federal authority associated with inland waters and wetlands was assumed by the state in 1984. Section 10 of the Rivers and Harbors Act of 1899 is a federal law which regulates construction in, over, and under navigable waters.

Wetlands on agricultural land are regulated by the USDA Natural Resources Conservation Service under the Wetland Conservation provisions, commonly referred to as Swampbuster, which prohibit USDA program participants from converting remaining wetlands on their agricultural operations to cropland, pasture, or hay land unless the wetland acres, functions, and values are compensated for through wetland mitigation. The 2014 USDA Farm Bill established a Wetlands Reserve Easements program that is designed to provide a financial incentive to private landowners to encourage the restoration of previously degraded or drained wetlands. NRCS pays a per-acre easement fee, plus 100 percent of the cost to restore the agricultural lands back to natural wetland ecosystems. The landowner retains title, control of access, and hunting rights, but must protect the restored wetland ecosystem for future generations. The landowner can sell the land, but the easement (and its protections) remain in force for perpetuity.

3.1.7 Biological Diversity: Natural Communities and Species

While foresters often categorize forests in broad classes according to dominant species type and timber qualities (oak-hickory, maple-beech, or conifer forests; hardwoods vs. softwoods), ecologists divide them into finer categories according to landscape position and characteristics, ecological processes, and shrub and herbaceous species associated with dominant trees.

The Michigan Natural Features Inventory, which "conducts field surveys to locate and identify threatened and endangered species and communities throughout the state, and maintains a database of all relevant species and community locations" (DNR, Natural Features Inventory), has created a Natural Community Classification for Michigan that includes 77 communities

grouped into 18 ecological groups, defined by their landscape occurrence and vegetation characteristics. The three ecological groups that include forests are the forest, forested wetland, and savanna groups with a total of 21 natural communities; 13 of them presently occur, or historically occurred, in Washtenaw County (Table 3.2, above). Among these, oak-hickory forests (the Dry-Mesic Southern Forest and Dry Southern Forest communities)—included with sugar-maple beech (Mesic Southern Forest) in the "deciduous forest" land cover class (MDNR/NLCD map shown above)—are the most common and cover the largest area of Washtenaw County forests.

Floodplain Forests and Oak Barrens are considered of particular conservation interest or value. Floodplain Forests are valuable for protecting water quality were identified by county planners during the 1990s as "Fragile Lands" because they are frequently destroyed during waterfront development and residential construction. Oak Barrens have been assigned a high state conservation ranking, S1, which indicates habitats that are "critically imperiled in the state because of extreme rarity (often five or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state." Oak Barrens, along with other savanna communities, including oak openings and bur oak plains, have been greatly reduced in the County due to land use changes and fire suppression, as have wetland forests (described above).

Rare natural communities—including wetland and grassland, as well as forested communities—are widely distributed in Washtenaw County (Figure 3.17). In fact, the County has more sites with rare natural communities than any of the 6 other counties in south central Michigan.

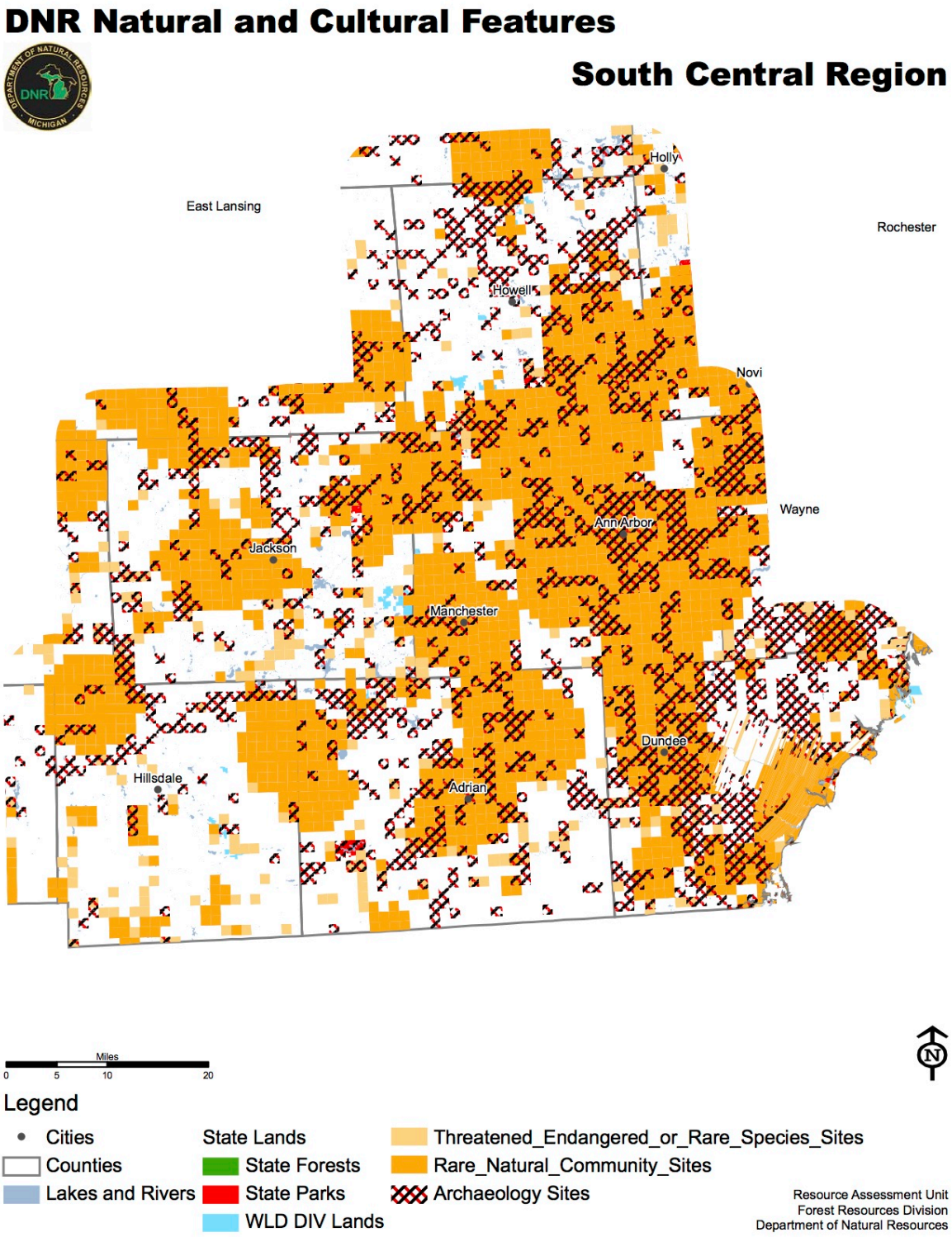


Figure 3.17. Rare species and communities in South Central Michigan. Washtenaw County is centered on Ann Arbor. Archaeological sites, also shown, are discussed in Section 3.1.13, below. Natural community descriptions, below, are condensed from Cohen et al. 2015, *A Field Guide to the Natural Communities of Michigan*.

Terrestrial class: Forest group
Terrestrial forest communities are tree-dominated uplands with canopy cover of greater than 60%. These are the dominant forest types in southeastern Michigan, often referred to as oak-hickory and sugar maple-beech forests, that are lumped together in the "deciduous forest" land cover class (Table 3.1 and Figure 3.8, above) and together account for 18.5% of the County's total cover, comprising 63% of all forest cover. Although conifer plantations now occupy some upland areas within Washtenaw County, in areas with natural vegetation, conifers are generally found in forested wetlands rather than in upland forests.

Dry southern forest: this oak-dominated fire-dependent forest is typically found on well-drained and acidic sands, sandy loams, and loamy sands on outwash plains and kettle-kame topography. Typically dominated by black oak (*Quercus velutina*) and white oak (*Quercus alba*), along with pignut hickory (*Carya glabra*) and black cherry (*Prunus serotina*). Red maple (*Acer rubrum*) is increasingly abundant with absence of fire. Insect outbreaks (such as invasive gypsy moths, *Lymantra dyspar*) and various pathogens leading to oak decline, including Oak Wilt (*Ceratocystis fagacearum*) can influence tree species composition. Shrubs include blueberries (*Vaccinium* spp.) and huckleberries (*Gaylusaccia baccata*), and wildflowers include several species of tick-trefoils (*Hylodesmum* [formerly *Desmodium*] spp.) and woodland sunflower (*Helianthus divaricatus*). Examples are found in the Waterloo State Recreation Area in Washtenaw and neighboring Jackson County.

Dry-mesic southern forest: an oak-dominated, fire-dependent forest on slightly acid loam and sandy loam soils in various landscape settings. Dominant trees are several species of oaks and hickories: white oak (*Quercus alba*); black oak (*Q. velutina*); red oak (*Q. rubra*); pignut hickory (*Carya glabra*); and shagbark hickory (*C. ovata*). Shrubs include blueberries (*Vaccinium* spp.), raspberries and blackberries (*Rubus* spp.), serviceberries (*Amelanchier* spp.), witch-hazel (*Hamamelis virginiana*), and hazelnut (*Corylus americana*). The ground cover includes familiar spring flora such a trillium (*Trillium grandiflorum*), hepatica (*Hepatica americana*), doll's eyes (*Actaea pachypoda*), and wild geranium (*Geranium maculatum*). In Washtenaw County, the Pinckney State Recreation Area contains representatives of this community type.

Mesic southern forest: found on many landforms with fertile, well-drained soils with high water-holding capacity, this hardwood deciduous community is dominated by sugar maple (*Acer saccharum*) and beech (*Fagus grandifolia*), with smaller numbers of red, white, and chinquapin oaks (*Quercus rubra, Q. alba,* and *Q. muehlenbergii*), tulip trees (*Liriodendron tulipifera*), and basswood (*Tilia americana*). Ground cover includes diverse ferns and sedges, and wildflowers include trillium (*Trillium grandiflorum*), wild ginger (*Asarum canadense*), and Dutchman's breeches (*Dicentra cucullaria*). An example in Washtenaw County is in The Nature Conservancy's Nan Weston Nature Preserve adjacent to Sharon Mills County Park.

Terrestrial class: Savanna group
Savannas are open woodlands—tree canopy typically ranges from 10 to 60%—with grassland cover and diverse forbs. This group is considered fire-dependent and was historically

maintained by natural or Native American fire, which served to limit tree colonization and favor fire-tolerant oaks. Agriculture has claimed most savanna land within Washtenaw County, while other savanna areas have grown into denser forests due to fire suppression. Because of this, land cover maps shown above do not indicate any savanna cover class; any remnant savanna-type areas would likely be included in, and indistinguishable from, the deciduous forest cover type.

Oak barrens: a fire-dependent oak-dominated community that typically occurs on sandy to loamy drought-prone soils on outwash plains or coarse-textured glacial moraines. Vegetation is characterized by scattered or clumped oaks—generally black (*Quercus velutina*) or white (*Q. alba*), but occasionally also northern pin oak (*Q. ellipsoidalis*), with a ground cover layer that contains species characteristic of both prairies and forests, including big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), wild lupine (*Lupinus perennis*), and false foxglove *(Aureolaria* spp.). This community has become rare with land use changes and the absence of fire, but examples of it occur in Washtenaw County in the Pinckney State Recreation Area (where restoration work has included invasives removal and prescribed burns) and in the Island State Recreation Area in nearby Livingston County.

Oak openings: a fire-dependent, oak-dominated woodland/grassland community that occurs on somewhat moister (less drought-prone) soils than oak barrens, on fertile sandy loams or loams, typically dominated by white oak (*Quercus alba*) but with bur oak (*Q. macrocarpa*) and chinquapin oak (*Q. muehlenbergii*) as frequent co-dominants. Ground cover includes a mix a prairie and forest species, including grasses such as big bluestem (*Andropogon gerardii*) and little bluestem (*Schizachyrium scoparium*), and diverse forbs. Land use changes and fire suppression have greatly diminished its occurrence throughout the state; no examples of this community remain on publicly accessible land in Washtenaw County.

Bur oak plains: this fire-dependent savanna community, dominated by bur oak (*Quercus macrocarpa*), was historically more common in western Michigan and infrequent in Washtenaw County, but has now disappeared from the state altogether due to agriculture and development on the fertile soils where it typically occurred.

Palustrine class: Forested wetlands

Forested wetlands may occur on mineral soils or in peatlands that are saturated or seasonally inundated. They typically have tree canopy cover of 50% or greater. Woody wetlands occupy 10.5% of Washtenaw County, comprising 35% of forest cover.

Poor conifer swamp: a forested peatland that typically occurs on depressions in glacial outwash, glacial lakeplain, or within kettle holes in ice-contact terrain. Dominant trees are black spruce (*Picea mariana*) and tamarack (*Larix laricina*), with a shrub layer that frequently includes leatherleaf (*Chamaedaphne calyculata*) and Labrador-tea *(Rhododendron groelandicum*). A nice example occurs in the Waterloo Recreation Area in Jackson, just west of Washtenaw County.

Rich conifer swamp: a groundwater-influenced, forested wetland with *Sphaghnum* moss prevalent; the swamp may be acidic on the surface but typically develops on circumneutral to moderately alkaline peat, often associated with springs and headwater streams. Northern white-cedar (*Thuja occidentalis*) is dominant, while other abundant trees are tamarack (*Larix laricina*), white pine (*Pinus strobus*, although more common farther north), black and white spruce (*Picea glauca* and *P. mariana*), red maple (*Acer rubrum*), and black ash (*Fraxinus nigra*, although high mortality due to Emerald Ash Borer has reduced its abundance). These wetlands typically provide habitat for diverse sedge, fern, and forb species, including several orchid species.

Rich tamarack swamp: a groundwater-influenced, forested peatland to rich conifer swamp in landscape locations and conditions in which it occurs, this community is dominated by tamarack (*Larix laricina*), with other prevalent trees mostly deciduous, including black ash (*Fraxinus nigra*), red maple (*Acer rubrum*), and yellow birch (*Betula alleghaniensis*), as well as white pine (*Pinus strobus*). Abundant shrubs, including poison sumac (*Toxicodendron vernix*) and winterberry (*Ilex verticillata*), may form a dense understory, along with numerous species of forbs and sedges; lady-slipper orchids *(Cypripedium* species) may also grow here. Examples of this community are found in the county in Hudson Mills Metropark, Park Lyndon (Washtenaw County Park), and Waterloo State Recreation Area.

Hardwood conifer swamp: a groundwater-influenced forested wetland that occurs on peat and poorly drained mineral soils, often at headwaters or groundwater seeps, dominated by a mix of hardwood and conifer species including red maple (*Acer rubrum*), yellow birch (*Betula alleghaniensis*), northern white-cedar (*Thuja occidentalis*), and hemlock (*Tsuga canadensis*). Marsh marigolds (*Caltha palustris*) and skunk cabbage (*Symplocarpus foetidus*) may be prominent in spring, along with numerous other forbs, ferns, and sedges.

Floodplain forest: a diverse bottomland forest community in low-lying areas along rivers and streams, where periodic flooding and cycles of erosion and deposition are frequent disturbances that shape landforms including natural levees near the waterbanks, with hills and troughs at increasing distances (first bottom, second bottom, backswamp, and terrace) along with old meanders and oxbows, each of which can have different characteristic trees and shrubs. First bottoms are generally dominated by silver maple (*Acer saccharinum*) and previously green ash (*Fraxinus pennsylvanica*, which has been greatly reduced due to die-backs associated with the Emerald Ash Borer). Characteristic species along levees and in less frequently flooded areas can be quite varied, and include cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), box-elder (*Acer negundo*), basswood (*Tilia americana*), swamp white oak (*Quercus bicolor*) and bur oak (*Quercus macrocarpa*), along with numerous species of forbs, shrubs, and woody vines.

Southern hardwood swamp: a groundwater-influenced wetland dominated by deciduous trees that typically occurs in shallow depressions and small stream drainages, often with an underlying clay layer that prevents drainage and prolongs seasonal flooding. Dominant trees include silver maple (*Acer saccharinum*), red maple (*Acer rubrum*), and swamp white oak

(*Quercus bicolor*). Historically, these were accompanied by green ash (*Fraxinus pennsylvanica*) and black ash (*Fraxinus nigra*), but both species have been decimated in this area by the introduced Emerald Ash Borer (*Agrilus planipennis*). American elm (*Ulmus americana*) was also previously a significant component of the canopy; introduced Dutch elm disease has killed many of the large canopy trees, although small-diameter trees are still common.

Wet-mesic flatwoods: a forest community that occurs on seasonally flooded mineral soils (rather than peat), poorly drained clayey soils, or areas underlain by impermeable clay. Dominant trees are diverse and include various species of oaks (*Quercus spp.*), hickories (*Carya* spp.), maples (*Acer* spp.), and beech (*Fagus grandifolia*). Ash (*Fraxinus* spp.) and American elm (*Ulmus americana*) were historically a significant component of the canopy until introduced pests and fungal diseases (Emerald Ash Borer, *Agrilus planipennis*, and Dutch elm disease, *Ophiostoma* spp. ascomycete fungi, spread by several species of native and invasive beetles) greatly reduced their occurrence. Blue ash (*Fraxinus quadrangulata*) appears somewhat resistant to Emerald Ash Borer and is common on a few fertile wet-mesic sites in Washtenaw County. Shrubs such as spicebush (*Lindera benzoin*) and winterberry (*Ilex verticillata*) as well as maple-leaved arrow-wood (*Viburnum acerifolium*) and witch-hazel (*Hamamelis virginiana*) are typical, along with diverse graminoids, forbs, and ferns. Small patches occur within some natural areas in the County, including Mary Beth Doyle Nature Area in Ann Arbor, and parts of LeFurge Woods (a preserve owned by the Southeast Michigan Land Conservancy in Superior Township).

Plant and Animal Species

Despite its fragmented habitats, Washtenaw County still supports thousands of species of plants, butterflies and other insects, mammals, birds, fish and shellfish, amphibians and reptiles, and other animals, many of which rely fully or partly on forests for habitat. Although there is no comprehensive survey of forest biodiversity of all species (including soil microbes, fungi, and arthropods, which play important ecological roles), this section offers an overview of some visible species groups and discusses species of concern (threatened and endangered species).

Washtenaw County harbors 1,730 plant species (summarized in Table 3.3), around 62% of the 2,880 species that have been found to occur in the state (in the 2010 Michigan Flora database, http://michiganflora.net). Statewide, non-native species make up 35% of the flora, and Washtenaw County mirrors that trend, with 32% of recorded plant species considered adventive (not native, though not all are aggressive invaders). Roughly 7% of plant species in Washtenaw County are classified as threatened, endangered, or special concern (a listing notes that populations are low and being observed, for which further population declines could trigger action to list the species as threatened). Threatened and endangered species of all types are discussed below and listed in the Appendix.

Table 3.3. Washtenaw County plant species.

Physiognomy (growth form)	Native	Adventive	Total	% Adventive	Special Concern	Extirpated/ Extinct
Ferns & Fern Allies	56	1	57	2%	1	0
Grasses (annual & perennial)	100	68	168	40%	7	0
Sedges (annual & perennial)	164	5	169	3%	12	3
Forbs (annual, biennial, perennial)	649	369	1018	36%	49	2
Vines (annual and perennial)	20	15	35	43%	3	0
Vines (woody)	13	9	22	41%	1	0
Shrubs	99	44	143	31%	4	0
Trees	84	34	118	29%	5	0
Total	**1185**	**545**	**1730**	**32%**	**82**	**5**

Trees account for 7% of Washtenaw's plant species, but many other species of all types occur fully or partly in closed canopy forests or open canopy woodland. A recent study of forests in the Northeastern U.S. suggests that in general, about 85% of the species diversity in forests is in the herbaceous plants, so it is important to keep in mind that forests are far more than trees. MNFI provides detailed lists of plant species characteristic of the different natural forest communities outlined above (Cohen et al. 2015, https://mnfi.anr.msu.edu/pub/abstracts.cfm#Communities).

Of the 83 mammal species that occur in the Great Lakes region, 46 live in Washtenaw County (Kurta 1995). Mammals include numerous species of rodents (rats, mice, squirrels, chipmunks, voles) as well as moles, shrews, bats, raccoons, weasels, mink, beaver, river otters, and white-tailed deer. Many of these species rely on forest habitats or on a mix of woodlands and wetlands, or woodlands and grasslands.

Washtenaw County had 267 species of birds observed between 1977 and 1991 (Kielb et al. 1992); that number had increased to 296 species in 2017. Although the number of species seen in the area increased, populations (and sightings) of many species groups, particularly songbirds and Neotropical migrants, declined. A few species appear to be expanding their breeding ranges north into Michigan, or overwintering when in the past they migrated farther south (Wolinski, personal communication, 2017). An active birding community has documented many species. With new online tools for recording bird observations (eBird.org), data on bird sightings are allowing ornithologists to track changes in species abundance and migration patterns, including changes in breeding sites and overwintering behavior (correlated with changes in climate and land use patterns).

While some birds are grassland specialists or rely on shrublands or early successional forests, most of Michigan's bird species rely at least in part on forests for roosting, foraging, or nesting and breeding. The top ten birding hotspots in the county are all characterized by a mix of open water, riparian vegetation, and nearby forests (data from eBird.org). Species including the Hairy Woodpecker, Acadian Flycatcher, Ovenbird, Red-eyed Vireo, and Scarlet Tanager all require forest interior for breeding sites (Kielb et al. 1992). Forest interior habitats must have mature trees and large contiguous tracts of forest to support enough habitat within the forest rather than at edges, where nests are more vulnerable to predation by non-native species, such as the cowbird. Kielb et al. (1992) note that "the clearing of the forests for agriculture reduced or eliminated several species associated with extensive mature southern woods such as the Louisiana Waterthrush and Hooded and Cerulean Warblers," while other species, including the Yellow-bellied Sapsucker, Red-breasted Nuthatch, Brown Creeper, and many warblers shifted to breeding grounds farther north. Wolinski (personal communication 2017) notes that many warblers and migratory songbird species that rely on forest habitats have continued to decline in abundance between 1992 and 2017. At least 31 bird species found in Washtenaw County among species documented by the U.S. Forest Service as nesting in tree cavities, which are found in mature forests with large and/or standing dead trees (Scott et al. 1977); at least 19 of them (including wood ducks, screech and barred owls, and various woodpecker species) have been reported in Washtenaw during the breeding season (Kielb et al. 1992, eBird.org). Many more bird species rely at least in part on forests for food, with the rich diversity of fruits, insects, and insect larvae that occur in forests.

Washtenaw County provides habitat for 213 species of butterflies and moths (confirmed sightings, as reported in *Butterflies and Moths of North America*, butterfliesandmoths.org). Species range from natives that rely on particular trees or shrubs as food during the larval stage [such as the Eastern tiger swallowtail (*Papilio glaucus*), for which black cherry is the larval host plant, required food for the caterpillars] to those that are considered problematic pests for trees, including native tent caterpillars (*Malacosoma americanum*) and non-native gypsy moths (*Lymantria dispar)*. Nielsen (1999) notes that among the notable species associated with forested habitats in southern Michigan are the Banded and Hickory Hairstreaks (southern oak-hickory communities), Dukes' Skipper (mixed swamp hardwoods and sedge meadows); at least 3 species of Duskywings rely on oaks as larval host plants along the Huron River in Ann Arbor alone (NAP 1999). Various other species are associated with open woodlands and oak savannas, including endangered Regal Fritillary and threatened Wild Indigo Duskywings (MNFI Rare Species Explorer, https://mnfi.anr.msu.edu/explorer/search.cfm).

Michigan has 22 species of frogs, toads, and salamanders (18 of which are found in Washtenaw County, Harding and Holman 1999) 12 species of turtles and lizards (10 are found in Washtenaw County, Harding and Holman 1997), and 18 species of snakes (15 in Washtenaw County, including the endangered Massasauga rattlesnake; Harding and Holman 2006). Nearly all of these species rely at least in part on trees and woodlands and occur in landscapes with a mix of wetlands, streams, and vernal ponds embedded in forested and grassland habitats.

Turtles often bask on fallen logs or prefer riverside areas with overhanging branches; snakes may use rodent burrows under fallen trees as winter hibernacula; salamanders often live in the moist soil under fallen logs; and most frogs and toads prefer wooded wetland areas. The Michigan Herpetological Atlas (MIHerpAtlas 2017 and an accompanying mapping app) collects observations about these species, searchable by county, to track populations over time. Many herp species are sensitive to changes in land use and poor water quality; maintaining a diverse mix of forests and fields adjacent to wetlands and rivers is imperative for their survival.

An Atlas of Michigan Fishes lists 157 species that occur in the state (Bailey et al. 2004). The Huron River hosts at least 54 fish species in the Ann Arbor area alone (NAP 1999), and the River Raisin and its major tributaries (including the Saline River) have 84 species (Smith et al. 1981). A total of 81 species have been documented within the Washtenaw County reaches of Huron and Raisin watersheds, as well as within the Grand and Stony Creek watersheds; 10 of these species are found in five or fewer Michigan counties, for which the County's rivers and streams are particularly important (Appendix D). Some are game species that have been stocked, while smaller species, including minnows and dace, have been affected by agriculture and land management practices.

While fish and forest management may seem unconnected, many fish species benefit from floodplain forests and woody vegetation; habitat recommendations often note the importance of woody debris, overhanging branches, and fallen logs, as well as the improved water quality offered by trees and other riparian vegetation. Streamside forests also offer shade and keep water temperatures cooler during the summer, as well as stabilizing soil and groundwater flows. Other aquatic species, such as native freshwater mussels (unionids) and many invertebrates that provide food for fish (such as stonefly and mayfly larvae) also benefit from riparian vegetation (including trees) that improve water quality and reduce sedimentation.

In particular, forested riparian zones are vital to maintaining native freshwater mussels (unionids). Unionids, which are very sensitive to water pollution, are considered one of Michigan's most endangered species groups; 19 of the 47 species native to Michigan are threatened or endangered; 14 of those occur in Washtenaw County (Badra 2005). Management guidelines for mussel habitat emphasize the importance of wooded streambanks:

> ***Forested riparian zones*** help maintain a balanced energy input to the aquatic system, provide habitat for fish hosts in the form of large woody debris, reduce the input of fine particles by stabilizing the stream banks with roots, and provide shade that regulates water temperature. Management techniques such as conservation tillage, maintaining or planting grass filter strips along streams and waterways, and ***maintaining forests in the floodplain can help reduce the input of silt and pollutants into the river*** (italics added; Badra 2005).

In sum, Washtenaw County's woodlands harbor a rich diversity of plants and animals. They serve as primary habitat for many species, and play important roles in protecting habitat even

for aquatic species. Species diversity depends on maintaining healthy and intact ecosystems along the continuum from forest to field, and from woodlands to wetlands to waterways.

A view of the River Raisin running through The Nature Conservancy's Nan Weston Preserve. Floodplain forests are often important in providing habitat for native fish and mussel species, which benefit from woody debris and overhanging branches, as well as from improved water quality and filtration of sediment offered by vegetated riparian buffers. Management guidelines for several mussel species of special concern proscribe timber harvests in areas adjacent to rivers and streams, and recommend maintaining or restoring vegetated riparian buffers (including various shrub and tree species). Photo ©Jason Whalen, The Nature Conservancy.
http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/michigan/placesweprotect/nan-weston-nature-preserve-at-sharon-hollow-1.xml

3.1.8 Timber and Non-Timber Forest Products

Washtenaw County is not a major timber-producing county. Annual timber harvests were in the range of 0–1,115,000 board feet (92,917 cubic feet) according to U.S. Forest Service 2009 data, less than 3/10 of one percent of the 340 million cubic feet of timber harvested. Harvest densities were in the range of 5–10 board feet per acre during resource assessments in 2006 and 2010 (Pugh 2007, Piva 2010, Haugen 2016). Harvests from the county are primarily hardwoods (although there may be limited amounts of pine from aging plantations), with largest timber harvests of white oak group, red oak group, soft maple, hard maple, and hickory (2006 data, Piva 2010).

Washtenaw County has a minimal wood products industry. There is one commercial sawmill in the county, and no mills for production of pulp, veneer, or other wood products. However, the Natural Resource Conservation Service maintains lists of timber buyers that serve Washtenaw County (https://www.washtenawcd.org/uploads/5/9/2/0/59207889/timberbuyers.pdf), as well as other resources for land-owners interested in harvesting timber (https://www.washtenawcd.org/timber-sales.html).

The County does have several businesses that specialize in reclaiming and using urban wood to make lumber and specialty products (from furniture to photo frames). Urbanwood.org is an organization, started in 2005, that grew out of efforts to salvage urban ashes killed by the emerald ash borer; the organization now serves as "Southeast Michigan's reclaimed wood marketplace," connecting small landscaping and wood reclamation businesses to markets, with a directory of local resource providers (http://urbanwood.org/partners/). Urbanwood's retail store, housed in Recycle Ann Arbor's ReUse Center, "is the first retail operation of its kind in the country, bringing together local producers of lumber, slabs, and other reclaimed urban wood products under one roof" (http://urbanwood.org/about/).

Firewood production statistics are hard to locate, but Washtenaw County has at least nine firewood vendors listed in the Firewood Scout directory (www.firewoodscout.org), an organization that promotes safe firewood production and use, emphasizing local firewood to prevent transport of insects and disease. Like Urbanwood.org, Firewood Scout grew out of the Southeast Michigan Resource Conservation and Development Council, which started in the emerald ash borer epicenter in southeast Michigan to address issues linked to widespread ash die-offs and concerns over how to prevent the ash borer's spread. The organization, now known as the Sustainable Resources Alliance (http://semircd.org) is headquartered in Ann Arbor and sponsors a range of natural resource projects, including several focused on developing techniques for and promoting wood energy as a sustainable biofuel.

While there are few timber businesses within the county, there are a number of farms that produce non-timber forest products, such as Christmas trees, maple syrup, nuts and fruits, and mushrooms. There is no comprehensive inventory of farms that plant or use trees for non-forest products, so it is difficult to assess acreages, but a few examples suggest the range of products produced. The Michigan Christmas Tree Association (http://www.mcta.org/choose-cut-farms-map) lists five Christmas tree farms in Washtenaw County. The Michigan Maple Syrup Association (http://www.mi-maplesyrup.com/about-us/directory/producers/) shows two member farms within the county, although a number of small farms that sell in local markets are likely not members and are not listed. The Michigan Nut Growers Association (https://michigannut.org/), which supports interest in and growers of nut trees, including English walnuts, chestnuts, hazelnuts, and pecans, as well as minor fruits, doesn't have a membership directory to show how many growers are in Washtenaw County, but its special interest groups for pawpaws and persimmons are based in Ann Arbor. Apple orchards were a common feature in the Washtenaw County landscape in the 1940s through 1980s, but orchard acreage in the area has declined significantly with changing economics and pressure from development. However, various directories of apple orchards list 8-10 farms in the county, most of which focus on apples but some that produce plums, pears, and peaches. Several local organic farms are harvesting oak logs for mushroom production, or growing mushrooms within woodlots; others are returning to traditional practices of allowing pigs to forage in woodlots for acorns and hickory nuts.

3.1.9 Forest Health

Michigan's forests have undergone dramatic changes in the past two centuries, from the cessation of Native American use of fire to large-scale logging that virtually eliminated old-growth forests in the Southern Lower Peninsula. Starting in the early 1900s, Michigan's forests have been hit by successive waves of insect and disease outbreaks, often originating from non-native pests and pathogens: chestnut blight; Dutch elm disease; gypsy moths; and Emerald Ash borer have killed millions of trees in southeast Michigan and have dramatically reshaped Washtenaw County forests. In recent years, some ecologists have come to believe that passenger pigeons, which disappeared from Michigan forests with overhunting in the early 1900s and went extinct in 1917, played key roles in forest regeneration, dispersing mast (acorns, beech and hickory nuts, walnuts) and in creating patches within forests where many species could find niches.

The fact that Washtenaw County has more forested land now than it did in the early 1900s—albeit a fragmented patchwork of mature secondary forest with many younger stands—shows the resilience of our forests. However, many threats are interacting in what appears to be an increasing rate. New pests and pathogens continue to emerge and be introduced, while forests are still recovering from past waves of mortality. Deer are browsing heavily in many area, potentially altering forest regeneration and species composition. Dense carpets of invasive shrubs and herbaceous plants may outcompete native species, including tree seedlings, and small forest patches are more vulnerable to invasion. A changing climate may pose further stresses: more frequent or intense droughts could affect species that prefer moist conditions, while extreme storm events accompanied with flooding can cause erosion and wind damage. And the changes are occurring on a landscape where habitat fragmentation reduces resilience by making it harder for seed sources to disperse into and replenish areas where species populations have declined or disappeared.

Timber stand improvement can help to keep forests healthy to withstand the numerous challenges. Management techniques include pruning and removal of trees that are of lower quality or in the wrong place. Pruning (which should be done in the dormant season) can be used to remove low limbs to produce a higher quality saw log. There are many common mistakes made in pruning, so the landowner should study the subject or hire a professional to do the work. A forester can be hired to mark the trees to be thinned or weeded (just like in a vegetable garden, one can select preferred plants). These operations can contribute to forest health by increasing growth of remaining trees and helping them to resist insects and diseases. There are several ways to deal with the material removed including pulp sale, fire wood harvest, or creating brush piles for wildlife. There are also machines that can grind up woody debris and create mulch on the soil surface (resulting in faster decomposition of branches). (Tree Owner's Manual: www.na.fs.fed.us/urban/treeownersmanual/)

Threats to forest health make every landowner's efforts important. MDNR and local stakeholders offer guidance including web resources and classes to provide tools for

responding to forest threats. This section outlines major threats to Washtenaw County's woodlands, along with resources for learning more and reporting pests.

Pests and Pathogens

Chestnut blight (*Cryphonectria parasitica*) was introduced in New York in 1904 and rapidly spread to decimate chestnut trees throughout the northeastern U.S. in the early part of the century; it reached Michigan in 1930 and virtually eliminated chestnuts—which occurred primarily in the southeastern Lake Erie counties and was present but not dominant in Washtenaw County forests—from naturally occurring forests. Although forest losses from chestnut blight are in the past, there have been many efforts to develop blight-resistant American chestnut (*Castanea dentata*) varieties (for example, the American Chestnut Foundation, https://www.acf.org/resources/faqs/, Horton 2013), as well as hybrids with various Asian species and cultivars. Landowners interested in planting chestnuts for nut production or forest restoration can find trees available online and can consult the Michigan Nut Growers Association, which has a special interest group devoted to chestnuts (https://michigannut.org/special-interest-groups/).

Dutch elm disease (*Ophiostoma ulmi* and two related species), a non-native fungal pathogen spread by bark beetles, arrived in New York on imported timber in 1928 and was documented in Wayne County by 1950. It killed tens of thousands of mature American elms (*Ulmus americana*) over the next several decades. Although large elms have disappeared from most Washtenaw County forests, smaller trees often survive and can be locally numerous, often reach 6–10 inches in diameter before they succumb to the disease. The fungal spores are carried by various species of native and non-native bark beetles. Chemical and biological controls have met with mixed success, and preventive treatment is costly for all but specimen trees. Efforts are underway to develop and test resistant cultivars of American-only genotypes, as well as hybrids, including test plots at Michigan State University. Nurseries and online sources stock many reputedly blight-resistant elms. Those wanting to plant elms should research cultivars carefully: some "blight-resistant" types have succumbed to blight over time; and tree growers will need to decide whether they prefer fully American genotypes or will accept hybrids with Asian species. (http://msue.anr.msu.edu/news/improved_elms_for_michigans_urban_landscapes, http://msue.anr.msu.edu/news/return_of_the_american_elm, http://bspm.agsci.colostate.edu/national-elm-trial/, https://www.fs.fed.us/psw/topics/urban_forestry/products/psw_cufr688_American_Elm_Renaissance.pdf).

Gypsy moths (*Lymantria dispar*) were accidentally brought into the Boston area in the 1860s and killed tens of thousands of trees in the Northeast in periodic outbreaks; the first major outbreak in Michigan was in 1986, when the caterpillars defoliated millions of trees on over 64,000 acres in the state (favorite trees include oak, birch, apple, willow, hawthorn, serviceberry and poplars, but they will eat leaves from maples and other non-preferred species). A 1992 outbreak resulted in 750,000 acres of Michigan trees defoliated, with other severe outbreaks in 1998 (Figure 3.17); with local or regional outbreaks in 2008, 2013, and 2016. Defoliation may not outright kill trees but leaves them vulnerable to drought, disease, and future insect outbreaks, and may continue

to cause occasional tree mortality in the oak-dominated forests of Washtenaw County and throughout lower Michigan.

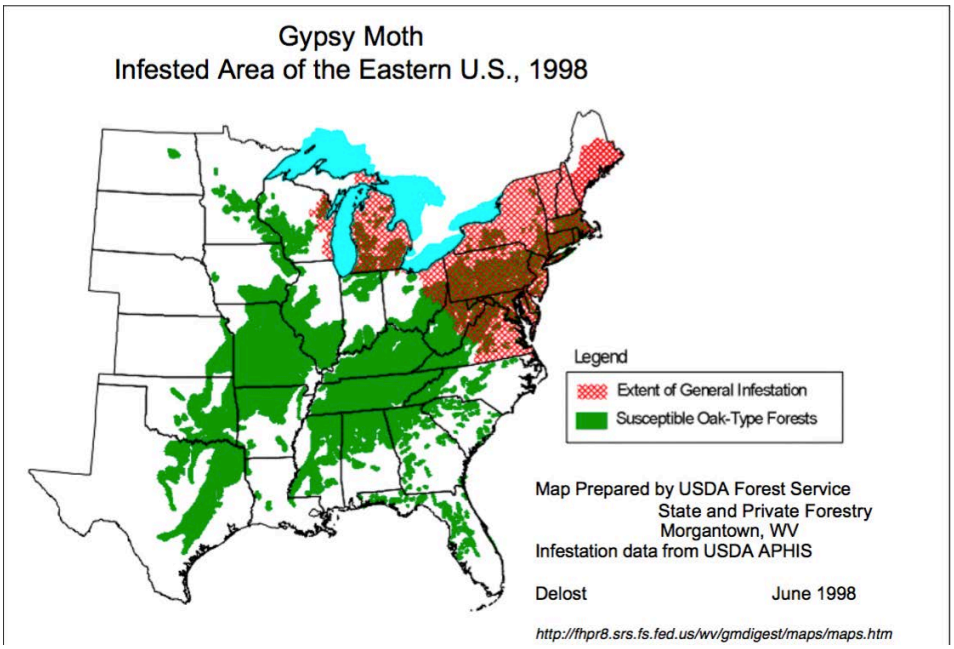


Figure 3.17. Gypsy moth infestation and forests at risk, 1998.

Gypsy moth outbreaks have declined somewhat in frequency and severity as natural and introduced biological controls, including the widely sprayed bacterial biological control *Bacillus thuringiensis* (Bt) helped to control populations, then a naturally occurring virus, nucleopolyhedrosis virus (NPV) and a naturally occurring fungus (*Entomophaga maimaiga*) together reduced and helped maintain populations at low levels for a number of years in Washtenaw County. The County's website offers guidance to landowners about gypsy moth identification and treatment, but due to the decreased severity of outbreaks since the 1990s, it no longer has a specific gypsy moth control program, nor does MDNR's website note any current control programs. However, the fungus that helps control gypsy moths is most plentiful when there is adequate spring and summer rain, so regional gypsy moth outbreaks have continued to occur when the fungas declines during or following drought years. (http://www.ewashtenaw.org/government/departments/extension/Hort/gypsymoth.pdf)

Emerald Ash Borer, EAB (*Agrilus planipennis*), is an invasive beetle inadvertently brought into the U.S. on wood imported from Asia. First documented in Detroit in 2002, it spread rapidly and within a few years, by 2007, it killed 99% of infected white, green, and black ash trees (*Fraxinus americana, F. pennsylvanica*, and *F. nigra*), decimating tens of millions of trees in southeastern Michigan and Washtenaw County, including thousands of Ann Arbor street trees (McCullough 2013 and http://emeraldashborer.info/state/michigan.php). It has spread to all neighboring states and continues to expand its range (Figure 3.18), with confirmed cases in three new states in 2016 (Delaware, Oklahoma, and Alabama).

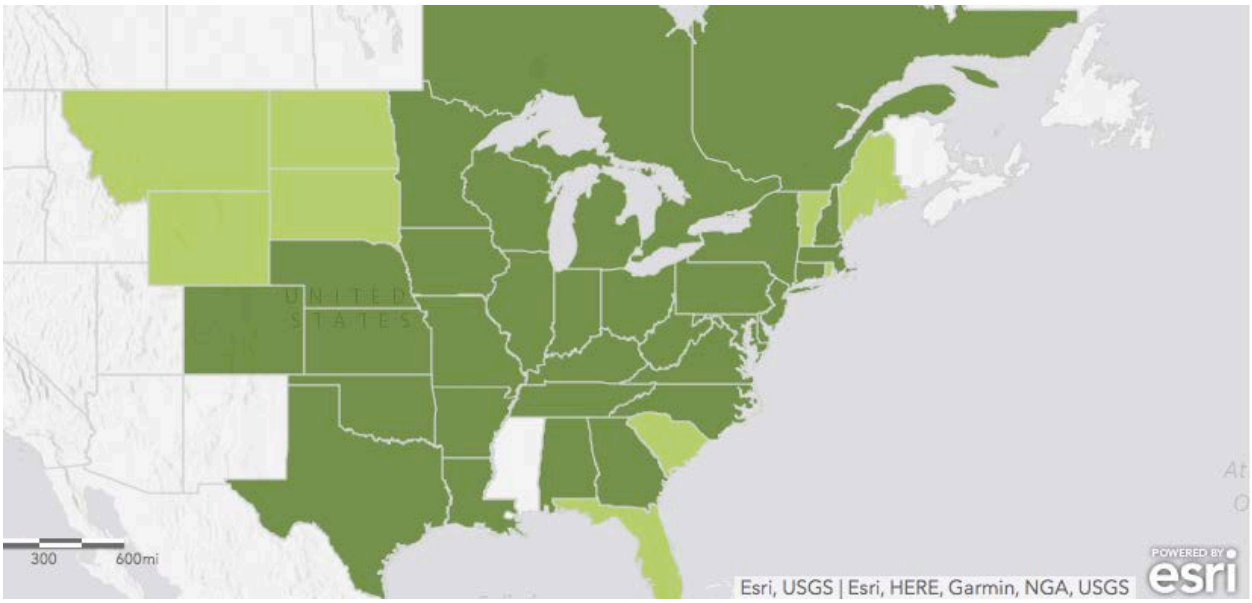


Figure 3.18. Emerald Ash Borer range in the U.S. and Canada, 2017. From http://www.emeraldashborer.info/index.php.

All Michigan counties, and many in surrounding states, have quarantines that restrict the movement of lumber, firewood, and other raw wood products. However, because EAB has now spread throughout the Lower Peninsula, residents (including those in Washtenaw County) no longer need to report EAB to the Michigan Department of Agriculture and Rural Development. MDNR and other organizations offers various web resources about detecting EAB and preventing its spread. Although it is too late to stop EAB in Washtenaw County, measures such as not transporting firewood may help to prevent infestations by other invasive pests as well, including newer threats like the Asian long-horned beetle and beech bark disease, described below. (http://www.michigan.gov/mdard/0,4610,7-125-2390_18298_41640---,00.html, https://www.dontmovefirewood.org/invasive-species/, http://www.americanforests.org/magazine/article/will-we-kiss-our-ash-goodbye/)

Asian long-horned beetle (ALB) (*Anoplophora glabripennis*) is a serious threat to Michigan forests because its preferred host is maple; more than one billion maple trees that occur in the state could be at risk. However, it also attacks dozens of other tree species from 12-15 plant genera, including poplar, willow, sycamore, and horse chestnut. This large, showy beetle was accidentally introduced into the U.S. on several occasions, probably in wood crating or pallets shipped from Asia. Larvae feed in tunnels (called galleries) in the wood of tree branches and trunks. The galleries can cause branches or trees to break and will eventually kill the tree. North American trees have little or no resistance to infestation, which is nearly always fatal. Early detection and eradication are key. Infected trees should be removed and destroyed.

ALB populations are known to be present in areas of southern Ohio, Massachusetts and New York but has not yet been detected in Michigan. ALB can be transported into new areas in logs and firewood. If ALB is not eradicated and populations spread across North America, the economic and ecological impacts would be enormous. The Michigan Department of Agriculture

urges landowners to pay attention to trees, especially maples, with dying branches, and to report any suspect trees or beetles: take photos; record the location; try to collect suspect beetles in a jar; and report to MDA:

- Email: MDA-Info@michigan.gov
  Phone: MDARD Customer Service Center (800) 292-3939
  Midwest Invasive Species Information Network: www.misin.msu.edu
- Learn more: www.michigan.gov/exoticpests, www.asianlonghornedbeetle.com, https://www.dontmovefirewood.org/pest_pathogen/asian-long-horned-beetle-html/

[Text in this section excerpted and modified from MDARD's Forest Pest Alert: http://www.michigan.gov/documents/mdard/AsianLonghornedBeetle_3-14_453144_7.pdf.]

Beech bark disease is a tag-team effort by the invasive sap feeding insect, beech scale (*Cryptococcus fagisuga*), which injures American beech trees (*Fagus grandifolia*), allowing them to become infected with two species of fungus (*Nectria* spp.). The fungus kills areas of woody tissue, and if large areas are affected, the tree may become girdled and die. Up to 75% of trees appear to be killed within three to six years following the infection. Other times, the trees may linger, but with dead branches that are easily blown off in windstorms (a condition known as "beech snap"). The beech scale was accidentally brought into Nova Scotia in 1890 and has gradually moved east; it was first documented in Michigan in 2000. Since then, it has spread widely in the state. As of 2015, it had not yet been reported in MDNR-owned lands in northwestern Washtenaw County, but beech does not occur on those properties (Figure 3.19). However, Legacy Land Conservancy has been monitoring beech trees in its Salem Township Creekshead Preserve since 2010, because the large beeches that form more than 50% of the forest canopy are considered vulnerable.

Although there appears to be some natural resistance among beech trees to beech bark disease, there are few control options in natural forest stands. Thinning is recommended to reduce beech density, as lower density stands may be less susceptible to the spread of the scale and fungus, along with removing trees that are affected. However, given that relatively few mature beech stands occur in Washtenaw County, the choice to further reduce them on conservation land could be complicated. (McCullough et al. 2005, http://msue.anr.msu.edu/uploads/files/e2746.pdf, https://www.dontmovefirewood.org/pest_pathogen/beech-bark-disease-html/)

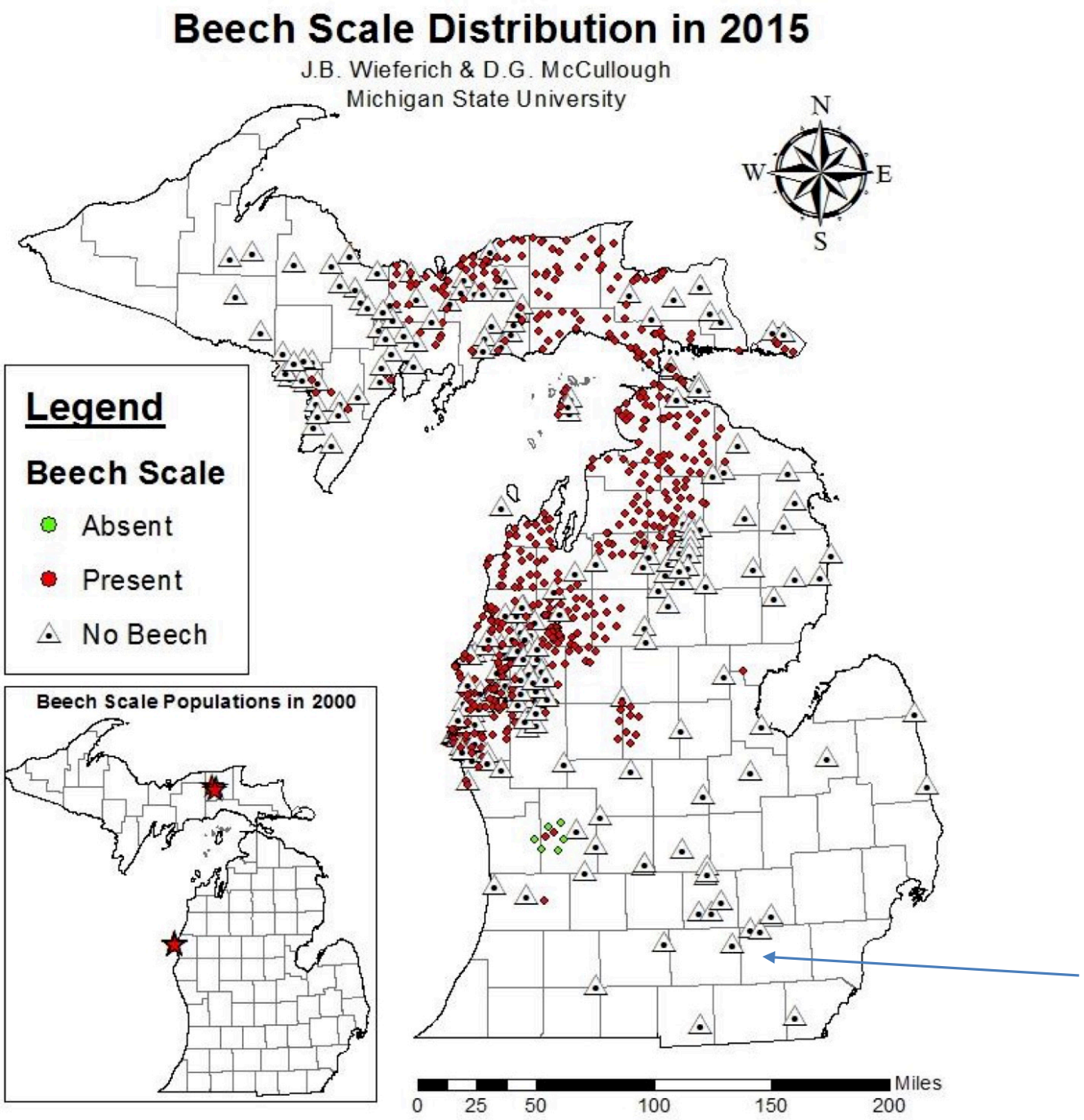


Figure 3.19. Beech scale distribution in Michigan, 2015.

Oak wilt and oak decline *(Ceratocystis fagacearum)* is a fungal disease spread by several beetle species that was first documented in the U.S. in the 1940s but has become an increasing threat in Michigan over the past 20 years. Oak wilt kills healthy red oaks (*Quercus rubra)*, often within a few months, and all species in the red oak group (including black oak and northern pin oak, *Q. velutina* and*Q. ellipsoidalis*) are susceptible. White oaks can also be affected but are more resistant and less vulnerable to mortality from the disease. Once infected, mortality of red oaks with oak wilt is nearly 100%, and there is no treatment to save the infected tree; the infection will spread to adjacent trees and can kill all trees in an area. Once an oak wilt infection is confirmed, however, removal and destruction of infected trees can save surrounding oaks and prevent the disease from spreading.

Oak wilt moves slowly on its own through root systems and can move from tree to tree via root root grafts, which connect the roots of adjacent trees. The fungus also travels short distances overland when new spores are moved by beetles from an infected tree to a freshly pruned or injured tree. Controlling the fungus requires removing all infected trees in an area and trenching around them to prevent spread through the roots.
Red oaks are an abundant—often canopy dominant—tree species in southeastern Michigan, an important producer of acorns relied on by dozens of wildlife species, and are common urban and suburban landscape trees. The estimated value of red oak timber in Michigan is approximately 1.6 billion dollars (based on Forest Inventory Analysis data from 2011 and current timber prices). Although Washtenaw County does not have a large timber industry, widespread mortality of oaks would have enormous negative impacts in Washtenaw County, ecologically, economically, and aesthetically.

Oak wilt has been documented in Michigan and at least 14 other states (Figure 3.20). A 2011 U.S. Forest Service report showed in occurring in Washtenaw County even in 2010, although local reports have suggested that it was first documented here in 2016. Legacy Land Conservancy is managing it in one of their preserves, and it has affected trees in several Metroparks in counties adjacent to Washtenaw.

The best way to prevent oak wilt is to take care not to damage oak trees during the active growing season—April through August—during construction and road work, or through intentional pruning. Damaged trees should be immediately painted with a sealant to prevent bark beetles from getting to the sap. Moving firewood can spread the disease, so avoid transporting firewood away from where it is cut. Report suspected cases of oak wilt:

- Email: DNR-FRD-Forest-Health@michigan.gov
  Phone: (517)284-5895
  Midwest Invasive Species Information Network: www.misin.msu.edu
- Learn more: http://michigansaf.org/ForestInfo/Health/E3169-OakWilt.pdf
  http://msue.anr.msu.edu/news/oak_wilt_disease_1,
  http://na.fs.fed.us/pubs/howtos/ht_oakwilt/identify_prevent_and_control_oak_wilt_print.pdf

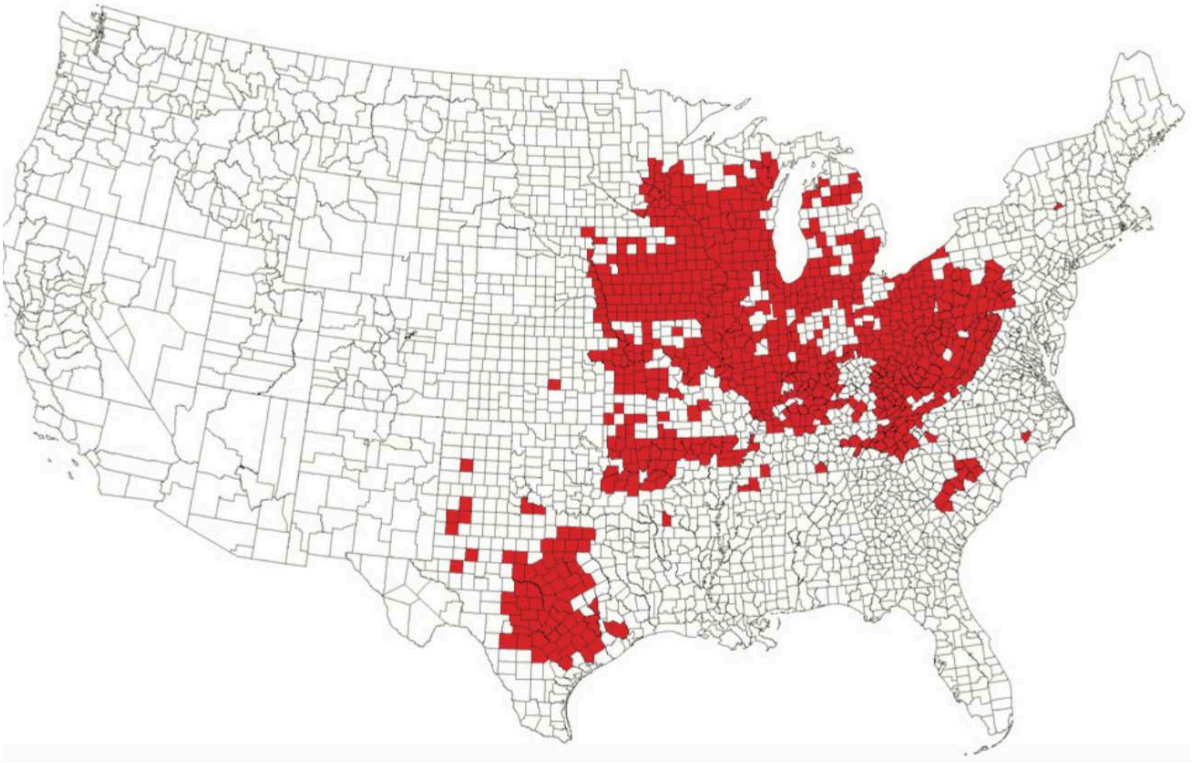


Figure 3.20. Distribution of Oak Wilt in the U.S. From U.S. Forest Service, *How to Identify and Prevent Oak Wilt.* https://www.na.fs.fed.us/pubs/howtos/ht_oakwilt/identify_prevent_and_control_oak_wilt_print.pdf

Oaks are also susceptible to other fungal diseases, native and invasive, including *Armillaria* root rot, anthracnose, and *Phytophthora ramorum* and *P. quercina,* which cause Sudden Oak Death and Oak Dieback. Complex interacting factors may also cause Oak Decline. Landowners with significant stands of oaks should monitor trees carefully and search for information on possible challenges.

Thousand Cankers Disease (TCD): A newly identified fungal pathogen *(Geosmithia morbida*) being spread by an insect native to the southwestern U.S. *(Pityophthorus juglandis)* is a relatively recent but potentially serious concern for black walnut trees (*Juglans nigra*). When the tiny walnut twig beetles drill tiny holes to feed on tree branches, they introduce the TCD fungus, which kill small areas of tissue, forming cankers. In time, more cankers form, branches die, and the entire tree succumbs, although it may take 10 years before the tree dies entirely.

TCD has not yet been found in Michigan but has been killing black walnut trees in California and other western states since the 1990s. By 2015, it had been found in six eastern states, including Indiana, Ohio, and Pennsylvania. An effective biological or chemical control for TCD has not yet been identified. A high proportion of black walnut trees will likely die if it becomes established in Michigan. Rapid early detection and removal and destruction of infected trees, are recommended to prevent the disease from spreading.

As noted in a Forest Pest Alert, "Michigan's forests are home to approximately 8.5 million black walnut trees with an economic value of more the $86 million and ecological value as a food source for birds, mammals and other wildlife. There are also more than 80 walnut growers in Michigan with approximately 4,000 trees in nut production…. Black walnut is a valuable timber species and important for wildlife."
(http://www.michigan.gov/documents/mdard/Final_TCD_WTB_MDARD_Forest_Pest_Alert_9_25_13_435045_7.pdf)
TCD can can be transported into new areas in firewood, logs, and woodworking staves. A quarantine in Michigan restricts transport of these materials, as was done for EAB.

The Michigan Department of Agriculture urges landowners to learn signs of potential infestation and monitor black walnut trees. Report suspect forest infestations:

- Email: MDA-Info@michigan.gov
  Phone: MDARD Customer Service Center (800) 292-3939
  Midwest Invasive Species Information Network: www.misin.msu.edu
- Learn more: www.michigan.gov/exoticpests, www.thousandcankers.com, https://www.dontmovefirewood.org/pest_pathogen/thousand-canker-disease-html/

Non-native (invasive) Species
While many pests and pathogens described above are non-native, many species of non-native plants, insects, and aquatic species, can also become invasive. (Some native species can also be aggressive weeds in the right circumstances, but the focus here is on non-native invasives.) Many non-native species in Michigan, including fruits, vegetables, field crops, livestock, and domestic animals, are important to our economy and most are not harmful. Invasive species cause harm when they out-compete native species by reproducing and spreading rapidly thus reducing the health of natural and managed communities.

Invasive species tend to have one or more characteristics that make them successful: they tolerate a wide range of environmental conditions; they grow and reproduce rapidly and abundantly, often maturing at a young age; they can be aggressive and effective competitors for resources including water, light, and soil nutrients; and they may lack the suite of specialist enemies—such as leaf miners, scale insects, host-specific caterpillars, and fungal pathogens—that help keep them in balance in their native ranges.

Invasive species can negatively impact ecosystems in complex ways. They can outcompete and displace native species; reduce or alter wildlife habitat (although several invasives were intentionally introduced and planted for wildlife); reduce forest health, productivity, and regeneration; and alter ecosystem processes including nutrient cycling, beneficial soil fungus (mycorrhizae), and leaf litter dynamics. They can invade fields and forest openings so densely that recreation and trails are affected.

One of the keys to avoiding infestation by invasive plants is to have a healthy community of native or intentionally introduced plants (crops, orchards, etc.). The more robust the desired vegetation is, the less likely that invasives will proliferate. Soil-disturbing activities such as plowing, land clearing, and vehicle trafficking can create a favorable zone for invasive plant establishment. Disturbance should usually be followed quickly by reseeding or planting to limit invasive species competition.

Timber harvests and other activities that disturb soil and affect canopy trees can have serious unintended negative effects on a forest ecosystem if the landowner does not realize that there are invasive species in the understory. If the harvest opens the canopy, the extra light could cause invasive species that had been fairly innocuous to grow, reproduce, and take over the open ground rapidly. For this reason, landowners should be aware of invasive species in the area and plan to treat such infestations prior to a harvest.

Cutting or mowing is not effective on many of these species and may actually make them more of a problem, so please seek treatment recommendations from Michigan DNR, BCK CISMA, or your local conservation district. Information, including photos and identification modules, can be found at misin.msu.edu.

Invasive Shrubs

Woody invasive shrubs are a pervasive challenge in Washtenaw County, with dense buckthorn thickets invading natural areas in and around Ann Arbor, and honeysuckle prevalent throughout city and surburban forests, while autumn olive is more common in open fields and forests and is a particular problem in the Waterloo-Pinckney area. They are a particularly important problem because they completely alter the forest community and, in many cases, prevent the growth of native species. Some key species of concern:

- Autumn olive (*Elaeagnus umbellata*)
- Buckthorn: common (*Rhamnus* cathartica) glossy (*R. frangula*)
- Bush honeysuckles (*Lonicera* spp.)
- Japanese barberry (*Berberis thunbergii*)
- Multiflora rose (*Rosa multiflora*)
- Privet (*Ligustrum vulgare*)

Many of these invasive shrubs leaf out earlier than natives, often in March, and retain leaves later into the fall, making it difficult for other plants to survive in their shade. These are forest invaders, thriving in or tolerating shade (autumn olive is more common in open fields and forests but can tolerate shade). All these species fruit abundantly, producing thousands of seeds that are transported by birds and mammals. Control can be achieved by several methods, some of which can be used in combination. Fire will set the plant back, but will not usually kill the autumn olive shrub. Because the plant stump sprouts after fire or cutting, it is usually treated with herbicide (triclopyr appears to be an effective chemical). The herbicide can be sprayed on a

cut stump (avoid spring when sap is rising), applied to foliage (normally done in late fall when other plants are dormant), or as a basal bark treatment (apply to lower 18 inches of trunk except when sap is rising).

Invasive Trees

Black locust (*Robinia pseudoacacia*), Norway maple (*Acer pseudoplatanus)*, and tree of heaven *(Ailanthus altissima*) are the key invasive tree species found in Washtenaw County; Scots pine (*Pinus sylvestris)* can also become locally invasive near planted areas. These tree species can be locally abundant but are typically not as widespread a problem as invasive shrubs. Black locust can spread clonally and can become an aggressive invader on sandy post-agricultual areas, but its rot-resistant timber is considered useful for fencing materials. Landowners should be aware of how to identify and treat these species if needed.

Vine Management

Fast-growing non-native vines (oriental bittersweet, English ivy, Japanese honeysuckle, Chinese yam, black swallow-wort, pale swallow-wort, mile-a-minute weed, and kudzu) are increasing problems in Michigan, and many have established and are becoming abundant in Washtenaw County. Oriental bittersweet (*Celastrus orbiculatus*) is a particular challenge, invading some Ann Arbor natural areas in dense and impenetrable thickets. These vines can shade the tree's leaves and the competition can reduce tree growth or kill young trees. They can cause structural problems due to the added weight which can break branches or topple the tree. A few vines grow thick enough to "strangle" the tree. Some vines that start as a groundcover (such as ivy), form a dense mat of leaves on the tree's base which traps moisture against the trunk and can result in fungal and bacterial diseases. Native grape vines can cause damage, but poison ivy and Virginia creeper usually don't damage trees and they do serve as a food source for wildlife. (https://midwesternplants.org/2015/02/25/vines-growing-on-trees-good-or-bad/)

Invasive Herbaceous Plants

Depending on how open the canopy is, a landowner may encounter herbaceous invasive species such as garlic mustard, dame's rocket, narrowleaf bittercress, black jetbead, spotted knapweed, and others. Garlic mustard became a problem invasive in Washtenaw County starting in the late 1990s, while narrowleaf bittercress has taken off within the past five to seven years.

Garlic is a biennial, herbaceous plant that has the ability to dominate the forest floor, limit the growth of other species, and prevent reproduction of native species. It spends its first year as a rosette and then sends up a flowering stalk in the second year that produces a prolific number of seeds. The seed is transported by birds, rodents, deer, and humans and can remain viable for 10 years. Garlic mustard releases allelopathic compounds that harm other plants by interfering with mycorrhizal relationships (an interaction between fungi and plant roots that provides

nutrients to the plant). Control can be achieved by pulling (preferably before flowering), herbicide application (early season application can be done before other plants emerge), limiting disturbance, and maintaining a high level of canopy. Treatment has to be performed over multiple years to reduce the negative impacts of the invasive. For invasive species control, monitor the land to determine infestations early in their development, treat satellite populations first, and then work towards more densely infested weed areas to be efficient.
Garlic mustard has been recognized as a problem in Ann Arbor and throughout the County. All land managers and landowners interviewed for this report noted their efforts to remove it, and the challenge it poses for their natural areas.

Ann Arbor conservation efforts over the years have helped educate many engaged citizens to recognize and remove garlic mustard. Many local stewardship workdays feature garlic mustard pulls during the spring, and roadsides and trails in the area are often littered with garlic mustard plants that people have pulled while they are out walking. The Stewardship Network features an annual Garlic Mustard Challenge, encouraging residents in different cluster areas to compete to see who can remove the most. The Huron-Arbor cluster won the 2016 challenge with a reported total of 29,776 lbs of garlic mustard pulled and removed.
Garlic Mustard:
http://www.ipm.msu.edu/invasive_species/garlic_mustard/about_garlic_mustard

Aquatic Invasives
There are many problem plants that thrive in water, and property owners on lakes, streams, and wetlands should be aware of them as they can limit land use and cause harm to healthy systems. Major wetland and aquatic invasive species in Washtenaw County include non-native phragmites, reed canarygrass, non-native cattails, purple loosestrife, flowering rush, and Eurasian milfoil. Other species that are occasionally found or are increasing problems are European frogbit, yellow floating heart, hydrilla, curly leafed pondweed, Carolina fanwort, Brazilian elodea, and starry stonewort.

Plant growth is accelerated by excess nutrients from lawn and agricultural runoff, increased surface runoff due to increased impermeable surfaces (roads), failed septics, and other sources.

The City of Ann Arbor is under a Federal mandate to reduce phosphorus levels in the Huron River in order to lower the growth of algae which can crowd out beneficial plants and then decompose, reducing oxygen levels. To meet requirements, Ann Arbor has placed restrictions on phosphorus in fertilizers used within city limits (http://www.a2gov.org/departments/systems-planning/planning-areas/water-resources/Documents/phos_retail.pdf). It is not clear whether this might also reduce abundance of other aquatic invasive plants. Treatment of invasive species in wetlands or aquatic systems should only be done with wetland safe products and with the appropriate DEQ permits. Establishing natural vegetative shoreline buffers can also reduce issues with problem plants.

Some aquatic invasive animals are invasive carp (silver, bighead, and grass), Northern snakehead, red swamp crayfish, zebra mussel, quagga mussel, and New Zealand mudsnail. To avoid the spread of these invasive species, boats (motorized and non-motorized) should be fully cleaned, drained of any bilge or other water, and dried before leaving a launch site. Boats should be left to dry for five days before entering another body of water. Tackle should be decontaminated before changing locations and all bait should be disposed of only in a trash can. http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3710-134641--,00.html https://www.invasivespeciesinfo.gov/aquatics/main.shtml

Resources for Landowners

Washtenaw County, the City of Ann Arbor, and the University of Michigan Botanical Gardens/Nichols Arboretum spend considerable effort in controlling these invasives, particularly invasive plants. They including volunteer trainings and workdays that can help citizens learn control techniques. Their websites describe their control efforts and offer guidelines about these and other invasive species: http://www.ewashtenaw.org/living/environmental_health_and_services/healthy_home_portal/invading_pests, http://www.a2gov.org/departments/Parks-Recreation/NAP/Pages/InvasivePlants.aspx. The USDA also offers links to numerous invasive plant fact sheets for many species: https://www.invasivespeciesinfo.gov/plants/factsheets.shtml)

The Midwest Invasive Species Information Network (MISIN) is a regional effort to develop and provide an early detection and rapid response resource for invasive species. The goal of this regional resource is to assist in the detection and identification of invasive species in support of the successful management of invasive species. To report an invasive species sighting, visit www.michiganinvasives.org.

Cooperative Invasive Species Management Areas (CISMA) are a collaboration of private landowners, non-governmental organizations, natural resource management groups, governmental agencies, and others who are interested in combating invasive species. The Stewardship Network's Huron Arbor cluster has applied for but not yet received funding from Michigan's DNR, DEQ, and the Agriculture and Rural Development Department (DARD) to start a CISMA for Washtenaw County to focus on early detection and control of newer invasive species.

Washtenaw County landowners and land managers interviewed for this report all identified invasive species as a major challenge in forest stewardship, and repeatedly emphasized the challenges. Institutional managers noted that it is not sustainable to continue spending as much on continued invasives management as they have for the past decade or two. Private landowners expressed deep concerns over their inability to control invasives despite continuing efforts, and noted that management grows more difficult as they grow older.

Figuring out ways to support private landowners in managing invasives is a major need in Washtenaw County. One possible model is Iron Creek Properties in the Stewardship Network's River Raisin cluster, where a group of 10 property owners has shared resources to support purchasing equipment and hiring workers who can assist on all properties. Another model might be to have a more informal cooperative invasives management group, in which landowners could contribute volunteer time or money (or both) into a shared bank and, in exchange, receive services to assist with their invasives control efforts.

Climate Change

Most climate models and recent weather records show Michigan getting warmer (average annual temperature has increased 1.5 F in the last 100 years) and having more extreme weather events such as rainfall in excess of 2 inches (NOAA 2011). However, warmer summer temperatures and low summer rainfall may lead to an increase in drought (https://www.epa.gov/climate-impacts/climate-impacts-midwest).

Recent weather patterns in Washtenaw County have shown an increase in extreme weather events, both droughts and downpours, that can interact with pests and pathogens to further stress forests. Major drought in 2012 led to some tree mortality, while lack of rain in July 2016 led to near drought conditions, likely leading to tree seedling and sapling mortality. For example, major windstorms within Washtenaw County during July 2014 and March 2017 topped or downed thousands of trees, including large oaks, and knocked branches off many more, leaving them vulnerable to insects and disease. The National Weather Service has documented an increase in severe precipitation events: "Ann Arbor has seen a 48% increase in the number of daily precipitation events that exceed 1.25" of precipitation (above which nuisance and problematic flooding occur)" (NOAA 2011). Extreme precipitation can stress trees in low-lying areas if it leads to flooding or prolonged soil saturation in non-wetland areas; at the same time, floodplain forests and other wetlands are all the more important to handle stormwater.

According to the third U.S. National Climate Assessment, "The composition of the region's forests is expected to change as rising temperatures drive habitats for many tree species northward. The role of the region's forests as a net absorber of carbon is at risk from disruptions to forest ecosystems, in part due to climate change. Among the varied ecosystems of the region, forest systems are particularly vulnerable to multiple stresses. The habitat ranges of many iconic tree species such as paper birch, quaking aspen, balsam fir, and black spruce are projected to decline substantially across the northern Midwest as they shift northward, while species that are common farther south, including several oaks and pines, expand their ranges northward into the region." (NCA, Ch. 18: Midwest. www.globalchange.gov)

The Northern Institute of Applied Climate Science (NIACS) and Northern Michigan University have produced vulnerability reports for Michigan forests, identifying "winners" and "losers" among tree species and forest communities (www.nrs.fs.fed.us/pubs/45688). Another report on

future tree species distribution, published by the US Forest Service, predicts that oaks can benefit from climate change in Michigan, but most conifers are negatively impacted (Prasad et al. 2007, http://www.nrs.fs.fed.us/atlas/tree). However, climate and pests can interact in important ways: even if weather is favorable for oaks, the rising incidence of oak wilt could prevent them not only from taking advantage of opportunities for expansion, but leave them vulnerable to further decline if increases in precipitation and humidity favor fungal growth.

In Washtenaw County specifically, the Huron River Watershed Council (HRWC) has been active in assessing how climate change could affect the Huron watershed as well as natural resources in general. "HRWC worked with the Great Lakes Integrated Sciences and Assessments Center (GLISA) to develop localized and easy to understand fact sheets summarizing the best available climate data for the area and explaining potential impacts of climate change to key sectors" (http://www.hrwc.org/the-watershed/threats/climate-change/). The report outlined forest management strategies:

> Forest management in the region will need to adapt as the potential impacts become clearer. Planting species that will provide critical habitat for wildlife while remaining resistant to increased risks from pests is one potential option. In many cases, the facilitation of new species into the region may be more ecologically sound than the preservation of existing traditional species. (http://www.hrwc.org/wp-content/uploads/2016/11/HRWC-Natural-Resources.pdf.)

HRWC's worked with "the Great Lakes Integrated Sciences and Assessments Center (GLISA) to develop localized and easy to understand fact sheets summarizing the best available climate data for the area and explaining potential impacts of climate change to key sectors" (http://www.hrwc.org/the-watershed/threats/climate-change/), including assessments of forest resources, and looked at potential "winners and losers" among 30 key tree species in the watershed (many of them flound in floodplain forests). Similar to regional assessments, HRWC found that many oaks could benefit from climate change, but that conditions would not be favorable for red oak, along with sugar maple, American beech, American hornbeam, and tamarack. HRWC's website offers detailed reviews of these 30 species, to educate residents on where trees occur and how they could be affected, and also features a "tree toolkit" aimed at increasing resiliency (http://www.hrwc.org/wp-content/uploads/2015/12/Impacts-of-Climate-Change-on-Tree-Species-in-Southeast-Michigan_One-pager.pdf, http://www.hrwc.org/wp-content/uploads/2013/03/Natural%20Infastructure.pdf, http://www.hrwc.org/the-watershed/threats/climate-change/tree-resource-resiliency-toolkit/).

While climate change will have major impacts on forests and tree species, trees can also ameliorate climate—they take up and store carbon (carbon sequestration or carbon sinks). On a landscape level, it is important to consider maintaining and preserving forests to prevent the carbon releases that occur when forests are converted to other land uses. On a smaller scale,

particularly in urban areas, trees can act to ameliorate climate by providing shade, moderating temperatures, reducing water use (for lawns), and lowering energy use for air conditioning.

The City of Ann Arbor recently assessed the value of its urban forests in sequestering carbon (and absorbing other pollutants) as well as reducing energy costs and carbon emissions. The value of these ecosystem services is in the millions of dollars per year:

Urban forests have a structural value based on the trees themselves (e.g., the cost of having to replace a tree with a similar tree); they also have functional values (either positive or negative) based on the functions the trees perform.

The structural value of an urban forest tends to increase with a rise in the number and size of healthy trees…. Annual functional values also tend to increase with increased number and size of healthy trees, and are usually on the order of several million dollars per year. Through proper management, urban forest values can be increased; however, the values and benefits also can decrease as the amount of healthy tree cover declines.

Structural values:

- Structural value: $993 million
- Carbon storage: $18.3 million

Annual functional values:

- Carbon sequestration: $670 thousand
- Pollution removal: $3.85 million
- Lower energy costs and carbon emission reductions: $481 thousand

Note: negative value indicates increased energy cost and carbon emission value (http://www.a2gov.org/departments/forestry/Documents/AnnArbor_iTreeEcoReport.pdf)

In summary, although climate change presents challenges for forest stewardship and management, it increases the importance of maintaining healthy forests in urban as well as natural areas.

3.1.10 Tourism and Recreation

Excerpted, with modifications, from 2015-2019 Washtenaw County Parks & Recreation Commission Master Plan.

State of Michigan

The State of Michigan is the largest provider of recreational land in Washtenaw County. The Michigan Department of Natural Resources (MDNR) operates 20 state parks in Southeast Michigan, seven located wholly or partially within Washtenaw County. These include State Recreation areas Waterloo, Pinckney, and Walter J. Hayes, and four State Game Management areas: Chelsea, Sharon, Little Goose Lake, and Gregory. In total, the state has more than 15,000 acres under its management in Washtenaw County. Most of the acreage is undeveloped—much

of it forested or a combination of forests, wetlands, and grasslands (including old fields, wet meadows, and fens) and provides wildlife habitat and nature study. Approximately 1,200 acres are developed for intensive recreation.

Regional Parks: Huron-Clinton Metropolitan Authority
Regional park facilities within the County are provided by the Huron-Clinton Metropolitan Authority (HCMA or "Metroparks"), which operates approximately 24,000 acres of land in its five-county district. Within Washtenaw, HCMA manages more than 1,600 acres in one large and two small Metroparks on the Huron River: Hudson Mills, Dexter-Huron, and Delhi. HCMA sponsors numerous nature, farm, and historical programs and special events, including golf and boat shows, fireworks, festivals, music concerts, and children's programs.

County Recreation
Washtenaw County Parks operates 13 County Parks, which feature many outdoor recreational opportunities (golf courses, sports fields, splash parks, etc.). At least 4 of the parks (totaling 1,124 acres) include significant acreages of natural areas; in particular, Park Lyndon has an outstanding fen complex within a matrix of mature oak-hickory forest and post-agricultural young forest. In addition, as of spring 2014, the County manages 24 Nature Preserves (3,334 acres) purchased under the county's Natural Area Ordinance and millage, started in 2000 and renewed in 2010, focused on protecting natural areas within Washtenaw County. The Natural Areas Technical Advisory Committee recommends land for protection with the aim of increasing the size and contiguity of habitat patches within the landscape, as well as connecting patches by protecting riparian areas or and other corridors of natural land. Many of the Nature Preserves are dominated by forests, or feature a mix of woodlands, wetlands, and grasslands.

The Washtenaw County Greenways Initiative is an effort by the Washtenaw County Parks and Recreation Commission to expand hiking and biking trails along the Huron River. The Border-to-Border Trail (B2B) is a major focus, with communities and organizations collaborating to construct over 24 miles of paved, shared-use paths to date (Figure 3.18). In addition, the Huron Waterloo Pathways Initiative seeks to connect to the Lakelands Trail to form 70-mile trail connecting to communities west of Washtenaw (http://huron-waterloo-pathways.org).

Figure 3.18. The Huron River Greenway, with existing and planned Border-to-Border trail.

Local Recreation

Local communities have the primary responsibility for meeting public recreational needs of residents in their individual communities. Cities, villages, and the more urbanized townships provide approximately 5,000 acres of municipal parkland for their residents. Park areas are developed for intensive uses such facilities as athletic fields and picnic grounds. Community park facilities are sometimes located on school district property.

The City of Ann Arbor, with more than 2,100 acres of parkland, is the major local recreation provider within the County. Ann Arbor maintains two municipal golf courses and has designated several areas for nature study. Increasingly, the City of Ypsilanti, and Ypsilanti and Pittsfield townships have provided more recreation services. The outlying municipalities of Milan, Manchester, Chelsea, Dexter, and Saline are also managing growing park acreage. Other townships that are active in recreation are Augusta, Northfield, Superior, and York. In addition, Ann Arbor, which is nicknamed Tree Town, has earned the Arbor Day Foundation's Tree City USA designation for its urban forestry management program, maintaining a tree board or department, having a community tree ordinance, spending at least $2 per capita on urban forestry, and celebrating Arbor Day.

Institutional Recreation

Significant acreages of open space, recreational lands, and facilities in the County are owned by publicly funded educational institutions: 11 public school systems, two state universities, and a community college. This category includes public school athletic areas, school nature preserves, university sports fields, golf courses, and field research properties.

Local public school districts control about 2,100 acres developed primarily for playgrounds and playfields; some districts have also made provision for nature study areas. School district

Community Education Programs are major providers of recreation services, and have allowed the use of the facilities by outside groups. In rural areas, local schools are more likely to be the primary providers of recreation services.

The universities and colleges located in Washtenaw County provide recreation facilities totaling some 2,800 acres for the use and instruction of students. The University of Michigan, for example, manages a botanical garden and arboretums and provides two golf courses, primarily for the use of their students and staff. The major portion of their landholdings is reserved for scientific study and research, but many (including Saginaw Forest, Stinchfield Woods, and Horner Woods) are open to the public for passive recreation.

Private Recreation
Private lands devoted to recreation in Washtenaw County account for approximately 4,000 acres. Located primarily in outlying areas, country clubs, sports clubs and camps are available to members of particular organizations, with membership fees a usual requirement.

Conservation Lands
Conservancy lands, both public and privately owned, primarily provide protection of natural, cultural, or historic features and account for approximately 11,000 acres. Some of this land is open to the general public for passive recreation use, such as nature study and hiking.

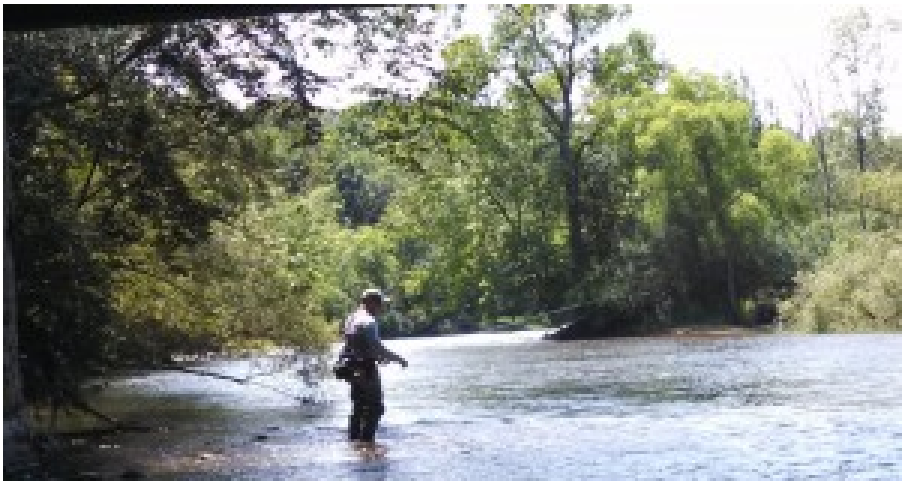
River Recreation
The Huron River is the only state-designated Country-Scenic Natural River in southeast Michigan (26.5 miles of the main stream and 10.5 miles of tributary creeks, partly in Washtenaw County and partly upstream in Livingston and Oakland Counties). The Country-Scenic character comes in part from the woodland vegetation lining many stretches of the river. In addition, nearly 104 miles of the 126-mile length of the main stream of the river, including all reaches in Washtenaw County, are designated as the Huron River Water Trail, part of the National Water Trails System administered by the National Park Service (https://www.nps.gov/WaterTrails/Trail/Info/53), and floated or paddled by over 100,000 recreationists per year. Several major canoe liveries operated by parks and private franchises offer canoe, kayak, and stand-up paddleboard rentals; many of these liveries are fully booked for weekends May through September or October. The River Raisin, though lacking the Scenic River designation, is also popular among paddlers, floaters, and anglers. Private liveries offer rentals and transportation.

Economic benefits of outdoor and forest-based recreation
Data on the economic benefits of outdoor and forest-based recreation and tourism are difficult to obtain. Recreation and tourism statistics for Washtenaw County do not categorize spending that is associated with outdoor activities in general, or forests in particular. On the other hand, analysis that look at the economics of particular outdoor recreation activities or sections, such as fishing, hunting, or wildlife viewing, generally focus on state-wide rather than county-level trends.

Although dollar values are hard to assess, there is no doubt that Washtenaw County's partly forested landscape forms the backdrop for its reputation as a desirable place to live due to natural beauty and plentiful outdoor recreation opportunities intertwined with its educational and cultural offerings.

3.1.11 Fish and Wildlife Habitat

The MDNR lists 75 lakes and river reaches as fishing areas within Washtenaw County (http://www.michigan.gov/dnr/0,4570,7-153-10364_52261_52964_66796-67618--,00.html), including warmwater fisheries along the Huron Rivers. As noted above (3.1.7, biological diversity), 81 fish species have been documented within Washtenaw County portions of Huron and Raisin watersheds, as well as the Grand and Stony Creek watersheds (complete list in Appendix D). The Huron River has naturally occurring or stocked populations of sport fishes including small and large-mouth bass, rock bass, perch, steelhead, walleye, and pike, with notable fly fishing for bass. The River Raisin is a favored spawning ground of smallmouth bass, and also has bullhead, carp, catfish, crappie, largemouth bass, northern pike, sucker, sunfish, and yellow perch, but MDNR listings do not indicate which of these fish also occur in Washtenaw County (http://www.michigan.gov/dnr/0,4570,7-153-10364_53405-303082--,00.html).



Fly fishing on the Huron River. Photo: Ric Lawson, Huron River Watershed Council (http://www.hrwc.org/category/fishing/)

Forests and riparian woodlands benefit fish habitat in various ways, including stabilizing soil and reducing sedimentation in waterways; providing shade; and moderating temperature. An analysis started for this report in partnership with the Huron River Watershed Council will assess how forest cover in buffer zones along rivers and streams correlates with aquatic biodiversity and will be available in summer 2017.

Although the Huron River is significantly less polluted now than it was in the 1960s and 1970s, fish still contain some chemical contaminants, including mercury (often coming from power plant emissions), PCBs (from industrial processes), and DDT (a pesticide that was banned in the

1970s but has lingering environmental accumulations). Consumption of certain species, fished from certain areas, should be limited to one or a few fish per month to limit toxic exposures. Anyone fishing in Washtenaw County should consult the Michigan Department Health and Human Services' *Eat Safe Fish Guide* (https://www.michigan.gov/documents/mdch/MDCH_EAT_SAFE_FISH_GUIDE_-_SOUTHEAST_MI_WEB_455358_7.pdf).

Washtenaw County has public land open to hunting in four state game areas owned and operated by MDNR: Chelsea; Sharonville; and Goose Lake (Figure 3.19); the Gregory State Game Area is just a few miles from Washtenaw in Livingston County. In addition, State Wildlife Areas open to hunting are found within the Pinckney and Waterloo State Recreation Areas and in Unadilla. Additional private lands, including Commercial Forests and private land enrolled in the Hunter Access Program, are available for hunting in some parts of the state, but Washtenaw County does not have any lands enrolled in these programs. Hunting on private lands, and retrieving dead or injured game, requires express permission of landowners.

Notable game species within Washtenaw County include white-tailed deer, wild turkey, ruffed grouse, woodcock, and cottontail rabbit (Table 3.4).

Table 3.4. Game species managed in State Game and Wildlife Areas, Washtenaw County.

State Management Area	American Woodcock	Cottontail Rabbit	Eastern Wild Turkey	Mallard	Ring-necked Pheasant	Ruffed Grouse	White-tailed Deer	Wood Duck
Chelsea		X		X				X
Goose Lake		X	X	X			X	X
Sharonville	X	X	X		X	X		
Unadilla			X		X		X	

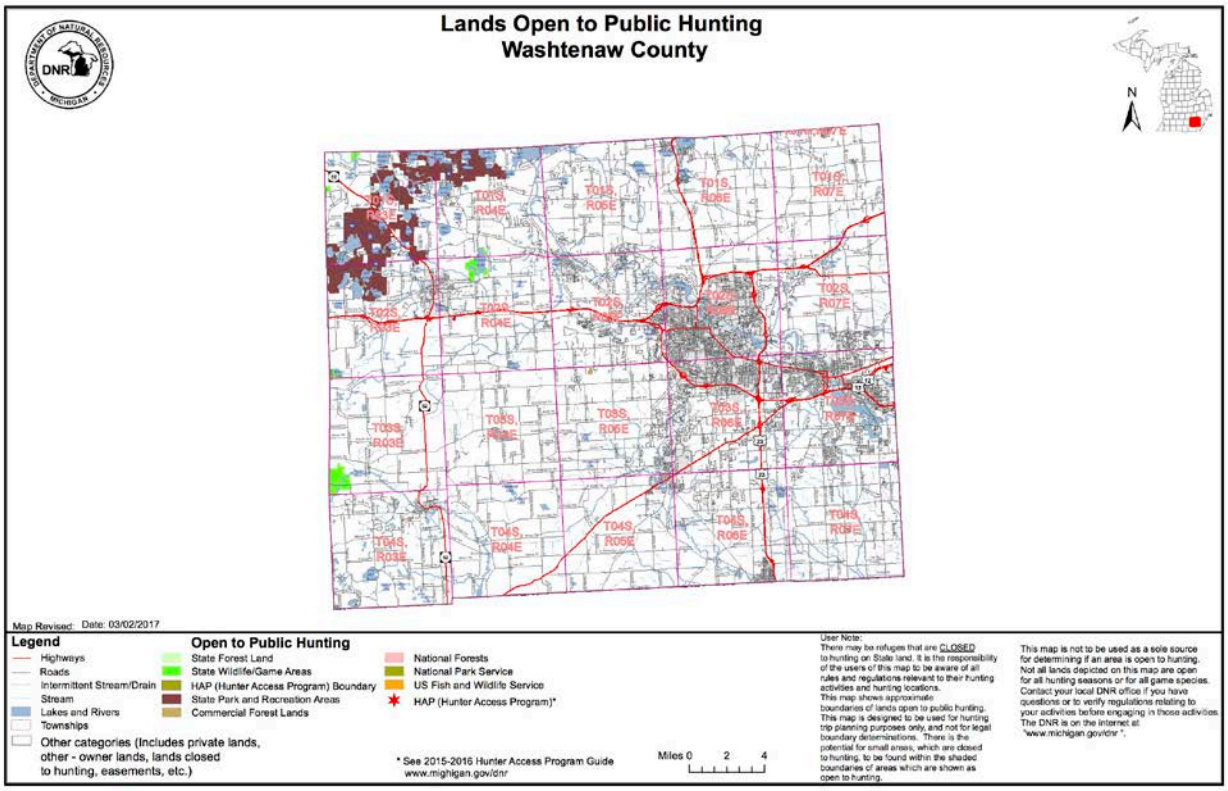


Figure 3.19. Public Hunting Land in Washtenaw County.

The Michigan DNR, in partnership with the Michigan United Conservation Clubs (MUCC) offers guidance for private landowners interested in managing land for wildlife habitat (Sargent and Carter 1999, *Managing Michigan Wildlife: A Landowners Guide*), available online for a free download. The handbook contains information about managing different forest types as well as for particular species groups, and addresses how to make backyards wildlife friendly. http://www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/landowners_guide/Resource_Dir/Acrobat/index.htm

One section of the handbook that is key for Washtenaw County focuses on managing edges and fragments. As noted above, edges have increased with land development, leading to vulnerability or decline of species that rely on undisturbed interior forest. However, the handbook notes that numerous species rely on edges, using different types of habitat (such as forests and grasslands or wetlands) for cover, nesting, or feeding. Absence of forest interiors make habitats unfavorable for some species, but edges can be managed in ways to improve their habitat value for many others. For example, planting native shrubs and small fruit trees along forest-field borders can provide food and cover; and expanding fencerows to allow wider corridors of trees and shrubs can allow migration corridors. (http://www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/landowners_guide/Habitat_Mgmt/Planning/Edges_and_Fragments.htm)

A challenge in Washtenaw County is that many edges are already dense thickets of invasive species (see section 3.1.9), which may partially serve food and cover needs, but may not always

provide fruits that are as nutritious and attractive to diverse native species, or may not provide the most suitable branch architecture for nesting. Balancing management for native plants and wildlife can be complicated: is it better fostering native plant species by combating invasives, or to allow some invasives where they may offer characteristics that modify edges in partly favorable ways?

Habitat management efforts take place in the context of climate change. A 2013 MDNR report notes that 17% of terrestrial game species in Michigan "are vulnerable… and will likely experience range or population reductions due to climate change" (Hoving et al., 2013). Many potentially affected species are in northern Michigan or the Upper Peninsula, but the ruffed grouse (*Bonasa umbellus*) is one in Washtenaw County that could be at risk.

Some game species prefer grassland or early succession forest, so game habitat management includes sometimes contradictory forest management activities, aimed at maintaining large mast trees while also creating openings with young trees in ways that may differ for a given species and across species. This emphasizes the need for landscape management to maintain a mosaic of habitat types. The following forest management activities are included in MDNR habitat management recommendations for game species within Washtenaw County:

<u>American Woodcock</u>
- Maintaining young forests by continually harvesting timber.
- Maintaining forests with diverse age classes through rotational harvesting of timber.
- Maintaining small openings adjacent to young forest stands through mowing or prescribed burning.

<u>Cottontail Rabbit</u>
- Providing steady supply of young forests through short rotation of timber harvests.

<u>Eastern Wild Turkey</u>
- Providing roosting sites: retaining mature trees when harvesting timber.
- Establishing brush through timber harvesting practices.
- Maintaining forest openings: planting, applying herbicides, mowing, disking, fertilizing, haying, and prescribed burning.
- Maintaining hard mast (beech, oak) and soft mast (cherry, crabapples): allowing forests to mature, retaining mast-producing trees when harvesting timber.

<u>Ruffed Grouse</u>
- Preserving brush, slash, and drumming logs during timber harvests.
- Maintaining forested stands, especially aspen, with diverse age classes by clear cutting adjacent stands on a 10 to 20 year rotation.
- Seeding log landings and access trails with clover.
- Maintaining a young, deciduous component in lowland and riparian stands.

White-tailed Deer

- Maintaining and facilitating hunting opportunities on state land by planting food plots including fruit-bearing trees.
- Maintaining trees that produce hard mast (beech, oak): maintaining an oak component, promoting the regeneration of oak, and retaining a representation of mature acorn producing trees during harvests.
- Maintaining abundant browse by managing for young forests: performing clear cuts and rotational harvests of timber.
- Maintaining and expanding thermal cover in high snow areas by selecting for conifers, particularly the white cedar, and hemlock component.

(From State Game management or habitat plans, http://www.michigan.gov/dnr/0,4570,7-153-10370-31657--,00.html)

In addition to game, fur-bearing animals that can be hunted or trapped include raccoon, skunk, red and gray fox. Trapping on public land is carefully regulated—consult MDNR guidelines. (http://www.michigan.gov/documents/dnr/hunting_and_trapping_digest_461177_7.pdf).

White-tailed deer

White-tailed deer merit particular mention due to their pervasive influence on Washtenaw County's forested landscapes. Deer have been recognized as the Michigan State Game Animal, and are valuable for hunters and the many local businesses that supply them. They are also a key component of the state's cultural heritage and are highly valued by many wildlife watchers.

MDNR's deer management plan describes their complications in the Southern Lower Michigan (SLP): after being overhunted and disappearing from the area in the late 1800s, populations recovered over time when hunting regulations went into effect, then started a dramatic increase with the increase in southern Michigan's farm country in the 1980s and 1990s. While deer populations in Northern Lower Michigan and the Upper Peninsula are controlled by difficult winters with heavy snow cover, predators (including wolves and bobcats), and hunting (with more public land available for hunting), deer populations in SLP have continued to increase:

> In the SLP, deer populations are highly productive, with many factors working together to produce a challenging management scenario. The abundance of food in the form of available agricultural crops combined with the more than adequate cover of scattered woodlots and idle fields provide near perfect white-tailed deer habitat. In addition, relatively mild winter conditions, the near elimination of natural predators, and limited hunting access on private land (including numerous parcels where no deer hunting occurs at all) contribute to the growth of these populations. The SLP has recently experienced sporadic outbreaks of Epizootic Hemorrhagic Disease (EHD) at varying intensities that has impacted deer populations in certain areas for several years. With the discovery of chronic wasting disease (CWD) in the SLP in 2015, these factors present tremendous challenges to managing this disease.

DNR *Draft Deer Management Plan, 2016*
(https://www.michigan.gov/documents/dnr/deer_management_plan_525849_7.pdf)

The plan notes that when deer populations are out of balance with their habitat, deer can harm plants and other wildlife species:

> By foraging selectively, deer affect the growth and survival of many herbaceous, shrub and tree species, modifying patterns of relative abundance, species interactions, and potentially altering successional pathways (Stromayer and Warren 1997, Cote et al 2004). When populations are not in balance with habitat, deer have the ability to alter their environment by over-browsing preferred plants and destroying the vegetative cover upon which they and other species depend. Over-browsing can result in reduced availability of adequate ground-level vegetation (herbaceous plants, seedlings, saplings, and shrubs) that provides the food and cover required by deer (Alverson et al. 1988, Cote et al 2004). In addition to impacts on deer habitat, over-browsing by deer can degrade the quality of habitats for other wildlife species and alter entire ecosystems. Numerous wildlife species use ground level and mid-story vegetation of forests in Michigan for nesting and escape cover that may be negatively impacted by intense deer browsing (deCalesta 1997, Cote et al. 2004). Once these deleterious effects have been observed, hunting has proven to allow the recovery of degraded plant communities (Jenkins et al 2014). In addition, deer compete directly with wild turkeys, ruffed grouse, squirrels, and a variety of other birds and small mammals for acorns, fruits, and other mast.
>
> Deer browsing can impact the quality and viability of entire natural communities. Damage to natural communities extends to a variety of other species including insects, birds, reptiles, amphibians, and other mammals that are dependent on those communities. Impacts on rare plants, animals, and communities are of special concern as years of over-browsing can threaten viability of local populations. In addition, over-browsing of native vegetation facilitates invasion of aggressive, non-native plant species like garlic mustard (*Alliaria petiolata*). Many of these invasive plants degrade habitat for deer and other species by crowding out preferred deer forage and changing ground flora to species that provide little or no benefit to most wildlife species. Management activities designed to benefit deer must ensure that other resources are not negatively impacted. It is important that deer impacts are kept below levels where they may cause long-term damage to the ecosystems in which they live.
> DNR *Draft Deer Management Plan, 2016*
> (https://www.michigan.gov/documents/dnr/deer_management_plan_525849_7.pdf)

Deer impacts on forest vegetation have been documented in many studies throughout Northeastern U.S. in recent years, with numerous studies finding serious declines in forest regeneration and herbaceous plants (major studies include Frerker et al. 2014, Pendergast et al. 2016, Rawinski 2014, Rawinski 2009, Rooney and Waller 2003). MDNR's management plan reflects this concern. In outlining deer management goals for the state, two of the six priorities are aimed at keeping deer populations in balance with habitat, including vegetation and other wildlife species:

> 1) manage deer populations at levels that do not degrade the vegetation upon which deer and other wildlife depend; 2) promote deer hunting to provide quality recreational opportunities, as the primary tool to achieve population goals, and as an important social and cultural activity; 3) manage habitat to provide for the long-term viability of white-tailed deer in Michigan while limiting negative impacts to the habitats of other wildlife species; 4) reduce conflict between humans and deer; 5) reduce the threats and impacts of disease on the wild deer population and on Michigan's economy; and 6) enhance public engagement in and awareness of deer management issues and knowledge of deer ecology and management.
> DNR *Draft Deer Management Plan, 2016*
> (https://www.michigan.gov/documents/dnr/deer_management_plan_525849_7.pdf)

Washtenaw County makes up MDNR Deer Management Unit (DMU) 081. A 2014 report for the DMU outlined the status of deer management in the area:

> Although much of the private lands toward the south central parts of the DMU are in agriculture, private and public lands in the area support cover habitat for deer (e.g., woodlots, shrub/brush, and wetland). Deer throughout the Washtenaw DMU have ample access to food, water, and cover … and can meet all life requisites in every portion of the DMU. However, ***in many cases, they may be meeting these requirements in areas closed to hunting…. Increasing development across the DMU often can help increase survival of deer using non-huntable lands as refuge, but it may come at a price of natural vegetation resources.*** Also, high commodity prices have led to less acreage enrolled in the Conservation Reserve Program, expansion of row crop agriculture, and decline in deer cover. Although agriculture can provide highly nutritional food resources to deer, it is seasonally available and comes at a cost of naturally occurring food sources and cover. The conversion of acreage from acceptable deer cover to agriculture and removal of brushy field rows further fragments habitat, homogenizing the landscape and reducing the richness of a "patchwork" of habitat types in which deer thrive. [Despite slight declines over the past decade] ***[T]he estimated deer population remains over goal.*** [italics added]
> (Bissell 2014, http://www.michigandnr.com/Publications/pdfs/wildlife/dmu_info/DMU_081.pdf).

Interviews with natural area managers in Washtenaw County found that most are concerned about the negative impacts of deer on forests. Nearly every landowner interviewed for this report noted that deer posed a challenge for their forest stewardship efforts. Landowners near Ann Arbor were particularly dismayed that deer were destroying their efforts to foster native plants—trees and shrubs as well as prairie plantings.

At the same time, recent efforts to manage deer in the Metroparks and in Ann Arbor have shown that deer management can be controversial. As noted in the MDNR deer management plan, "While white-tailed deer are highly valued by Michigan residents, conflicts between deer and humans occur at various levels of intensity across the State." Significant portion of the public enjoy deer viewing and disapproves of efforts to limit populations through lethal means.

Among the specific actions recommended in the MDNR management report is to "develop a current urban/suburban deer policy and develop an urban/suburban deer management plan that provides specific, consistent guidelines and recommendations for communities

dealing with urban/suburban deer issues." Washtenaw County, with its urban and suburban landscape, will benefit from clear guidance from MDNR.

3.1.12 Threatened and Endangered Species

Washtenaw County is home to 163 rare plant and animal species—those that are listed by the State of Michigan as endangered or threatened, or of special concern (being tracked due to low populations; further declines could make the species eligible for consideration as threatened). A complete list appears in the Appendix D. Seven species are also listed Federally under the Endangered Species Act, administered by the U.S. Fish and Wildlife Service, as threatened or endangered: Indiana and long-eared bats, both of which rely on wooded areas for habitat; the Eastern massasauga rattlesnake; the snuffbox mussel; the Mitchell's satyr butterfly and the Poweshiek skipperling; and the Eastern prairie fringed orchid (https://www.fws.gov/midwest/endangered/lists/michigan-cty.html). Federal listing of endangered species requires a longer and more detailed process, assessing the full species range across all states, so it covers fewer species.

The Michigan Natural Features Inventory maintains information on these species and their habitat needs and distributions (https://mnfi.anr.msu.edu), along with a Rare Species Explorer that allows searches for these species by county and by various habitat attributes, such as the community types in which they are found. A review of MNFI habitat notes shows that 63% (103) of species of concern in Washtenaw County are associated with or benefit from forest communities, while over 36% of these (60 species) depend on forests as their primary habitat (Table 3.4).

Wetland forest communities, and in particular, floodplain forests, are important for many rare species. A total of 64 species are found in wetland forest communities including hardwood and tamarack swamps. Of those, 42 species—25% of all special concern species in the County—are found in floodplain forests, and this total does not include any of the aquatic species (fish and mussels) that benefit directly from overhanging tree branches or downed trees for habitat, or that are more likely to be found in high-quality streams within forested riparian zones. Floodplain forests were identified as a "fragile land" in a 1990s Washtenaw planning report. Given their habitat value for so many rare species, they should be a high priority for conservation and restoration efforts.

Upland forest communities (oak-hickory and maple-beech forests, including dry, dry-mesic, and mesic southern forests, and wet-mesic flatwoods) provide habitat for 55 special concern species. Savanna or open woodland communities (which are among the most threatened community types in the state as most have either been converted to agriculture or succeeded to closed-canopy forests in the absence of fire) are home to 37 special concern species. (Note that species may occur in several types of forest communities, or a combination of forest, wetland, or grassland communities, so habitats are not mutually exclusive.)

Table 3.4. State Endangered, Threatened, and Special Concern Species Occurring in Washtenaw County, and their use of Forest Habitats.

Species of Concern	# Species	Partly relies on woodlands, trees	Forest is primary habitat
Animals	81	47	27
bird	16	7	5
butterfly/moth	11	6	4
fish	11	5	2
insect	7	4	
mammal	4	3	2
mussel/clam	14	6	1
reptile/amphibian	8	8	6
snail (aquatic)	2	2	1
snail (terrestrial)	8	6	6
Plants	82	56	33
herbaceous	75	49	27
woody plant	7	7	6
Grand Total	**163**	**103 (63.2%)**	**60 (36.8%)**

Major threats to Washtenaw County's rare species are habitat loss to agriculture and development and edge effects from forest fragmentation. Climate change poses an increasing threat as well. MDNR assessed climate variability of rare wildlife species statewide and found that 61% of them are vulnerable to climate change (Hoving et al. 2013). Climate change may adversely affect species and ecosystems depending on how sensitive they are to climate, how capable they are of adapting, and how exposed they are to changes (given their particular niche). While the study assessed vulnerability at the state rather than county level, many of the rare species found in Washtenaw are among those identified as moderately, highly, or extremely vulnerable, including most amphibians of special conservation concern, many reptiles, most mussels and terrestrial snails, several fish, butterflies including the Dusted Skipper, Swamp Metalmark, and Wild Indigo Duskywing, and the Emerald Hines Dragonfly.

3.1.13 Archaeological, Cultural and Historic Sites

Archaeological Sites

Washtenaw County has a long history of use by Native American communities, shown by the relatively high density of known archaeological sites in the state: a total of 4,260 sites— an average of 5.9 sites per square mile—have been reported to the State Historic and Preservation Office (for more information about the office and its programs, see Appendix C). Among the

landscapes covered by this project, only TSN's Lake Erie Cluster (Monroe County), has more sites or a higher site density. Figure 3.17 (in section 3.1.8, above) shows general locations of archaeological sites in the county.

The density of archaeological sites might be partly due to the presence in Washtenaw County of a university with an archaeology department, so there may be more knowledgeable observers roaming the landscape who are more likely to observe, record, and report archaeological findings. (The same is often true with plant and animal species inventories—counties near universities and colleges with botany and zoology departments tend to have more species records, Reznicek, pers.comm.) However, the high density is likely also linked to the mix of natural resources in the area that offered Native Americans rivers and lakes for fishing and transportation, woodlands and savannas for hunting and foraging, and fertile riverside land for farming (O'Shea 2000).

A map compiled in the 1920s shows the location of Native American sites in Washtenaw County, including trails, mounds, villages, and burial grounds (Figure 3.20). While it is difficult to ascertain how many archaeological sites are (or were) in wooded areas, many trails and sites are along waterways, which suggests that present-day floodplain forests, as well as lakeside woodlands in the northwestern part of the County, might still contain artifacts.

Landowners who believe they have found Native American artifacts in their forests should contact the State Archaeologist's office at the State Historic Preservation Office, and record and report the artifacts (reporting form available at http://www.michigan.gov/mshda/0,4641,7-141-54317_19320_54320---,00.html, with explanations at http://www.miarch.org/site-recording.html). The State Archaeologist can also offer advice about consulting archaeologists who can help assess the site. Any site that appears to be a burial ground must not be disturbed. According to SHPO guidance, "It is illegal to intentionally disturb human remains and associated artifacts. If you accidentally discover human remains, immediately stop any activities in the area and contact the police and the State Archaeologist. Respect the dignity of burial sites by protecting and reporting them. Do not disturb them."
(http://www.michigan.gov/documents/mshda/mshda_shpo_20140211_archaeology_brochure_447191_7.pdf)

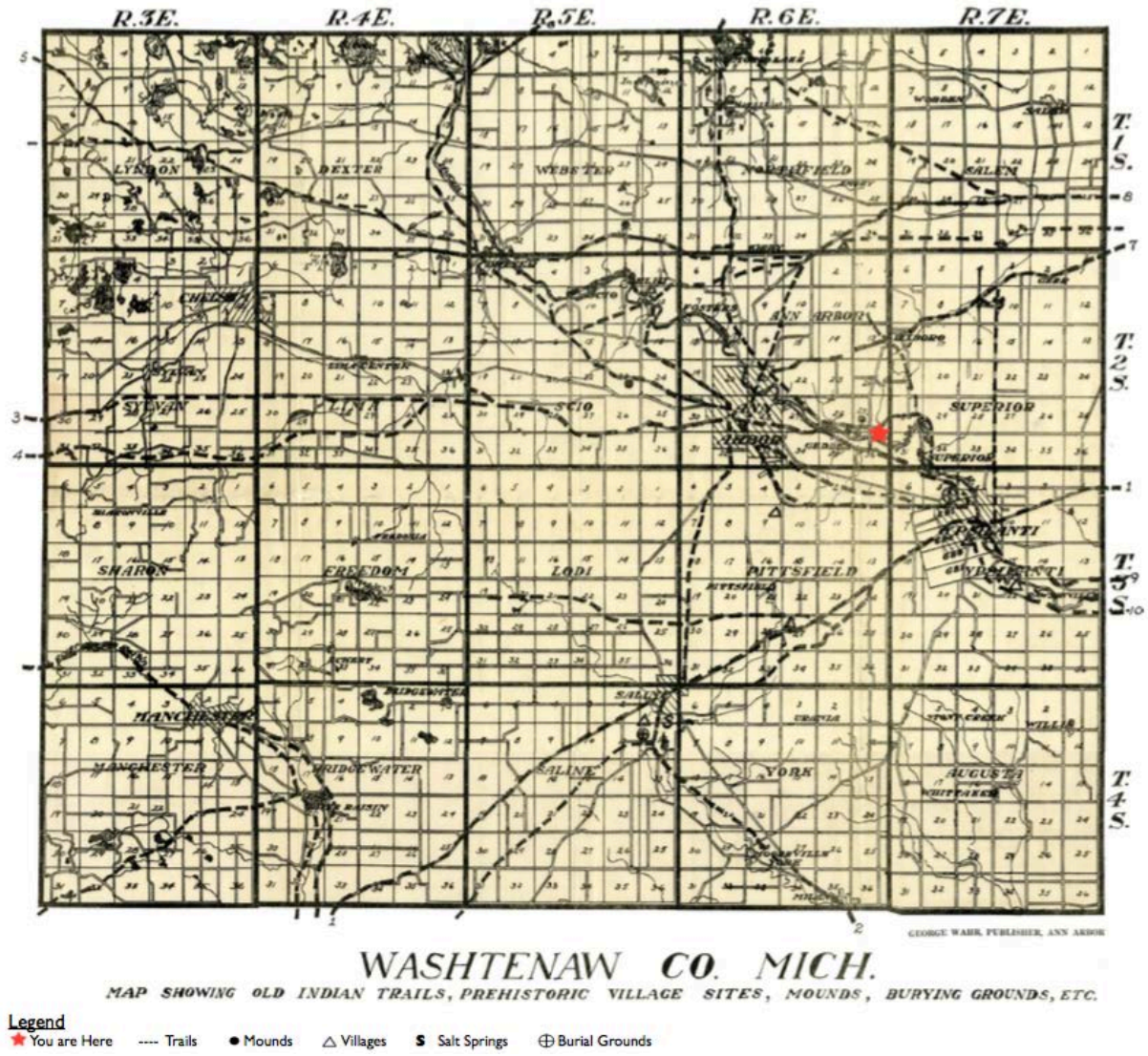


Figure 3.20. The Hinsdale map of Native American sites in Washtenaw County. During the 1920s, former University of Michigan professor W.B. Hinsdale compiled a comprehensive survey of Native American trails and sites in Michigan. His research and map suggests the broad reach and vibrancy of Native American communities in Washtenaw and throughout Michigan before European settlement. The red star shows the location of a historical marker in Parker Mill County Park that displays this map. Map Source: *The Indians of Washtenaw County*, W.B. Hinsdale, 1927.

Cultural and Historic Sites
Washtenaw County has 78 historic sites listed on the National Register of Historic places, according to National Park Service listings (https://www.nps.gov/nr/index.htm), and 95 sites that are designated as Michigan State Historic Sites by the Michigan State Historic Preservation Office (http://www.michigan.gov/mshda/0,1607,7-141-54317---,00.html). There is some overlap between the National and State designations—26 places appear on both lists—but many appear on the State but not National list, or vice versa. Most historic sites are in cities, but a few are in rural areas with woodland characteristics.

While historic sites include several old mill sites along waterways adjacent to floodplain forests, they are not generally found in woodlands. However, one University of Michigan professor is exploring whether a forest stand could be designated as a historic place. The earliest white pine plantations in the university's Saginaw Forest, dating to 1905, are the oldest forest plantations in southeastern Michigan, and among the oldest in the state. It remains to be seen whether the university will pursue the historic designation process, and whether other woodlands merit recognition as historic sites.

Most of Washtenaw County's major cultural sites are associated with its universities and academic heritage. However, its pastoral and woodland landscapes are celebrated through its Natural Beauty Road designations (see Stewardship Story); many of these roads are old farm roads where forests and fields are mingled, and historic farmhouses are nestled within spreading branches of large old oaks and maples in yards and along fencerows.

3.1.14 Fire Management
Many plant communities (prairies, oak savannas, fens, oak-hickory forests, etc.) in southeastern Michigan are fire dependent. Many plants coevolved with fire but some (such as maples and beech) are sensitive to burning. Fire was used by Native American tribes for many purposes, including to reduce the number of woody plants in cultivated lands and around settlements.

Michigan Natural Features Inventory (Cohen et al. 2016) has noted that prescribed fire is the single most significant factor in preserving fire-dependent communities such as oak barrens, oak openings, dry sand prairie, and prairie fen. Many current dry-mesic southern forests are degraded oak openings that have been long deprived of fire. The use of prescribed fire is a management tool for promoting oak regeneration, deterring the succession of shade-tolerant species, and reducing the encroachment by invasive shrubs such as honeysuckles and autumn olive. Open canopy conditions can be restored by mechanical thinning or girdling. Restored sites will need to be maintained by periodic prescribed fire, control of woody invasive species, and may require native plant seeding. Periodic fire causes the tree canopy of an oak savanna to remain open, with wide spaces between the branches. The two principal fuels of an oak savanna fire are grasses and oak leaves. Oaks produce leaves that contain flammable chemicals and the leaves curl, so that fire moves more easily through the area. http://oaksavannas.org/index.html

All major conservation/land management agencies in Washtenaw County use prescribed fire to manage natural areas of all types (forests, grasslands, and wetlands). MDNR has used prescribed fire to open up and restore oak barrens—a high-priority natural community in Washtenaw County, at the state level, and in (S1) due to its rarity—in the Hankerd Prairie and Oak Barrens complex near Pickerel Lake, cited by MNFI as a good example of the community type. Natural area managers at the Metroparks, County Parks (NAPP), and Ann Arbor City Parks (NAP), as well as at the University of Michigan Matthaei Botanical Gardens/Nichols Arboretum (MBGNA) use prescribed burns to manage their properties. Both NAP and MBGNA offer training programs for volunteers interested in assisting with prescribed burns; these programs provide an invaluable resource for landowners seeking education and experience before attempting their own burns. The area also has several ecological restoration companies that offer or focus on prescribed fire.
(http://www.a2gov.org/departments/Parks-Recreation/NAP/volunteering/Pages/PrescribedBurnCrew.aspx, http://www.lsa.umich.edu/mbg/about/PrescribedBurns.asp)

Landowners who want to manage fire-dependent communities may need to burn or to introduce that disturbance with other practices such as mowing or chemical control of non-target species. One of the problems that most landowners experience is the growth of invasive plants such as autumn olive, bush honeysuckle, and other woody shrubs. Fire can top kill these shrubs, but they will resprout from the stumps. Because of the low amount of fuel, areas invaded with bush honeysuckle don't carry fire well. Many land managers use fire as a complement to mechanical (pulling or cutting) or chemical methods to control the invasives.

Fire involves risk because of changing winds, unpredictable fuel conditions, human error, etc. Particularly during drought conditions, appropriate care must be taken to keep prescribed fires under control. Property owners should also check their insurance coverage before starting a blaze. Unless the landowner has experience with fire management, it is prudent to hire contractors to conduct burns (See list in 3.2.3). Under DEQ air quality rules, the burning of logs, stumps, trees, and brush is not allowed within 1,400 feet of a city or village. Local regulations vary, often regulating the times fires can be set and the distances to buildings and property lines, so check ordinances and consult your local fire department before lighting your fire.

Burns for land clearing and related activities require a burn permit issued by the local MDNR Fire Manager. The MDNR encourages residents with Internet access to get their burn permits online (www.michigan.gov/burnpermit). Residents can use the interactive map to find the burn conditions in their area. If a "yes" is shown in the "burning permits issued" column, burning is allowed for that day. There is no need to print anything; this serves as a burn permit. The MDNR's toll-free burn permit number is 866-922-2876.
(http://www.michigan.gov/dnr/0,4570,7-153-30301_30816_44539---,00.html)

3.1.14 Challenges and Resources for Forest Stewardship: Key Issues

A review of thousands of pages of natural resource documents and web resources for the Northeastern U.S., the State of Michigan, SLP and southeastern Michigan, and Washtenaw County, as well as interviews with dozens of stakeholders, suggests that the following are key issues that frame forest stewardship in this landscape:

- Timber is not a major product in Washtenaw County, which produces less than 0.04% of the State's timber, but forests are highly valuable for non-timber uses, including harboring biodiversity and wildlife habitat, water quality, recreation and aesthetic enjoyment, agroforestry and non-forest timber products, and hunting.
- Land use patterns (a mix of agriculture and residential development) have led to fragmented forests, with few forest patches over 1,000 acres, and even these may have large ratios of edge to interior.
- Parcellization, the process in which land is divided into smaller parcels, has led to a proliferation of private landowners with small amounts of forest on their land. Although 70% of the County's total forested land occurs in patches of 75 acres or larger, those patches have been carved into smaller parcels, with 59% occurring on parcels of 20 acres or less.
- Coordinated management is a large challenge in a fragmented and parcellized landscape. Managing in even small ecological units (such as patches) requires coordination among many different landowners, public and private.
- Land preservation programs have embraced landscape goals such as increasing patch size, connectivity, and corridors. However, many protected lands have multiple owners, complicating coordinated management.
- Despite the fragmented landscape, Washtenaw forests harbor considerable biodiversity, with 63% of the County's rare species (threatened, endangered, and special concern plants and animals) relying at least partly on forest habitats, and 37% entirely dependent on forests.
- Two forested natural communities merit particular attention in the landscape: Oak barrens are of statewide conservation concern due to their rarity; and floodplain forests are considered sensitive lands as they play vital roles in protecting quality but have been lost or degraded in many areas.
- Invasive plant species, both shrubs and herbaceous, and deer overbrowsing are major challenges for forest stewardship, and are taxing many institutional and private landowner's resources.
- Non-native pests and pathogens have affected Washtenaw woodlands in dramatic ways, most recently with the Emerald Ash Borer (EAB) killing off tens of millions of trees. The EAB experience shows the importance of early detection and eradication of new and emerging threats to forest health: Asian Longhorned Beetle; Oak Wilt; Thousand Canker Disease; Beech Bark Disease (Beech Scale); and others.
- Climate change poses additional management challenges, with some forest species increasingly vulnerable to changing weather patterns, but nurturing healthy forests can also contribute to efforts to combat increasing atmospheric carbon dioxide.

While the challenges are many, Washtenaw County also has unique resources for forest stewardship:

- All major institutional landowners, including city and county parks, Metroparks, and the University of Michigan's Matthaei Botanical Gardens/Nichols Arboretum, have active forest stewardship programs that benefit their own lands as well as contributing to the larger landscape by educating residents about stewardship issues and management techniques (such as native plants, invasive species, and benefits of prescribed fire).
- The County has active, educated, and engaged residents who are committed to stewardship of their own land as well public lands (through extensive volunteering).
- The Huron River Watershed Council offers landowners the opportunity to get a free ecological field assessment to identify valuable species and habitats on woodlands, wetlands, and grasslands, and to assess management challenges, such as invasive species.
- The Stewardship Network's Huron Arbor Cluster offers resources for coordinated management through educational and networking programs, grant funding (for projects such as this and a potential CISMA), and a forum for conservation managers to consider issues.

This Forest Stewardship Plan for Washtenaw County finds that coordination across multiple owners, both institutional and private, may be the biggest challenge in maintaining healthy forests into the future. Our forests are owned and managed by thousands of people. Many are already highly motivated to care for their woodlands. Providing them the resources to support their stewardship efforts will be essential.

3.2 Local Resource Providers and Existing Stewardship Plans

Many forest resource assessments at the state and Federal level are focused on the Northern Lower Peninsula and the Upper Peninsula, where state and national forests have a majority of their holdings. In the Southern Lower Peninsula, forests are likely valued more for habitat, maintenance of biodiversity, and ecosystem services including water quality, erosion control, recreation, nature connection, and spiritual/aesthetic enjoyment than for timber resources. Accordingly, the primary plans, visions, and resources for forest stewardship are more likely to be in various land use plans and park mission statements, which are available online.

3.2.1 Government Agencies and Land Managers

Michigan Department of Natural Resources (MDNR) is the largest landowner in Washtenaw, with 35,904 acres, around 8% of the County's land, including the Pinckney and Waterloo State Recreation Areas and four State Game Areas. MDNR manages these lands for diverse habitat and recreation goals using many forest management approaches. MDNR has been active in restoring and maintaining an important Oak Barrens community in the Pinckney State Recreation Area.

In addition to its particular role in Washtenaw County, Michigan's four-million acres of state-managed forest land provide critical habitat for wildlife, valuable resources for a thriving timber products industry, and beautiful outdoor spaces for a variety of outdoor recreation activities. To encourage this $14 billion/ year industry, the Forest Division has completed several planning activities.
MDNR Forest Management Plan: www.Michigan.gov/forestmanagement

The State Forest Management Plan written in 2008 provides strategic direction with goals and objectives for management of Michigan's state forests. The plan was amended in 2014 with a 10 year time framework. http://www.michigan.gov/dnr/0,4570,7-153-30301_30505---,00.html

Regional State Forest Management Plans are only available for the Western Upper Peninsula, Eastern Upper Peninsula, and Northern Lower Peninsula (there are no state forests in the Washtenaw County), but the information contained within can be useful for forest management by private and public landowners. www.Michigan.gov/regionalforestplans

Michigan's 2010-2020 Forest Action Plan provides a statewide assessment of forest conditions and trends for all Michigan forest land. The plan focuses on private landowner assistance through cooperative programs for forest stewardship, urban and community forestry, forest health, wildfire management, and forest legacy.

The Forest Resources Division also developed a five-year strategic plan to guide decisions and actions governing the health of Michigan's state forest resources. The goals and objectives of the plan lay the groundwork for meeting the division's mission and complement the MDNR's overall strategic direction. The first goal of the Forest Resources Division's Strategic Plan is: Sustainably and proactively manage and protect forest resources.

www.michigan.gov/dnr/0,4570,7-153-30301_30505_62551---,00.html

The MDNR Forest Stewardship office offers several programs that help fund Forest Steward plans

Helping Private Forest Landowners Develop Plans for Sustainable Forest Management: A Landowner's Guide. www.michigan.gov/foreststewardship

Plan Writers: www.michigan.gov/dnr/0,4570,7-153-30301_34240_68762---,00.html

Michigan Landowner Forest Stewardship Plan (Sample)

www.michigan.gov/.../FSP_Plan_Example_September2014_468852_7.pdf

Michigan's Forest Legacy Program is a partnership with USDA Forest Service with a goal of protecting privately owned and environmentally significant forest lands from being converted to non-forest uses. This voluntary program acquires land through purchase of fee simple title or by conservation easements, legally binding agreements that transfer a negotiated set of property rights without removing the property from private ownership. Conservation easements purchased using FLP funds restrict development, require sustainable forestry practices, and

protect a variety of other values. Michigan's FLP encourages partnerships with local governments and land trusts, recognizing the important contributions landowners, communities and private organizations make to conservation efforts. The program requires public access for fee lands but not for conservation easements.

The MDNR state forest resources have been recognized by the Forest Stewardship Council® (FSC®) and the Sustainable Forestry Initiative® (SFI®). Independent auditors have reviewed the MDNR's on-the-ground forest practices against biological, social, and economic requirements in the FSC and SFI standards and certified those practices as sound and comprehensive.

MDNR Forest Stewardship Program (MDNR-FSP) offers resources to private landowners to support forest stewardship efforts, in recognition of the fact that a majority of the state's forests are on private property. MDNR-FSP certifies forest stewardship plan writers to assure that they can offer sound information on best forest stewardship practices, maintains a listing of plan writers in different regions, and offers cost-sharing to landowners to assist them in forest stewardship planning. MDNR-FSP has assisted in the development of 27 forest stewardship plans in Washtenaw County, covering 2,076 acres.

Huron-Clinton Metropolitan Authority (HCMA) is a regional park system that owns and operates three Metroparks totaling more than 1,600 acres within Washtenaw County, as part of its larger system of 24,500 acres in a five-county region. Roughly 1/3 of Metroparks land is forested. Although recreation is a primary mission, maintenance of diverse species and habitats is another important goal. Park naturalists and stewardship staff and volunteers manage natural areas to remove invasives, control deer populations, and use prescribed burns to benefit native plants.

Washtenaw County Parks operates 13 County Parks, at least 4 of which have significant natural areas in addition to recreational land (golf courses, sports fields, etc.), totaling 1,124 acres. The fen and associated uplands at Park Lyndon are particularly notable. In addition, the County's Natural Area Preservation Program (NAPP) owns and operates 24 Nature Preserves (3,334 acres) acquired as part of the County's "Greenbelt" program, a millage approved by county voters to purchase and protect natural land in view of rapid development. "NAPP was established in 2000 by the Washtenaw County Board of Commissioners through the passage of Natural Areas Ordinance No. 128. The ordinance provides procedures and standards for purchase and protection of natural areas by the County. In 2010, voters chose to renew the County-wide, ¼ mill tax that funds the program. Funding will continue through 2021." Most NAPP preserves are forested or featuring a mix of woodlands, wetlands, and grasslands, and NAPP staff engage in many forest stewardship activities to promote biodiversity, including invasives removal and prescribed burns. All preserves offer public access with parking and trails.
(http://www.ewashtenaw.org/government/departments/parks_recreation/napp/pr_natac.html)

University of Michigan owns 1,804 acres, including significant forest tracts, within the **Matthaei Botanical Gardens/Nichols Arboretum (UMBGNA)** and various research properties and preserves within the county (Horner-McLaughlin Woods, Mud Lake Bog, the Newcomb Tract, Radrick Forest and Fen, Saginaw Forest, Stinchfield Wood), as well as a 1,300 acres mostly wooded research property (E.S. George Reserve) just north of the Washtenaw County line in Livingston County. Property is managed with a primary focus on research and education, driven by faculty and student interests. UMBGNA properties originally featured plants from around the world, but have increasingly showcased species native to Michigan and the Great Lakes Region. UMBGNA actively manages its forest, grassland, and wetland properties with prescribed burns and invasive species removal to promote native species. The Marilyn Bland prairie at MBG, created by a graduate student in the 1960s, is one of the early prairie restorations in the area, while Dow Prairie in Nichols Arboretum was the site of perhaps the earliest prescribed burns in the County, in 1989. MBGNA and the E.S. George Reserve have compiled extensive data on species and communities that are available online and may be of interest to nearby landowners.

Washtenaw Conservation District (WCD) administers USDA-NRCS programs for agriculture and forest land, including the Michigan Agriculture Environmental Assurance Program (MAEAP) for farmers whose lands include forests, wetlands, and wildlife habitat. The voluntary program, aimed at preventing pollution, guides landowners through steps they can take to assess environmental risks and incorporate best management practices, outlined in the *Forest, Wetlands, and Habitat-A-Syst (Assessment System)*. WCD can offer support and guidance for landowners who want to develop forest stewardship plans using the NRCS program rather than MDNR-FSP. (While the NRCS offers greater funding, landowners must agree to more management constraints than imposed by the FSP process.) The Conservation District also holds an annual tree and shrub sale, to supply species for conservation plantings, and runs a Tree Conservationist of the Year Award to recognize outstanding tree planting efforts.

Washtenaw County Water Resources Commission, WCRC (formerly Drain Commission) has a mission to protect surface water and water quality, "providing storm water management, flood control, development review and water quality programs." WCRC oversees the county drain system, which includes channelized and natural streams and irrigation ditches, many with floodplain forests and vegetation. WCRC also operates a rain garden program, promoting planting of water tolerant native plant species (including various woodland species) in excavated areas that serve to slow and absorb stormwater and pollutants before the water enters rivers and streams. WCRC has trained dozens of county residents in these techniques through its Master Rain Gardener program, some of who have become dedicated native plant enthusiasts and stewards.

City of Ann Arbor Natural Area Preservation manages over 500 mostly forested acres designated as natural areas within the 159-park system (totaling over 2,100 acres). NAP staff aim to foster biodiversity in these natural areas through invasives removal, prescribed burns, and other restoration methods. NAP has also conducted extensive plant inventories and

continues to monitor birds and herps annually, as well as doing photo monitoring. An essential part of NAP's mission is education and public engagement, so the program hosts numerous volunteer training sessions and stewardship workdays. NAP's effects have rippled outwards to other area organizations, as many staff who have learned stewardship by working at NAP for a season or two have gone on to work in other conservation organizations or have started businesses related to ecological restoration (including companies that grow native plants and contract landscape restoration including prescribed burns and invasives removal).

Pittsfield, Scio, and Webster Township Open Space programs. In addition to the County's greenbelt program, several townships have their own programs to further promote preservation of natural lands and open space (often including farmland). While the County program requires public access, some township programs contribute funds toward the purchase of development rights (PDR) for properties that remain in private ownership (although preferably with at least limited public access). Consult websites for each township.

3.2.2 Nonprofit, Non-Governmental Conservation Organizations

The Nature Conservancy (TNC) owns two nature preserves in Washtenaw County and nearby, and has historically been a driver in efforts to assess the region's natural heritage (MNFI evolved from the Natural Heritage Program, which grew out of TNC's work).

Legacy Land Conservancy has worked with private landowners to preserve land through conservation easements in Washtenaw County and adjacent counties. To date, Legacy has preserved 110 properties with a total of 6,858 acres. Exact cover estimates aren't available, but 78 of those properties are identified as having at least some woodlands, with an estimated 971 acres of forest. Easements require that land be maintained as natural, and Legacy trains volunteers to monitor properties periodically to ensure that they are in compliance. Although Legacy tries to promote active stewardship measures, such as invasive species removal, most easements focus on preserving rather than managing land.

Southeast Michigan Land Conservancy (SMLC) has protected over 3,400 acres of natural and agricultural lands, preserving open space through conservation easements or purchases in a 7-county area of southeast Michigan, including Washtenaw. SMLC operates 5 preserves within Washtenaw County, totaling 580 acres of forests, fields (some fallow, some still farmed), and wetlands, including 325-acre LeFurge Woods Nature Preserve. SMLC has engaged in stewardship activities on some of its properties, although staff time and resources for stewardship and volunteer coordination have been limited.

In addition to its own holdings, SMLC has collaborated with Washtenaw County Parks and Superior Township on the Superior Greenway project, which has protected 2,007 acres to create a wildlife corridor that protects open space in rapidly developing Superior Township (http://smlcland.org/superior_greenway.php).

Huron River Watershed Council (HRWC) has broadly interpreted its mission to protect the Huron River watershed. In addition to administering the Natural River Plan for the river—which sets guidelines for riparian vegetation management, including floodplain forests—and various watershed management plans for its different river stretches and tributaries, HRWC has engaged in a large effort, the Bioreserve Project, to assess all natural area in the watershed, noting that all natural areas contribute to water quality. The Bioreserve Project includes a mapping component that assessed all properties with natural vegetation cover of 10 acres or more for landscape characteristics including type of cover, patch size, contiguity, connectivity, and corridors. The resulting GIS database and maps have been contributed to various township planning boards to support inclusion of natural vegetation (and ultimately water quality) in land use planning. A second part of the project is ecological field assessments, offering an opportunity to public organizations and private landowners to evaluate their natural lands for biodiversity, important species and communities, and management challenges (such as invasive species). In addition to the Bioreserve Project, HRWC has been active in projects to look at climate resilience, including impacts and management strategies for forests in the watershed, and has recently been active in green infrastructure planning activities, which emphasize the importance of total tree canopy in the county.

The Stewardship Network (TSN) "connects, equips and mobilizes people and organizations to care for land and water in their communities….The Stewardship Network's mission is to connect, equip, and mobilize people and organizations to care for lands and waters in their communities. As a 501c(3) nonprofit with a strong record of apolitical, transformational change leadership, the network provides a unique function in the conservation community: facilitating the work of many by connecting conservation minded volunteers and practitioners to experts, to government agencies, to local organizers, to tribes and researchers and to each other; to craft and implement solutions to a multitude of the most pressing and challenging community conservation problems (water quality, invasive species control, biological diversity, habitat improvement, local food systems, civic engagement, etc.), which results in real on-the-ground conservation based eco-system vitality. This model is effective because individuals and organizations that care about their community, yet are unsure of what to do, address conservation problems one property at a time at a scale that is personal to those involved and now executable with their resources complemented by those brought to the table by the network. Our community-based, collaborative model is unique among the conservation world, as we ask the critical question 'What do you need to increase capacity to care for land and water?' We are not driven by a single species or issue and instead focus on revitalizing the system as a whole."(https://www.stewardshipnetwork.org/about-us)

As part of this larger collaborative mission, the Huron Arbor cluster in Washtenaw County has "two main areas of focus: 1) on the ground conservation action and planning, and 2) educating community members in conservation issues, techniques and other relevant topics. We focus on local stewardship issues and plans to address those concerns through implemented action. We provide unique educational opportunities through events, workshops, activities and online networking to share ideas, information, skills and resources to enable local groups to increase

their capacity to care for local land and water." Upcoming events include workshops on oak wilt and vegetation monitoring, edible plants, and recognizing emerging invasive species threats. (https://www.stewardshipnetwork.org/clusters/huron-arbor-cluster)

TSN can offer the kind of collaborative management approach that is vital to forest stewardship in a fragmented and parcellized landscape, with diverse public and private landowners, and will be continuing to explore approaches and funding in the coming year.

Other non-profit groups: Numerous conservation-related non-profit organizations play direct or indirect roles in preserving and managing natural lands, including forests or the landscape mosaics in which they occur, or educating people about them. Some notable organizations active in Washtenaw County and surrounding areas:

- Audubon Society, a national organization with a local chapter focused on birds and bird habitat
- Michigan Botanical Club, with several local chapters of plant devotees
- Washtenaw Citizens for Ecological Balance, a local organization formed to support deer management in the Ann Arbor area to protect native plants and ecosystems and keep deer in balance with other species and goals
- Wild Ones, a national organization with a local chapter, dedicated to landscaping and ecological restoration with native plants
- Various private landowner organizations, such as the Michigan Friends Center in Chelsea, a lakeshore retreat on 92 acres, with cabins available for member rentals, but much of the forest land preserved for "the rejuvenating beauty of the woods."
- Friends of Greenview Nature Area, and other similar groups, that have formed non-profits dedicated to protecting parks and preserves.
- Conservation groups focused on wildlife management for game and hunting, such as Ducks Unlimited, Pheasants Forever, Michigan United Conservation Clubs, and Whitetails Forever

3.2.3 Private Sector Natural Resource Professionals

Ann Arbor is an active conservation community associated with various park systems, the University of Michigan, and connected through the Stewardship Network, has spawned a number of business focused on ecological restoration rather than traditional forestry and natural resources management:

- David Borneman LLC, Restoring Nature with Fire, offers prescribed burn services to private landowners and municipalities
- Native Plant Nursery LLC, offers local genotypes of over a hundred species of native plants grown from seed collected within the county.
- PlantWise LLC offers ecological restoration services including restoration and management planning, invasives removal, prescribed burns, and native plantings

- WildType, native plant nursery in nearby Ingham County but also serving Washtenaw County with local genotypes of over a hundred species of native plants grown from seed collected within 50 miles.

Forest Stewardship Plan writers that serve Southern Lower Michigan, and can assist landowners in developing forest stewardship plans that focus on wildlife habitat and other ecological goals, in addition to timber management, can be found on the MDNR-FSP website: http://www.michigan.gov/documents/dnr/FSP_PlanWriters_SELP_527326_7.pdf

Mills and wood reclamation services include the following:

- Urbanwood
- Urban Ashes
- Pleasant Lake Hardwoods

4. Landscape Stewardship Stories

Rather than just listing recommended practices that should be done, we spoke with your neighbors and are sharing their stories about how they've managed their own forest lands in order to inspire other landowners to become more actively engaged in creating their own stories.

Interviews with over 40 stakeholders, including land managers at park agencies and land conservancies, university researchers, conservation easement holders with forest lands ranging from 5 acres to over 50 acres in size, agroforestry enterprises, native plant enthusiasts, and others can offer insight and inspiration about forest stewardship efforts in Washtenaw County. The following table below shows Stewardship Stories that have been written or are under development. Four stories are included in final appendix; the remaining stories will be made available on the Stewardship Network website and in a later version of this report.

4.1 Farming the Forest: Nature and Nurture Farm

How can a farm be a forest? And how can a forest be a farm? Nature and Nurture Farm in Scio Township offers one model.

On a Friday in May, the whine of an electric drill punctuated the air as volunteers and interns prepared 4-foot lengths of oak logs for cultivating shiitake mushrooms. Alternating with the drill was the thud of a hammer, as a volunteer pounded small wooden pegs of mushroom spawn (the mycelium or rootlike underground growing parts of the fungus) into the drilled holes. The sharp scent of fresh-cut logs, which must be inoculated with shiitake pegs immediately after being cut to prevent other fungal species from first invading, mingled with the earthy musk of mushrooms and the sweet honey aroma of beeswax painted over the driven pegs to seal in the spawn. The treated logs will be stacked in the shade of a small windbreak of spruces and pines near the farmhouse, covered with shadecloth, then left to allow the mushroom fungus to grow. The logs will yield a crop of mushrooms in 18–24 months.

Left: Cut logs awaiting inoculation with shiitake mushroom spawn. Right: volunteer hammers mushroom pegs into log.

Left: Farmer Mike Levine prepares oak logs for mushroom inoculation. Right: Inoculated logs are stacked under conifers and will be kept moist and shaded for the 18-24 months needed to produce shiitake mushrooms.

Mushroom production takes planning and patience, but these farmers are ready for the long haul. Their goal is to plant oak trees and other hardwoods trees so that they can harvest thousands of feet of small-diameter trees for mushroom production for the next several decades.

Growing mushrooms is just one of many agroforestry practices at Nature and Nurture, where farmers Mike Levine and Erica Kempter are trying to manage their woodlands for agriculture AND biodiversity. Their goal is to integrate ecological management with agricultural production, setting aside forested areas of high biodiversity to maintain and restore as habitat for diverse species and ecological processes, while nurturing trees and shrubs as part of food production on the remainder of the farm. They envision evolving their farm into a food forest—moving from the present mix of 40 acres of cropland and alfalfa fields, and 40 acres of hardwood forest and swamp to an agricultural production system with relatively few acres of tilled fields (food crops and the organic heritage seeds that are another part of their business) intermingled among a patchwork of nut- and fruit-producing trees and shrubs and preserved and restored forests. They want their property to contribute to a species-friendly landscape matrix that will offer high-quality habitat and a migration corridor for wildlife and seeds—a vital connection to other wooded patches nearby.

Township land preservation committee contributes funds for conservation easement (CE) and purchase of development rights (PDR)

In 2005, Levine and Kempter, business and life partners who have run the Nature and Nurture LLC organic and edible landscaping and a related heritage seed company for more than a decade, set out to find 20 acres in Washtenaw County. They sought a place with a mix of woodlands and fields where they could use their background in ecology to develop, test, and put into practice ideas about transforming agriculture from low-diversity and high-chemical-input systems to alternative practices, including permaculture and forest farming (see definitions below), that would nurture the land and diverse species while also producing food.

Their search for land lasted several years. Prices were high—often out of reach of the income generated by their interconnected small businesses—and many places didn't offer a suitable mix of forest and field, along with the isolation from other vegetable farms needed for their seed business. Along the way, they contacted Scio Township's Land Preservation Committee.

Scio Township is among several Washtenaw County government units that have passed "greenbelt" millages over the past two decades to support conservation of natural areas, open space, and farmland. (Other greenbelt programs include those operated by Washtenaw County, the City of Ann Arbor, and Webster and Pittsfield Townships.) These programs sometimes acquire land outright, but more often negotiate contracts to protect land by offering money to private landowners if the will protect land with permanent conservation easements; the program purchases development rights using millage funds (see definitions below). Since the Ann Arbor and Washtenaw millages started in the 1990s, thousands of acres have been protected, some to become public preserves operated by the county, while others are maintained as private landholdings.

Conservation easements with purchase of development rights can offer an alternative to retiring farmers who might like to conserve their land, but still need to realize a financial gain from the property. These agreements have also turned out to offer a potential avenue to land acquisition for young farmers just starting out: several local farmers have coordinated with local land preservation organizations to acquire land that is considered to have conservation value; by selling the purchase of development rights at the same time they purchase the land, they are able to make the property more affordable.

Which was just what Levine and Kempter were hoping to do. The process turned out to be long and arduous, with complicated price negotiations and legal agreements. Mike would caution potential sellers of development rights that "it's not always a transparent process, and it should be pursued with great patience, caution, planning, and an attorney who is familiar with the process and can help negotiate and think it through." He wishes he had "been able to afford to do more work with an engineering firm to help choose which acres to leave out of the easement… but buying the land was enough of a financial stretch without those costs." As he has worked to develop a plan for the farm that includes 40 acres of adjacent land that his parents bought, he has encountered further complications. He notes, "it can be difficult to predict and design for for any and all future plans. Even when the easement allows for agriculture, it may still interfere with agricultural site planning."

Despite the challenges, the process did help the couple acquire an 80-acre property with a mix of southern hardwood (oak-hickory) forest, deciduous forest swamps, and tilled and fallow fields. The conservation easement they negotiated requires that the land be "perpetually preserved in its scenic, agricultural and open space condition."

USDA/NRCS provides funding to develop forest management plan

The conservation easement that helped fund the farm required that Levine and Kempter develop a forest management plan under the Natural Resources Conservation Service (NRCS) of the U.S. Agriculture Department (USDA). Levine appreciated that NRCS covered 75% of the cost of plan development, but found the process challenging. Not only were the forms lengthy and filled with small print requirements for the funding, but the rules for different programs weren't readily applicable for the kinds of agroforestry and foresting farming techniques he hoped to implement.

For example, one NRCS program encouraged and offered financial incentives for shelterbelt plantings of trees and shrubs. But the program prohibited use of non-native species—even

horticultural cultivars of native trees—and did not allow harvest of tree products. These requirements promote important goals for providing wildlife habitat and preventing the spread of invasive species on conventional farms, but are complicated to apply on farms implementing alternative and agroforestry production practices.

Still, the NRCS-funded planning process helped Levine and Kempter to articulate management goals, including key priorities for their woodlands:

- maintaining and restoring high-quality habitat areas for biodiversity, forest regeneration, and other ecosystem services;
- harvesting and replanting oak and other hardwoods for mushroom production;
- tapping maple sap (in limited, sustainable amounts) for maple water or syrup; and
- converting conventional agricultural fields to a diverse mix of nut- and fruit-producing trees, shrubs and other perennials, with only a small acreage to be tilled for annual crop and seed production.

The forest management plan also outlined forest stand improvement activities, including salvage harvest (of dead ashes and elms), crown thinning, and brush removal (mostly invasive shrubs and multiflora rose).

So far, Levine has planted over 300 oak acorns and seedlings, which he hopes to harvest in 15–20 years as they reach the 3" to 8" diameter that is ideal for growing shiitakes. He is eager to plant American persimmon, chestnut, and pecan trees, as well as smaller fruit-producing trees and shrubs, including pawpaws, plums, and serviceberries. He dreams of breeding fruit varieties from native species that would have a longer growing season (such as serviceberries, *Amelanchier arborea*) or larger fruits (such as Michigan's native plum species, *Prunus americana* or *Prunus nigra*). Mostly, he wants to find what works. His approach in the nursery and forest farm, he explains, is like "throwing stuff at a wall and seeing what sticks."

University of Michigan master's students contribute ecological inventory and design skills for developing master plan

While the NRCS-funded plan focused on forest management priorities and strategies for the land to be conserved as forest, Levine and Kempter wanted a management plant that would integrate forests and farming for the entire 80 acres, along with an adjacent 40-acre parcel now owned by Levine's parents. Levine and Kempter have the background in ecology and management to prepare a plan, but are too busy with the daily work of farming to have time for long-term planning. So they turned to a local resource not often used by local landowners: University of Michigan's School of Natural Resources and the Environment (SNRE). The SNRE master's program requires that students do a capstone project to apply their academic knowledge to real-world problems for real-world clients. Levine and Kempter put in a request for a project team to develop an integrated agroecology plan for their farm.

On a Saturday in May, SNRE graduate students Alexandria Peters, Michael Lordon, Yihan Li, and Jared Aslakson trudged across the loose, recently plowed soil of the farm fields at Nature

and Nurture and into the forest areas. They carried a soil corer, a shovel, plastic bags, and a cooler. Their mission was to collect soil samples from around the farm to assess soil quality throughout the area. Based on their findings, they will recommend soil parameters that can be measured periodically for improvement—soil nitrogen and organic matter are potential metrics—and recommend forestry and farming practices that will actively improve the soil.


Left: Li, Lordon, Peters, and Aslakson collecting forest soil samples. Right: Vegetation survey plot.

Peters, who is studying landscape architecture, notes that she was drawn to this master's project for the opportunity to design an ecologically functional landscape that also allowed for human access and use. "Lots of landscape architecture is focused on urban areas," she says, "but we also need to think about agricultural land." Lordon, who worked on the farm as an intern before starting on this project, notes that agroecology operations such as this one can provide "a biodiversity-friendly mix of land uses, even if the land is not all conservation land—it is important to include migration corridors and temporary refuges."

The students lugged the increasingly heavy cooler of soil samples through several plowed fields, then into the forest. The soil here was darker and easy to dig. They pointed out flagged plots where they had surveyed vegetation the previous week; they would revisit the plots in the summer to complete a vegetation inventory and floristic quality index. They also planned to survey birds, insects, reptiles, and amphibians as they assess biodiversity throughout the woodlands, wetlands, and fields.

As the team moved out of the forest and into an alfalfa field, they almost tripped over a young fawn bedded down in the 8-10" tall cover, its white spots helping to hide it in the sun-dappled leafy greens. While moving carefully away, so as not to disturb the fawn, they couldn't help but contemplate the fact that deer pose a management challenge for a forest farm aiming to grow trees and shrubs. Levine has had to replant many trees and shrubs that have been damaged by deer, and the only way that Kempter can grow organic seeds is to have an 8-foot tall fence around the field to protect crops from being destroyed by deer. Levine remarks that he recently observed 50–60 deer in the fields, and muses that maybe he should "farm deer." The couple allow bowhunting to help control the farm's deer population.

Challenges and Opportunities

As the SNRE students complete their management recommendations in 2017, Levine and Kempter are excited about farming in a way that nurtures nature, and that allows them to preserve and restore high-quality forests while creating new food-producing woodlands. They have been savvy and persistent in using available resources and programs, including the township's PDR program to help fund the purchase of their farm and NRCS programs to develop a management plan and support some of the tree and shrub planting. They tapped the SNRE master's program for students who have brought enthusiasm to developing a management plan with much-needed data on soil quality and surveys of biodiversity.

Still, long years of hard work at low pay sometimes make them wonder about the long-term financial sustainability of their ecological goals. Deer and invasive species pose challenges for both food production and ecological restoration, and require constant management efforts. Transforming conventional cropland into a forest farm will take much work over many years.

At the end of the day, though, Levine shakes his head in awe of the amazing diversity on the woodlands that he and Kempter lucked into. He marvels at the forest wildflowers and the many species of ferns in the woods that he is still coming to know. And he can't wait to start planting trees and shrubs to convert agricultural fields to food-producing woodlands that incorporate and mimic natural ecosystems.

Left: Oak sapling has been heavily browsed by deer, illustrating the potential challenges for woody plantings and natural forest regeneration. Right: Autumn olive and other invasive shrubs are abundant in some parts of the fields and forests.

A Few Definitions

Agroecology is the study of agriculture as an ecology system, often including practical applications for making agricultural systems more like natural ecosystems. *Permaculture*, from "permanent agriculture," a term that covers practices including *agroforestry* (growing trees or other woody plants as crops), *forest farming* or *non-timber forest products* (managing existing forests to serve for production of planted or wildcrafted crops such as mushroom and berries or medicinal herbs such as ginseng and goldenseal), and *restoration agriculture* (combining forest trees and shrubs with other crops to make agricultural systems that mimic natural ecosystems and require minimal inputs and minimal damage to the environment).

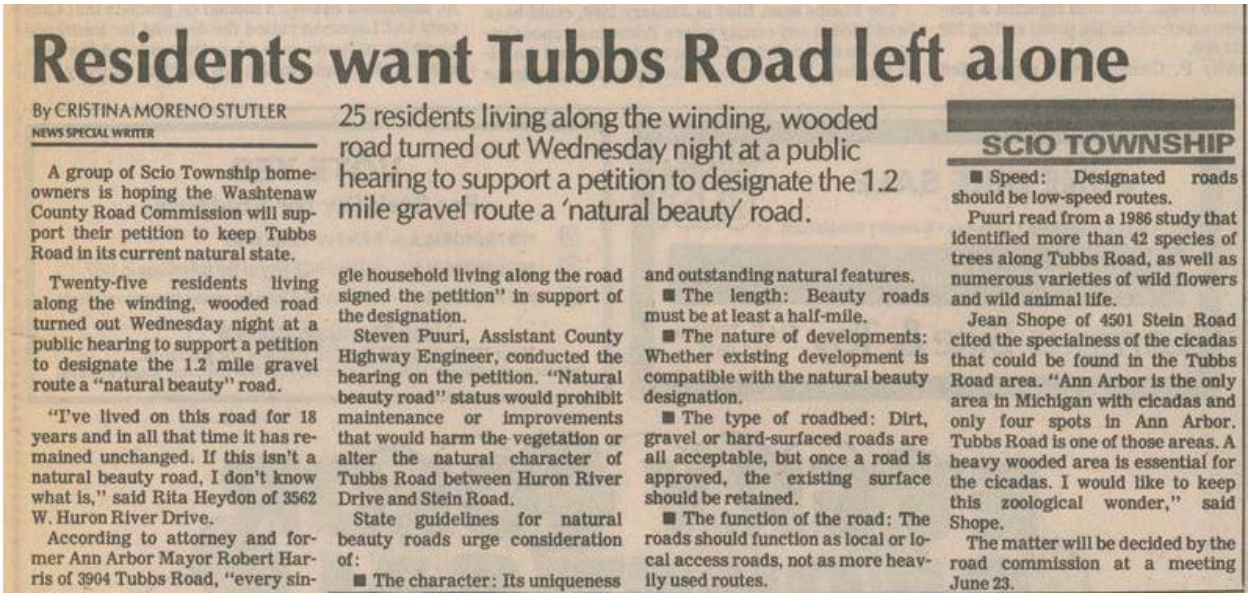
Conservation easements and purchase of development rights are legal agreements through which a growing land conservation movement in which cities, townships, counties, and other government units and non-governmental conservation organizations encourage long-term conservation in areas facing development pressure. These agreements allow private land-owners to voluntarily agree to set aside some or all of their land and protect it from any future development. If the land is considered to have conservation value within the region, various government or land trust organizations may negotiate a purchase of the development rights to provide land-owners with an economic benefit and incentive for agreeing not to gain the potentially higher profit that would come from selling to developers. A purchase of development rights is accompanied by a conservation easement that remains with the property in perpetuity, so that any future land-owner must abide by the conservation terms set forth in the easement. Some easements target preservation of natural lands, while others are more broadly focused on farmland or open space in general.

4.2 Natural Beauty Roads Showcase Woodland Landscapes

Woodlands come in many forms in Michigan, from the vast mantles of trees cloaking mountains and bluffs in the Upper Peninsula to the large forests in Michigan's state and national forests, and even the 5 to 10-acre woodlot islands in the sea of southern Michigan farm fields. Roadside trees don't generally count as woodlands. But in the suburban and increasingly developed, highly fragmented landscapes of southeastern Michigan, they are an important resource. Trees along roadways provide corridors for wildlife species to travel, and those wildlife species in turn often disperse seeds that allow forest species to migrate and repopulate nearby habitable areas where plowing and development are not presently occurring. Furthermore, natural vegetation and trees along roads can help absorb stormwater, slow runoff, and improve water quality in nearby rivers and streams. Washtenaw County's nine Natural Beauty Roads, covering 10–12 miles, are woodland byways, interspersed with farms, fields, and low-density houses, that serve ecological functions as well as providing scenic views and a glimpse of the County's pastoral history.

Roadside trees can be hard to protect, even where the Natural Beauty Road designation would seem to safeguard them. On a weekday in autumn of 2016, Anne Knott parked her car along the road and charged out, eyes blazing, to accost a Washtenaw County road crew that was scraping ditches along a section of Tubbs Road, one of the County's scenic Natural Beauty Roads, lined with large-limbed oaks with arching branches that make the road a tunnel through the trees. The Natural Beauty Road designation carries with it instructions for how the road should be maintained—including a provision to minimize disturbance to vegetation—and Anne had been alerted by neighbors concerned that these directions were not being followed. She exhorted then entreated the driver of the bulldozer, then the crew manager, to take care not to damage the roots and bark of the large oaks lining the road. "What would you do on your road?" she asked, "wouldn't you want it to be taken care of?"

An artist and retired realtor and fund-raiser for the University of Michigan, she and her husband, retired English professor John Knott, are among many residents who have worked tirelessly to keep this road natural—and to protect the arching tunnel of oak trees along a steep slope and meandering stream that make the road beautiful. The Knotts moved to Tubbs in 1992, just five years after the road's 1987 designation as a Natural Beauty Road, drawn by its beauty and quiet.



Residents want Tubbs Road left alone

By CRISTINA MORENO STUTLER
NEWS SPECIAL WRITER

25 residents living along the winding, wooded road turned out Wednesday night at a public hearing to support a petition to designate the 1.2 mile gravel route a 'natural beauty' road.

A group of Scio Township homeowners is hoping the Washtenaw County Road Commission will support their petition to keep Tubbs Road in its current natural state.

Twenty-five residents living along the winding, wooded road turned out Wednesday night at a public hearing to support a petition to designate the 1.2 mile gravel route a "natural beauty" road.

"I've lived on this road for 18 years and in all that time it has remained unchanged. If this isn't a natural beauty road, I don't know what is," said Rita Heydon of 3562 W. Huron River Drive.

According to attorney and former Ann Arbor Mayor Robert Harris of 3904 Tubbs Road, "every single household living along the road signed the petition" in support of the designation.

Steven Puuri, Assistant County Highway Engineer, conducted the hearing on the petition. "Natural beauty road" status would prohibit maintenance or improvements that would harm the vegetation or alter the natural character of Tubbs Road between Huron River Drive and Stein Road.

State guidelines for natural beauty roads urge consideration of:

■ The character: Its uniqueness and outstanding natural features.

■ The length: Beauty roads must be at least a half-mile.

■ The nature of developments: Whether existing development is compatible with the natural beauty designation.

■ The type of roadbed: Dirt, gravel or hard-surfaced roads are all acceptable, but once a road is approved, the existing surface should be retained.

■ The function of the road: The roads should function as local or local access roads, not as more heavily used routes.

SCIO TOWNSHIP

■ Speed: Designated roads should be low-speed routes.

Puuri read from a 1986 study that identified more than 42 species of trees along Tubbs Road, as well as numerous varieties of wild flowers and wild animal life.

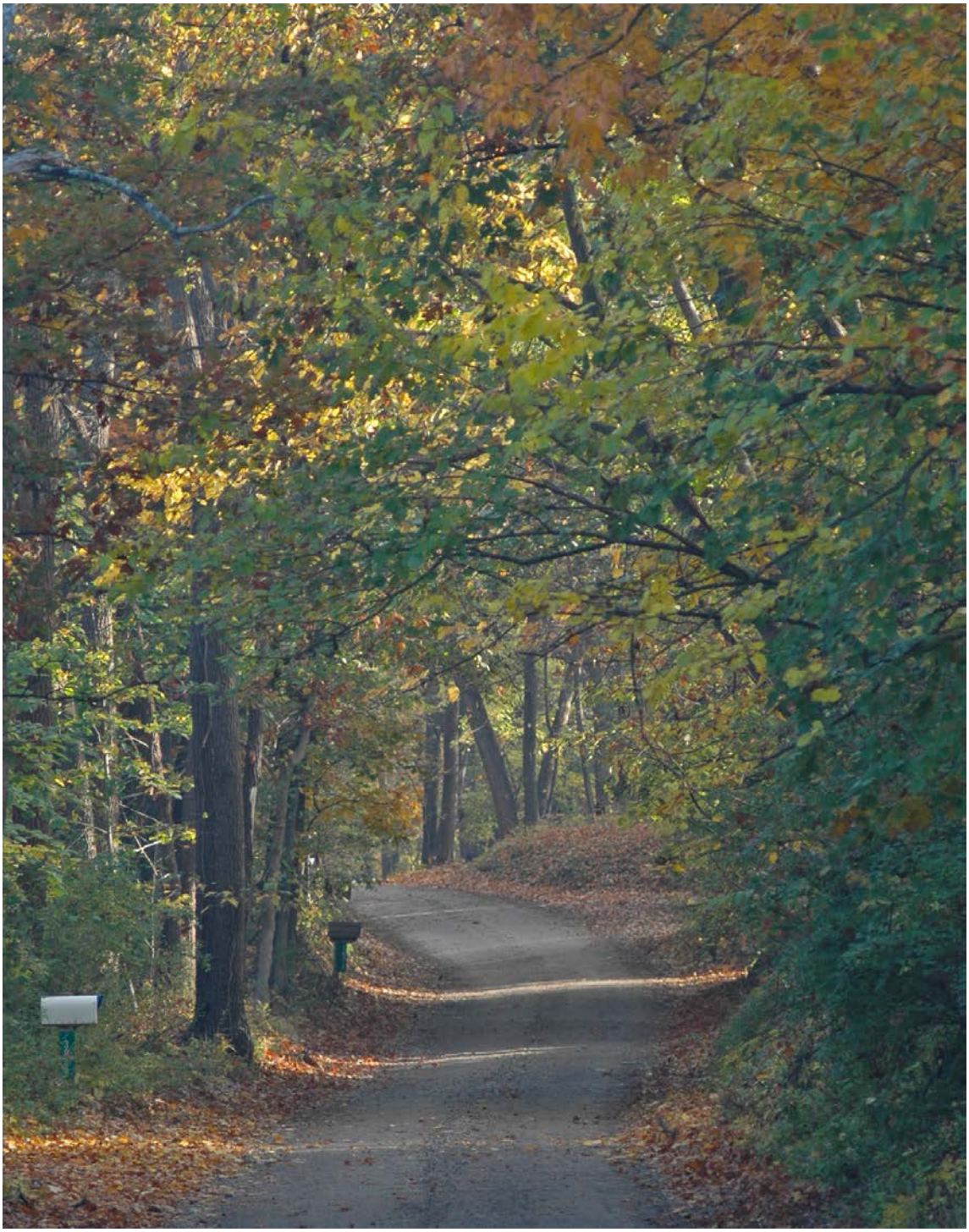
Jean Shope of 4501 Stein Road cited the specialness of the cicadas that could be found in the Tubbs Road area. "Ann Arbor is the only area in Michigan with cicadas and only four spots in Ann Arbor. Tubbs Road is one of those areas. A heavy wooded area is essential for the cicadas. I would like to keep this zoological wonder," said Shope.

The matter will be decided by the road commission at a meeting June 23.

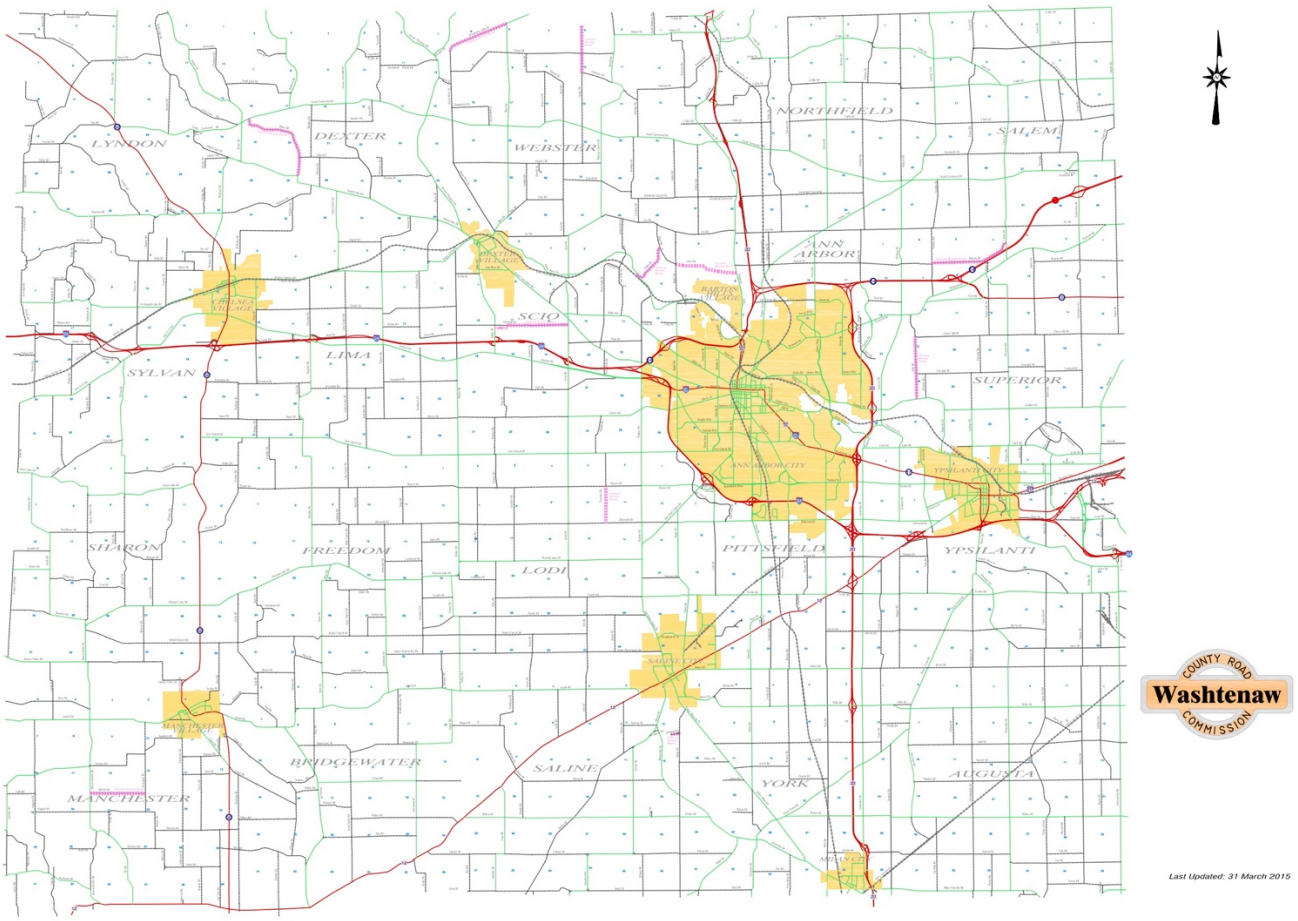
The Ann Arbor News, June 4, 1987.

Tubbs Road was designated a Natural Beauty Road after vigorous lobbying by residents who wanted to protect the road's beautiful natural vegetation. When the Knotts moved there, neighbors alerted them to another development that was threatening the road's natural beauty character. The developer who had already illegally filled in wetlands at the head of a spring-fed stream on the east side of the road was now trying to obtain a zoning variance to allow him to divide land on the west side of the road into smaller parcels than allowed by township ordinance, so that he would be able to fit more home sites into the subdivided parcel. Neighbors rallied and spoke at the Zoning Board of Appeals to protest the move. In the end, the Township did grant the variance—but they also required that a buffer along the development's edge be protected in its natural state by a conservation easement.

Not long after, John and Anne joined neighbors (and helped lead the charge) against another landowner/developer who wanted to change zoning to allow for a larger and higher-density residential development with more traffic and an on-site wastewater treatment plant that would discharge thousands of gallons of treated sewage to a small stream leading directly to the Huron River. The complicated case took years, and convoluted legal wrangling, and ended up in something between a victory and a draw—the state Department of Environmental Quality (DEQ) granted a permit to build the controversial wastewater treatment plant, but the township's decision to prevent the developer from subdividing the site into many small parcels (which would have required a zoning variance) prevailed in a series of legal challenges and appeals. The lower number of housing sites likely affected the project's economic viability, and the 2007–08 economic downturn likely played a role in slowing further attempts at development for now, though it is hard to say what the future will hold.



Tubbs Road in autumn shows off the natural beauty—and woodland character—that neighbors want to protect. Photo: John Knott.



Natural Beauty Roads in Washtenaw County, shown by the thick pink lines (from http://www.wcroads.org/wp-content/uploads/Maps/2015NaturalBeautyRoad.pdf): Gale Rd. (1.67 miles from Cherry Hill Road to Geddes, Superior Township); Warren Rd. (3.09 miles from Curtis to Dixboro Road, Superior Township); Napier Rd. (Superior Township); Tubbs Rd. (Ann Arbor); Mahrle Rd. (1.53 miles from Grossman to Sharon Hollow Road, Manchester); Marshall Rd. (2 miles from Zeeb Road to 1688 east of Baker Road, Dexter); Scully Rd. (Dexter); Riker Rd. (Chelsea); and Strawberry Lake Rd. (Dexter). Glazier Way (Ann Arbor Township) was previously a Natural Beauty Road but the designation was revoked in 1995 when the Washtenaw County Road Commission determined that traffic (associated new housing developments) exceeded the 2,000 vehicles per day limit established in NBR guidelines.

More recently, efforts to conserve this Natural Beauty Road have been directed at the Scio Township Roads Advisory Committee and the Washtenaw Road Commission. The issue of what, exactly, the township must do to protect Natural Beauty Roads arose when the township board levied a special assessment for improving roads, and township officials made gravel connector roads, including Tubbs, a top priority. But neighbors weren't persuaded that the announced "improvements" would protect the road's natural beauty, based on the drastic tree-trimming and extensive ditching done on nearby roads, including another Natural Beauty Road (Marshall Road). A majority of the road's residents attended an initial information meeting sponsored by the Roads Advisory Committee in late 2015 to express their concerns. Opinions differed about how much the road needed work, but all neighbors agreed that the the large oaks

that give the road its character must not be damaged—and they wanted to see plans before the work was going to be done.

One lesson of past battles, as John notes, is that the Natural Beauty designation "means relatively little in the way of protection or special maintenance." Passed in 1970 as Michigan's Public Act 150, the Natural Beauty Road Act was conceived and promoted by Bertha Daubendiek and the Michigan Nature Association as a way to protect wildflower-lined stretches of road (http://www.csmonitor.com/1982/0909/090941.html). But while the law was effective in defining and encouraging protection of natural vegetation by designating Natural Beauty Roads, it provides no mechanism for regulatory enforcement. If increasing development, traffic, or road maintenance activities change the road's character, the only penalty is to have the "natural beauty" designation removed.

Anne is passionate about protecting the road and its magnificent oak trees, some of them rare hybrids that she learned about when she audited University of Michigan's Woody Plants class with Herb Wagner and Burt Barnes, authors of *Michigan Trees.* Anne has made nearly a full-time job of researching the Natural Beauty Road designation and regulations in an effort to minimize the tree-trimming and ditching that might accompany the planned road work. She has spent hours canvassing and communicating with neighbors about their visions for and concerns about the proposed improvements. She has persuaded Township officials to go slow, and to conduct a drainage study before doing any road work (because increased runoff on the road partly stemming from the newer subdivisions has contributed to the need for improvement). Anne knocked on every neighbor's door and persuaded a majority of them to sign a petition urging the township to spend a portion of the road improvement funds on conducting a drainage study and working to address the drainage issues before doing major work on the road—which the township board agreed to. And she attends County Road Commission and township meetings to advocate for the road and its trees.

John, who was more involved in the previous political battles, has become the road's informal historian. An inveterate essayist, he has written a series of reflections about life on Tubbs Road, and its natural and human history. He has described the natural environment and Native American residents that predated European settlement, the rural character and early settlers on the road. He notes that Tubbs, and roads like it, form part of the rural and cultural heritage of the County. He points out that the road has at least two farmhouses dating to the 1850s. "Tubbs Road," he writes, "is itself a reminder of a much earlier time….[I]t must have been much narrower in the 19th and early 20th centuries, when traffic would have consisted of farm wagons and horse-drawn carriages in addition to individuals on foot or on horseback." Old photos from Paul Favreau, who grew up on on the road, show a view of the road wending through farm fields, neighborhood children standing at the edge of the road looking at cattle in the fields, and a family on the old Huron River bridge.

Historical photos of Tubbs Road: early days as a narrow lane winding through farm fields where cattle grazed as children watched. Photos: Paul Favreau family.

Pastoral vista from Tubbs Road past, and the old steel bridge that originally crossed the Huron River where the road started. Photo: Paul Favreau family.

Meanwhile, Anne actively monitors and attends meetings and fires off emails to keep Tubbs Road concerns prominent in front of township officials and boards and the Washtenaw County Road Commission. One issue that she's recently focused on is the prospect of Oak Wilt. This fungal disease, which is generally fatal for red, black, and scarlet northern pin oaks, has the potential to become similar to Dutch elm disease in its impacts, potentially devastating tens of thousands of trees if it were to spread widely in the region's oak-dominated forests. The fungus can also infect white, bur, and swamp white oaks, but is less likely to kill them.

First identified in the U.S. in the 1940s, Oak Wilt has been of increasing concern in Great Lakes and Ozark regions and in Texas since the 1990s. It can be spread by pruning or wounding trees during the growing season, when sap is actively flowing. Trees that are pruned or damaged by utility or construction work (including road work) are at risk of being infected by the fungal spores, which can be carried by various species of sap and picnic beetles; once trees are infected, the disease can be transmitted to nearby intact and healthy trees through interconnected root systems. MDNR recommends that trees not be trimmed or damaged during the active growing season, characterized in one informational pamphlet as April 15–July 15, but with recent deviations from average weather patterns, it would safer to avoid risking tree damage during the full growing season, from March 15–November 1. Oak Wilt has led to dramatic tree die-offs in many parts of the country, and has been of growing concern in Michigan. To date, it has been detected in only one site in Washtenaw County (at a Legacy Land Conservancy preserve, in 2016), but it has been found in the Metroparks in adjacent counties where management to limit its spread may require the removal of numerous large old oaks.

As Anne continues to work on protecting this Natural Beauty Road, she has become an early-warning system, helping to educate the Road Commission on tree-trimming and road management practices that will help prevent the spread of this disease. Meanwhile, John documents the road's history and participates in the political battles when necessary. Together, they've become the Loraxes of Tubbs Road—the latest in a lineage of dedicated residents who have worked and fought to preserve and maintain this tunnel of trees.

4.3 Evolving Views of Metroparks: From Recreation to Nature Connection, Biodiversity, and Stewardship

As Ryan Colliton greeted visitors to a tour of the Kensington Metropark Nature Area deer exclosures in October, a pair of sandhill cranes stood nearby in the parking lot, unfazed by traffic and allowing park visitors to approach to within 20 feet or less to snap iPhone photos. Colliton, who is Stewardship Coordinator of the Huron-Clinton Metroparks, shook his head at their acclimation to humans, which showcases the dilemma facing the Metroparks in managing natural areas. On the one hand, park staff are eager to encourage visitors to connect to nature and experience wildlife. On the other hand, the wildlife (including the park's deer, geese, chipmunks, and chickadees) have become so accustomed to the protection from hunting and the presence of humans—who are often bearing food, despite the park's many warnings that prohibit feeding wildlife—that they are no longer truly wild, but beg for handouts as their populations increase and behavior changes.

Sandhill cranes have made a remarkable comeback from near extinction in the Upper Midwest after hunting and the destruction of many feeding and nesting areas as land was converted to agriculture. But the species that has increased so much that it now threatens plant diversity is the white-tailed deer. Like sandhill cranes, deer were hunted so heavily in the late 1800s that they had virtually disappeared from southeast Michigan's landscape by the early 1900s. Alarmed at their disappearance, hunting groups joined forces with scientists and others in the incipient wildlife conservation movement to enact regulations that restricted and controlled hunting across the state. At the same time, the State of Michigan and many counties were starting to acquire land for public hunting and recreation areas and parks. Some of these newly acquired lands were managed for game habitat (often focused on deer or game birds) with species planted or forest succession directed to create the mix of early successional and mature forests that deer find ideal for providing acorns (an important food source) and browse (twigs of saplings and shrubs at a height that deer can browse) as well as fruits and berries. Deer populations rebounded. Between the 1930s and 1950s, populations grew so large that some scientists in the area started studying how these burgeoning populations might harm tree regeneration in forests. Deer populations declined in the 1960s and 1970s, but increased again in the 1980s, so that by the 1990s, Metroparks naturalists were concerned that deer were eating other species out of house and home.

The Huron-Clinton Metroparks consist of 13 large regional parks, encompassing rivers, lakes, forests and wetlands, and covering over 25,000 acres throughout Southeast Michigan, encompassing Wayne, Oakland, Macomb, Washtenaw, and Livingston counties. Operated by the Huron-Clinton Metropolitan Authority (HCMA), the Metroparks grew out of concerns in the 1930s about the lack of access to recreation areas for residents of Detroit and the surrounding areas. Private land-owners often restricted access, so there were few places where southeast Michigan residents could swim in a lake or paddle a river.

While the primary focus in acquiring parkland was recreation, a National Park Service survey in 1930 and an emerging park ethic in the 1940s also promoted placing parks to preserve natural features such as streams and stream valleys, lakes and lake shores, wetlands, and forests. So even while focusing on recreation, the land acquired for Metroparks included a diverse range of wetland and (often forested) upland ecosystems.

Over time, the emphasis on recreation has evolved to a multiple use and ecosystem management approach, in which maintaining biodiversity is an important part of the Metroparks mission. So Colliton spends his days trying to encourage busy staff naturalists to engage in stewardship and monitoring activities (such as pulling invasive garlic mustard and shrubs, and keeping track of deer browse damage on wildflowers) when they aren't busy offering tours and hikes to the public and school groups. He also runs a volunteer program to keep the public engaged in stewardship work.
Colliton notes that with 24,000 acres to manage (roughly 40% of that forested), it is vital to prioritize management to focus on high-quality natural areas. "People get 'invasives fatigue'—but doing nothing is not an option." Differences exist in management approach at all levels within and outside the organization about what natural resources management is and how it should be done. For example, deer management has been controversial for the whole organization, but necessary for the natural areas.

Colliton stays inspired and energized by rereading Aldo Leopold's book, *A Sand County Almanac*, three times a year. And he is committed to continuing to actively steward natural lands, including forests. As he notes, "Preservation is not a viable option in southeast Michigan—you can't just set aside an area and walk away from it" and assume that it will continue to harbor the biodiversity you know and love. Stewardship is a constant process rather than an endpoint.

4.4 Celebrating and Preserving Forest Wildflowers

Mary & Will Hathaway

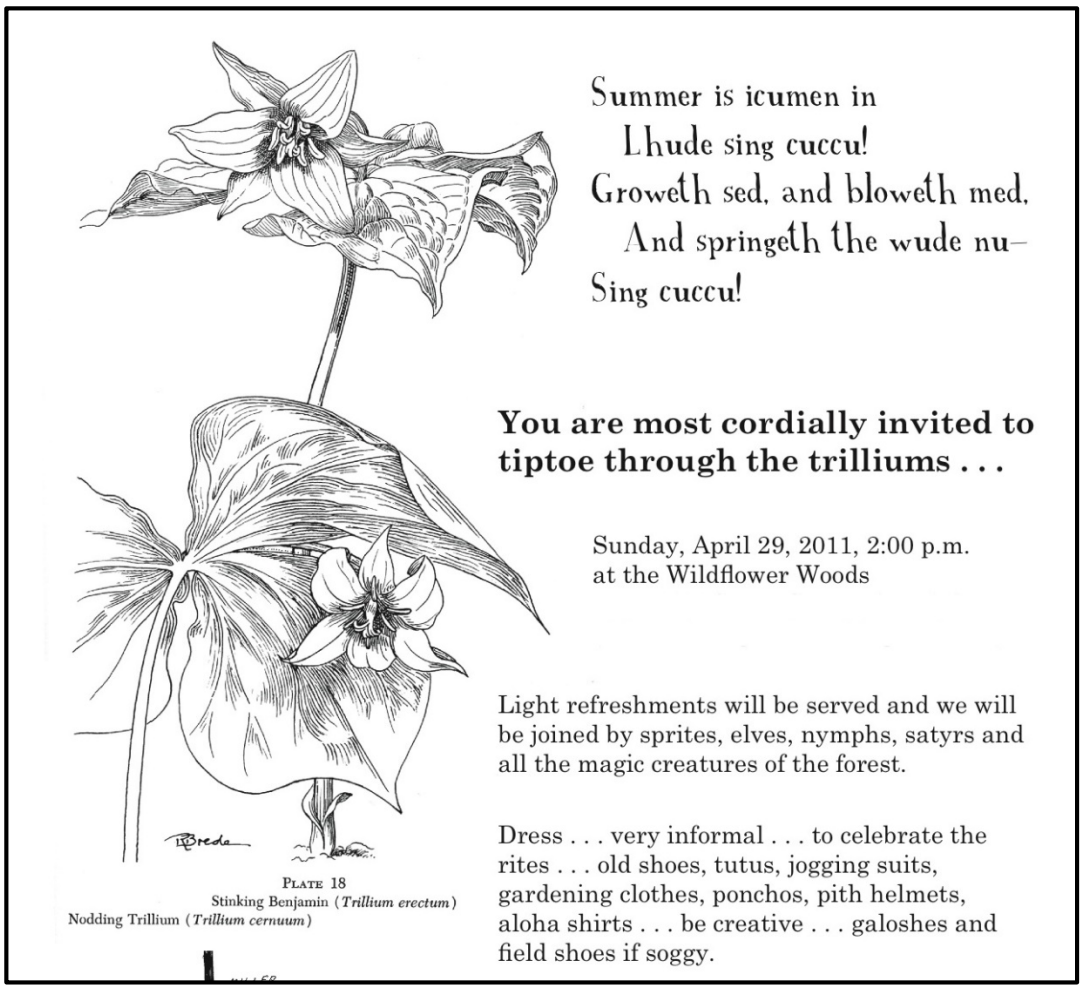
Mary Hathaway notes that it was "love at first sight" when she and her husband, John, first walked into ten acres of forest on the outskirts of Ann Arbor in the mid-1970s. They fell in love with the trees, the wildlife—and the woodland wildflowers. They visited the place in mid-May when the trilliums were in full glory. "It was the most beautiful trillium place we had ever seen. That was before the deer had become so voracious," remembers Mary. They looked at each other and knew that they wanted to save this place, the forest and the beautiful flora. "We knew that if we didn't buy it, someone else would ruin it."

Mary reminisces, "For John and me, buying the woods was almost an accident. We weren't looking for a woodland, nor for an investment. Mr. and Mrs. Dockter notified John that they were selling, because they saw that John had bought several small lots adjacent to the woods"—'casual purchases' of undeveloped land sold at tax sales, that Hathaway was able to buy inexpensively while he was still in law school. "It was fun for a guy in his twenties to bid on a piece of land, buy it for a song, then drive out to see what it looked like."

"So John and I accepted the Dockters' invitation to look at their woods on a day in May, 1974. As I said, it was love at first sight. The sales agreement is dated August 15." The sale included two houses and ten acres, mostly paid on a land contract, for $86,500. "Prices were much lower in those days, but even then we knew that the Dockters were offering us a bargain. We guessed that they wanted us to have it because we shared their vision of keeping it natural."

The Hathaways continued to live in Ann Arbor for several years with their growing family. But they visited and enjoyed their lovely property on the outskirts of Ann Arbor, and in 1977, started what would become an annual tradition—the trillium party. The Hathaways were nature enthusiasts and wanted to share the natural beauty of their forest, its trillium and other wildflowers, with their friends. They marked a trillium trail through the woods, and set up tables for picnicking.

The trillium parties, which often fall on Mother's Day, have continued for 30 years now. Over the years, they added a zipline to keep restless youngsters entertained. During a recent walk in the woods with her son Will and her dog, Mary—now in her late 70s—was ready to try out the zipline herself.



Trillium party invitation from 2011.

Though there are fewer trilliums now with the "voracious deer," there are still patches along fallen logs, and populations are starting to recover in response to deer and invasive species management and controlled burns. The Hathaways also enjoy bird-watching, and recently saw a pileated woodpecker on their ten-acre woodland.

The Hathaways always intended to preserve the land. Several years ago, they took a step toward permanent legal protection by setting up a conservation easement on the property through Legacy Land Conservancy. The Conservancy approached the Hathaways after an adjacent ten acres owned by Don Botsford was protected with an easement. (Indeed, Mary suggests that "Don Botsford's story…of single-minded, passionate dedication to his beloved woods"—is a whole other story deserving to be told.) Legacy, like many land preservation and acquisition organizations and advisors in Washtenaw County, has placed a high priority on protecting contiguous land parcels to increase core habitat size and maintain connectivity of natural areas for wildlife migration and seed dispersal corridors. Says Mary, "Part of what motivated me [to do the conservation easement] was that it made it more feasible to protect his [Botsford's] land, by adding on to the side."

Mary Hathaway, with her son, Will, and her dog, at the 9-acre woodland they have protected with a conservation easement administered by Legacy Land Conservancy.

Placing the property in a conservation easement provided an unexpected tax benefit. “My accountant said it was brilliant—it reduced taxes a lot,” due to the difference between the value of the acreage for development and its value as undeveloped open space. Mary, whose husband, John, died several years ago, was in the process of down-sizing and coincidentally sold the house she and her husband had owned for decades in Ann Arbor the same year as the conservation easement was finalized, canceling out a large capital gains payment that would otherwise have been due.

While the conservation easement offered unexpected financial benefits, and now protects the land from development in perpetuity, protecting the health and the diversity of the forest and its wildflowers has required active management and a large investment of time, physical labor, and resources. Mary recounts the many challenges faced by the forest canopy during the 40+ years her family has owned it: a severe gypsy moth defoliation in 1997–98 damaged many trees (even including pine trees) and killed some old oaks; then the Emerald Ash Borer arrived and killed many more. The standing dead trees were vulnerable to windstorms and took out neighboring trees in a domino effect as they fell.

Equally difficult has been maintaining the forest understory. Mary notes that trillium has declined with the dual pressure of invasive species and deer browsing. “Invasives—we have almost everything—garlic mustard, dame’s rocket, Japanese barberry, honeysuckle, buckthorn.” Mary has hired local contractors to combat invasive shrubs with a combination of cutting and herbiciding the shrub honeysuckle and buckthorn, and two prescribed burns, including a pretty major burn several years ago, followed by a more limited burn two years ago. Still, every spring a gathering of family, friends, and occasional hired help pulls out many garbage bags of garlic mustard; it sometimes takes several trips with a minivan to dispose of it all.

As for the deer, for the past several years, the Hathaways have given permission to a bow-hunter to hunt the woods. He usually takes one buck and four or five antlerless deer. “I don’t take delight in that,” says Mary, “but in the big picture, the whole balance is getting tilted—we are getting away from balance. Deer are a sustainable resource, but the trillium—once they’re gone, they’re gone.” She pauses, then notes that hopefully they haven’t disappeared for good. “We do see some small trillium returning in recent years, perhaps as a result of all our efforts.”

The Hathaway property, in the foreground; the green wall of invasive honeysuckle at the back property edge (adjacent to the unmanaged Botsford Preserve) shows the both the success of the Hathaways' herculean efforts at removing invasive shrubs, and the extent of the constant management challenge.

The Hathaway property is a testament to what property owners will do to safeguard woodlands and wildflowers—and to the challenges of private forest stewardship. "We wanted to preserve something not just for us, but for the future. It sounds trite, but if our generation doesn't preserve natural areas, they won't be there for others to enjoy in the future." At the same time, the continual investment of time and resources needed to manage invasives and deer is hard to maintain. It takes a lot of really hard work—"and now that we're older, we're less able to come out and yank weeds. We could use more resources—more people to help with invasives removal."

A small wooden sign marks the edge of the Hathaway property under conservation easement (left). Will Hathaway stands near the official conservation easement marking (right). The Legacy Land Conservancy web site offer more perspectives about Hathaways and their conservation property (http://legacylandconservancy.org/?s=hathaway)**.**

4.5 A land use trifecta: Prairie restoration, scientific research, and community gardening

By Sarah Turner, Legacy Volunteer and School of Natural Resources and Environment master's candidate

Of Legacy's six public preserves, Lloyd and Mabel Johnson Preserve is the only one with both natural and agricultural lands. It is home to regionally important natural communities including mesic (moderately wet) forest, buttonbush swamp, and a shallow-water wetland. The preserve also contains 18 acres of farmland that have been under cultivation since the nineteenth century.

Since acquiring the property in 2007, Legacy has hoped to restore the farm fields to a more natural and sustainable land cover. During the summer of 2016, I worked with Legacy staff to develop a comprehensive restoration plan. With financial support from the Natural Resource Conservation Service's (NRCS) Conservation Reserve Program (CRP), Legacy is turning fifteen acres of agricultural land into a native prairie. The CRP is designed to help landowners remove sensitive land from agricultural production by planting long-lived native grass and wildflowers to reduce soil erosion, improve water quality, and provide wildlife habitat.

Turning farmfields into native prairie. Staff photo.

Beginning this spring, a rich diversity of native grasses and wildflowers will take the place of soybeans and corn. We selected a combination of native plant species that suit the current soil

and water conditions. The deep roots typical of native grasses will reduce soil erosion and improve the quality of water entering the nearby marsh and buttonbush swamp. The plantings will also provide abundant habitat for native pollinators, insects, mammals, and birds. The trail system on the preserve will remain the same, so preserve visitors can view all stages of the restoration effort.

This is Legacy's first large-scale ecological restoration project. It will serve as a demonstration for farmers or other landowners who may be interested in returning parts of their land to a more natural state.

The remaining three acres of agricultural land at Johnson Preserve are devoted to two partnerships:

- Dr. Emily Grman of Eastern Michigan University is conducting a long-term prairie restoration experiment to examine weed suppression, native biodiversity, and performance of various seed mixes. These experiments provide hands-on learning for EMU students and will contribute to the science of grassland restoration in southern Michigan.
- Project Grow, a nonprofit that provides community garden space, will create at least ten new garden plots and educational space to increase community members' ability to grow fresh food.

Professor Emily Grman (second from right) and her students have enthusiastically helped clear invasive plants at the preserve to help prevent contamination of their seed plots. Photo by Allene Smith.

On a more personal note, I'm excited to watch all the positive results from returning an ecologically important ecosystem to this site. Developing the plans for this site has given me the opportunity to dig into the field of farmland restoration. We hope you'll stop by Johnson Preserve to see our progress over the coming months and years!

4.6 Working to Protect Water Quality and Restore Native Plant in an Urban Landscape: Challenges and Opportunities

University of Michigan professor emerita Maurita Holland sadly points out the window at the stubby, deer-browsed twigs of a Viburnum bush that used to provide bright red fruits and a perch for the birds she loves to watch. This shrub is one of hundreds of plants that she has worked hard to cultivate in her suburban lawn as she has embraced native plant restoration, stormwater management through rain-gardening, and watershed protection through best practices in yard management and erosion control to protect water quality in Miller Creek, which flows along her property edge and into the Huron River a quarter of a mile away.

Rain garden established summer 2012 (left); by spring of 2013, deer had browsed plants, including 4 native red-osier dogwoods, to stubble.

The pared-back shrub seems like a fitting symbol for the work she's put in to landscape her half-acre yard in Ann Arbor. When she and her partner, Roger, purchased their house at the edge of Ann Arbor 11 years ago, the people who had lived there had an unfenced garden plot with no trouble. Now, she says, that area is constantly browsed by deer, trampled, and as used as a bedding spot. As we look out at the yard, where all of the woody plants and almost every herbaceous plant she's put into the prairie restoration, rain garden, or landscaped edges has been killed by deer browsing over the past few years, 7 deer wander by, pause, then startle and bound off, white tails flagging.

Deer browsing viburnum and wild grape.

Holland is an energetic and optimistic gardener who has embraced the environmental goals promoted by the city with vigor and ceaseless effort. She has taken classes and volunteered for numerous programs in gardening and environmental stewardship—she is a Master Gardener, Advanced Master Gardener (she worked on state gardening hotline for a time), Conservation Steward, and Master Rain Gardener, a member of the Wild Ones native plant society and board president of The Stewardship Network.

She has worked hard to plant native trees and shrubs, as well as to remove turf grass and replace it with prairie species and to contribute to water quality by maintaining natural vegetation buffer—including shrubs—along the stream to help slow water flow, prevent erosion, and filter sediment and nutrients. But every shrub she has planted has been browsed.

But she has grown increasingly frustrated that urban deer negate all her efforts. She has planted hundreds of plants, including dozens of trees and shrubs, only to watch deer browse them so heavily that they died within a season or two. “Deer have been relentless in eating most of the native plantings, now leaving mostly ferns.”

Holly in front of house in 2012, heavily browsed by deer by 2014.

Although this is a non-native landscaping plant, it illustrates the impacts that deer have had on many woody plantings. Notes Holland, "I've lost oak leaf hydrangea, forsythia, native euonymus, redbud, aronia, and spicebush."

Holland recently spoke at a meeting of the Washtenaw County Board of Commissioners to advocate for deer management in the County. She noted that while the County promotes "protection, preservation and management of significant natural resources throughout the County and the stewardship…and improved water quality through County programs that inform citizens and encourage their involvement and action," yet allowing the abundant population of urban deer is working at cross-purposes with these goals.

8-point buck bedded down in back yard; lower branches of tree saplings heavily browsed.

The frustration has spurred her to activism. Holland is one of a core group of Washtenaw County residents who started the Washtenaw Citizens for Ecological Balance (www.wc4eb.org) to provide information about urban deer impacts. She and others in the group have advocated for deer management in Ann Arbor, attending countless meetings and pointing out that deer don't just affect a few gardeners, but may harm a range of environmental stewardship goals. She has participated in the Ann Arbor Garden Tour with a lovingly designed brochure highlighting her gardening efforts and gently noting how even "deer-resistant plants" are heavily browsed in her yard and rain garden. She is even establishing a fenced deer exclosure around half of her rain garden and some of her streamside shrubs so that she can demonstrate deer impacts to skeptical neighbors.

Looking at photos of a heavily browsed tree, Holland vents her frustration at the damage caused by deer on her native plantings. "It's a farce…. While citizens are exhorted to remediate runoff with rain gardens and protect our creeks and waterways, deer destroy the native plantings…. It can't be done."

4.7 Getting Ahead of Oak Wilt

By Allene Smith, Land Steward, Legacy Land Conservancy

You might have heard through the grapevine (or through root grafts, in this case) that Legacy's Reichert Nature Preserve has come down with a case of oak wilt. This 92-acre preserve features rolling wooded terrain, kettle lakes, and frontage along Little Portage Lake and Portage Creek. This property bridges the border of Washtenaw and Livingston Counties and was donated to Legacy Land Conservancy by Dr. Rudy Reichert in 2012. We are beginning remediation of this site in 2017.

What is oak wilt?

Oak wilt is caused by the fungus *Ceratocystis fagacearum* and is most lethal to trees in the red oak group. That brings six of Michigan's native oak species into the crosshairs: northern red oak (*Quercus rubra*), black oak (*Q. velutina*), Hill's oak (a.k.a. northern pin oak, *Q. ellipsoidalis*), pin oak (*Q. palustris*), shingle oak (*Q. imbricaria*), and Shumard oak (*Q. shumardii*). I'm sure you can imagine that losing these species *en masse* would drastically change the natural communities we call home.

Oak wilt is often referenced as a new forest threat, but it was identified in Wisconsin circa 1940. Similar mortality patterns were recorded in Wisconsin and Minnesota as early as 1912. The disease has become more prevalent in the past 20 years, possibly due to changes in land use and forest management.

How oak wilt impacts trees

Once infected, trees wilt and die rapidly, sometimes within weeks. The most visible symptom is leaf scorching and defoliation. Infected trees often drop leaves while they are still green. The following season, fungal mats (known as pressure pads) develop under the surface of the bark.

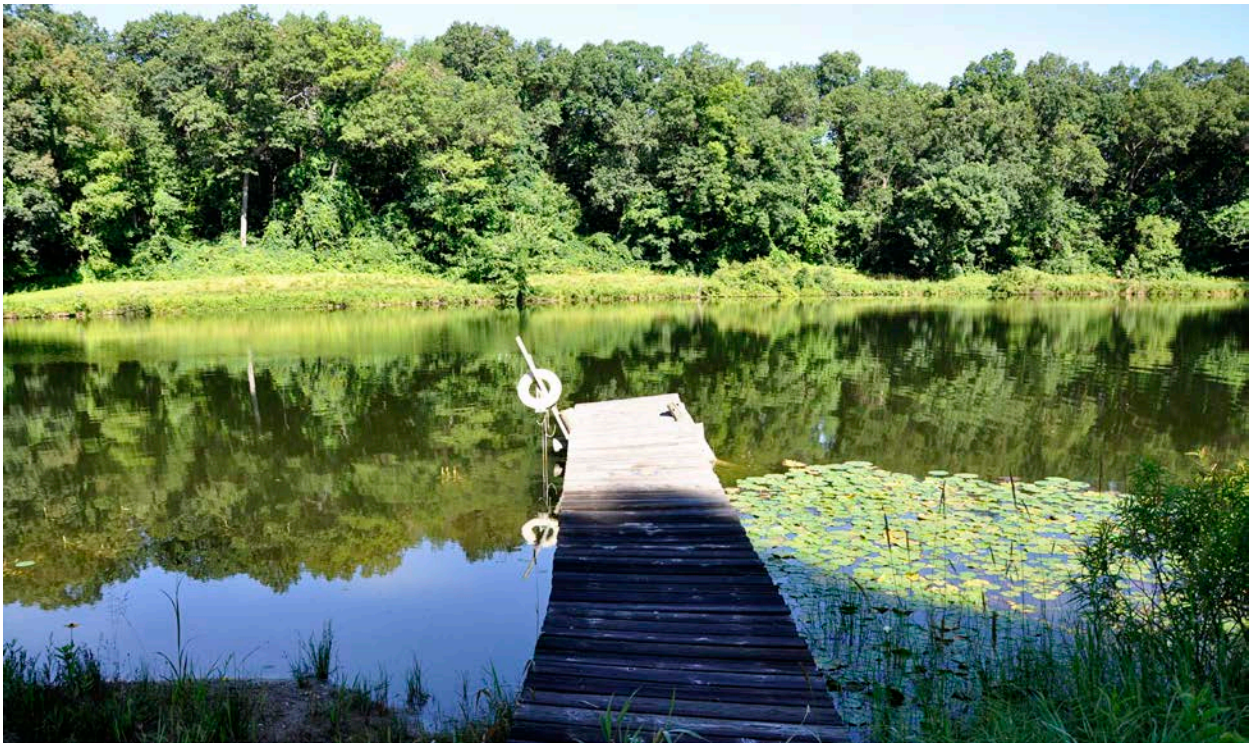
Cracks form and allow sap-feeding beetles access to the sweet, yeasty-smelling fungus beneath. These beetles deposit spores from their fungal frolic on the next oak they visit and the cycle starts anew. Once oak wilt claims one tree in an area, the disease can spread through connections in the trees' root systems, a.k.a. root grafts.

What can we do?

As with other forest management issues, prevention offers the biggest reward. The beetles that spread spores from tree to tree will only visit a freshly wounded tree. Consequently, experts recommend avoiding pruning oaks from just prior to bud opening to after leaf drop (roughly from April to October). If you must prune during the growing season, use wound paint. If you hire a professional tree service, look for one that is aware of oak wilt and doesn't use climbing spikes.

Remediation for oak wilt is costly and drastically disturbs the treated area, making prevention all the more attractive! Preventing infection through conscientious pruning and maintenance of storm-damaged trees has an impact beyond the individual trees you care for—it impacts the entire forest.

There are many other reasons a tree might be ailing, so proper diagnosis is paramount.



Oak trees make up a large portion of the forest at Reichert Nature Preserve. Legacy is treating oak wilt to keep the forest looking as beautiful and healthy as you see here.

4.8 Urban Forest Preserve Showcases Steward's Efforts—and the Need for Deer Management

Urban forests couldn't have a better friend than Kurt Sonen, whose energetic embrace of native plants and ecological restoration has led him to be a nearly full-time volunteer forest steward, managing his own urban woodlot as well as the adjacent 7-acre Hillwood Preserve. He also logs many hours working on removing and controlling invasives in the forests of the nearby University of Michigan Nichols Arboretum—as well as educating and corralling his family and friends to help with some of the work. As he has witnessed deer damage to the many trees and shrubs he has nurtured, he has become an active and articulate advocate for deer management in Ann Arbor.

Sonen, who is a full-time stay-at-home dad, grew up on a hobby farm in Pennsylvania hunting deer, picking apples in the orchard, and roaming nearly 100 acres of woodlands and fields. Though he had a love of nature and trees, he "did the ChemLawn approach" at the first house he owned in Ypsilanti 30 years ago when he was working as an engineer for Ford — "lawns were lawns and not native". Over time, he started leaving that approach. An article in *Parade* magazine about native lawns provided an "aha!" moment that catalyzed learning, while his wife, Megan (a graduate of University of Michigan's School of Natural Resources and the Environment) offered ecological perspectives that helped his views evolve. The couple started gardening with native species, and hired a local ecological restoration firm to help design a native prairie that they planted in the backyard.

When the couple moved, they wanted to be near protected natural areas. They were drawn by the large wooded lot that came with their Ann Arbor house, and by the woods and natural areas nearby—both the Hillwood Preserve and the Nichols Arboretum. Sonen took an early retirement from his job, and dedicated himself to raising his kids and stewarding the forest—sometimes doing both together, getting his kids to help remove invasive shrubs and plant native trees and shrubs.

Although the Hillwood Preserve was maintained, that consisted of trail maintenance and cutting hazard trees until Sonen arrived. For the past 10 years, he has worked hard to broaden the management to include ecological goals and has embraced a full range of forest stewardship activities. There is an annual workday for the neighbors to remove herbaceous weeds in addition to the workday to spread wood chips on the trails. He persuaded neighbors that invasive shrubs should be removed, and one of them contributed his teenage kids to do a first round of shrub cutting. Since then, Sonen has spent countless hours removing more buckthorn and honeysuckle trees and seedlings (as they resprout), as well as other woody and herbaceous invasives, such as garlic mustard and bittercress. He has expanded his knowledge by inviting local experts from nearby Nichols Arboretum to assess the Preserve. With guidance from local experts and his own research (and through attending programs organized by the Stewardship Network, the native plant society Wild Ones, workdays sponsored by the City of Ann Arbor

Natural Area Preservation program, and other local conservation groups), he was able to identify new invasives and to prevent their spread.

Once the dense thicket of invasives had been removed, Sonen planted dozens of trees and shrubs on his own land and throughout the preserve, including shingle and bur oaks, redbud, serviceberry, New Jersey tea, spicebush, native willows, ninebark, and pawpaw. When he found native seedlings, he would transplant them to forest gaps. He restored natural vegetation to the banks of the stream that runs through the Preserve in order to slow erosion and protect water quality. (The stream probably existed historically, but has been significantly altered by housing development and became a stormwater drain for the area; runoff during rainstorms leads to "flashy" conditions that tear away at the banks and dump sediment into the water.)

But right away, Sonen noticed the deer impacts. As soon as he planted trees and shrubs, the deer destroyed them, whether through browsing, antler rubs, or trampling. "My big concern then and now is that there is no regeneration in the forest due to the deer."

Sonen quickly realized that in order to get trees and shrubs to establish, he would have to cage them. The cages had to be installed immediately—deer "stripped a shingle oak [sapling] literally overnight, before I could plant it". Cages had to be solid, sturdy, tall, and supported, or they would be knocked over or browsed through. "I have to fence 2 meters high for the taller trees and shrubs." And sometimes even cages weren't enough—bucks would push over or just ignore cages to get at preferred antler rubs.

Sonen with one of the cages he uses to protect the young trees and shrubs (left)—and shows the deer-browsed branches of New Jersey Tea, a native shrub he protected with a fence that was obviously not high enough (above).

Sonen became active in the local citizens group, Washtenaw Citizens for Ecological Balance (wc4eb.org) that advocates for deer management in Ann Arbor. WC4EB provided facts about deer population growth and the damage occurring in the natural areas to the Ann Arbor City Council, enabling Council to make a decision to manage the deer population. The City is in the midst of a 4-year deer management program, including deer culls in city parks and a surgical sterilization program in two neighborhoods.

Although deer management is underway, Sonen still sees plenty of evidence of deer damage, and knows that management will be an on-going process. He notes that "deer are by far the biggest management challenge" in the preserve, and that part of the challenge is to educate the neighbors to help them understand the damage and accept the need for management. To that end, Sonen has built and maintains two small (2 meter square) exclosure and control plots, which he periodically surveys. "I knew I needed better proof" of deer impacts—"I needed to up my game to show the damage done to trillium and other plants."

Sonen notes that he's benefited from the tremendous resources in Washtenaw County, the knowledge gained from experts and organizations included Wild Ones, the Nichols Arboretum, and local ecological consultants. He is inspired as he sees "the progress I'm making and seeing what's coming back" in the forest ecosystem. "But," he notes, "it is also painful to see the amount of damage the deer are doing, limiting the success" of forest regeneration and of his restoration efforts. "I'm feeling empowered by the success, but frustrated because I know it could be so much more if the deer were successfully managed."

Sonen points to the numerous deer-browsed stems of Virginia creeper just outside one of his fenced deer exclosure demonstration plots.

4.9 University of Michigan Properties Offer Opportunities for Forest Research, Education, and Management—and a Slice of Forest History

University of Michigan (UM) is a major institutional land-holder in the greater Washtenaw County area, including significant acreages of forest. UM owns 1,804 acres of natural areas (apart from campus grounds). These properties include land in Ann Arbor (the Matthaei Botanical Gardens/Nichols Arboretum), various research properties and preserves within the county (Horner-McLaughlin Woods, Mud Lake Bog, the Newcomb Tract, Radrick Forest, Saginaw Forest, Stinchfield Wood), and a 1,300 acre mostly wooded research property (E.S. George Reserve) just north of the Washtenaw County line in Livingston County.

Although all of UM's forest lands are linked in some way to the institution's educational mission, different properties were acquired or donated for purposes ranging from experimental forestry and research to botanical display. Properties are overseen by different departments, and management (or lack of it) has been shaped by evolving trends in faculty and student interest, as well as university resources. Areas such as Saginaw Forest, Stinchfield Woods, and the Newcomb Tract were acquired and managed for forest experimentation from the early 1900s through the 1960s, when UM had a Forestry Department and then a School of Forestry. Efforts on these lands included planting and harvesting different tree species (mostly conifers) and conducting experimental tests of the growth and timber quality of different genotypes (e.g., the International Larch Provenance Test compared performance of several *Larix* species).

When interest in forestry waned or was channeled into broader environmental and natural resource concerns, these properties were left fallow. Today, they still host field classes and occasional research projects (driven by faculty and student interest). They have also become important recreational spaces for the surrounding community. The Nichols Arboretum and Matthaei Botanical Gardens have evolved over time from places where exotic plants could be displayed for the public to having an increasing focus on cultivating, showcasing, and restoring native plants—including oak savannas and a tamarack fen. The E.S. George Reserve, nearly two square miles enclosed by a 10-foot tall deer fence, was the site of ground-breaking research on deer biology in the 1950s through 1970s, and now hosts a long-term forest monitoring plot as well as other forest-related research. A few of these educational and research activities are highlighted below.

Current University of Michigan graduate student Benjamen Lee is working with Inés Ibañez in the School of Natural Resources and the Environment on a project to assess short-term tree recruitment in a changing climate. Lee is monitoring thousands of red oak and sugar maple seedlings that have been transplanted into Saginaw Forest and 11 other sites, including several UM properties in Washtenaw and northern Michigan. Twice a season, he visits the sites to relocate the small seedlings, which can be difficult when they have died back. He assesses seedling growth and checks soil moisture at the site. In addition, an array of climate instruments set up for each plot gather a constant stream of data on light, temperature, and relative humidity. Ibañez has separate on-going research projects that examine forest mycorrhizal associations along an urban to rural continuum and assess how disturbance and

urban conditions might affect tree performance mediated by beneficial fungi. She also has proposed a long-term forest monitoring project across all UM-owned properties to look at forest response to climate change.

Left: Benjamen Lee revisits tree seedling plots in Saginaw Forest, checking previous data on his clipboard and monitoring soil moisture by each seedling. Center: Tag marking red oak (*Quercus rubra*) that has died back. Right: Instruments measure temperature, humidity, and light year-round.

Larch plantation on the Newcomb tract dating from the International Larch Provenance Test, initiated in 1958 conducted by UM forest ecologist Burt Barnes and colleagues from 1958–1977. Plot markers and maps are no longer easily available, so it is not which *Larix* species glowed in the autumn sun (likely *Larix siberica*, but cones had not fallen to allow definitive species identification).

Sylvia Taylor, shown here with University of Michigan students in a field ecology class at the E.S. George Reserve, is a retired DNR wildlife biologist who was the first coordinator of Michigan's Endangered Species Program. She did her dissertation work on the ecology of ash trees (*Fraxinus* species) in Washtenaw County, including on the Matthaei Botanical Gardens property, and was the first to document hybrids of white and green ash. In her retirement, she has returned to Matthaei Botanical Gardens to study ash, this time searching for whether there are genotypes resistant to the Emerald Ash Borer.

David Allen (now a professor at Middlebury College) completed dissertation research in forest ecology at the E.S. George Reserve. Together with UM faculty members John Vandermeer and Ivette Perfecto, he set up a long-term forest monitoring project to assess forest succession and understory tree distribution in an oak-hickory forest that now appears to be transitioning to red maple and black cherry, with witch hazel dominant in the understory.

David Allen describes different types of insect herbivory on witch hazel to students in a field ecology class.

Left: Burnham project on woody and herbaceous vines and climbing plants, in eastern deciduous forests (Photo: E.S. George Reserve, https://sites.lsa.umich.edu/esgr/research-projects/burnham-project/). Right: Burnham searching for lianas along a transect in an oak forest invaded by autumn olive (Photo: J. Courteau)

4.10 Neighbors Unite for Conservation Easement to Protect Woodlands, Wetlands, and Wildlife Habitat

Cynthia Zuccaro & Ernie Becker

"The smartest thing I ever did was place my land in a conservation easement," says Webster Township resident Cynthia Zuccaro. She and her husband, Ernie Becker, placed their own 33 acres, a mix of forest and wetlands, in a conservation easement with what was then the Potawatomi Land Trust (now Legacy Land Conservancy). And then, when adjacent land was for sale several years ago, the Zuccaro/Beckers and two neighbors pooled resources to buy the land and place it into a conservation easement to prevent further development. Together, Zuccaro, Becker, and their neighbors have protected a 65-acre patch of natural area. "The building [boom during the early 2000s] was insane," notes Zuccaro. "We loved that land and wanted it as a wildlife corridor. I hated that there wasn't space for other creatures."

Zuccaro's love of animals is apparent from the moment you drive up the dirt road onto her curving driveway, where free-range chickens greet visitors with inquiring clucks and an elaborate set of interconnected wooden sheds offers shelter for the chickens as well as a rabbit hutch for rescued bunnies. She delights in the birds and other wildlife that she views on daily walks with her dogs through the property.

On a walk in November, Zuccaro enthusiastically points out some of her favorite plants, or the sites where she has seen them, noting their beauty and herbal/medicinal uses. She indicates a wet patch where yellow iris grows, and describes how there used to be more tamarack in the wetland, but it died back with the larch sawfly outbreak in the late 1990s. She was pleased to see a nice-sized larch with a glorious autumnal gold cape of deciduous needles. She pauses by a favorite tree on a sandy hillside, a black oak barren peninsula jutting into the wetlands, and points out the nearby picnic table. "There is something special about this spot, she says, describing time spent with Becker as well as friends on campfires and picnics, evenings watching sunsets, and snowshoeing during winter.

Zuccaro and Becker recall first reading a newspaper article about the Potawatomi Land Conservancy during the 1990s, and deciding that they wanted to protect their land. They initially put 14 acres into a conservation easement, and that spurred interest among their neighbors, who put an easement on part of their property. They purchased more land and put it into an easement as well, and then when an intervening piece of property became available, the neighbors worked together to purchase it, which the owner/seller offered at a reduced rate because he was able to get tax benefits stemming from the fact that the land price was reduced because of the conservation easement. The joint arrangement required complicated legal work to clarify the deed, and on-going management requires continuing negotiations, such as where to put the deer blind for the bowhunter who they've permitted to help control the deer herd.

Zuccaro and Becker are learning about their woodlands and wetlands, as well using them for recreation and limited firewood harvests. They sought out an ecological assessment through the

Huron River Watershed's Bioreserve Project, which helped identify the natural communities and species on the land, and noted the presence of invasive species that could pose a management challenge. Zuccaro notes that for years, she pulled garlic mustard, but she finds that it only comes back stronger. And she does not actively combat the autumn olive—she enjoys eating the fruits herself, and notes that they contain high levels of Vitamin C, and that wildlife enjoy eating them, so she figures they can't be all bad. The couple takes pride in the fact that they have been able to preserve their woodland and wetland property, so that they and wildlife can continue to enjoy it into the future.

Top: Zuccaro's dogs trot ahead on the trail through a mature oak woodland protected by conservation easement.

Right: Zuccaro pauses by a favorite tree.

Left: The autumn gold of tamaracks shows that trees are starting to recover following declines linked to the larch sawfly in the late 1990s and early 2000s.

Right: Signs for eggs and the conservation easement show the Zuccaro/Beckers interest in animals and the land.

LOCAL

LOCAL EDITOR
Tom Krisher
can be reached at
(734) 994-6872
Fax: (734) 994-6879

Webster land enrolled in trust

By WILL STEWART
NEWS STAFF REPORTER

Cyndi Zuccaro and Ernie Becker love the stream that runs through the back of their Webster Township homestead. They love the wetland that surrounds the stream and the upland forest that provides habitat for deer and other wildlife.

And they especially love the fact that it's going to stay that way, even when they no longer own the land.

Zuccaro and Becker are among a growing number of local landowners, who are guaranteeing the future of their property through conservation programs designed to protect open space and farmland from development.

"It enables us to know that it will always look like this," said Becker, looking over his 20-acre spread from the balcony of the house he built. "When you consider all the development that's happening all around us, that's a comforting thought."

THE CHANGING LANDSCAPE

Another in an occasional series relating to the housing boom in rural Washtenaw and Livingston counties

Becker and Zuccaro are the first landowners in burgeoning Webster Township to enroll property in the Washtenaw-Potawatomi Land Trust, a nonprofit organization dedicated to preserving open space.

By signing over the so-called "conservation easement," the couple have forfeited the right to develop their property. A document will be attached to the deed restricting future owners from developing it, too.

The conservation easement allows Becker and Zuccaro to deduct from their federal income taxes the value those development rights would have added to their property.

But more importantly, they said, it provides them with peace of mind.

"We did it for reasons of the heart," Zuccaro said. "We knew we weren't going to develop it, but you never know what might happen sometime in the future.

"Now we know."

Barry Lonik, executive director of the Wash-

See TRUST, B2

Cyndi Zuccaro, left, and her husband, Ernie Becker, on the deck of their Webster Township home overlooking the conservation easement on their land which they donated to the Washtenaw Potawatami Land Trust.

NEWS PHOTO
SON NORWEDEL

Left: An article in the *Ann Arbor News* (March 19, 2000) described the Zuccaro-Beckers land conservation efforts; the article led to further interest and more land place in conservation easements.

5. Develop Your Own Story: Resources and Services for Landowners

A variety of programs and informational resources are offered by state and federal resource agencies and nonprofit conservation organizations to help you take the next steps toward meeting your own land stewardship goals.

5.1 Forest Stewardship Program

The Forest Stewardship Program was created by the USFS in 1991 to encourage long-term stewardship of family forest land by providing professional planning and technical assistance to private landowners. Ultimately, the purpose of the program is to enhance and sustain the long-term productivity of forest resources and produce healthy and resilient forest landscapes. As part of the process, landowners work with a certified Forest Stewardship Plan Writer to develop a custom plan that describes your personal land stewardship goals, unique forest resources and suggested management activities.

There are many benefits to developing a Forest Stewardship Plan, including enhanced access to USDA conservation programs, forest certification programs, and forest product and ecosystem service markets. For example, you can use your Forest Stewardship Plan to prepare for a timber sale, improve wildlife habitat, or to enroll in other programs that require a forest management plan. Participation in the Forest Stewardship Program is voluntary and landowners can obtain information and cost-share assistance throughout the year.

Administration of the Forest Stewardship Program varies by state. In Michigan the program is administered by the Michigan DNR, who trains and certifies 130 professional foresters and 15 wildlife biologists in the private sector to write simple yet comprehensive Forest Stewardship Plans. Since 1991, almost 5,000 Michigan landowners have used their Forest Stewardship Plan to help them to protect, manage, and enjoy their forest.
Visit www.michigan.gov/foreststewardship to connect with a certified plan writer and take your next step toward managing your land to meet your stewardship goals. More information about the program can also be found at http://www.fs.fed.us/spf/coop/programs/loa/fsp.shtml/.

5.2 American Tree Farm System

The American Tree Farm System is a certification program of the American Forest Foundation that acknowledges land management practices meeting certain Standards of Sustainability. As part of this program, a network of more than 82,000 family forest owners sustainably managing 24 million acres of forestland across the country. The American Tree Farm System is recognized by the Programme for the Endorsement of Forest Certification, which is an international forest certification system. Landowners following the Standards of Sustainability can feel proud to be recognized as ambassadors for sustainable woodland stewardship.

The eight Standards of Sustainability that must be met in order to gain recognition as a certified tree farm under the American Tree Farm System program are listed below. An approved Forest

Stewardship Plan completed through the Forest Stewardship Program or a qualifying NRCS incentives programs can be written to also serve as a qualifying forest management plan under the American Tree Farm System. There is no additional cost to be enrolled in the American Tree Farm System certification program. For more information please visit www.treefarmsystem.org.

- **Commitment to Practicing Sustainable Forestry**: Landowner demonstrates commitment to forest health and sustainability by developing a forest management plan and implementing sustainable practices.
- **Compliance with Laws**: Forest-management activities comply with all relevant federal, state, and local laws, regulations, and ordinances.
- **Reforestation and Afforestation**: Landowner completes timely restocking of desired species of trees on harvested sites and nonstocked areas where tree growing is consistent with land-use practices and the landowner's objectives.
- **Air, Water and Soil Protection**: Forest-management practices maintain or enhance the environment and ecosystems, including air, water, soil, and site quality.
- **Fish, Wildlife and Biodiversity**: Forest-management activities contribute to the conservation of biodiversity.
- **Forest Aesthetics**: Forest-management activities recognize the value of forest aesthetics.
- **Protect Special Sites**: Special sites are managed in ways that recognize their unique historical, archaeological, cultural, geological, biological, or ecological characteristics.
- **Forest Product Harvests and Other Activities**: Forest product harvests and other management activities are conducted in accordance with the landowner's objectives and consider other forest values.

5.3 Qualified Forest Program

The purpose of the Qualified Forest Program, administered by MDARD, is to encourage landowners to actively manage their privately owned forests for commercial harvest, wildlife habitat enhancement, and improvement of other non-forest resources. In exchange for managing their forests in a sustainable fashion, enrolled landowners will receive an exemption from the local school operating millage. In order to qualify for the program, landowners must have between 20 and 640 acres, have an approved forest management plan, and must comply with the prescriptions included in that plan. See www.michigan.gov/qfp for more information or to begin the enrollment process. The application deadline in order to receive tax benefits the following year is September 1.

5.4 Commercial Forest Program

The Commercial Forest Act gives property tax breaks for forest owners in Michigan that voluntarily enroll in the Commercial Forest Program. Under this program, landowners pay a specific rate of $1.25 per acre for property taxes and the State of Michigan pays counties another $1.25 per acre. Landowners must have at least 40 acres of contiguous forest, an appropriate

forest management plan, and conduct commercial harvests as prescribed in their plan. Land that is included under the Commercial Forest Program must be open to the public for non-motorized recreational use. More information about this program, which is administered by the MDNR, is available online at www.michigan.gov/commercialforest. The application deadline in order to receive tax benefits the following year is April 1.

5.5 Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is a voluntary conservation program administered by the USDA Natural Resources Conservation Service. It supports production agriculture and environmental quality as compatible goals. Through EQIP, farmers, ranchers, private forest land owners and federally-recognized American Indian tribes may receive financial and technical assistance to implement structural and land management conservation practices on eligible agricultural land.

Program priorities aim to address resource concerns including soil erosion, soil quality, water quality degradation, plant productivity, habitat fragmentation, invasive plants, and forest health. Conservation practices related to forestry may include forest trails and landings, stream crossings, riparian forest buffers, forest stand improvement, tree and shrub establishment, brush management, early succession habitat, wetland wildlife habitat, and upland wildlife habitat. EQIP activities are carried out according to a site specific conservation plan developed in conjunction with the producer. Forest Stewardship Plans are accepted by the NRCS when applying for EQIP funding. All conservation practices are installed according to NRCS technical standards.

Contact your local District Conservationist or forester for information and enrollment forms for EQIP or other USDA-NRCS assistance programs. For more information please visit www.nrcs.usda.gov/wps/portal/nrcs/main/mi/programs/.

5.6 Best Management Practices for Forest Health, Water Quality and Wildlife

Best Management Practices (BMPs) are stewardship activities that are generally accepted by resource professionals to be the most effective and up-to-date management practices available for protecting forest health, water quality, and wildlife habitat. Local agencies and organizations can help you select appropriate BMPs to meet your land management objectives. Financial and technical assistance may be available to help you implement certain BMPs on your land, while other BMPs are simple things you can do on your own to become a better steward of your land.

One such program is the *Forest, Wetlands, and Habitat-A-Syst (Assessment System)*, developed under the Michigan Agriculture Environmental Assurance Program (MAEAP) for farmers whose lands include forests, wetlands, and wildlife habitat. The voluntary program, aimed at preventing pollution, guides landowners through steps they can take to assess environmental

risks and incorporate best management practices. The Washtenaw County Conservation District can offer advice and support in using the program (see contact information below).

Table 5.1, below, makes it easy for you to get in touch with the local agency and nonprofit organization contacts that can help you enroll in any of the programs mentioned above, develop your Forest Stewardship Plan, and identify and implement on-the-ground Best Management Practices that will allow you achieve your own management objectives while also protecting and enhancing Michigan's unique Jack Pine Landscape.

Table 5.1: Forest Stewardship Contacts serving Washtenaw County, MI

Organization	Contact	Email	Phone
Stewardship Network	Jason Frenzel and Michael Benham, Huron-Arbor cluster coordinators	HuronArbor@ StewardshipNetwork.org	
Website: stewardshipnetwork.org			
Comments: The Stewardship Network is a non-profit organization providing tools, resources and funding in order to increase the collective regional impact of local conservation efforts. This award-winning approach to solving local, regional and global issues surrounding our natural areas has been developed over the course of 18 years. Our community-based, collaborative model is unique among the conservation world, as we ask the critical question "What do you need to increase capacity to care for land and water?" We are not driven by a single species or issue and instead focus on revitalizing the system as a whole, including forest stewardship among these efforts. Huron-Arbor cluster activities in Washtenaw County feature educational events and field hikes (2017 topics will include sessions on oak wilt, vegetation monitoring, edible plants, and new invasive species), monthly Steward's Circles, for education and conversation around topics such as invasive species, prescribed fire, and forest health, and an event calendar that allows conservation partners to post notices for stewardship workdays and other events.			
Michigan DNR, Forest Stewardship Program	Mike Smalligan, Forest Stewardship Coordinator	SmalliganM@michigan.gov	(517) 284-5884
Website: www.michigan.gov/foreststewardship			
Comments: The Michigan DNR is heavily involved with forest stewardship in Michigan. MDNR manages state forests and recreational areas under its ownership and also offer a variety of forms of assistance for private landowners. MDNR administers the Forest Stewardship Program in the state of Michigan and can help you find certified Forest Stewardship Plan Writers and guide you through the process of developing and implementing a forest stewardship plan and enrolling in other forestry related assistance programs.			
USDA–NRCS (Washtenaw)	District Conservationist	7203 Jackson Road Ann Arbor, MI 41803	734-205-0537
Website: http://www.nrcs.usda.gov/wps/portal/nrcs/main/mi/programs/financial/eqip/			
Comments: USDA-Natural Resources Conservation Service offers a variety of technical and financial assistance programs for landowners, including agricultural producers and private forest landowners. The Environmental Quality Incentives Program (EQIP) helps landowners address resource concerns including soil erosion, soil quality, water quality degradation, plant			

	productivity, habitat fragmentation, invasive plants, and forest health. Structural and land management practices are eligible under the EQIP program.		
Washtenaw County Conservation District	Dennis Rice, District Manager	dennis.rice@mi.nacdnet.net	734-761-6721 extension 5
	Website: https://www.washtenawcd.org		
	Comments: Michigan's conservation districts receive grant funding from MDARD through the Forestry Assistance Program to provide education and one-on-one technical assistance to private land owners and to communities regarding local forest health issues. Conservation District Foresters help Michigan citizens better understand, plan, manage, protect and utilize their forest resources. The primary goal of the Forestry Assistance Program is to increase the active management of Michigan's non-industrial private forest lands. Conservation Districts also work closely with various partners to provide educational workshops, connect landowners with agricultural stewardship cost-share opportunities and sell trees and other native plants.		
Michigan Department of Agriculture and Rural Development (MDARD)	Qualified Forest Program	MDARD-QFP@michigan.gov	517-284-5630
	Website: https://www.michigan.gov/mdard/0,4610,7-125-1599_28740---,00.html		
	Comments: MDARD administers the Qualified Forest Program as well as the Forestry Assistance Program, which provides grant funding to Conservation Districts to help them connect landowners with forest stewardship opportunities. Contact MDARD for more information about the Qualified Forest Program.		
Huron River Watershed Council	Kris Olsson Bioreserve Project	kolsson@hrwc.org	(734) 769-5123 x 607
	Website: www.hrwc.org		
	Comments: HRWC's Bioreserve Project offers free field assessments to landowners interested in finding out about the forests, grasslands, and wetlands on their properties. Conducted by trained volunteers, the assessments help identify valuable natural communities and species, as well as invasive species, and can suggest general management strategies. Landowners with 10 acres or more of natural (non-agricultural) areas on their land can request a voluntary assessment, or can attend a training session to learn how to do one. Contact Kris Olsson for details.		

5.7 Capital Gains Tax Information

Profits from timber sales are taxed as capital gains, rather than ordinary income, if you own the timber for more than twelve months. Expenses, including the cost of a management plan or a consulting forester's fees for a timber sale, can be deducted from profits. There are many great tax related resources available on www.timbertax.org, including the most recent edition of the annual "Tax Tips for Forest Landowners."

Appendix A: Glossary of Common Forestry Terms

The following glossary is adapted from www.dnr.state.md.us/forests/gloss.html.

Agroforestry - a land-use system that combines both agriculture and forestry in one location.
Alley Cropping - widely spaced rows of trees with annual crops growing in between the rows.
Basal Area (Tree) - cross sectional area of a tree at 4.5 feet off ground in units of square feet (ft^2).
Basal Area (Forest) - basal area of all trees per acre summed up, in units of ft^2/acre; measure of density.
Biomass – harvesting and using whole trees or parts of trees for energy production
Board Foot – a measure of volume 1 foot by 1 foot by 1 inch or 144 cubic inches of wood.
Bolt – 8 foot long log
Browse - parts of woody plants, including twigs, shoots, and leaves, eaten by forest animals.
Carbon Cycle – the biogeochemical cycle to exchange carbon between the biosphere and atmosphere by means of photosynthesis, respiration and combustion.
Clearcut - the harvest of all the trees in an area to reproduce trees that require full sunlight.
Cord - a unit of wood cut for fuel that is equal to a stack 4 x 4 by 8 feet or 128 cubic feet
Cordwood - small diameter or low quality wood suitable for firewood, pulp, or chips.
Crop Tree - a young tree of a desirable species with certain desired characteristics.
Crown - the uppermost branches and foliage of a tree.
Cruise - a forest survey used to obtain inventory information and develop a management plan.
Cull - a sawtimber size tree that has no timber value as a result of poor shape or damage.
Diameter at Breast Height (DBH) - diameter of a tree trunk taken at 4 1/2 feet off the ground.
Diameter-Limit Sale - a timber sale in which all trees over a specified DBH may be cut. Diameter-limit sales often result in high grading and is a very poor forestry practice.
Endangered Species – a species in danger of extinction.
Even-Aged Stand - stand with age difference between oldest and youngest trees is minimal (<10 years).
Food forest – an agroforestry or permaculture cropping system in which woody plants that produce food (including fruit and nut trees and berry-producing shrubs) are intermingled with other perennial and annual food plants in a way that mimics natural forest ecosystem structure.
Forestland – land at least one acre in size that is at least 10 percent stocked with trees.
Forest Farming - cultivating high value specialty crops in the shade of natural forests.
Forest Stand Improvement (FSI) - any practice that increases the health, composition, value or rate of growth in a stand. Also called Timber Stand Improvement when focused on timber**.**
Group Selection - harvesting groups of trees to open the canopy and encourage uneven aged stands.
Habitat - the ecosystem in which a plant or animal lives and obtains food and water.
Hardwoods - a general term encompassing broadleaf, deciduous trees.
High Grading - to remove all good quality trees from a stand and leave only inferior trees.
Intolerance - characteristic of certain tree species that does not permit them to survive in the shade.
Landing - cleared area where logs are processed, piled, and loaded for transport to a sawmill.

Log Rule - a method for calculating wood volume in a tree or log by using its diameter and length. Scribner, Doyle and the International 1/4-inch rule are common log rules.
Lump-Sum Sale - a timber sale in which an agreed-on price for marked standing trees is set before the wood is removed (as opposed to a mill tally or unit sale).
Mast - nuts and seeds such as acorns, beechnuts, and chestnuts that serve as food for wildlife.
Non-timber forest products – include forest plant products harvested for food (such as nuts, berries, maple sugar), medicine, crafts, or purposes other than commercial timber. The website http://www.ntfpinfo.us offers information on hundreds of uses for more than 1,000 forest species.
Over-mature - trees that have declined in growth rate because of old age and loss of vigor.
Overstocked - trees are so closely spaced that they do not reach full growth potential.
Pole Timber - trees 4 to 10 inches DBH.
Pre-Commercial Operations - cutting to remove wood too small to be sold.
Prescribed Fire – an intentional and controlled fire used as a management tool used to reduce hazardous fuels or unwanted understory plants (invasive, undesirable species, etc.).
Pulpwood - wood suitable for use in paper manufacturing.
Range - cattle grazing in natural landscapes.
Regeneration - the process by which a forest is reseeded and renewed.
Riparian Forest Buffers - strips of land along stream banks where trees, shrubs and other vegetation are planted and managed to capture erosion from agricultural fields.
Salvage Cut - the removal of dead, damaged, or diseased trees to recover value.
Sapling - a tree at least 4 1/2 feet tall and between 1 inch and 4 inches in diameter.
Sawlog - log large enough to be sawed economically, usually >10"diameter and 16' long.
Sawtimber stand - a stand of trees whose average DBH is greater than 11 inches.
Sealed-Bid Sale - a timber sale in which buyers submit secret bids.
Seed-Tree Harvest - felling all trees except for a few desirable trees that provide seed for the next forest.
Selection Harvest – harvesting single trees or groups at regular intervals to maintain uneven-aged forest.
Shelterwood Harvest – harvesting all mature trees in two or more cuts, leaving trees to protect seedlings.
Silvopasture - growing trees and improved forages to provide suitable pasture for grazing livestock.
Silviculture - the art and science of growing forest trees.
Site Index - measure of quality of a site based on the height of a dominate tree species at 50 years old.
Site Preparation - treatment of an area prior to reestablishment of a forest stand.
Skidder - a rubber-tired machine with a cable winch or grapple to drag logs out of the forest.
Slash - branches and other woody material left on a site after logging.
Snag - a dead tree that is still standing and provide food and cover for a variety of wildlife species.
Softwood - any gymnosperm tree including pines, hemlocks, larches, spruces, firs, and junipers.

Species of Special Concern – not threatened or endangered yet, but has low or declining populations.
Stand - a group of forest trees of sufficiently uniform species composition, age, and condition to be considered a homogeneous unit for management purposes.
Stand Density - the quantity of trees per unit area, evaluated in basal area, crown cover or stocking.
Stocking - the number and density of trees in a forest stand. Classified as under-, over-, or well-stocked.
Stumpage Price - the price paid for standing forest trees and paid prior to harvest.
Succession - the replacement of one plant community by another over time in the absence of disturbance.
Sugarbush – plantation of sugar maples, or woodlot managed for maple syrup production.
Sustained Yield - ideal forest management where growth equals or exceeds removals and mortality.
Thinning - partial cut in an immature, overstocked stand of trees to increase the stand's value and growth.
Threatened Species - a species whose population is so small that it may become endangered.
Timberland - forest capable of producing 20 ft^3 of timber per acre per year.
Tolerance – the capacity of a tree species to grow in shade
Under-stocked - trees so widely spaced, that even with full growth, crown closure will not occur.
Understory - the level of forest vegetation beneath the canopy.
Uneven-Aged Stand - three or more age classes of trees represented in a single stand.
Unit Sale - a timber sale in which the buyer makes regular payments based on mill tally and receipts.
Veneer Log - a high-quality log of a desirable species suitable for conversion to veneer.
Well-Stocked – stands where growing space is effectively occupied but there is still room for growth.
Windbreaks - rows of trees to provide shelter for crops, animals or farm buildings.

Appendix B: Forest Laws and Programs

Federal and State Laws Related to Forest Management

- USA - Federal Insecticide, Fungicide, and Rodenticide Act, 1947
- USA - National Historic Preservation Act, 1966
- USA - Clean Water Act, 1948 and 1972
- USA - Endangered Species Act, 1973
- MI - Michigan Pesticide Control Act, Public Act 171 of 1976
- MI - Natural Resources and Environmental Protection Act, Public Act 451 of 1994
- MI - Right to Forest Act, Public Act 676 of 2002

Michigan Laws Related to Forestry

This is a partial list of Michigan laws related to forestry:

- Natural Resources and Environmental Protection Act, Public Act 451 of 1994
- Right to Forest Act, Public Act 676 of 2002
- Commercial Forest Act, Parts 511 and 512 of Public Act 451, 1994, as amended
- Qualified Forest Program, Public Acts 42 and 45 of 2013

Forest Health

The MDNR publishes the annual "Forest Health Highlights" that has information about the forest insect and disease problems in Michigan. See www.Michigan.gov/ForestHealth for a pdf of the most recent edition. To report an unusual insect or disease in your forest, please email several photos to DNR-FRD-Forest-Health@Michigan.gov.

MDNR Forest Health - www.Michigan.gov/ForestHealth
MDNR Invasive Species Info - www.Michigan.gov/InvasiveSpecies
MDARD Exotic Forest Pests – www.Michigan.gov/ExoticPests
USFS Forest Health - http://fhm.fs.fed.us/

Forest Best Management Practices

Best Management Practices (BMPs) are guidelines published by the State of Michigan to protect Michigan's water resources from non-point source pollution and erosion while working on forest land. BMPs are now called "Sustainable Soil and Water Quality Practices on Forest Land" and the document is online at www.Michigan.gov/PrivateForestLand. BMPs include proper location and construction of logging roads, the use of riparian management zones, installation of culverts and other stream crossings, proper use of pesticides and other chemicals, and site preparation for planting. BMPs also include the proper seasonal timing of activities to minimize the spread of insects or disease. Any forest management activities should minimize soil erosion near wetlands and surface water. Tree Farm certification requires compliance with best management practices.

Qualified Forest Program

The Qualified Forest Program (Public Acts 42 and 45 of 2013, as amended) exempts forest owners from paying local millage taxes up to 18 mills in each tax jurisdiction (township). Landowners must have between 20 and 640 acres, a forest management plan, and agree to comply with their forest management plan. Landowners must report harvests to the Michigan Department of Agriculture and Rural Development after they occur. A Forest Stewardship Plan is accepted by the Qualified Forest program. See www.Michigan.gov/QFP for information and enrollment forms. The application deadline is September 1 for tax benefits in the following year.

Commercial Forest Program

The Commercial Forest Program offers a specific property tax of $1.25 per acre (Parts 511 & 512 of Public Act 451, 1994, as amended). Landowners must have at least 40 acres of forest, a forest management plan, conduct commercial harvests as prescribed in the plan, and allow public foot access for hunting and fishing. Landowners must notify the MDNR before they harvest forest products. A Forest Stewardship Plan is accepted by the Commercial Forest program. For more information and enrollment forms, see www.Michigan.gov/CommercialForest. The application deadline in April 1 for tax benefits in the following year.

Financial Assistance Programs

The Natural Resources Conservation Service (NRCS) administers several programs such as the Environmental Quality Incentives Program (EQIP) or Conservation Stewardship Program (CSP) that may provide financial assistance to forest owners to implement "conservation practices" to address "resource concerns" on their land. Landowners must have an approved forest management plan prior to enrolling. Forest Stewardship Plans are accepted by the NRCS when applying for EQIP funding, although they do not require the same level of detail as NRCS conservation activity plans. Work with your NRCS District Conservationist and forester to fill out supplemental "Job Sheets." See www.mi.nrcs.usda.gov/technical/forestry.html for info. Some of the recommended activities in this plan have potential for financial assistance. NRCS forestry "conservation practices" include forest trails and landings, stream crossings, riparian forest buffers, stream habitat improvement, forest stand improvement, tree and shrub establishment, brush management, early succession habitat, wetland wildlife habitat, and upland wildlife habitat. NRCS conservation practices address "resource concerns" (environmental problems) like soil erosion, soil quality, water quality degradation, plant productivity, habitat fragmentation, invasive plants, forest health, etc. Contact your local NRCS Service Center to apply for financial assistance (see www.nrcs.usda.gov/wps/portal/nrcs/main/mi/contact/local).

Forest Economics

Capital Gains Tax Information. Profits from timber sales are taxed as capital gains, rather than ordinary income, if you own the timber for more than twelve months. Expenses, including the

cost of a management plan or a consulting forester's fees for a timber sale, can be deducted from profits. There are many great tax related resources available on www.TimberTax.org, including the most recent edition of the annual "Tax Tips for Forest Landowners."

American Tree Farm System

The American Tree Farm System offers private land-owners the opportunity to certify exemplary and sustainable forest management. A free inspection from one of the 138 Tree Farm Inspecting Foresters is required to enroll. This Forest Stewardship Plan complies with the Farm System's eight Standards of Sustainability listed below. See www.TreeFarmSystem.org for information about the Tree Farm program, forest certification, and the full Standards of Sustainability.

1. **Commitment to Practicing Sustainable Forestry.** Forest owner demonstrates commitment to forest vitality by developing and implementing a sustainable forest management plan.
2. **Compliance with Laws.** Forest management activities comply with all relevant federal, state and local laws, regulations and ordinances.
3. **Reforestation and Afforestation.** Forest owner completes timely restocking of desired species of trees on harvested sites and non-stocked areas where tree growing is consistent with land use practices and the forest owner's management objectives.
4. **Air, Water, and Soil Protection.** Forest management practices maintain or enhance the environment and ecosystems, including air, water, soil and site quality.
5. **Fish, Wildlife and Biodiversity.** Forest management activities contribute to the conservation of biodiversity.
6. **Forest Aesthetics.** Forest management plans and management activities recognize the value of forest aesthetics.
7. **Protect Special Sites.** Special sites are managed in ways that recognize their unique historical, archeological, cultural, geological, biological or ecological characteristics.
8. **Forest Product Harvests and Other Activities.** Forest product harvests and other management activities are conducted in accordance with the management plan and consider other forest values.

Notes, Records, Updates or Modifications

Appendix C: Historic and Archaeological Sites

In 1966, in response to growing public interest in historic preservation, Congress passed the National Historic Preservation Act (NHPA of 1996, amended 1980, 1992 [USC Sec. 470-470t]). The act required that each state establish a SHPO and that the governor of each state appoint an officer to oversee the preservation activities. Each year Michigan receives a Historic Preservation Fund grant from the National Park Service to operate its program. The Michigan SHPO identifies, evaluates, registers, interprets and protects the state's historic properties.

Michigan's SHPO was established in the late 1960s. Its main function is to provide technical assistance to local communities in their efforts to identify, evaluate, designate, and protect Michigan's historic above- and below- ground resources. The SHPO also administers an incentives program that includes state and federal tax credits and pass-through grants available to Certified Local Governments. The SHPO is led by the state historic preservation officer, who is designated by the governor to carry out provisions of the Historic Preservation Act of 1966, as amended. The SHPO's programs are funded through a Historic Preservation Fund grant, an annual federal matching grant administered by the National Park Service.

The SHPO programs are funded, in part, with federal funds from the National Park Service, U.S. Department of the Interior. However, the contents and opinions herein do not necessarily reflect the views or policies of the Department of the Interior, nor does the mention of trade names or commercial products constitute endorsement or recommendation by the Department of the Interior. Under Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, and the Age Discrimination Act of 1975, as amended, the U.S. Department of the Interior prohibits discrimination on the basis of race, color national origin, or disability or age in its federally assisted programs. If you believe you have been discriminated against in any program, activity, or facility as described above, or if you desire further information, please write to: Office for Equal Opportunity, National Park Service, 1849 C Street, N.W., Washington, DC 20240.

Appendix D: Wildlife Species and Habitat Management

The MDNR Wildlife Division has an excellent publication on managing wildlife habitat at www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/Landowners_Guide/index.htm.
MDNR Wildlife Division – www.Michigan.gov/Wildlife
Michigan United Conservation Clubs - https://mucc.org
Quality Deer Management Association – www.qdma.com
Audubon Society - www.MichiganAudubon.org
Foresters for the Birds – http://vt.audubon.org/foresters-birds
Ruffed Grouse Society - www.RuffedGrouseSociety.org
National Wild Turkey Federation - www.nwtf.org
Michigan Trout Unlimited – www.MichiganTU.org
US Fish and Wildlife Service - www.fws.gov/partners

Game Species in Washtenaw County

Hunting

Cottontail Rabbit and/or Snowshoe Hare
Crow
Deer
Pheasant
Quail
Ruffed Grouse
Squirrel, Fox and Gray (black phase included)
Woodcock
Opossum
Porcupine
Weasel
Red Squirrel
Skunk
Ground Squirrel
Woodchuck
Feral Pigeons
Starlings
House Sparrows
Wild Turkey
[Feral Swine]

Fur Harvest, Hunting

Coyote

Fox, Gray and Red

Raccoon

Fur Harvest, Trapping

Badger

Beaver

Coyote and Fox Gray and Red Fox

Fisher/Marten

Muskrat and Mink

Otter

Raccoon

Fish Species in Washtenaw County

Common Name	Genus, Species	Watershed	Found in 5 or fewer MI counties?
Northern Brook Lamprey	*Ichthyomyzon fossor*	Huron, Raisin	
American Brook Lamprey	*Lampetra appendix*	Huron	
Longnose Gar	*Lepisosteus osseus*	Huron	
Bowfin	*Amia calva*	Huron, Grand	
Central Stoneroller	*Campostoma anomalum pullum*	Huron, Raisin, [Grand]	
Goldfish	*Carassius auratus*	Huron	
Redside Dace	*Clinostomus elongatus*	Huron	X
Spotfin Shiner	*Cyprinella spiloptera*	Huron, Raisin	
Common Carp	*Cyprinus carpio*	Huron, Raisin	
Striped Shiner	*Luxilus chrysocephalus*	Huron, Raisin	
Common Shiner	*Luxilus cornutus*	Huron, Raisin, [Grand]	
Redfin Shiner	*Lythrurus umbratilis*	Raisin, [Stony Creek]	
Hornyhead Chub	*Nocomis biguttatus*	Huron, Raisin	
River Chub	*Nocomis micropogon*	Huron, Raisin	
Golden Shiner	*Notemigonus crysoleucas*	Huron, Raisin, Grand	
Bigeye Chub	*Notropis amblops*	Raisin, [Stony Creek]	X
Emerald Shiner	*Notropis atherinoides*	Huron	
Silverjaw Minnow	*Notropis buccatus*	Huron, Raisin	X
Blackchin Shiner	*Notropis heterodon*	Huron, Raisin, Grand	

Blacknose Shiner	*Notropis heterolepis*	Huron, Raisin, Grand	
Spottail Shiner	*Notropis hudsonius*	Huron	
Silver Shiner	*Notropis heterogenis*	Huron, Raisin	X
Rosyface Shiner	*Notropis rubellus*	Huron, Raisin	
Sand Shiner	*Notropis stramineus*	Huron, Raisin	
Mimic Shiner	*Notropis volucellus*	Huron	
Northern Redbelly Dace	*Phoxinus eos*	Huron	
Southern Redbelly Dace	*Phoxinus erythrogaster*	Huron, Raisin	X
Bluntnose Minnow	*Pimephales notatus*	Huron, Raisin, Grand, Stony Creek	
Fathead Minnow	*Pimephales promela*	Huron, Raisin	
Western Blacknose Dace	*Rhinichthys obtusus*	Huron, Raisin, Stony Creek, [Grand]	
Creek Chub	*Semotilus aromaculatus*	Huron, Raisin, Grand, Stony Creek	
Common Name	**Genus, Species**	**Watershed**	**Found in 5 or fewer MI counties?**
White Sucker	*Catastomus commersonii*	Huron, Raisin, Grand, Stony Creek	
Lake Chubsucker	*Erinmyzon sucetta*	Huron, Raisin, [Grand]	
Northern Hog Sucker	*Hypentelium nigricans*	Huron, Raisin, Grand, Stony Creek	
Spotted Sucker	*Minytrema melanops*	Raisin	
Black Redhorse	*Moxostoma duquesnei*	Huron, Grand, [Raisin]	
Golden Redhorse	*Moxostoma erythrurum*	Huron, Raisin	
Greater Redhorse	*Moxostoma valenciennesi*	Huron	
Black Bullhead	*Ameiurus melas*	Huron, Raisin	
Yellow Bullhead	*Ameiurus natalis*	Huron, Grand, Raisin	
Brown Bullhead	*Ameiurus nebulosus*	Huron, Grand	
Channel Catfish	*Ictalurus punctatus*	Huron	
Stonecat	*Notorus flavus*	Huron, Raisin	
Tadpole Madtom	*Notorus gyrinus*	Huron, Grand	
Brindled Madtom	*Notorus miurus*	Huron, Raisin	
Northern Madtom	*Notorus stigmosus*	Huron	X
Grass Pickerel	*Esox americanus vermiculatus*	Huron, Raisin, Grand	
Northern Pike	*Esox lucius*	Huron, Raisin, Grand	

Central Mudminnow	*Umbra limi*	Huron, Raisin, Grand, Stony Creek	
Lake Herring	*Coregonus artedi*	Huron	
Brown Trout	*Salmo trutta*	Huron	
Western Banded Killfish	*Fundulus diaphanus menona*	Huron, Raisin	
Blackstripe Topminnow	*Fundulus notatus*	Huron, Raisin	
Brook Silverside	*Labidesthes sicculus*	Huron, Raisin, Grand	
Brook Stickleback	*Culaea inconstans*	Huron, Raisin	
Mottled Sculpin	*Cottus bairdii*	Huron, Raisin, Grand, Stony Creek	
White Perch	*Morone americana*	Huron	
Rock Bass	*Ambloplites rupestris*	Huron, Raisin, Grand, Stony Creek	
Green Sunfish	*Lepomis cyanellus*	Huron, Raisin, Grand, Stony Creek	
Pumpkinseed	*Lepomis gibbosus*	Huron, Raisin, Grand	
Common Name	**Genus, Species**	**Watershed**	**Found in 5 or fewer MI counties?**
Warmouth	*Lepomis gulosus*	Huron, Grand	
Orangespotted Sunfish	*Lepomis humilis*	Raisin	X
Bluegill	*Lepomis macrochirus*	Huron, Raisin, Grand	
Redear Sunfish	*Lepomis microlophus*	Huron, [Grand]	X
Northern Longear Sunfish	*Lepomis peltastes*	Huron, Raisin, Grand	
Smallmouth Bass	*Micropterus dolomieu*	Huron, Raisin, [Grand]	
Largemouth Bass	*Micropterus salmoides*	Huron, Raisin, [Grand]	
White Crappie	*Pomoxis annularis*	[Huron]	
Black Crappie	*Pomoxis nigromaculatus*	Huron, Raisin, [Grand]	
Eastern Sand Darter	*Ammocrypta pellucida*	Huron	X
Greenside Darter	*Etheostoma blennioides*	Huron, Raisin, Grand, [Stony Creek]	
Rainbow Darter	*Etheostoma caeruleum*	Huron, Raisin, Grand, [Stony Creek]	
Iowa Darter	*Etheostoma exile*	Huron, [Raisin], [Grand]	
Barred Fantail Darter	*Etheostoma flabellare flabellare*	Huron, Raisin, Grand	
Least Darter	*Etheostoma microperca*	Huron, Raisin	
Johnny Darter	*Etheostoma nigrum*	Huron, Raisin, Grand, Stony Creek	

Orangethroat Darter	*Etheostoma spectabile*	Huron, Raisin	X
Yellow Perch	*Perca flavescens*	Huron, Raisin, [Grand]	
Northern Logperch	*Percina caprodes semifasciata*	Huron, Raisin	
Blackside Darter	*Percina maculata*	Huron, Raisin, Stony Creek	
Walleye	*Sander vitreus*	Huron, Raisin, [Grand]	

Rare Species of Special Conservation Concern in Washtenaw County

Threatened, Endangered, and Special Concern Animal Species
The Michigan Natural Features Inventory Rare Species Explorer shows 80 animal species in Washtenaw County that have a Federal Status or State Status of Threatened (T, or LT for Federal) or Endangered (E, or LE for Federal) species. SC indicates species of Special Concern due to low populations or small habitat areas within the state. Global Rank and State Rank indicate priority rankings for conservation concern given species rarity; the lowest numbers are of highest concern. (https://mnfi.anr.msu.edu/explorer/search.cfm)

Scientific name	Common name	Federal status	State status	Global Rank	State Rank
Acris crepitans blanchardi	Blanchard's cricket frog		T	G5T5	S2S3
Acronicta falcula	Corylus dagger moth		SC	G2G4	S2S3
Alasmidonta marginata	Elktoe		SC	G4	S2S3
Alasmidonta viridis	Slippershell		T	G4G5	S2S3
Ambystoma texanum	Smallmouth salamander		E	G5	S1
Ammodramus henslowii	Henslow's sparrow		E	G4	S2S3
Ammodramus savannarum	Grasshopper sparrow		SC	G5	S3S4
Anguispira kochi	Banded globe		SC	G5	SU
Battus philenor	Pipevine swallowtail		SC	G5	S1S2
Botaurus lentiginosus	American bittern		SC	G4	S3S4
Buteo lineatus	Red-shouldered hawk		T	G5	S3S4
Calephelis mutica	Swamp metalmark		SC	G3	S1S2
Catinella protracta	A land snail (no common name)		E	G2Q	SNR
Cincinnatia cincinnatiensis	Campeloma spire snail		SC	G5	SNR
Cistothorus palustris	Marsh wren		SC	G5	S3S4
Clemmys guttata	Spotted turtle		T	G5	S2
Clinostomus elongatus	Redside dace		E	G3G4	S1S2
Clonophis kirtlandii	Kirtland's snake		E	G2	S1
Coregonus artedi	Lake herring or Cisco		T	G5	S3
Cryptotis parva	Least shrew		T	G5	S1S2
Cyclonaias tuberculata	Purple wartyback		T	G5	S2S3
Cygnus buccinator	Trumpeter swan		T	G4	S3
Dendroica cerulea	Cerulean warbler		T	G4	S3
Dendroica discolor	Prairie warbler		E	G5	S1
Discus patulus	Domed disc		SC	G5	SU
Dorydiella kansana	Leafhopper		SC	GNR	S1S2
Emydoidea blandingii	Blanding's turtle		SC	G4	S3
Epioblasma triquetra	Snuffbox	LE	E	G3	S1
Erynnis baptisiae	Wild indigo duskywing		SC	G5	S2S3
Etheostoma spectabile	Orangethroat darter		SC	G5	S3
Euphyes dukesi	Dukes' skipper		T	G3	S1
Falco peregrinus	Peregrine falcon		E	G4	S1
Gallinula chloropus	Common moorhen		T	G5	S3
Gastrocopta holzingeri	Lambda snaggletooth		E	G5	S1
Haliaeetus leucocephalus	Bald eagle		SC	G5	S4
Hemileuca maia	Barrens buckmoth		SC	G5	S2S3

Scientific name	Common name	Federal status	State status	Global Rank	State Rank
Hetaerina titia	Smokey rubyspot		SC	G5	SNR
Ixobrychus exilis	Least bittern		T	G5	S2
Lampsilis fasciola	Wavyrayed lampmussel		T	G5	S2
Lepisosteus oculatus	Spotted gar		SC	G5	S2S3
Lepyronia angulifera	Angular spittlebug		SC	G3	S1S2
Ligumia recta	Black sandshell		E	G5	SNR
Mesomphix cupreus	Copper button		SC	G5	SU
Microtus pinetorum	Woodland vole		SC	G5	S3S4
Myotis septentrionalis	Northern long-eared bat	LT	SC	G4	SNR
Myotis sodalis	Indiana bat	LE	E	G2	S1
Neonympha mitchellii mitchellii	Mitchell's satyr	LE	E	G1G2T1T2	S1
Nicrophorus americanus	American burying beetle	LE	X	G2G3	SH
Notropis anogenus	Pugnose shiner		E	G3	S3
Notropis photogenis	Silver shiner		E	G5	S1
Noturus miurus	Brindled madtom		SC	G5	S2S3
Noturus stigmosus	Northern madtom		E	G3	S1
Oarisma poweshiek	Poweshiek skipperling	LE	T	G1	S1
Obovaria olivaria	Hickorynut		E	G4	S2S3
Oecanthus laricis	Tamarack tree cricket		SC	G1G2	S1S2
Oxyloma peoriense	Depressed ambersnail		SC	G4G5	SNR
Pantherophis spiloides	Gray ratsnake		SC	G5T5	S3
Papaipema beeriana	Blazing star borer		SC	G2G3	S1S2
Papaipema sciata	Culvers root borer		SC	G3G4	S2S3
Papaipema silphii	Silphium borer moth		T	G3G4	S1S2
Phoxinus erythrogaster	Southern redbelly dace		E	G5	S1
Pisidium cruciatum	Ornamanted peaclam		SC	GU	SNR
Pleurobema sintoxia	Round pigtoe		SC	G4G5	S2S3
Pomatiopsis cincinnatiensis	Brown walker		SC	G4	SU
Prosapia ignipectus	Red-legged spittlebug		SC	G4	S2S3
Ptychobranchus fasciolaris	Kidney shell		SC	G4G5	SNR
Pupilla muscorum	Widespread column		SC	G5	SU
Pyrgulopsis letsoni	Gravel pyrg		SC	G5	SU
Rallus elegans	King rail		E	G4	S1
Seiurus motacilla	Louisiana waterthrush		T	G5	S2S3
Sistrurus catenatus catenatus	Eastern massasauga	LE	SC	G3G4T3T4Q	S3S4
Speyeria idalia	Regal fritillary		E	G3	SH
Sphaerium fabale	River fingernail clam		SC	G5	SNR
Spiza americana	Dickcissel		SC	G5	S3
Stylurus laurae	Laura's snaketail		SC	G4	S1S2
Terrapene carolina carolina	Eastern box turtle		SC	G5T5	S2S3
Utterbackia imbecillis	Paper pondshell		SC	G5	SNR
Ventridens suppressus	Flat dome		SC	G5	SNR
Venustaconcha ellipsiformis	Ellipse		SC	G4	S2S3
Villosa iris	Rainbow		SC	G5Q	S2S3
Wilsonia citrina	Hooded warbler		SC	G5	S3

Threatened, Endangered, and Special Concern Plant Species

The Michigan Natural Features Inventory Rare Species Explorer shows 82 animal species in Washtenaw County that have a Federal Status or State Status of Threatened (T, or LT for Federal) or Endangered (E, or LE for Federal) species. SC indicates species of Special Concern due to low populations or small habitat areas within the state. X indicates Extinct. Global Rank and State Rank indicate priority rankings for conservation concern given species rarity; the lowest numbers are of highest concern. (https://mnfi.anr.msu.edu/explorer/search.cfm)

Scientific name	Common name	Federal status	State status	Global Rank	State Rank
Adlumia fungosa	Climbing fumitory		SC	G4	S3
Agrimonia rostellata	Beaked agrimony		T	G5	S2
Angelica venenosa	Hairy angelica		SC	G5	S3
Aristolochia serpentaria	Virginia snakeroot		T	G4	S2
Artemisia ludoviciana	Western mugwort		T	G5	S1
Asclepias purpurascens	Purple milkweed		T	G5?	S2
Asclepias sullivantii	Sullivant's milkweed		T	G5	S2
Aster praealtus	Willow aster		SC	G5	S3
Astragalus canadensis	Canadian milk vetch		T	G5	S1S2
Astragalus neglectus	Cooper's milk vetch		SC	G4	S3
Baptisia lactea	White or prairie false indigo		SC	G4Q	S3
Betula murrayana	Murray birch		SC	G1Q	S1
Bouteloua curtipendula	Side-oats grama grass		E	G5	S1
Bromus nottowayanus	Satin brome		SC	G3G5	S3
Carex davisii	Davis's sedge		SC	G4	S3
Carex festucacea	Fescue sedge		SC	G5	S1
Carex lupuliformis	False hop sedge		T	G4	S2
Carex seorsa	Sedge		T	G4	S2
Carex squarrosa	Sedge		SC	G4G5	S1
Carex trichocarpa	Hairy-fruited sedge		SC	G4	S2
Celtis tenuifolia	Dwarf hackberry		SC	G5	S3
Chelone obliqua	Purple turtlehead		E	G4	S1
Cypripedium arietinum	Ram's head lady's-slipper		SC	G3	S3
Cypripedium candidum	White lady slipper		T	G4	S2
Dichanthelium leibergii	Leiberg's panic grass		T	G5	S2
Draba reptans	Creeping whitlow grass		T	G5	S1
Echinacea purpurea	Purple coneflower		X	G4	SX
Eleocharis equisetoides	Horsetail spike rush		SC	G4	S3
Eleocharis geniculata	Spike-rush		X	G5	SX
Eleocharis radicans	Spike rush		X	G5	SX
Eragrostis capillaris	Love grass		SC	G5	SH
Eragrostis pilosa	Small love grass		SC	G4	SH
Euonymus atropurpurea	Wahoo		SC	G5	S3
Eupatorium sessilifolium	Upland boneset		T	G5	S1
Fuirena pumila	Umbrella-grass		T	G4	S2
Galearis spectabilis	Showy orchis		T	G5	S2
Gentiana flavida	White gentian		E	G4	S1
Gentiana puberulenta	Downy gentian		E	G4G5	S1

Scientific name	Common name	Federal status	State status	Global Rank	State Rank
Gentianella quinquefolia	Stiff gentian		T	G5	S2
Geum virginianum	Pale avens		SC	G5	S1S2
Helianthus hirsutus	Whiskered sunflower		SC	G5	S3
Hemicarpha micrantha	Dwarf-bulrush		SC	G5	S3
Hybanthus concolor	Green violet		SC	G5	S3
Hydrastis canadensis	Goldenseal		T	G4	S2
Isotria verticillata	Whorled pogonia		T	G5	S2
Jeffersonia diphylla	Twinleaf		SC	G5	S3
Justicia americana	Water willow		T	G5	S2
Lechea minor	Least pinweed		X	G5	SX
Linum virginianum	Virginia flax		T	G4G5	S2
Liparis liliifolia	Purple twayblade		SC	G5	S3
Lithospermum latifolium	Broad-leaved puccoon		SC	G4	S2
Lycopodiella margueritae	Northern prostrate clubmoss		T	G2	S2
Lycopodiella subappressa	Northern appressed clubmoss		SC	G2	S2
Morus rubra	Red mulberry		T	G5	S2
Muhlenbergia richardsonis	Mat muhly		T	G5	S2
Myrica pensylvanica	Northern bayberry		T	G5	S2
Panax quinquefolius	Ginseng		T	G3G4	S2S3
Paronychia fastigiata	Low-forked chickweed		X	G5	SX
Penstemon pallidus	Pale beard tongue		SC	G5	S3
Platanthera ciliaris	Orange- or yellow-fringed orchid		E	G5	S1S2
Platanthera leucophaea	Prairie white-fringed orchid	LT	E	G3	S1
Poa paludigena	Bog bluegrass		T	G3	S2
Polemonium reptans	Jacob's ladder		T	G5	S2
Populus heterophylla	Swamp or Black cottonwood		E	G5	S1
Ranunculus rhomboideus	Prairie buttercup		T	G5	S2
Rhynchospora scirpoides	Bald-rush		T	G4	S2
Ruellia humilis	Hairy wild petunia		T	G5	S1
Sabatia angularis	Rosepink		T	G5	S2
Sanguisorba canadensis	Canadian burnet		E	G5	S1
Scirpus clintonii	Clinton's bulrush		SC	G4	S3
Scleria triglomerata	Tall nut rush		SC	G5	S3
Silphium integrifolium	Rosinweed		T	G5	S2
Silphium laciniatum	Compass plant		T	G5	S1S2
Silphium perfoliatum	Cup plant		T	G5	S2
Spiranthes ovalis	Lesser ladies'-tresses		T	G5?	S1
Sporobolus heterolepis	Prairie dropseed		SC	G5	S3
Strophostyles helvula	Trailing wild Bean		SC	G5	S3
Tradescantia virginiana	Virginia spiderwort		SC	G5	S2
Trillium sessile	Toadshade		T	G4G5	S2S3
Valeriana edulis var. ciliata	Edible valerian		T	G5T3	S2
Viburnum prunifolium	Black haw		SC	G5	S3

Zizania aquatica var. aquatica	Wild rice		T	G5T5	S2S3

Washtenaw County Amphibian and Reptile Species (Herps)
Amphibian and reptile species, including frogs, toads, salamanders, snakes, and turtles—often known as herpetofauna and referred to as "herps" for short—are catalogued in several books by the Michigan State University Extension Service, with county maps that indicate which species occur in Washtenaw County:

- Harding, James H., and J. Alan Holman. 1999. *Michigan Frogs, Toads, and Salamanders: A Field Guide and Pocket Reference.* East Lansing: Michigan State University Extension. 144 p.
- Harding, James H., and J. Alan Holman. 2006. *Michigan Snakes: A Field Guide and Pocket Reference.* East Lansing: Michigan State University Extension. 74 p.
- Harding, James H., and J. Alan Holman. 1997. *Michigan Turtles and Lizards: A Field Guide and Pocket Reference.* East Lansing: Michigan State University Extension. 94 p.

In addition, the *Michigan Herpetological Atlas* (https://www.miherpatlas.org) offers a "comprehensive and publicly accessible database of reptile and amphibian observation records" that can be searched by county.

Herps, many of which are associated with forests, are sensitive to environmental changes and are often considered indicator species of environmental quality (or disturbance). Recent efforts in Michigan have aimed "to increase the state's knowledge of reptile and amphibian distribution and population health" (https://www.miherpatlas.org). To this end, the Michigan Herpetological Atlas, maintained by David Mifsud and Herpetological Resources Management, offers online reporting features and a mobile app and encourages landowners (or anyone interested) "to report herp species so that their population trends can be tracked over time." They have also developed guidelines for best management practices to recognize, conserve, and restore herp habitat, especially when undertaking construction or development activities in natural areas—including timber harvesting (Mifsud 2014). Printed copies of the *Michigan Amphibian and Reptile Best Management Practices* guide can be ordered for $40, or a free download is available at http://www.herprman.com/amphibian-reptile-management-practices-michigan.

Washtenaw County Bird Species
Washtenaw County bird species were catalogued and described in 1991 book:
Kielb, Michael A., John M. Swales, and Richard A. Wolinski. 1991. *Birds of Washtnaw County*. Ann Arbor: University of Michigan Press. 261 p.
In the 26 years since the publication of that book, the county's bird species and bird populations have changes in response to changes in land use and weather, and the authors plan an updated volume (Wolinski, personal communication). In the meantime, the online bird observation reporting site, *eBird* (http://ebird.org/content/ebird/) allows anyone to create an account and

report bird observations, and maintains a database of reported records that can be searched by county. In addition to listing the species recorded, the search will show times of year when birds have been observed in a county, indicating which are migratory vs. which are nesting and breeding in the county. Searches can also be done by year to show changes in seasonal habitat use over time. For example, Sandhill Cranes (*Antigone canadensis)* are typically considered a summer resident of Michigan, but sightings in Washtenaw County during winter 2016–2017 show that some birds are now overwintering here.
The Cornell Lab of Ornithology maintains an online bird guide with identification keys and song recordings that can help landowners identify birds in their woodlands: https://www.allaboutbirds.org/guide/search/.

Washtenaw County Butterfly, Skipper, and Moth Species
Michigan's butterfly, skipper, and moth species have been catalogued in two identification guides with county maps that indicate species distributions by county, and can be used to check which species occur in Washtenaw:
Nielsen, Mogens C. *Michigan Butterflies and Skippers.* 1999. Michigan State University Extension Service. 248 p.
Douglas, Matthew M., and Douglas, Jonathan M. 2005. *Butterflies of the Great Lakes Region.* Ann Arbor: University of Michigan Press. 345 p.
The Butterflies and Moths of North America database, compiled from observations reported by citizen scientists and expert observers, can be searched at the state and county levels to find species that have been recently reported in Washtenaw County: http://www.butterfliesandmoths.org.

Washtenaw County Insect Species
Insects are an enormously diverse group. No single source lists species in Washtenaw County. However, at least one regional guide that offers information on classes and orders of insects (other than the butterfly and moth guides listed above):

- Dunn, Gary A. 2001. *Insects of the Great Lakes Region*. Ann Arbor: University of Michigan Press.

Online insect identification guides of common insects can be searched by state:
http://www.insectidentification.org/insects-by-state.asp?thisState=Michigan
MDNR provides information on a few rare insect species:
http://www.michigan.gov/dnr/0,4570,7-153-10370_12145_12204---,00.html

Washtenaw County Mammal Species
At least two regional guides to mammals show species distribution maps, so that they can be used to find which mammals are found in Washtenaw County:

- Kurta, Allen. 1995. *Mammals of the Great Lakes Region.* Revised edition. Ann Arbor: University of Michigan Press. 376 p. An updated version of the 1957 version first written by William H. Burt.

- Tekiela, Stan. 2005. *Mammals of Michigan: Field Guide.* Cambridge, MN: Adventure Publications**.** ISBN-10: 1591930006. 283 p.

In addition, the MDNR website offers information on some major wildlife species: http://www.michigan.gov/dnr/0,4570,7-153-10370_12145_12205---,00.html

Washtenaw County Tree and Shrub Species and Forest Communities

Several guides describe Michigan's trees and shrubs, as well as its forest communities; a few are listed below. *Michigan Flora Online* (http://michiganflora.net), is based on Ed Voss's three-volume *Michigan Flora*, a technical botanical guide that may be challenging for general users. However, *Michigan Flora Online* contains the most up-to-date listings of all plant species in the state, along with plant images, and is searchable by common name and by county, as well as by plant type (physiognomy), so it can be used to find lists of all tree species in Washtenaw County.

- Barnes, Burton V., and Warren H. Wagner. 2004. *Michigan Trees, Revised and Updated: A Guide to the Trees of the Great Lakes Region.* Ann Arbor: University of Michigan Press.
- Barnes, Burton V., Christopher E. Dick, and Melanie W. Gunn. 2016. *Michigan Shrubs and Vines: A Guide to Species of the Great Lakes Region.* Ann Arbor: University of Michigan Press. ISBN-10: 0472036254. 440 p.
- Dickmann, Donald L. 2004. *Michigan Forest Communities: A Field Guide and Reference.* East Lansing: Michigan State University Extension. 158 p.
- Dickmann, Donald L., and Larry A. Leefers. 2016. *Forests of Michigan: Revised edition.* Ann Arbor: University of Michigan. ISBN-10: 047203653X. 336 p.
- Tekiela, Stan. 2002. *Trees of Michigan: Field Guide.* Cambridge, MN: Adventure Publications**.** ISBN-10: 1591930006. 236 p.

In addition, MDNR's "All About Trees" website offers information on tree identification and many aspects of tree care: http://www.michigan.gov/dnr/0,4570,7-153-30301_69181---,00.html

For the many herbaceous plant species found in Washtenaw County's forests —wildflowers and graminoids (grasses, sedges, and rushes)—few guides other than *Michigan Flora* contain both identification keys and species distribution maps. Identification guides may or may not have habitat notes indicating whether species are typically found in forests. As with trees, *Michigan Flora Online* (http://michiganflora.net) has the most comprehensive and up-to-date listing, with images and distribution maps, and can be used to generate a complete plant list for the county (which is too long to include here). Searches can also target plants that are likely to be found in wetlands, although habitat information—including whether species generally occur in forests—is not easily searchable. The following guides may be useful for interested land owners and citizen scientists:

- Rabeler, Richard K. *Gleason's Plants of Michigan: A Field Guide.* 1998. Ann Arbor: Oak Leaf Press. 398 p.
- Fassett, Norman C. 1976. *Spring Flora of Wisconsin.* Madison: University of Wisconsin Press. 413 p. (Many Wisconsin species are also found in Michigan.)
- Newcomb, Lawrence. 1989. *Newcomb's Wildflower Guide*. Boston: Little and Brown. 490 p.

Appendix E: Bibliography

Albert, Dennis A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification. Gen. Tech. Rep. NC-178. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/1998/rlandscp/rlandscp.htm and Michigan map (https://www.nrs.fs.fed.us/pubs/gtr/other/gtr-nc178/michmap1.htm) (Version 03JUN98).

Alverson, W. S. 1998. Forests too deer: edge effects in northern Wisconsin. *Conservation Biology* 2:348-358.

Badra, Pete. 2005. *Freshwater Mussels of Michigan.* Michigan Natural Features Inventory brochure. 6 p. Available online: http://web4.msue.msu.edu/mn. Accessed 27.01.2017.

Bailey, R. M., W. C. Latta, and G. R. Smith. 2004. *An atlas of Michigan fishes with keys and illustrations for their identification*. Available: http://www.michigan.gov/dnr/0,4570,7-153-10371_14793-30538--,00.html. Accessed: 27-01-2017.

Barnes, B.V., and W.H. Wagner. 2004. *Michigan Trees, Revised and Updated: A Guide to the Trees of the Great Lakes Region.* Ann Arbor: University of Michigan Press.

Bissell, Kirsten. 2013. *Deer Management/Status Overview, Southeast Region: Deer Management Unit 081*. Michigan Department of Natural Resources, DMU 081. Unpublished report. 6 p.

Burger, T.L., and J. Kotar. 2003. *A Guide to Forest Communities and Habitat Types of Michigan*. Madison: Department of Forest Ecology and Management, University of Wisconsin.

Cohen, Joshua G., Michael A. Kost, Bradford S. Slaughter, and Dennis A. Albert. 2015. *A Field Guide to the Natural Communities of Michigan.* East Lansing: Michigan State University Press. 362 p.

Cote, S. D., T. P. Rooney, J. P. Tremblay, C. Dussault, and D. M. Waller. 2004. Ecological impacts of deer overabundance. *Annual Review of Ecology, Evolution, and Systematics 35*:113-147.

deCalesta, D. S. 1997. Deer and ecosystem management. Pages 267-279 in: W. J. McShea, H. B. Underwood, and J. H. Rappole, editors. *The science of overabundance: deer ecology and population management.* Smithsonian Institution Press, Washington, D.C., USA.

Dickmann, Donald L. 2004. *Michigan Forest Communities: A Field Guide and Reference.* East Lansing: Michigan State University Extension. 158 p.

DNR (Department of Natural Resources). 2016. *Michigan Deer Management Plan*. Michigan Department of Natural Resources Wildlife Division Report Draft. https://www.michigan.gov/documents/dnr/deer_management_plan_525849_7.pdf.

Faaborg, John; Brittingham, Margaret; Donovan, Therese; Blake, John 1993. Habitat fragmentation in the temperate zone: a perspective for managers. In: Finch, Deborah M.; Stangel, Peter W. (eds.). *Status and management of neotropical migratory birds: September 21-25, 1992, Estes Park, Colorado.* Gen. Tech. Rep. RM-229. Fort Collins, Colo.: Rocky Mountain Forest and Range Experiment Station, U.S. Dept. of Agriculture, Forest Service: 331-338.

Fizzell, Chad. 2014. *Status and trends of Michigan's wetlands pre-European settlement to 2005*. Michigan Department of Environmental Quality report. 20 p. Accessed online: http://www.michigan.gov/documents/deq/DEQ-Water-Wetlands_-Status_and_trends_498644_7.pdf.

Frerker, K. A. Sabo, and D. Waller. 2014. Long-term regional shifts in plant community composition are largely explained by local deer impact experiments. *PLoS ONE* 9(12): e115843. doi:10.1371/journal.pone.0115843.

GLISA (Great Lakes Integrated Sciences + Assessment). 2015. *Historical Climatology: Ann Arbor, Michigan.* Fact sheet, 4 p. GLISA is a NOAA funded research partnership between the University of Michigan and Michigan State University. Accessed online: http://glisa.umich.edu/media/files/AnnArborMI_Climatology.pdf

Harding, James H., and J. Alan Holman. 1999. *Michigan Frogs, Toads, and Salamanders: A Field Guide and Pocket Reference.* East Lansing: Michigan State University Extension. 144 p.

Harding, James H., and J. Alan Holman. 2006. *Michigan Snakes: A Field Guide and Pocket Reference.* East Lansing: Michigan State University Extension. 74 p.

Harding, James H., and J. Alan Holman. 1997. *Michigan Turtles and Lizards: A Field Guide and Pocket Reference.* East Lansing: Michigan State University Extension. 94 p.

Haugen, David E. 2016. *Michigan timber industry, 2010*. Resource Update FS-78. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 p. Accessed online 2 February 2017: https://www.fs.fed.us/nrs/pubs/ru/ru_fs78.pdf.

Hinsdale, W.B. 1927. *The Indians of Washtenaw County Michigan.* Ann Arbor, MI: George Wahr Publisher. 69 p. Accessed online from the Making of Ann Arbor Text Collection: http://quod.lib.umich.edu/m/moaatxt/3933309.0001.001/1?view=image&size=100.

Horton, Tom. 2013. Revival of the American Chestnut. *American Forests*. *Best of American Forests* online: http://www.americanforests.org/magazine/article/revival-of-the-american-chestnut/.

Hoving, Christopher L., Yu Man Lee, Peter J. Badra, and Brian J. Klatt. 2013. *Changing Climate, Changing Wildlife: A Vulnerability Assessmentof 400 Species of Greatest Conservation Need and Game Species in Michigan.* Michigan Department of Natural Resources. Wildlife Division Report No. 3564. April, 2013. 82 p. Accessed online 29 March 2017: http://www.michigan.gov/documents/dnr/3564_Climate_Vulnerability_Division_Report_4.24.13_418644_7.pdf.

Hupy, Christina M., and Catherine H. Yansa. 2009. The Last 17,000 Years of Vegetation History. Ch. 9 in Schaetzl, Randall J, Joe T Darden, and Danita S Brandt. *Michigan Geography and Geology.* New York: Custom Publishing. Pp. 92–105. Accessed online: https://msu.edu/~yansa/2009a-Hupy%20&%20Yansa-CH%207-MI%20Book%20Chapter.pdf

Jenkins, L. H., M. A. Jenkins, C. R. Webster, P. A. Zollner, and J. M. Shields. 2014. Herbaceous layer response to 17 years of controlled deer hunting in forested natural areas. *Biological Conservation* 175: 119-128.

Kielb, Michael A., John M. Swales, and Richard A. Wolinski. 1991. *Birds of Washtnaw County*. Ann Arbor: University of Michigan Press. 261 p.

Knott, John, and Keith Taylor, eds. 2000. *The Huron River: Voices from the Watershed.* Ann Arbor: University of Michigan Press. 230 p.

Kurta, Allen. 1995. *Mammals of the Great Lakes Region.* Ann Arbor: University of Michigan Press. 376 p.

McCullough, Deborah. 2013. Will we kiss our ash goodbye? *American Forests*. Winter 2013. Accessed online: http://www.americanforests.org/magazine/article/will-we-kiss-our-ash-goodbye/

McCullough. Deborah G., Robert L. Heyd, and Joseph G. O'Brien. 2005. *Biology and Management of Beech Bark Disease: Michigan's Newest Exotic Forest Pest.* Michigan State University Extension Bulletin E-2746. Reprinted March 2005. Accessed online: http://msue.anr.msu.edu/uploads/files/e2746.pdf.

Mifsud, David A., 2014. *Michigan Amphibian and Reptile Best Management Practices.* Herpetological Resource and Management Technical Publication for Michigan Department of Environmental Quality and U.S. Environmental Protection Agency.

MIHerpAtlas. 2017. *MIHerpAtlas - A Statewide Herpetological Atlas and Data Hub*. Michigan, U.S.A. Available http://www.miherpatlas.com. Accessed: 27-01-2017.

NAP (Natural Area Preservation Division, Department of Parks and Recreation, City of Ann Arbor). 1999. *Along the Huron: The Natural Communities of the Huron River Corridor in Ann Arbor, Michigan.* Ann Arbor: University of Michigan Press.

NOAA (National Oceanic and Atmospheric Administration). 2011. *Atlas 14 data and analysis* http://hdsc.nws.noaa.gov/hdsc/pfds/. Accessed: 27-03-2017.

NRCS [United States Department of Agriculture, Natural Resources Conservation Service]. 2016. *Field Indicators of Hydric Soils in the United States,* Version 8.0. L.M. Vasilas, G.W. Hurt, and J.F. Berkowitz (eds.). USDA, NRCS, in cooperation with the National Technical Committee for Hydric Soils. (https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/)

Nunez, Katharine L. 1993. *Fragile Lands and Relationships in Washtenaw County: A guide to the protection of natural resources through environmental education, planning and design*. Master's thesis, University of Michigan.

O'Shea, John M. 2000. "The Huron River Past." In Knott, John, and Keith Taylor, eds. *The Huron River: Voices from the Watershed.* Ann Arbor: University of Michigan Press. pp. 20–26.

Pendergast, T.H., S.M. Hanlon, Z.M. Long, A.A. Royo, and W.P. Carson. 2016. The legacy of deer overabundance: long-term delays in herbaceous understory recovery. *Canadian Journal of Forest Research* 46(3): 362-369. 10.1139/cjfr-2015-0280

Piva, Ronald J.; Weatherspoon, Anthony K. 2010. *Michigan timber industry: an assessment of timber product output and use, 2006.* Resour. Bull. NRS-42. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 66 p. Accessed online 2 Feb 2017 https://www.nrs.fs.fed.us/pubs/rb/rb_nrs42.pdf.

Prasad, A. M., L. R. Iverson., S. Matthews., M. Peters. 2007-ongoing. A Climate Change Atlas for 134 Forest Tree Species of the Eastern United States [database]. Northern Research Station, USDA.

Pugh, S.A. 2007. Michigan's forest resources, 2006. Research Note NRS-6. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. 4 p. Accessed online 2 Feb 2017 https://www.nrs.fs.fed.us/pubs/rn/rn_nrs6.pdf.

Rawinski, T.J. 2014. *White-tailed deer in Northeastern forests: Understanding and assessing impacts.* Report for U.S. Department of Agriculture Forest Service, Northeastern Area State and Private Forestry, www.na.fs.fed.us. Reprinted January 2016 NA–IN–02–14. 28 p.

Rawinski, T.J. 2008. *Impacts of White-Tailed Deer Overabundance in Forest Ecosystems: An Overview.* Report for U.S. Department of Agriculture Forest Service, Northeastern Area State and Private Forestry Forest Service. www.na.fs.fed.us. June 2008. 8 p.

Rooney, T.P., and D.M. Waller. 2003. Direct and indirect effects of white-tailed deer in forest ecosystems. *Forest Ecology and Management* 181: 165–176. Mifsud, David A., 2014. Michigan Amphibian and Reptile Best Management Practices. Herpetological Resource and Management Technical Publication 2014.

Sargent, M.S and Carter, K.S., ed. 1999. *Managing Michigan Wildlife: A Landowners Guide*. Michigan United Conservation Clubs, East Lansing, MI. 297 p. Accessed online: http://www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/landowners_guide/Resource_Dir/Acrobat/index.htm

SCS [United States. Department of Agriculture, Soil Conservation Service]. 1977. *Soil Survey of Washtenaw County, Michigan*. In cooperation with Michigan Agricultural Experiment Station. 111 pp.

Scott, Virgil E., Keith E. Evans, David R. Patton, and Charles P. Stone. 1977. Cavity-nesting birds of North American forests. U.S. Dep. Agric., Agric. Handb. 511, 112 p. Accessed online: https://www.na.fs.fed.us/spfo/pubs/wildlife/nesting_birds/CavityNestingBirds.pdf

Smith, Gerald R., Jeffrey N. Taylor, and Thomas W. Grimshaw. 1981. Ecological survey of fishes in the Raisin River drainage, Michigan. *Michigan Academician* 13(3): 275–305.

Snyder, Michael. 2014. "What is Forest Fragmentation and Why Is It A Problem?" *Northern Woodlands*, Issue 82: 11–12. August 2014. http://northernwoodlands.org/articles/article/forest-fragmentation

Stanton, Ryan. 2017. "$1.8m in federal funds to help protect Huron River watershed." *MLive.com*. 3 January 2017. Accessed online: http://www.mlive.com/news/ann-arbor/index.ssf/2017/01/18m_in_federal_funds_to_help_p.html

Stein, Susan M.; McRoberts, Ronald E.; Alig, Ralph J.; Nelson, Mark D.; Theobald, David M.; Eley, Mike; Dechter, Mike; Carr, Mary. 2005. *Forests on the edge: housing development on America's private forests.* Gen. Tech. Rep. PNW-GTR-636. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 16 p.

Stromayer, K. A. K. and R. J. Warren. 1997. Are overabundant deer herds in the eastern United States creating alternate stable states in forest plant communities? Wildlife Society Bulletin 25(2): 227-234.

Thomas, S.A., Y. Lee, M. A. Kost, & D. A. Albert. 2010. Abstract for vernal pool. Michigan Natural Features Inventory, Lansing, MI. 24 pp.

USNVC [United States National Vegetation Classification]. 2016. United States National Vegetation Classification Database, V2.0. Federal Geographic Data Committee, Vegetation Subcommittee, Washington DC. [usnvc.org] (accessed 18 January 2017).