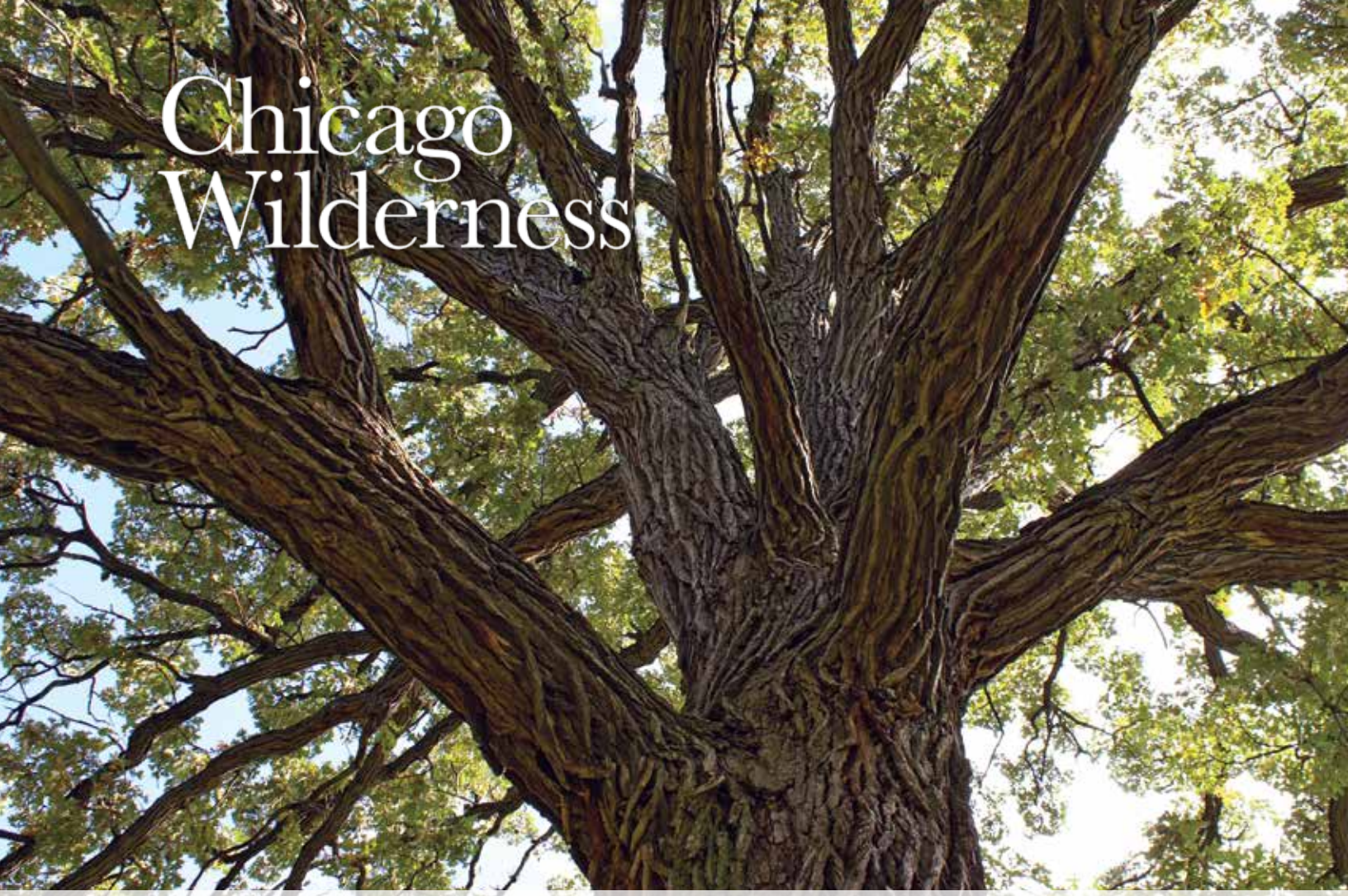


Oak Ecosystems Recovery Plan

SUSTAINING OAKS IN THE CHICAGO WILDERNESS REGION

Funded by USDA Forest Service and US Fish & Wildlife Service
Lead collaborators: Lake County Forest Preserve District • The Morton Arboretum

Chicago Wilderness

Chicago Wilderness is a regional alliance leading strategies to preserve, improve, and expand nature and quality of life. By connecting leaders in conservation, health, business, science, and beyond, we tackle challenging issues to ensure a resilient region.

Building on a 20-year legacy of collaboration, our broad alliance of member organizations advance work in Illinois, Indiana, Wisconsin, and Michigan.

Chicago Wilderness leverages members' collective strengths to drive one regional strategy through the following focused efforts:

Oak Ecosystems: ensuring a future for oaks and their ecosystems

Priority Species: conserving a targeted group of species to benefit our region's lands and waters

Water as a Resource: addressing regional water issues through conservation action

Landowners: engaging landowners in conservation actions

Public Engagement: building and sustaining a broad, representative, and active constituency

Data & Member Tools: applying technology and data to accelerate collaboration

Using this cross-disciplinary and measurable approach, Chicago Wilderness addresses critical challenges and inspires meaningful change. We harness adaptive and innovative thinking, apply solid science, and connect diverse constituencies.

Learn more at:
www.chicagowilderness.org



Oak Ecosystems Recovery Plan

SUSTAINING OAKS IN THE CHICAGO WILDERNESS REGION

Funded by USDA Forest Service and US Fish & Wildlife Service
Lead collaborators: Lake County Forest Preserve District • The Morton Arboretum

Chicago Wilderness
Oak Ecosystems Recovery Working Group

Authors: Robert T. Fahey, PhD, Forest Ecologist, The Morton Arboretum; Lindsay Darling, Research Assistant, The Morton Arboretum; Jim Anderson, Director of Natural Resources, Lake County Forest Preserve District

OCTOBER 2015

ECOLOGY AND HISTORY OF OAK ECOSYSTEMS IN THE CHICAGO REGION

The Chicago Wilderness Region lies at the intersection of the Eastern Broadleaf Forest and Prairie Parkland ecoregions (Bailey 1995), and features a mixture of ecosystems characteristic of both areas. Tall grass prairies were historically the most abundant ecosystem type, but oak forests, woodlands, and savannas also occurred across the region (Fig. 1) (Borchert 1950, Curtis and McIntosh 1951, Curtis 1959, Leitner et al. 1991, Bowles et al. 1994). The distribution of these wooded ecosystems in the region has depended primarily on the interaction between landscape features (e.g. soil texture, geology, depth and drainage, rainfall, slope and aspect, and hydrology) and disturbance regimes, both natural and anthropogenic.

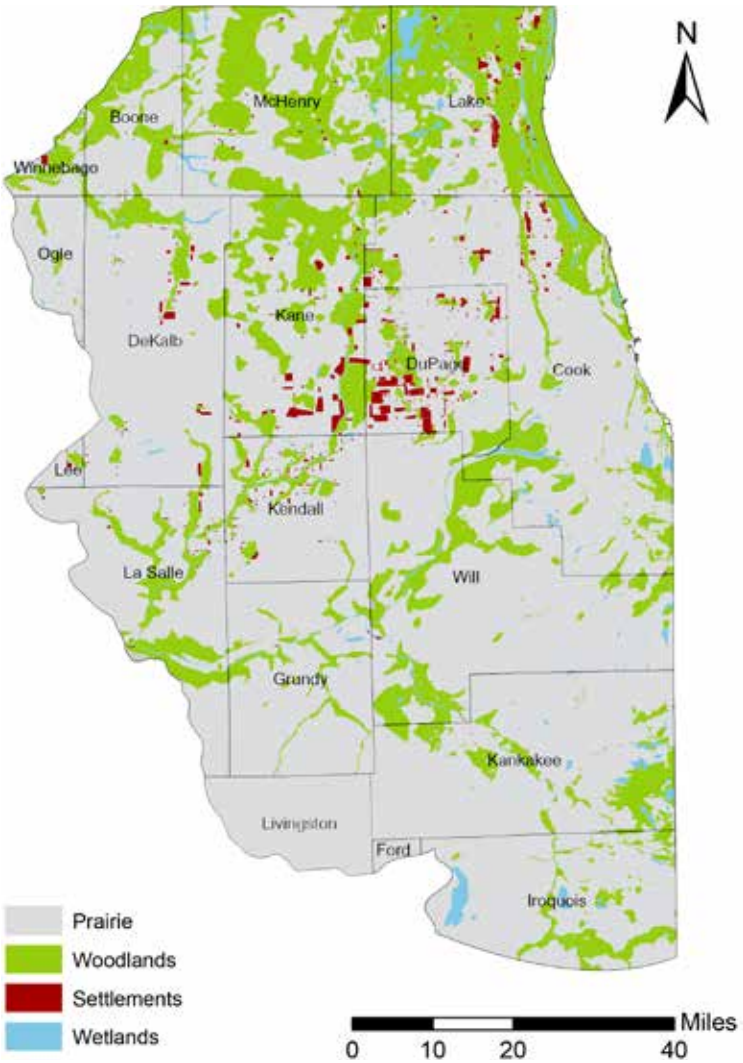


Figure 1. Vegetation type at the time of initial Euro-American settlement in the 1830s.

Historic Fire Regimes

Fire, in particular, has shaped the region's ecosystems. Historically, fires were common and were ignited by lightning and Native Americans (Nowacki and Abrams 2008). Fires maintained grass-dominated ecosystems or open oak barrens, savannas and woodlands, and precluded the growth of fire-intolerant species (Pyne 1982, Hicks 2000, McBride and Bowles 2007). The fires typically moved from west to east with the prevailing wind, and wooded areas were most abundant on the eastern side of firebreaks, such as rivers (Bowles et al. 2011).

Animal disturbance has also influenced the region's ecosystems. Bison and elk grazed until they were extirpated around 150 years ago, after which domestic grazers became common. Grazing disturbances can affect the structure, diversity, and productivity of ecosystems (Belsky 1992, Olff and Ritchie 1998, Knapp et al. 2008). Passenger pigeons also caused significant disturbance in wooded ecosystems prior to their extinction in the early 20th century. Millions of these birds would roost and nest in trees, and their weight and guano would create openings in the canopy (Ellsworth and McComb 2003, Buchanan and Hart 2012).

Oak ecosystem classification

The oak ecosystems of the Chicago region are generally classified into the following four categories based on canopy density and composition and structure of associated plant communities:

- *Forests—60-100% cover, >100 trees/ha: dense canopy and understory dominated by spring ephemeral forbs.*
- *Woodlands—25-60% cover, 50-100 trees/ha: intermediate canopy density with a mixture of shrubs, forbs, and grasses in the understory.*
- *Savanna—10-25% cover, 10-50 trees/ha: open canopy conditions with a mostly grass-dominated understory.*
- *Open savanna/barrens—>0-10% cover, >0-10 trees/ha: very little canopy, mostly small stunted trees with grass-dominated groundlayer.*

Oak ecology

Many of the oak species that were abundant in the Chicago region are adapted to live in fire-dominated ecosystems. These species have corky bark that makes them relatively fire resistant (Abrams 1992). They also allocate a large proportion of their energy to root growth, allowing them to re-sprout if the tree is top killed by fire (Kolb and Steiner 1990). A variety of oak species are native to the Chicago region. White, bur, red, and black oak were most common, but varied in abundance across the region with fire frequency and edaphic factors *(See Box 1)*.

Oak seedlings are relatively shade intolerant, and they need high light levels to grow well (Abrams 2003, Ellsworth and McComb 2003, Nowacki and Abrams 2008, Buchanan and Hart 2012). Historically, light levels were maintained by

BOX 1 OAKS OF THE CHICAGO REGION

White oak *(Quercus alba)*—Prior to Euro-American settlement, one of the most abundant species in the region, but its numbers have been reduced at a greater rate than other oak species. White oak grows from dry, upland soils to well-drained bottomlands. Requires full sun and does not regenerate well in closed canopy forests. Acorns are preferred by wildlife.

Swamp white oak *(Quercus bicolor)*—Historically present, but not abundant in the region. Largely restricted to wet soils and was primarily found along wetlands. Range extends from Minnesota to as far south as Tennessee. Frequently planted in urban sites due to its tolerance of compacted, alkaline soils and salt spray.

Shingle oak *(Quercus imbricaria)*—Distribution is largely to the south, but is occasionally found along streams and prairie borders. The leaves are not lobed and are broadest near the middle with a slightly wavy margin. Holds onto its leaves through the winter, which offers superior protection for wildlife. Frequently used in urban areas.

Bur oak *(Quercus macrocarpa)*—Among the most fire tolerant of the oaks, very shade intolerant, and is consequently often associated with savannas. Extremely tolerant of drought and is found as far south as southern Texas. Bur oak is a large, broad tree and is long-lived. Produces ample acorns and provides important food and habitat for wildlife.

Chinquapin oak *(Quercus muehlenbergii)*—Grows in shallow, calcareous soils. Chicago is at the northern edge of the species range, and it is not abundant in the region's natural areas. Features simple, oblong leaves that are coarsely toothed. Well-suited for urban areas due to tolerance of poor, compacted soils. Acorns are preferred by wildlife.

Pin oak *(Quercus palustris)*—Does best in wet soils and tolerates intermittent flooding. Occurs in bottomlands and bordering wetlands. Occasionally present in Chicago natural areas, but the bulk of its range is to the south. Has an attractive, oval habit with a straight trunk, making it popular in landscaping. However, does not tolerate droughts.

Red oak *(Quercus rubra)*—One of the most abundant oak species in the Chicago region. More shade tolerant than other oaks, does well on moist soils, and is frequently found in denser woodlands. Red oak has a broad range, and grows from northern Minnesota to Mississippi and throughout eastern North America.

Black oak *(Quercus velutina)*—An upland species that grows on rocky or sandy soils. It is broadly distributed throughout the eastern United States but has a patchy distribution in the Chicago region. It is not one of the most abundant species in the area but is locally dominant.

the disturbance regimes previously noted. In the modern landscape, controlled burns and understory clearing can reduce direct competition, but canopy level disturbances are also needed to ensure the establishment of oak seedlings and promote the recruitment of these trees into the canopy (Dey et al. 1997, Brose et al. 2012). For a thorough treatment of the ecology and management of oaks and oak forests, see Johnson et al. (2009).

Ecological history of Chicago region oak ecosystems

Paleo history

Oak ecosystems have existed in North America for 20-25 million years before the present (BP) (Thomas and Spicer 1987). The Chicago region experienced glacial advances and retreats from 85,000-10,000 BP (Pielou 2008), and oak ecosystems established and retreated from the Midwest as the glaciers moved. The ice sheet finally receded from the region around 10,000 years ago (Pielou 2008), and oak ecosystems became re-established soon afterwards (Leitner et al. 1991).

The Native American era

Native Americans colonized the Chicago region soon after the final glacial retreat (Hicks 2000), suggesting that the current incarnation of the region's oak ecosystems have always had some human influence. Early Native Americans managed the land with the goal of improving hunting prospects and burned prairies and savannas in order to clear land and prevent woody encroachment (MacCleery 1992, Lesser 1993).

Under Native American management, the pre-settlement ecological mosaic comprised of prairies, savannas and forests was formed (Curtis and McIntosh 1951). Much of our knowledge about the distribution of ecosystems prior to Euro-American settlement comes from Public Land Surveys (PLS) that were completed in the 1830s (Fig. 1 and 2). For more information on these surveys see McBride and Bowles (2007). At the time of Euro-American settlement of the Chicago region there were ~1,000,000 acres of oak ecosystems in the area, representing ~22% of the total land area (Fig. 1). Oaks were the predominant woody species at that point (Fig. 2) (Bowles et al. 1994, Abrams 2003), while mesophytic species, such as sugar maple, green ash, and basswood were found occasionally as understory species or in areas protected by fire breaks (Leitner et al. 1991, Abrams 1992).

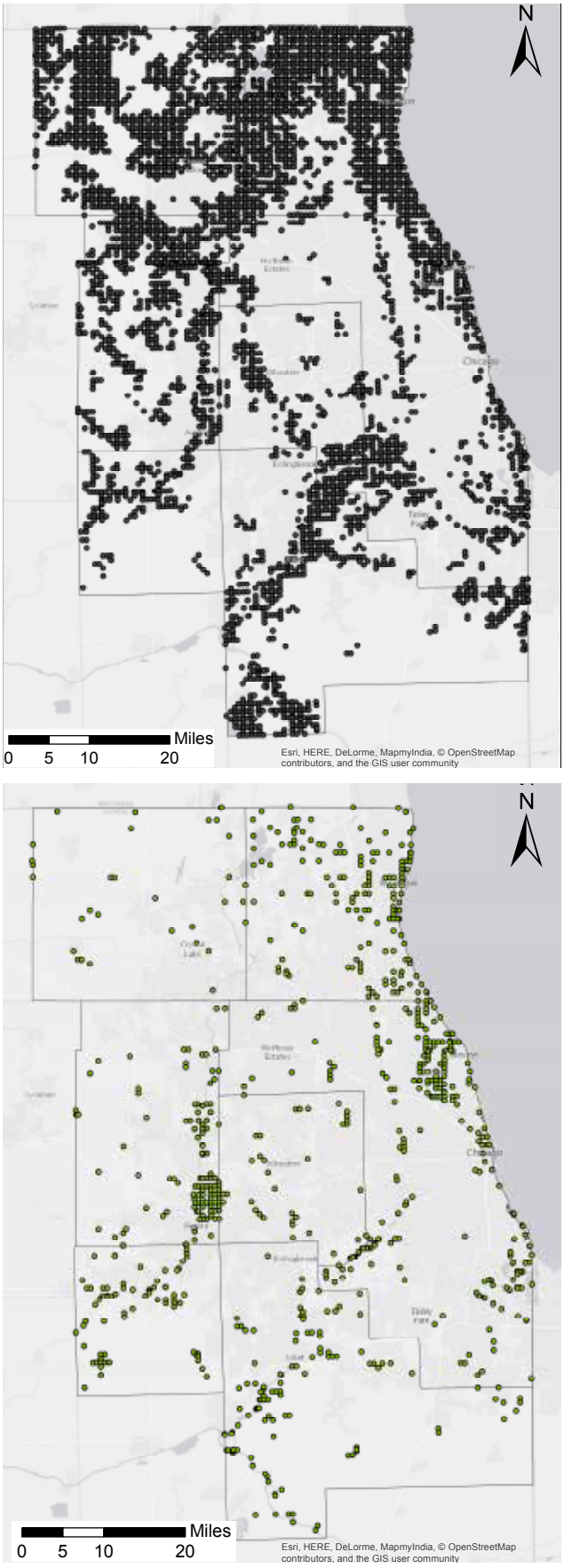


Figure 2. Distribution of oak (top) and non-oak (bottom) witness trees in the 1830s Public Land Survey.

The Euro-American settlement era

Euro-American settlers replaced Native Americans beginning in the early 19th century and converted prairies and savannas to agriculture. They used wood products at a much greater rate than Native Americans, felling many trees to build houses, fences and barns, to cook, and to heat their homes (MacCleery 1992, Hicks 2000). Settlers purposely suppressed fire, largely removing this disturbance from the landscape. Animals that caused disturbance were also removed from the area. Elk and bison were extirpated, as were large predators, such as wolves, bears, and mountain lions (Musiani and Paquet 2004), and passenger pigeons became extinct (Ellsworth and McComb 2003).

By the late 1930s Euro-American settlement had caused profound changes to the Chicago region's landscape. At this stage ~280,000 acres of the original oak ecosystem remained intact, which represents ~27% of the original area (Table 1, Fig. 3). Thus, a large majority of the region's oak ecosystems were destroyed by this time to make room for agriculture and settlements, including the burgeoning metropolis of Chicago and the infrastructure that supported it (Fig. 3, Table 1).

The modern era

In the modern era intensification of agricultural activities, urbanization and suburban sprawl led to the destruction and further fragmentation of many remaining natural areas (Mankin and Warner 1997, Fahey et al. 2012). Fire was removed from the landscape, invasive species were introduced, and white-tailed deer and other herbivores became overabundant (Russell et al. 2001, Rooney et al. 2004). Suppression of fire allowed mesophytic species, such as maples, ashes and basswood to proliferate and become dominant.

In the period between 1939 and 2010 there were significant additional losses of oak ecosystem area. By 2010 there were ~173,000 acres of remnant oak ecosystems in the region, which represents ~17% of the original area occupied by these communities (Table 1, Fig. 3). This also represents a 40% reduction in area relative to the 1939 time period. County-level patterns illustrate the intense effect that suburban development had on oak ecosystems during this time period, with very high conversion occurring in Lake, DuPage, Kane and Will counties (Table 1).

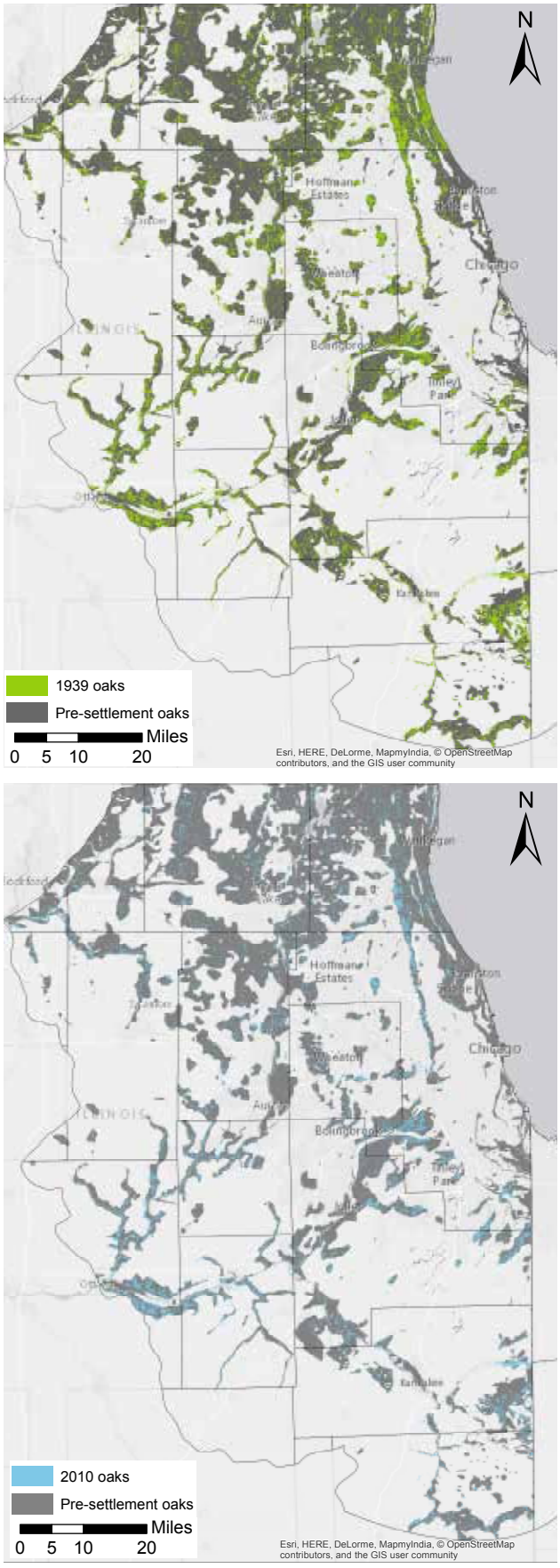


Figure 3. Distribution of remnant oak ecosystems based on aerial image analysis in 1939 and 2010.

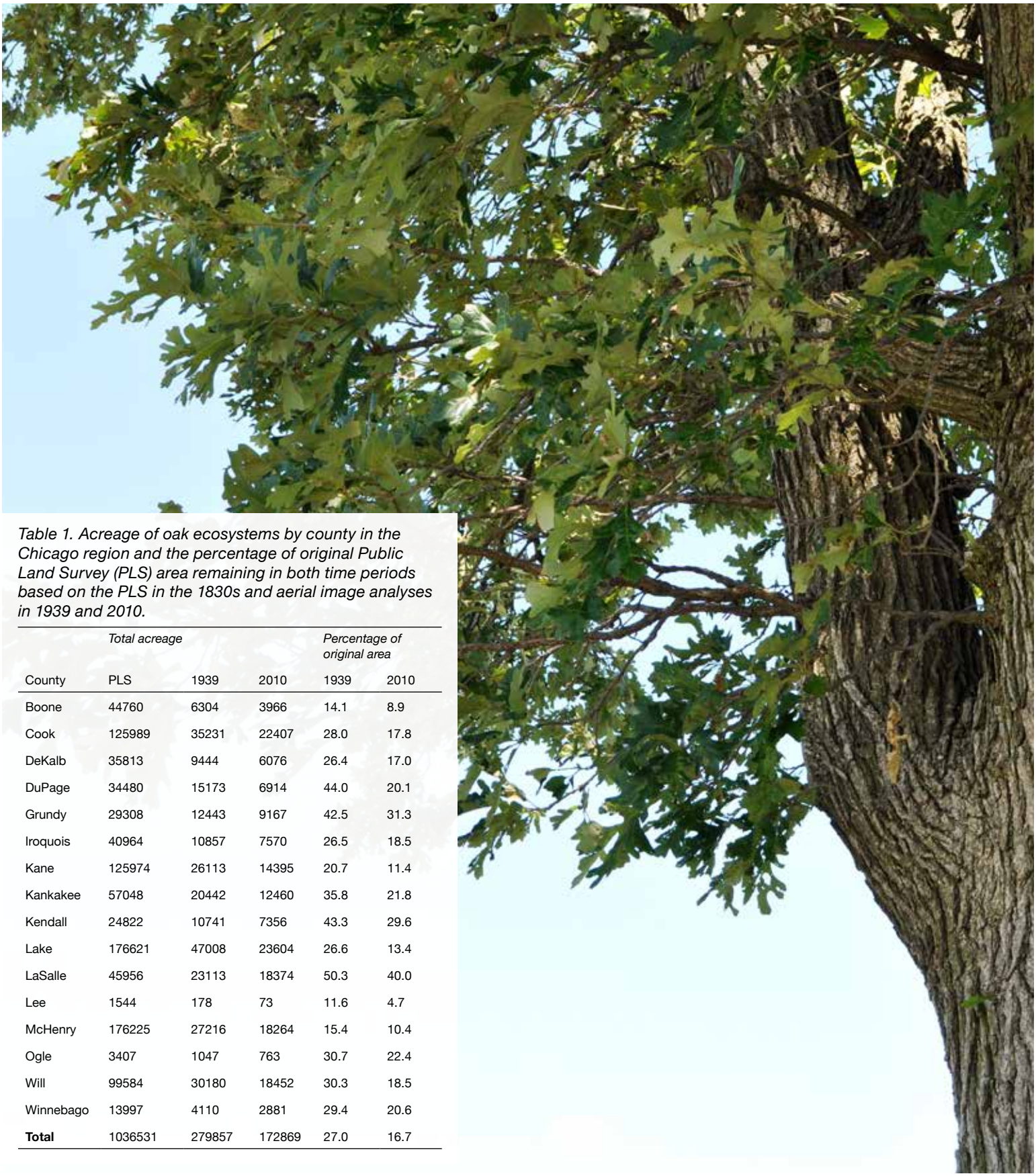


Table 1. Acreage of oak ecosystems by county in the Chicago region and the percentage of original Public Land Survey (PLS) area remaining in both time periods based on the PLS in the 1830s and aerial image analyses in 1939 and 2010.

	Total acreage			*Percentage of original area*	
County	PLS	1939	2010	1939	2010
Boone	44760	6304	3966	14.1	8.9
Cook	125989	35231	22407	28.0	17.8
DeKalb	35813	9444	6076	26.4	17.0
DuPage	34480	15173	6914	44.0	20.1
Grundy	29308	12443	9167	42.5	31.3
Iroquois	40964	10857	7570	26.5	18.5
Kane	125974	26113	14395	20.7	11.4
Kankakee	57048	20442	12460	35.8	21.8
Kendall	24822	10741	7356	43.3	29.6
Lake	176621	47008	23604	26.6	13.4
LaSalle	45956	23113	18374	50.3	40.0
Lee	1544	178	73	11.6	4.7
McHenry	176225	27216	18264	15.4	10.4
Ogle	3407	1047	763	30.7	22.4
Will	99584	30180	18452	30.3	18.5
Winnebago	13997	4110	2881	29.4	20.6
Total	1036531	279857	172869	27.0	16.7

The dominance of oaks in the Chicago region's forest has declined steeply relative to pre-settlement conditions—from ~60% to ~20% of total basal area (Table 2). In addition, the region's oak population lacks size and age class diversity. In smaller size classes oaks are rare, and non-native and opportunistic native species dominate (Fig. 4). Most oaks are pre- and immediate-post-settlement trees, making them ~200 years old (Bowles et al. 2005, Bowles and Jones 2008). The lack of size diversity and presumed advanced age of the oaks in the regional forest suggest a potential precipitous decline in oak canopy dominance in the near future. As the canopy trees decline there are no young trees to replace them. These regional-scale findings correspond with data from natural areas, which have consistently shown a trend of decreasing oak dominance (Bowles et al. 2005).

Table 2. Percent of total basal area (dominance) by species in the 1830s Public Land Surveys (PLS) and 2010 Chicago region tree census (Nowak et al. 2010).

	2010 Urban Tree Census	*1830s PLS*
Species	Dominance	Dominance
Quercus alba	6.91	41.28
Quercus macrocarpa	8.86	13.09
Quercus rubra	5.70	6.60
Acer saccharinum	9.44	0.01
Acer negundo	7.89	0
Populus deltoides	5.75	0.02
Fraxinus pennsylvanica	4.97	0
Prunus serotina	4.55	0
Juglans nigra	2.53	2.18
Ulmus americana	2.50	9.03

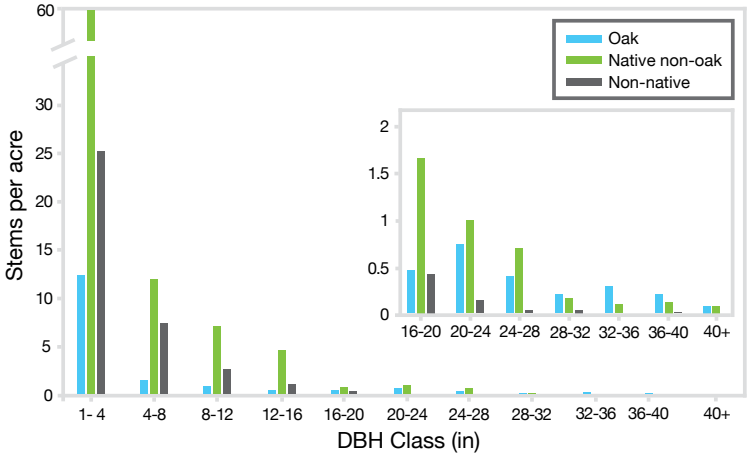


Figure 4. Number of stems per hectare by size class (in cm) in the 2010 Chicago region tree census.

Parcel size and fragmentation

In the period between 1939 and 2010 there were high levels of fragmentation of remnant oak ecosystems. In the 1939 landscape, although there were extreme levels of conversion from the original landscape, there were nonetheless many large remnant parcels. For example, there were 26 parcels greater than 500 acres in size (Table 3, Fig. 5). By the modern era most of these had been fragmented and only six parcels greater than 500 acres in size remained intact.

Table 3. Remnant oak ecosystems by parcel size (acres).

Parcel Size	*1939*	*2010*	*2010 Protected*
100 – 200	*297*	*160*	*64*
200 – 500	*139*	*70*	*29*
500 – 1000	*25*	*6*	*1*
1000+	*1*	*0*	*0*

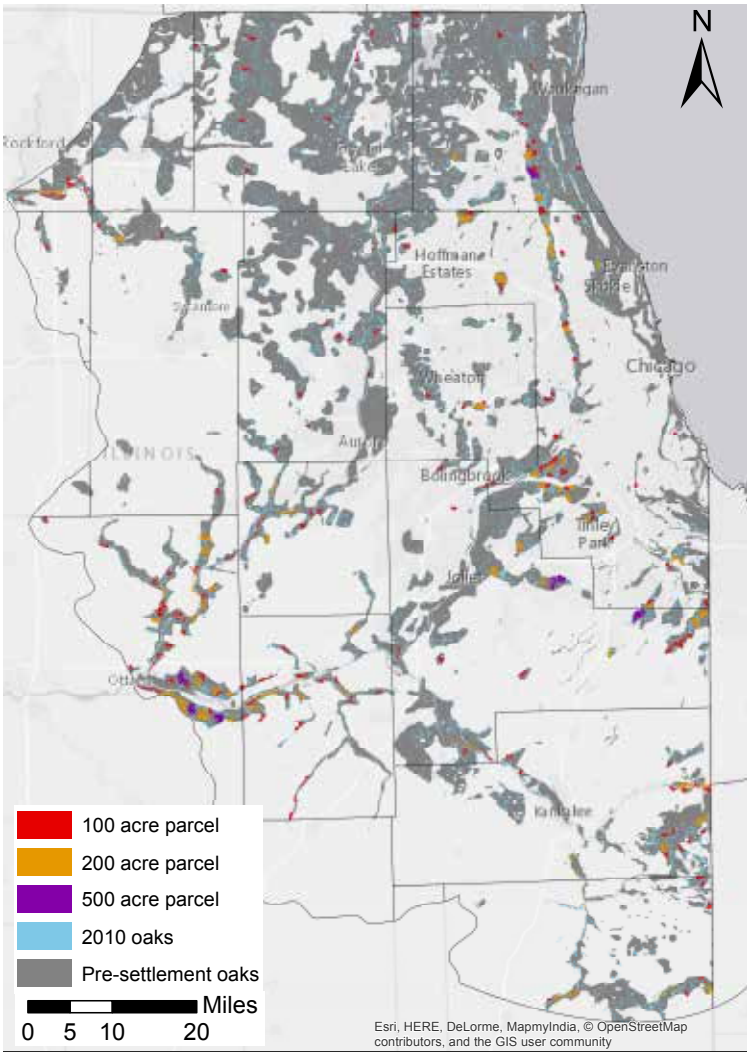


Figure 5. Modern (2010) remnant oak ecosystems by parcel size.

Ownership and protected status

At a regional scale, approximately 30% of the remnant oak ecosystem areas identified in the 2010 imagery analysis were in some type of protected status (Table 4, Fig. 6). The majority of these protected parcels (74%) were in local ownership, primarily as county forest preserves or conservation districts. The degree to which remnant oak ecosystems were protected varied greatly across the region. In Cook County, 80% of the remnant oak ecosystems are in some form of protected status, while rural counties generally had less than 10% protected.

Table 4. Remnant oak ecosystem areas by categories of protected land status.

Land Status	Acreage	% of Total
Federal land	958	0.6
Joint ownership	806	0.5
Local land	38587	22.3
Private conservation land	1711	1.0
Private land	93	0.1
State land	9943	5.8
Total land protected	52098	30.1

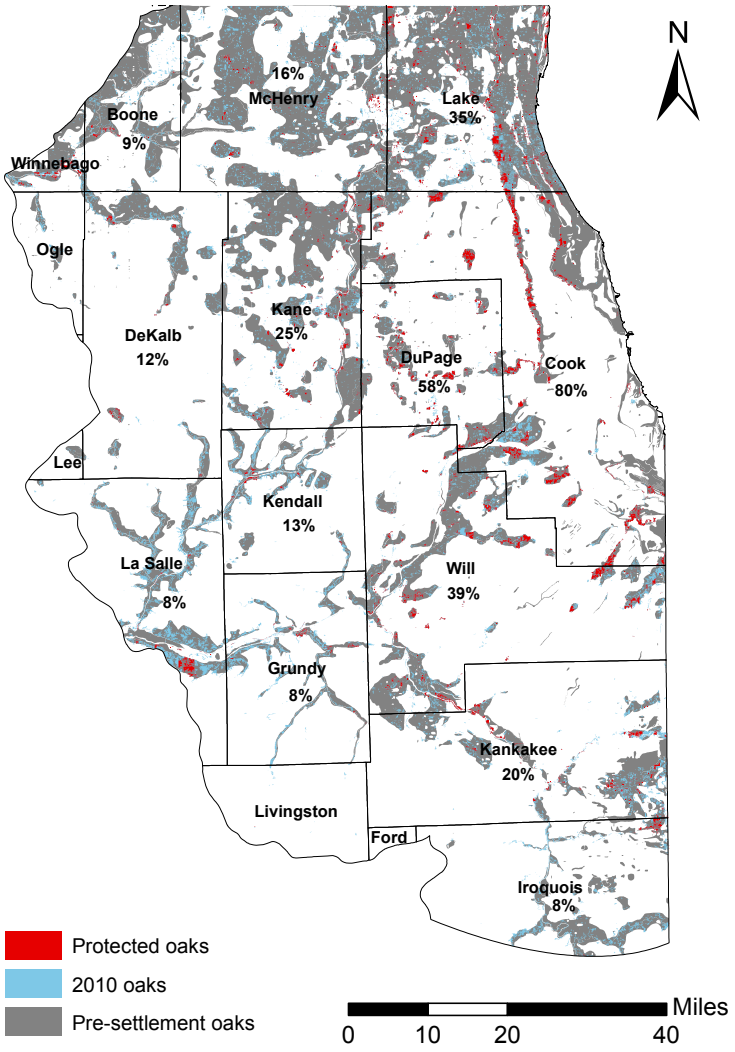


Figure 6. Modern oak ecosystems by protected status with percent protected by county.

Urban oaks

Although many of the original oak ecosystems have been converted to urban uses, a portion of the oak canopy remains in some of these areas. In DuPage County an analysis was conducted to assess whether areas developed between 1939 and 2010 retained elements of oak ecosystem structure. There were 5,693 acres (~69% of the total area converted between 1939 and 2010) that appeared to have retained some canopy oaks (Fig. 7). These parcels tended to be small with an average size of only 5.2 acres, but there was one parcel that covered 434 acres.

At a regional scale, oaks comprise a highly variable proportion of municipal trees, both streets and parks. Inventories from 35 Chicago region municipalities show that oaks make up less than 4% of street trees and less than 10% of park trees.

In some areas increased planting of oaks could help municipalities reach species diversity goals outlined by the Chicago Region Trees Initiative (CRTI), which recommends that no more than 10% of any one genus be planted in a municipality. No surveyed municipalities have greater than 10% oaks as street trees, but a few have greater than 10% when parks are included. However, neither sample fully encompasses the species mix of the entire land base, which also includes private property, vacant land, and natural areas.

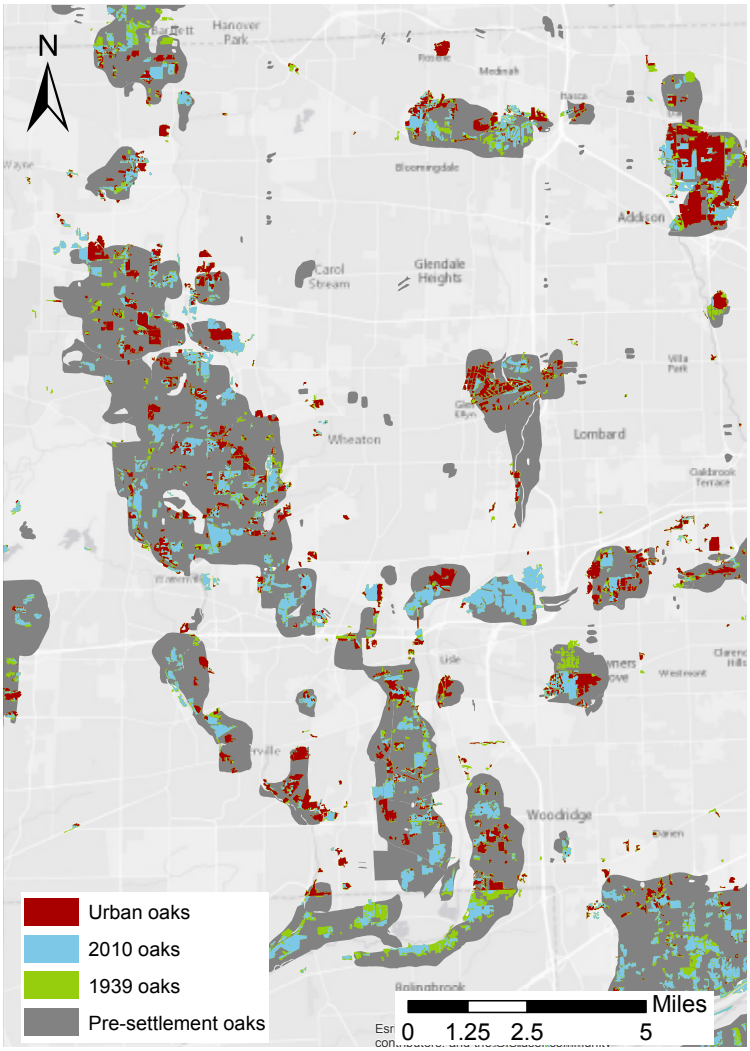


Figure 7. Map illustrating DuPage County "urban oak ecosystems"—areas that were developed between 1939 and 2010 but retained features of remnant oak ecosystems.

Opportunities for conservation and connectivity

The barriers that fragment oak ecosystems are often permanent features of the urban landscape, such as highways or other transportation corridors. In some cases there may be opportunities to connect ecosystems through management or acquisition. Developed areas with some remnant oak character could be important connections or buffers for remnant ecosystems. For example, the largest gaps of non-protected land in the extensive Des Plaines River corridor (Fig. 8) are two large cemeteries, which may already have significant canopy and could be managed to promote oak ecosystem values. Reforestation of vacant land with oaks as a component of the planting pool could be another avenue for expanding or enhancing the value of existing remnant oak ecosystems. In rural areas, fragmentation is largely related to agriculture, and these areas are unlikely to revert to open space in the foreseeable future. However, some parcels could be acquired or targeted for conservation easements.

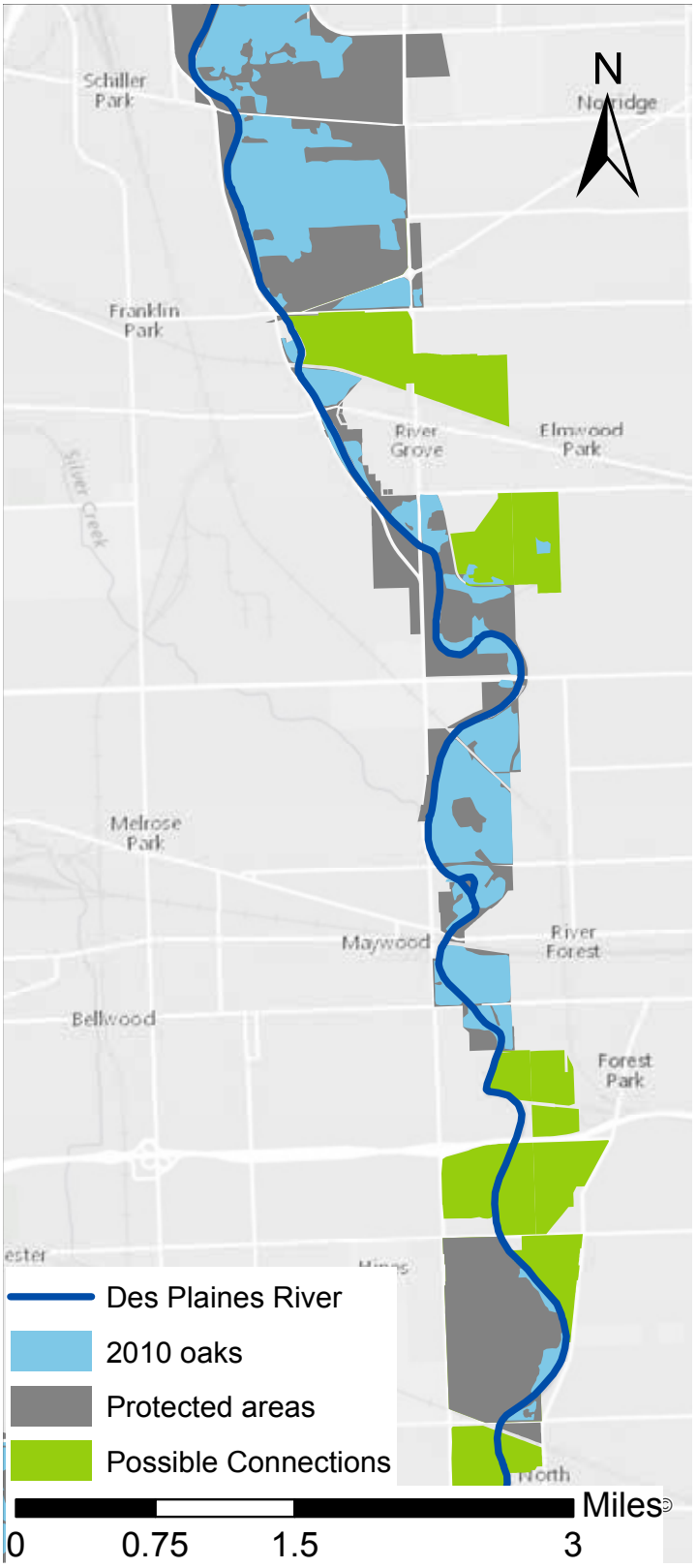


Figure 8. Targeted reforestation of protected lands (gray) that are interrupted by cemeteries and golf courses (green) along the Des Plaines River corridor could increase connectivity (blue).

Oaks and oak dominated ecosystems provide myriad benefits within the Chicago region, including food and habitat for wildlife species, ecosystem functions such as carbon storage and water regulation, and natural beauty for the enjoyment of the people who inhabit the landscape (Dwyer et al. 1992). As a large, long-lived species, oaks are especially useful for climate mitigation via long-term carbon storage. Their vast canopies produce shade, which reduces urban heat island effects and can also reduce energy use in buildings, thereby reducing greenhouse gas emissions.

Biodiversity in oak ecosystems

Oaks are foundational species in forested ecosystems across the temperate zone, creating ecosystem structure and supporting an array of plant and animal life (McShea and Healy 2002, Rodewald and Abrams 2002, Spetich 2004). Oak ecosystems support high biodiversity, in part, because they are heterogeneous environments. Oak woodlands and savannas have open canopies that create highly variable light levels and foster variability in soil moisture, pH, potassium, and organic matter (Ko and Reich 1993). This heterogeneity allows numerous plants and animal species to find niches within the ecosystem.

Oaks not only encourage biodiversity by structuring the ecosystems in which they occur, but the trees themselves also offer habitat and food for a variety of birds, invertebrates, and mammals. Over 500 species of insects live and feed on oaks (Tallamy 2007). Many of these insects, in turn, provide

BOX 2 CRITICAL WILDLIFE SPECIES IN OAK ECOSYSTEMS

Species included here are among those identified by the Illinois State Wildlife Action Plan as "critical" wildlife species in the Northeastern Morainal Division of Illinois and can be associated with oak ecosystems. Many species that are commonly associated with prairies and open wetlands may also utilize oak savannas or flatwoods as habitat, especially if these ecosystems are restored to more open conditions.

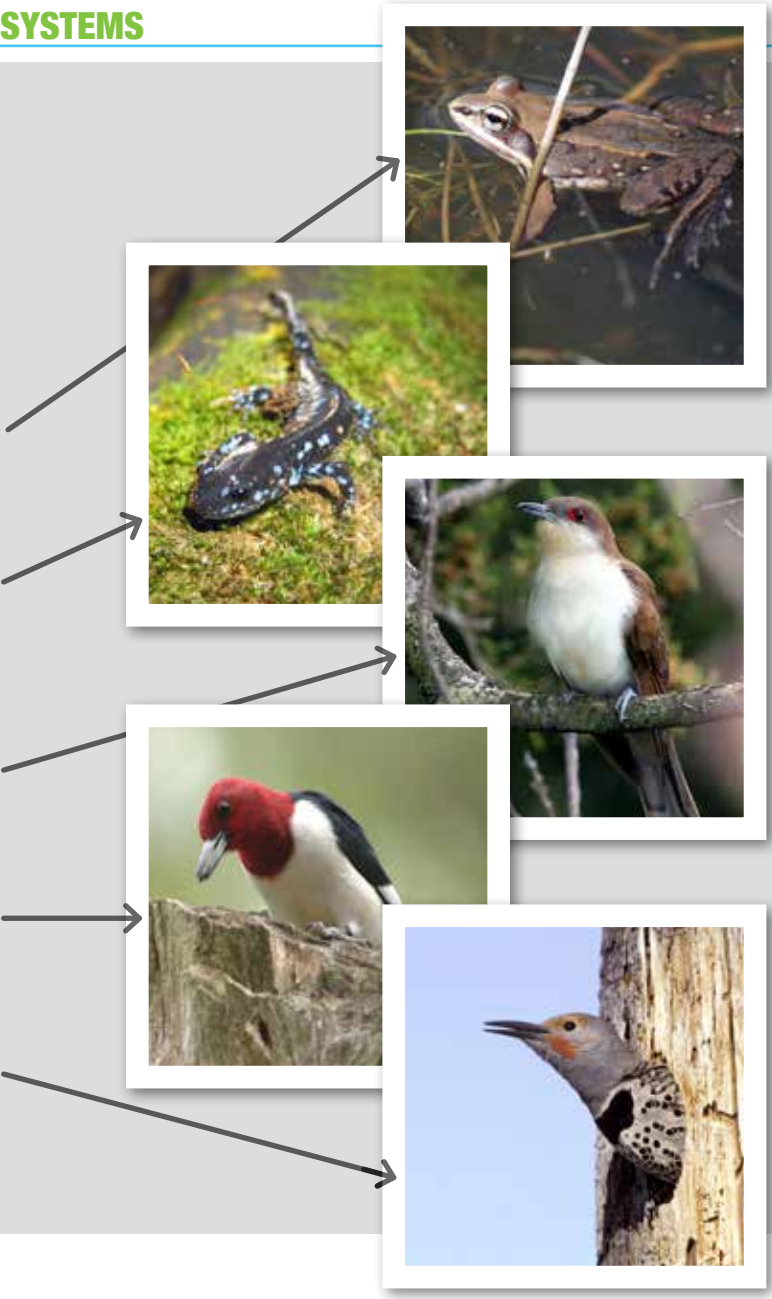
Wood frog (*Rana sylvatica*)—Solitary inhabitant of mature, moist forests. May wander far from breeding habitats of shallow vernal pools and forest ponds.

Blue-spotted salamander (*Ambystoma laterale*)—Most common in moist hardwood forests and northern Illinois swamp white oak flatwoods. Burrows under logs, rocks, and mats of moss and vegetation. Greatest threat is urban sprawl, according to the Illinois Natural History Survey.

Black-billed cuckoo (*Coccyzus erythropthalmus*)—Found in woodlands with moderate understory. Listed as threatened in a number of northern Illinois counties, including DuPage, Lake, Lee and McHenry counties.

Red-headed woodpecker (*Melanerpes erythrocephalus*)—Open woodlands are important habitat, but numbers have declined as standing snags or large, dead trees have become less common.

Northern flicker (*Colaptes auratus*)—Open woodlands, forest edges, and open fields with scattered trees, as well as city parks and suburbs.



food for migrating and nesting birds. Over 250 species of birds (and around five million individuals) migrate through Chicago twice each year (Chicago Audubon). A number of migratory bird species have been found to prefer oaks over other native tree species (Wood et al. 2012). The matrix of tall trees, shrubs and graminoid species that grow in oak ecosystems provide habitat for many of the nearly 100 bird species that nest in the Chicago region (Chicago Audubon Society).

Many wildlife species identified as “critical species” in the Illinois Wildlife Action Plan are found in high quality, open oak ecosystems, including red-headed woodpeckers, black-billed cuckoos, northern flickers, wood frogs, and blue-spotted salamanders *(See Box 2)*. In addition, energy rich oak acorns and nuts of hickories, walnuts, and hazelnuts that are associated with oak ecosystems are a major food source for a wide variety of birds, mammals, and insects and play a key role in the food webs of the region. Oaks are a very important source of shelter for wildlife species in the form of cavities in large, old trees, standing snags, and downed woody debris. Many species rely on these cavities for burrows or nesting locations.

Oaks also foster a rich assemblage of fungi and invertebrates. A study of a Chicago region oak woodland found 177 species of fruiting fungal organisms (Schmit et al. 1999). Furthermore, oak ecosystems have a higher abundance of microfungi (non-fruiting fungi) when compared to other temperate forest types (Buée et al. 2009). The dense leaf layer that is characteristic of oak woodlands promotes high invertebrate diversity. Over 250 species of mites can be found in a square meter of forest soil (Behan-Pelletier and Newton 1999).

For all of these reasons, restoration and management of oak-dominated ecosystems is an essential goal in promoting biodiversity and managing wildlife in the Chicago region. The importance of these ecosystems for these purposes is reflected in their prominent inclusion in the Chicago Wilderness Biodiversity Recovery Plan, the Illinois Statewide Forest Resource Assessments and Strategies, and the Illinois Wildlife Action Plan *(See Box 3)*. All of these plans, as well as other local, regional and national forest and other land management documents, call out the management of oak ecosystems as an essential component of overall ecological land management.

grandmother oak

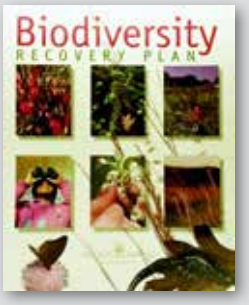
oak seedlings

BOX 3 REGIONAL INITIATIVES—OVERLAPPING OAK RECOVERY GOALS

Chicago Region Trees Initiative

The vision of this initiative is to ensure the following:

- The region's tree population is broadly understood and valued.
- Collaborative management opportunities are identified and enacted.
- There are measurable improvements toward the health and vigor of the region's trees, humans and wildlife.
- Public awareness and support is established to preserve, protect and enhance our urban forest for the future.



Chicago Wilderness Biodiversity Recovery Plan

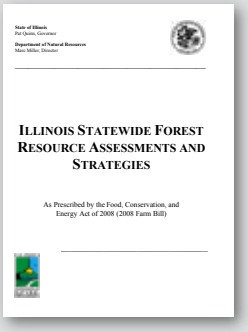
- Protect natural communities of the Chicago region and restore them to long-term viability, in order to enrich the quality of life of its citizens and to contribute to the preservation of global biodiversity.
- Restore natural processes, such as fire, allow canopy tree species to regenerate in viable numbers, and maintain and expand the cover of oak ecosystems to sustain viable populations of rare species and entire community assemblages.
- Approximately 50,000 to 100,000 acres of healthy forest and woodland complexes are needed.
- Create or manage 20 good quality sites larger than 500 acres and 10 sites of 800 to 1,000 acres that encompass a diversity of physiographic conditions, such as landform, slope, soils and hydrology.

Illinois Wildlife Action Plan

- Increase ecological connectivity among forests and other habitat patches, and reduce fragmentation of forests 500 acres and larger.
- Extent and condition of open woodland, savanna, and barrens habitats are known. Monitoring can identify conservation needs.
- Widen edges of forested habitats to create broader transition areas.
- Local and state authorities, citizens and stakeholders need to cooperate to develop zoning criteria and local greenway plans that protect important habitats and ensure "smart growth."

Specific Goals, Northeastern Morainal Division

- *Forests:* Increase by 8,000 acres. Restore and manage 20 sites >500 acres and four to five sites 800 to 1,000 acres.
- *Savannas:* Increase by 12,000 acres. Restore and manage 15-20 existing sites to >200 acres and 10 sites to >500 acres.



Illinois Statewide Forest Resource Assessment and Strategies

- One of the most promising ways identified to increase forest biological diversity, not only of tree species but also of groundcover vegetation, is to intensify canopy disturbances, midstory control and reintroduce fire into the system.
- Eradicate, control and prevent the introduction of invasive non-native species.
- Identify and conserve high priority forest ecosystems and landscapes.
- Programs geared toward encouraging voluntary coordinated management across ownerships could increase the positive impacts of forest management.
- Tax relief and incentives should be pursued in critical areas to retain forests.
- Within urbanizing areas, regional land-use planning that encourages conservation of greenways, riparian areas and wildlife travel corridors can increase connectivity among forested areas.
- Actively and sustainably manage forests.
- Connect people to trees and forests, and engage them in environmental stewardship activities.
- Work with state partners to assist in communication between nurseries and tree purchasers to ensure availability and quality of diverse species for public and private urban landowners. Look for collaborative opportunities to assist the nursery industry in forecasting future diversity needs.
- Provide up-to-date data on the benefits of trees to public and private landowners, land managers, foresters, developers, contractors, designers, planners, elected officials and decision makers.

ISSUES AND CONTINUING THREATS IN OAK ECOSYSTEMS

Remnant oak ecosystems and the potential to expand future oak populations are threatened by a variety of issues that act on multiple scales from individual trees to entire landscapes *(See Box 4)*. These issues include:

- *Lack of oak regeneration and general age diversity in oak populations.*
- *Mesophication of oak-dominated ecosystems.*
- *Fragmentation of regional ecosystems.*
- *Introductions and spread of invasive plants.*
- *Introductions and spread of diseases and pests.*
- *Expanded populations of herbivores.*
- *Pollution, including nutrient loading.*
- *Climate change.*

Oak regeneration and mesophication

One of the most difficult issues for the management and restoration of wooded ecosystems in the Chicago region is deficient oak regeneration (Holzmueller et al. 2011, Fahey et al. 2012). Oak seedlings are extremely rare in the Chicago region (Fahey et al. 2012). Unless an effort is made to address oak regeneration failures, the decrease in oak dominance in the landscape may become precipitously worse in the future.

Lack of oak regeneration is caused by changes in fire regimes, the shift to a dense canopy and an understory dominated by shade-tolerant, mesophytic species. These are all symptoms of what has been termed the "mesophication" of the forests of the northeastern United States (Nowacki and Abrams 2008). The removal of fire from these systems during the settlement period altered the overall structure and

BOX 4 THREATS TO OAK ECOSYSTEMS

A variety of threats are exacerbating the decline of oak ecosystems in the Chicago Wilderness region. Data on the perceived importance of these threats were collected in a survey of natural areas managers.

The primary threats perceived as limiting oak regeneration were canopy closure, non-native invasive plants, and the loss of fire disturbance from the landscape (Fig. 9). Among respondents, 71% believe that deer are negatively impacting oak regeneration and 93% consider deer as problematic in a majority of their properties (Fig. 10). Invasive woody plants were identified as being problematic on a large majority of properties by most managers (Fig. 11). In addition, 87% of respondents believe that mesophytic native invaders are impeding oak regeneration. A number of pest and disease problems have also been identified and are affecting the region's natural areas (*See Box 5*).

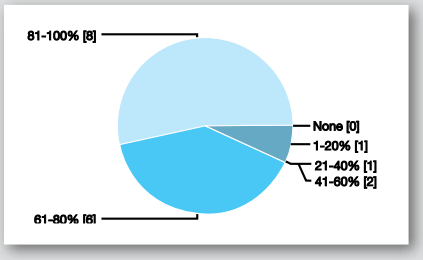


Figure 10. Percentage of sites where deer are considered a significant problem.

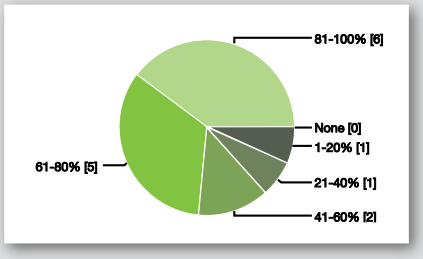


Figure 11. Percentage of sites where woody invasives are considered a significant problem.

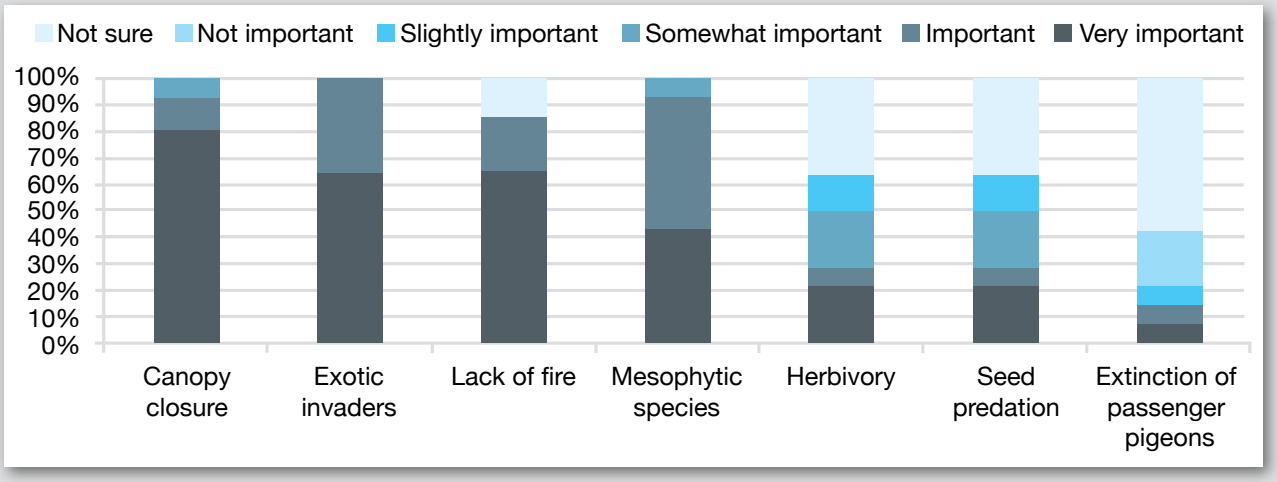


Figure 9. Respondents ranking of factors that contribute to oak regeneration failures.

functioning of the ecosystem (Black et al. 2006). Young oaks require substantial sunlight, and are unable to grow in the closed-canopy mesic forests that have formed in the region (Lorimer 2003). This problem is not isolated to the Chicago region and is evident across the forests of the northeastern United States and beyond (Lorimer 1993, 2003, Abrams 2003).

The mesophication of the region's forest has made managing for oak regeneration more difficult. While it is necessary to bring fire back to restore oak dominated ecosystems, the abundance of mesic species makes controlled burning more difficult and reduces intensity of fires that do occur. Therefore, many managers burn frequently, but these frequent, low intensity burns can top kill oak seedlings and prevent development of an oak sapling layer (Dey and Hartman 2005, Johnson et al. 2009).

Reintroduction of higher severity disturbance, such as more intense fires or canopy thinning, into these ecosystems may be necessary to promote oak regeneration. Fire has been absent from the region for so long that stems of fire-sensitive mesic species are now too large to be affected by surface fires. Therefore, canopy thinning may be necessary in many ecosystems. These actions would shift the structure, composition, and dynamics of the system towards a trajectory consistent with the historic range of variability (Drever et al. 2006). This shift could make lower intensity management treatments like controlled surface fires for promoting oak regeneration and other ecosystem management goals, such as groundlayer diversity, more likely to be successful in the future.

Destruction and fragmentation of ecosystems

Little of the original regional oak ecosystem remains, and fragmentation impacts the structure and function of the majority of the remaining remnant natural areas *(See pages 4–6)*. Fragmentation can severely limit the functional importance of oak ecosystems, especially as habitat for wildlife. As oak ecosystems are destroyed, species that require large, connected ecosystems could become regionally endangered or even extirpated (Davies et al. 2000). When natural areas become fragmented the ratio of core to edge habitat is reduced. Reduction of core habitat area has greatly reduced suitable habitat for many conservative birds, plants, and herpetofauna. Low levels of connectivity between habitat areas can also create genetic isolation where individuals from different fragmented forests are unable to interact and reproduce. This pattern effectively creates many small, isolated populations and can lead to inbreeding depression and loss of genetic fitness (Young et al. 1996, Kramer et al. 2008).

Connectivity between ecosystems needs to be restored in order to reduce fragmentation. Habitat corridors (i.e. swaths of natural habitat that connect larger sites) can be created to allow wildlife and plant seeds to move among sites. Such corridors can be built by restoring land along waterways or by planning easements through privately owned properties (for examples see Chicago Wilderness 2004). It is also possible to soften the edges of natural areas, thereby reducing the edge effect, by planting buffers of oaks and other native species in the more developed sites that surround them. These buffers can provide habitat to wildlife, even in a more urban context (Michael and Tietje 2008).

Non-native invasive plant species

Invasive plant species can outcompete native flora and alter soil chemistry, leading to reductions in biodiversity and changes in composition. Two of the most abundant and destructive invaders in the Chicago region are European buckthorn and garlic mustard. Other problematic woody invaders include non-native honeysuckles, multiflora rose, Japanese barberry, and oriental bittersweet. Other herbaceous invaders include Canada thistle, teasel, common reed grass, and Japanese hedge parsley.

European buckthorn (*Rhamnus cathartica*) is one of the most disruptive woodland invaders in the Chicago region (Knight et al. 2007). Buckthorn berries are dispersed by birds, and seeds can easily spread from urban sites into natural areas. Buckthorn forms dense thickets in which very few other species will grow, thus creating a monoculture of the invasive shrub (Knight et al. 2007). It also alters soil chemistry, which suppresses the growth of native species and could cause long-term difficulties in re-establishing oak ecosystems (Heneghan et al. 2006).

Garlic mustard (*Alliaria petiolata*) is a biennial herb that invades disrupted woodlands and precludes other forbs from flourishing. Its invasiveness is in part due to its ability to produce huge numbers of seeds (Cavers et al. 1979), but it also has allelopathic qualities (Prati and Bossdorf 2004). It releases chemicals from its roots that reduces the ability of other seeds to germinate (Prati and Bossdorf 2004) and inhibits mychorrhizal fungi (Stinson et al. 2006), which can reduce oak fitness. Although no studies have directly related garlic mustard to lack of oak regeneration. It is known that garlic mustard thrives in mesic environments and tends to form a feedback loop to keep forests mesic and suppress fire, which is detrimental to oaks (Rooney and Rogers 2011).

non-native invasive buckthorn

Diseases and pests

Oaks are affected by a number of pests and diseases, mostly related to insects or fungal pathogens. These vary widely in virulence and transmissibility and include both native and introduced pests and pathogens. Some of these pests and pathogens are currently present in the Chicago region, and there are others that threaten to become issues in the future. Many of the pests and diseases that affect oaks have relatively minor impacts unless trees are stressed by other factors, which could include urban site conditions or shifts in environmental conditions related to global climate change or development *(See Box 5)*.

Herbivores

The increase in populations of herbivores has also had an impact on oak ecosystems and is a significant factor limiting oak regeneration. White-tailed deer (*Odocoileus virginianus*) have experienced a fourfold increase in abundance in the last 50 years (McShea et al. 1997), due to removal of predators, forest fragmentation and agricultural expansion. High populations of deer and other herbivores, such as white-footed mice, can adversely affect oak regeneration through acorn predation and seedling browsing (Strole and Anderson 1992, McShea et al. 1997, Stromayer and Warren 1997, Russell et al. 2001, Rooney and Waller 2003, Aldrich and Parker 2005). These herbivores can also negatively impact other woodland species, such as spring wildflowers, and have been found to reduce plant species richness in midwestern woodlands (Rooney et al. 2004).

BOX 5 OAK PESTS AND DISEASES

Two-lined chestnut borer *(Agrilus bilineatus)*—This borer tunnels below the bark in oaks, which often kills a tree in two to three years. The borer only attacks trees that are already stressed or diseased. Infested trees can be treated with trunk injections if the pest is caught very early. However, prevention can be more effective than treatment. Only 9% of managers have detected two-lined chestnut borer.

Oak wilt *(Ceratocystis fagacearum)*—A systemic and usually lethal disease that is caused by a fungus. All oak species in the Chicago region are susceptible, but especially the red oak subgenus, which usually die within a single season of infection. The disease spreads through root connections and by movement of spores to wounded trees by wind or bark beetles. The spread of the disease can be limited by severing root connections among individuals, and limiting pruning to the winter when the fungus is not active. Individual trees can be treated with trunk injections. Oak wilt has been detected by 23% of managers in this region.

Gypsy moth *(Lymantria dispar dispar)*—The larvae of this non-native pest can rapidly defoliate large areas. The pest was introduced in Massachusetts in 1869. They have slowly radiated out from the origin and are becoming prevalent in the Chicago region. Even though this species is voracious, it does not usually kill a healthy tree in a single season. The pest can be controlled with insecticides, but these will also kill beneficial moths and butterflies and should only be used in severe cases. Gypsy moth damage has been reported by 86% of the region's managers.

Sudden oak death *(Phytophthoraramorum spp.)*—This fungal disease is currently limited to California and Oregon, but spread to the Midwest is a concern. The nursery industry is taking great care to ensure that infected trees are not moved to new areas. Red and pin oaks are particularly susceptible. The fungus can kill a tree in one season.

Bur oak blight *(Tubakia iowensis)*—This fungus only affects bur oaks. Leaves develop brown spots in the vein and eventually become necrotic. Heavily infected trees can die over several seasons of infection. The fungus reproduces in the spring, and its transmittance is amplified when there is heavy rainfall while it is reproducing. This disease is increasingly common in the Chicago region, and infestations have been reported in Lake County. Infected trees can be treated with fungicide.

gypsy moth eggs on oak tree

Nutrient deposition and pollution

In highly urbanized landscapes, such as the Chicago region, the effects of pollution can be especially intense and direct. There are a number of ways in which pollution could negatively affect oaks and oak ecosystems.

Heavy metal and salt deposition

While forests are heralded for their ability to intercept air pollution, high levels of pollutants can adversely affect many plant species. Industry and transportation create large amounts of salts and heavy metals, including mercury, lead, copper, and nickel (Pouyat et al. 1995, Helmreich et al. 2010). Runoff from roadways can introduce especially high levels of these pollutants, which are known to have adverse effects on tree health (Day and Wiseman 2010). While these inputs have been found to be deleterious to a broad number of species and ecosystems, their specific effects on oaks and oak ecosystems are relatively unknown.

Alteration of soil pH

In heavily urbanized sites soil pH is often higher than normal due to interactions of water with concrete and limestone (Ware 1990). Many oak species, including white, bur and pin oak, are intolerant of alkaline soils. They tend to become chlorotic in these soils, their growth is impaired, and in severely altered soils they can even die. Urbanization can also lead to acid deposition, which lowers soil pH and causes a reduction in fertility (Duchesne et al. 2002).

Nitrogen deposition

Increased nitrogen deposition can profoundly affect ecosystem functions (Carreiro et al. 2000). It can increase the rate of decomposition of litter (Heneghan et al. 2002) and facilitate the dominance of invasive plant species (Dukes and Mooney 1999). Oaks may be at a competitive disadvantage relative to both non-native and native invasive plants under high nitrogen conditions.

Climate change

Climate change is resulting in warmer temperatures, changes in precipitation, including dryer overall conditions with more frequent, intense storms, and changes in the length of the growing season (IPCC 2013). While it is very difficult to predict exactly how the ecosystems of the Chicago region will be affected by climate change, some predictions can be made based on species traits and ranges. These predictions will be modified in urban sites, making the consequences of climate change for urban forests highly uncertain.

A number of studies have predicted the effects of various climate change scenarios on tree species (Prasad et al. 2007, Iverson et al. 2008). Broadly, these studies predict that tree species will move north as temperatures increase. In the Chicago region few species are predicted to exit the region in the next 100 years, but many species will change in relative abundance. Most of the region's oak species are at the northern edge of their range, and are therefore expected to continue to thrive in the area. Oaks are also drought and heat tolerant and are thus relatively well adapted to some aspects of predicted future climate compared to species, such as sugar maple and paper birch. For more information about how individual species are predicted to adapt to climate change, see the interactive USFS Climate Change Tree Atlas: http://www.fs.fed.us/nrs/atlas/.

protected oak seedling

A VISION FOR SUSTAINING OAKS AND OAK ECOSYSTEMS IN THE CHICAGO WILDERNESS REGION

Given the extensive loss of oak ecosystems, decline in oak dominance, lack of oak regeneration, and severe landscape fragmentation in the Chicago region, we believe that significant actions are necessary to sustain oaks in the Chicago Wilderness (CW).

Our vision for the future of oaks and oak ecosystems as a component of the CW region is:

A physical landscape in which:

1. A regional network of oak ecosystems is developed and maintained that maximizes high quality interior habitat and landscape-level connectivity.
2. Remnant oak ecosystems are protected and managed to restore or maintain biodiversity and ecosystem structures and functions.
3. Oaks are planted, and oak ecosystems are created or restored across a range of land uses and ownerships.
4. Threats to oaks and oak ecosystems are managed proactively and removed whenever feasible.

A social landscape in which:

5. The story of the regional oak legacy is told widely to a variety of audiences in an authentic and engaging way.
6. A coordinated regional stewardship network is focused on maintaining and enhancing oaks and oak ecosystems in all of their incarnations.
7. The many values and services associated with oaks and oak ecosystems are understood and promoted to a wide variety of audiences.

This vision builds on the goals of the 1995 Midwest Oak Ecosystem Conference and is consistent with goals outlined in the Chicago Wilderness Biodiversity Recovery Plan, Illinois Wildlife Action Plan and the Illinois Statewide Forest Resource Assessments and Strategies Plan *(See Box 3)*.

In order to accomplish this vision, we advance the following primary goals for future efforts focused on maintaining the region's oak legacy:

1. Develop and maintain a regional network of publicly and privately owned land consisting of large, high quality remnant ecosystems (Cores) that are buffered and connected by a combination of smaller, lower quality natural areas, reclaimed ecosystems, and urban/residential plantings (Hubs and Corridors) consistent with the overall CW Green Infrastructure Vision.

a. Work to put Cores into some form of protected status.
b. Preserve and restore 10 functioning Core oak ecosystems of 1,000 acres and at least 20 of 500 acres.
c. Within Core areas—focus on maintaining or restoring characteristic species assemblages, maximizing biodiversity (including plants, animals, invertebrates, etc...), promoting ecosystem structure and function, and creating conditions that can be sustained with limited future management inputs.
d. Within Hubs and Corridors—focus on including and emulating some components of oak ecosystems, including plant species in the canopy (oaks, hickories, walnut), understory (hazelnut, ironwood, etc...) and groundlayer (coarse wood, native shrub layer, and natural duff/litter layer).

2. Develop, promote, teach and implement best management practices for restoring/maintaining oak ecosystem biodiversity, structure and function across a range of land-use/ownership types and a range of institutional capacities—from large, professional organizations to small, volunteer-based groups.

a. Promote the use of controlled burns and creating conditions for successful fire programs.
b. Focus treatments on reversing mesophication of oak ecosystems and promoting a balanced age structure at a regional scale, such as canopy and understory thinning when appropriate.
c. Utilize treatments that can eradicate or slow the spread of invasive species.
d. Plant and seed native species that are targeted to specific conditions or goals.

3. Proactively address threats to oaks and oak ecosystems through management, stewardship, monitoring and outreach programs.

a. Increase climate change resilience of oak ecosystems and improve landscape resilience through connection of oak ecosystems to create migration corridors.
b. Eradicate buckthorn and other invasive plant species that impact oak regeneration and oak ecosystem functions. Avoid additional introductions in conjunction with the Northeastern Illinois Invasive Plant Partnership.
c. Plan for impacts of pests and diseases and attempt to avoid future introductions.
d. Manage herbivore populations and assess impacts on regeneration and biodiversity.
e. Manage remnant oak ecosystems and restored stands to permit the natural regeneration of oaks and associated species, such as hickories.

4. Quantify and promote the myriad values associated with oaks and oak ecosystems as a component of regional green infrastructure valuation.

a. Habitat value of different components of the Core-Hub-Connector system, especially in relation to critical wildlife species (See Box 2) and species dependent on oaks and oak ecosystems.
b. Carbon storage and sequestration, energy reduction, stormwater mitigation for oaks relative to other species.

c. Socio-economic values of oaks and oak ecosystems in different contexts—factors such as health benefits, property values, crime reduction, etc...
d. Recreational and aesthetic values associated with oaks and oak ecosystems, such as birdwatching.

5. Make the production and planting of oaks a priority across the nursery-landscaping-landowner complex and across a variety of planting sites and land-use/ownership types both public and private.

a. Increase the proportion of oaks planted in parks and municipal forests to approximately 10–20%.
b. Market oaks and their benefits to industry professionals and consumers.
c. Assess potential of oaks in different landscape contexts and dispel unsupported negative views of oaks as landscape trees.
d. Work with the nursery industry and public nurseries in developing a sustainable pool of oak planting material with a diversity of species and stock types.
e. Conduct a market analysis for oak planting material to predict current and future demand.

6. Convey the story of our region's oak legacy to a wide array of stakeholders across the region.

a. Create promotional materials and media opprtunities that describe the oak legacy idea and the oak recovery vision.
b. Establish and maintain an oak awareness month, "OAKtober," that is recognized by the state of Illinois.
c. Educate and engage decision-makers to allocate resources in support of appropriate care and management of oaks and oak ecosystems.
d. Develop lesson plans and outreach materials in partnership with local educators from a variety of types of institutions—from primary school through college and continuing education.
e. Engage stakeholders, and especially volunteers, in authentic activities focused on maintaining or enhancing oak ecosystems, including tree planting and maintenance, invasive species removal, pest and disease monitoring, data collection, etc...

7. Continue to focus on fostering a better understanding of the status of the regional oak resource, building off the remnant ecosystem mapping for the Illinois portion of the CW region.

a. Map remnant oak ecosystems in remaining CW region in Indiana, Wisconsin and Michigan.
b. Link remnant data with site level data on composition, structure and quality, such as Illinois Natural Areas Inventory and oak ecosystems bioblitz efforts to create a comprehensive regional database of conditions.
c. Map areas of emergent and restored oak ecosystems outside remnant areas.
d. Identify and map priority areas for preservation, conservation, restoration or reclamation based on the regional Urban Tree Canopy Assessment and other data sources.

8. Evaluate potential future outcomes for regional oaks and oak ecosystems based on scenarios of management, development, land management practices, planting strategies, pests and disease, and climate change to guide specific actions for stakeholders.

a. Develop plans that maximize resilience of the region's oak population and oak ecosystems under different scenarios of inputs (management, funding, outreach) and stressors.
b. Link oak issues with existing and in-progress regional planning efforts, such as the Climate Change Response Framework in development by the USDA Forest Service and the CW Green Infrastructure Vision.

9. Develop and maintain a regional monitoring and research network dedicated to supporting the vision and goals outlined above and research needs ***(See Box 6)*****.**

a. Quantify ecosystem services benefits.
b. Create adaptive management strategies for restoration and reclamation projects.
c. Complete scenario modeling of future oak resources and associated biodiversity along with other benefits.
d. Monitor and research threats to oak ecosystems.
e. Analyze factors that support planting and production, including matching trees with sites and evaluating planting and maintenance strategies.
f. Develop regional scale system for tracking management, reclamation and reforestation activities.

10. Formalize the Oak Recovery Working Group within the Chicago Wilderness Trees and Green Infrastructure Work Group and Chicago Region Trees Initiative as a regional planning group to guide the implementation of this vision.

a. Coordinate regional stakeholders and the amplify efforts of existing groups, such as Project Quercus, Conservation@Home, TreeKeepers and Mighty Acorns.
b. Acquire funding and document efforts that are occuring at a regional scale.

BOX 6 RESEARCH OBJECTIVES TO SUSTAIN OAKS IN THE CHICAGO WILDERNESS REGION

The following are examples of research objectives that could aid in the recovery of oaks and oak ecosystems in the Chicago Wilderness region. Some objectives are currently being addressed in some form. All of these research objectives are likely to require additional funding and effort.

Landscape use
Site characteristics and environmental conditions required to grow healthy oak trees

Management in urban sites
Pruning and other cultural practices as applied to oaks

Production issues
Strategies and tactics for effectively growing oaks from different sources and into different types of growing stock

Nursery market analysis
Assess expected demand and supply needed to meet near and long-term planting and restoration goals

Map remnant oak ecosystems
Complete process for remaining (non-Illinois) portions of the Chicago Wilderness region, including developed areas

Tracking planting in urban areas
Numbers, stock types, and monitor growth and survival

great horned owls

Forest composition and structure
Assess status of oaks (composition, size structure, age structure) in the current regional forest at fine scale. Analyze current stand conditions across remnant and restored sites, potentially through a bioblitz program.

Restoration best management practices
Promoting oak regeneration and restoring other components and functions of oak ecosystems

Adaptability of oak species and genotypes
To urban habitats and future climate scenarios

Invasive plant management
Buckthorn and honeysuckle biomass utilization programs and feasibility studies

Monitor reforestation and reclamation projects
Feasibility of using oaks in different types of reclamation projects

Restoration, reforestation and reclamation tracking system
Locations of projects and management strategies used by all stakeholders

Prioritize land acquisition and protection, restoration, reforestation, and reclamation
Based on mapping of remnant oak ecosystems, CW Green Infrastructure Vision, Urban Tree Canopy assessment, etc...

Wildlife usage and other benefits associated with urban oaks and oak ecosystems
Including remnant and planted trees in developed areas and use of remnant ecosystems in different landscape contexts

big bur oak

In order to address the vision outlined on pages 17–18, actions will be needed on a number of topics and by a wide range of stakeholders. We have identified the following six focal areas that should be addressed to help maintain the presence of oaks and oak ecosystems as a dominant feature of the Chicago Wilderness region in the future.

For each focal area general strategies have been outlined, as well as examples of specific tactics that could be applied to help potential stakeholders sustain oaks and oak ecosystems in the region.

Case studies are also presented that illustrate major strategies or specific projects that could act as models for efforts at a regional scale.

Natural Areas Management in Publicly Owned Sites

Management of existing oak ecosystems, either remnant or more recently established, will be one of the most important avenues for sustaining the dominance of oaks, and their associated benefits, in the Chicago Wilderness region. Approximately 30% of the remnant oak ecosystems in the modern landscape are in some form of public ownership (Table 4). These properties represent the most likely candidates for management as natural areas and include many of largest remaining parcels of unfragmented ecosystems. Active management is necessary to combat the many issues facing oak ecosystems, such as invasive plants, mesophication, and oak regeneration failures *(See Pages 13–16)*. Natural resource managers in the region are focused on maintaining or increasing biodiversity and oak regeneration pools and re-establishing structural elements that have been lost from these ecosystems *(See Box 7)*.

BOX 7 NATURAL AREAS MANAGEMENT SURVEY

In order to better understand the current state of management actions in Chicago Wilderness natural areas, a survey of land managers was conducted. Twenty-two respondents from a wide range of organizations answered questions focused on general management strategies and specific actions.

Oak regeneration is widely recognized as an area of concern across eastern North America. Respondents to our survey considered removal of woody invasives and canopy thinning as the most important strategies to promote oak regeneration (Fig. 12). Most respondents use controlled burns in a majority of their oak ecosystems, but woodlands and savannas are burned much more frequently than forests (Table 5). Cited limits on burning include the short burning season and lack of appropriate weather conditions.

Other questions focused on how natural areas are managed to encourage the growth of oaks. Most managers (69%) protect young oaks from herbivory, and all but one organization conducts deer management. All but one respondent removes mesophytic species from oak ecosystems to create more open canopy conditions, and a majority of respondents do so on more than half of their oak dominated properties. Half said that they have previously removed canopy oaks to encourage oak regeneration, and 69% said that they would do so in the future.

Table 5. Land manager response rates across burn regularities and ecosystem types.

	Ecosystem Type		
Burn regularity	Savannas	Woodlands	Forests
Annually	0%	0%	0%
Biannually	57%	30%	17%
Every 3–5 years	43%	62%	33%
No regularity	0%	8%	33%
Never	0%	0%	17%

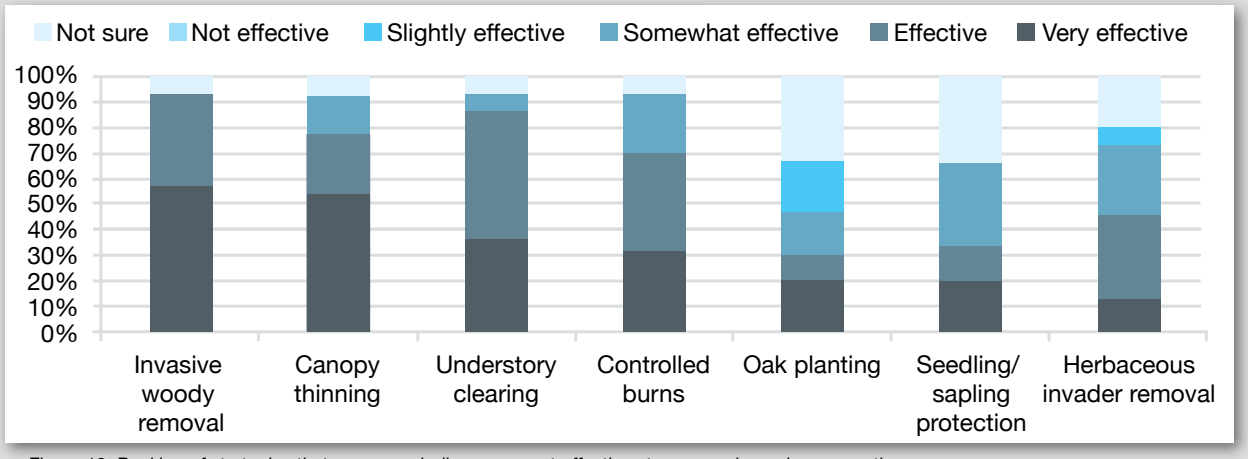


Figure 12. Ranking of strategies that managers believe are most effective at encouraging oak regeneration.

The primary goal of such work is not to re-create the historical ecosystem, but to promote some of the features of historical ecosystems that played an important functional role in the landscape. Another important goal is to create ecosystems that can either be self-sustaining or be maintained with minimal management inputs. To achieve these goals a variety of resources are needed, including increased funding, more overall management effort, changes in management practice, outreach to the public to communicate management tactics, and research and monitoring efforts to document new and ongoing management.

Strategies and Example Tactics

1. Promote and increase the use of controlled burn management in oak ecosystems. Promote cooperative burn units.

2. Implement "fire surrogate" management to alter structure and promote future use of fire management.
   a. Understory and canopy thinning—focused on reducing stem and canopy density, especially of mesophytic species as appropriate *(See Box 8)*. Remove and eradicate non-native invasive plant species, especially woody shrub species, that inhibit oak regeneration and shade out native herbaceous species. Prevent future infestations.
   b. Train and encourage volunteer land stewards.
   c. Begin biomass utilization projects and feasibility studies.
   d. Regional early detection partnerships, such as the Northeastern Illinois Invasive Plant Partnership.

3. Directly address biodiversity issues through management actions, such as native species reintroductions, and by maintaining or creating habitat features utilized by wildlife and plant species.
   a. Create snags and downed woody debris in thinning projects through stem girdling and "drop and leave" cutting.
   b. Create open canopy and understory conditions to promote light transmittance to herbaceous layer.
   c. Develop and expand monitoring programs focused on quantifying biodiversity in oak ecosystems.
   d. Reintroduce plant and animal species that have been locally extirpated.
   e. Conduct enrichment planting and seeding of rare or conservative species to improve biodiversity.

4. Increase oak regeneration, especially in the sapling layer (See Box 8).
   a. Canopy thinning and gap creation where appropriate.
   b. Planting of seedlings when natural seedling pool is lacking, especially to time with canopy thinning projects.
   c. Time controlled burns to reduce oak seedling mortality.

5. Create buffers and corridors around and within existing natural areas to increase interior habitat and connectivity to maximize wildlife habitat value *(See Box 9)*. Maintain or create urban oak ecosystems with some degree of natural structure or functions adjacent to natural areas.
   a. Acquisitions of remnant ecosystems not currently in protected status.
   b. Removal of roads, bypasses and overpasses to reduce fragmentation in remnant ecosystems.

6. Promote resiliency to future stressors, such as climate change and introduced pests and pathogens. Manage for diversity at a landscape scale—oak-dominated ecosystems where possible—but with components of associated species.

7. Quantify and promote the ecosystem services value of oaks and oak ecosystems. Target research to understand wildlife use of oak ecosystems in different landscape contexts.

8. Communicate management goals, strategies and tactics prior to implementation to reduce negative responses and increase public engagement.

9. Develop programs to track activities and prioritize preservation and restoration at a regional scale.
   a. Create a regional database to track and synthesize information on restoration activities and practices.
   b. Prioritization analysis for preservation and restoration based on regional mapping of remnant oak ecosystems.
   c. Develop "bioblitz" program to assess characteristics of select oak ecosystems across the region.

BOX 8 DES PLAINES RIVER ADAPTIVE MANAGEMENT IN LAKE COUNTY

Manipulation of canopy conditions will be necessary to promote oak regeneration in Chicago region's urban natural areas. Woodland restoration activities in the region to date have primarily focused on controlled burns and clearing of invasives, which often had positive effects on stand conditions but have largely failed to promote oak regeneration. Treatments that involve incremented and targeted partial canopy removal are likely to be necessary. However, optimal design for such treatments (timing, intensity, and spatial aggregation of removals) and their potential effectiveness is largely unknown. Experimental research on potential management strategies is necessary to determine minimum treatment intensity and provide strong evidence to managers of the effectiveness and feasibility of oak regeneration treatments.

In the Lake County Forest Preserve District's Woodland Habitat Restoration Project (WHRP) phased, multi-cohort adaptive management treatments are being used to promote regeneration and eventual canopy accession of oaks. All treatments are designed to emulate the impact of a mixed-severity fire regime with frequent low-severity surface fires and occasional high-severity canopy fire on canopy structure and composition. Management treatments are sited in dry-mesic stands in which the canopy is dominated by oak species and which have a history of invasive species removal and controlled burns.

Treatments are implemented at three preserves (Fig. 13): MacArthur Woods, Ryerson Woods, and Wright Woods Forest Preserves. Each of five treatments—woodland, moderate, light, group selection & shelterwood, and understory—is replicated in multiple blocks at each site (Table 6). Monitoring plots have been randomly located within treatments, and data on light availability, vegetation conditions, and oak seedling success will be collected on a regular schedule. Additional research will assess birds, herpetofauna, invertebrates, microbial communities, and invasive plant populations.

One of the most important components of this project that should be emulated in future implementations is extensive pre-treatment outreach to the public and conservation organizations. This outreach is necessary to communicate project goals and their scientific basis. This approach has been very successful in limiting negative reactions to these management actions.

For more information about the project visit their website at **www.LCFPD.org/woodlands**.

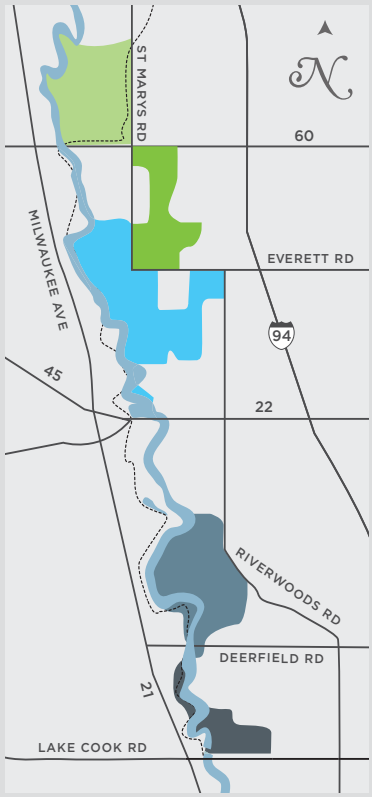


Figure 13. Adaptive management sites in the Lake County Forest Preserve District.

- MacArthur Woods Forest Preserve
- Grainger Woods Forest Preserve
- Captain Daniel Wright Woods Forest Preserve
- Ryerson Conservation Area
- Cahokia Flatwoods Forest Preserve
- Des Plaines River
- --- Des Plaines River Trail and Greenway

fish-eye lens photos of the canopy

Table 6. Canopy thinning and trreatment details.

Treatment	Phase 1	Phase 2	Total	% Area
Woodland structure	35%	0%	35%	100
Moderate thinning	20%	15%	35%	100
Light thinning	10%	10%	20%	100
Group selection	20%	10%	35%	32.5
Understory thinning	0%	0%	0%	100

BOX 9 DECREASING FOREST FRAGMENTATION AT WATERFALL GLEN

Fragmentation is a severe problem in the Chicago region's natural areas, and reducing it is a critical step to improving their functional value. Reconnecting parcels that have been split apart by urban land uses is usually the focus of efforts aimed at reducing fragmentation, but fragmentation can also occur within public landholdings. The Forest Preserve District of DuPage County (FPDDC) saw an opportunity to increase connectivity of natural ecosystems within one of their sites.

Waterfall Glen is a ~2,500 acre site that surrounds the Argonne National Lab. The site is extremely biologically diverse. It is home to around 740 plant species, 300 wildlife species and 647 known invertebrates. Several threatened and endangered species breed at the site, including the black-billed cuckoo, which is extremely sensitive to disturbances while nesting. The site's managers realized that a foot path bisected the bird's habitat, and that the traffic on this path was causing significant disturbance and reducing nesting potential.

The FPDDC determined that they could greatly increase core habitat by moving a path that divided a forested area (Fig. 14). Moving this path was not merely a physical matter. Users of the natural area have very strong connections with the site and are concerned about any changes to the area. In order to garner citizen support, FPDDC worked with the Sierra Club and the Trail Riders of DuPage County. Members of these organizations are some of the biggest users of the paths, and by reaching out to them FPDDC was able to explain why removing the path is important for wildlife habitat and received their approval. Additionally, FPDDC created a website for the public that included text, videos and maps that explained the project.

This project reduced fragmentation in a relatively small site, but the strategies that the FPDDC used could be applied on a broader scale. On a regional scale, moving roads, restoring native habitat, creating buffers around natural areas or changing development plans are essential for reducing fragmentation. However, in order for these sorts of projects to be successful managers need to gain public understanding and approval.

Figure 14. Changes in paths to reduce fragmentation.

Municipal and Parks Management

The Chicago region is among the most highly developed and densely populated areas in the nation, and thus any attempt to sustain oaks as a dominant component of the canopy must rely on urban sites, including those managed by municipalities. Oaks are often seen as difficult, slow to grow, and inappropriate for planting in urban areas, but there are a number of oak species that grow well in urban sites *(See Box 10)*. Oaks could work across a wider variety of land uses than where they are currently applied, especially if sites are designed to accommodate them and species are matched to appropriate sites *(See Box 11)*.

Strategies and Example Tactics

1. Plant oaks across the full range of urban sites in which they could be successful.
   a. Match species to sites.
   b. Identify sites that can support large trees.
   c. Create conditions in existing sites that will support oak success—design or amelioration.

2. Address potential misconceptions regarding difficulties of growing oaks in urban sites and develop best management practices for oak planting/management in different urban site types.
   a. Focus research on assessing perceived difficulties in growing/managing oaks and on developing BMPs for urban sites.
   b. Conduct outreach to managers to "myth bust" those perceptions which are found to be largely untrue and communicating best management practices.

BOX 10 OAKS FOR URBAN ECOSYSTEMS

White oak (*Quercus alba*)—Prefers dryer, slightly acidic soils. Does poorly in alkaline soils, and thus often struggles as a street tree. Trees with greater than a two-inch caliper do not transplant well. Works very well in parks and natural areas.

Swamp white oak (*Quercus bicolor*)—Does well in wetter soils. It can become chlorotic in dry, alkaline soils. Tolerates salt and compacted soils fairly well. These trees can do well as street trees if they are planted in moist areas.

Hill's oak (*Quercus ellipsoidalis*)—A smaller statured oak tree that can grow in sandy or clay soils. Has great fall color and can tolerate salty soils and therefore does well as a street tree.

Shingle oak (*Quercus imbricaria*)—Works well in difficult urban conditions. Tolerates salt spray and compacted soils. Can be used as a street tree or in tree pits.

Bur oak (*Quercus macrocarpa*)—A very adaptable tree that can tolerate urban conditions, including drought. Not frequently used as a street tree because of its very large size. Works wonderfully in parks and natural areas.

Chinquapin oak (*Quercus muehlenbergii*)—A good tree for tough conditions. Tolerates alkaline soils, salt spray and drought. Acorns are highly sought by wildlife.

Pin oak (*Quercus palustris*)—Has beautiful form and fall color but can be difficult to place. Not tolerant of salt or soil compaction, and should not be used as a street tree. Requires wet, acidic soils and can become fatally chlorotic if planted in the wrong site. Can be used in parks and natural areas where hydrology and soil conditions are appropriate.

Red oak (*Quercus rubra*)—Somewhat salt tolerant, but does not tend to perform well as a street tree. It tends to become chlorotic in alkaline soils. Well suited for parks and natural areas. Prefers moist soils and is relatively shade tolerant.

English oak (*Quercus robur*)—While it is not native to the region, it does offer ecosystem services and can be used in challenging sites. Tolerant of alkaline soils. Prefers substantial soil volume as it forms a deep taproot. Grows in well-drained to moist soils.


white oak


bur oak


pin oak

BOX 11 THE VILLAGE OF ALGONQUIN'S MUNICIPAL FOREST

In 2008, ashes made up 25% of Algonquin's municipal forest, making the introduction of emerald ash borer (EAB) especially destructive in the village. Mass removal of trees has been expensive and disruptive but allowed the municipality to increase species diversity by planting a wider palette of trees, including several oak species.

Oaks are often maligned as being slow growing or unhealthy when planted in urban sites, but in Algonquin oaks tend to be healthier than the average tree (Table 7). Algonquin's municipal foresters take care to fit tree species to site specifications. For example, oaks that are sensitive to salt or alkaline soils, such as pin oak, are only planted in parks or other large, undisturbed spaces. In urban sites, hardier species, such as swamp white oak, are used. See Box 10 for details about using oak species in urban sites.

Algonquin takes additional measures to ensure that newly planted trees will thrive, including the use of root bags instead of ball-and-burlap or containerized stock. These bags encourage fibrous root growth, which allows the tree to quickly acclimate to its new site. Many municipalities specify that all street trees must have a two-inch caliper, but Algonquin found that smaller trees tend to establish and start growing more quickly. In response to EAB, the village changed its codes to allow for trees as small as 1.5" caliper to be planted along streets.

Sourcing oaks can be a challenge for municipalities. Many foresters report that they are unable to find nurseries that grow oaks. Algonquin overcame this by starting their own nursery (Fig. 15). Algonquin's foresters collect acorns from the best specimens in their village and propagate them. They have found that they can grow the trees for a fraction of the cost, and they know that the seed stock is locally adapted. It takes them around five years to grow an oak to 1.5" caliper.

With only slight modifications to standard practices the Village of Algonquin has been able to integrate oaks into their municipal forest and has found that oaks can be as healthy and resilient as any other urban species, while offering superior habitat to native wildlife.

Table 7. Percentage of oaks and other species in each health class.

Condition	Oaks	Other species
Excellent	43.6%	33.6%
Good	52.2%	58.4%
Fair	3.6%	6.5%
Poor	0.3%	1.4%
Dead	0.3%	0.1%

Figure 15. Village of Algonquin's municipal nursery

3. Promote diversification and resiliency in the regional oak canopy through inclusion of a wide variety of species, including potentially future adapted species in urban plantings.
   a. Encourage the inclusion of a wide diversity of oak species in municipal planting lists across the region, including southern or drought tolerant oak species.
   b. Incorporate planting stock from outside the region to increase genetic diversity.

4. Maintain a healthy urban oak canopy.
   a. Develop tree protection ordinances for existing trees on public and private property.
   b. Monitor for potentially problematic pests and diseases.
   c. Prune and maintain individual trees.

5. Quantify and promote the ecosystem services values associated with oaks in different urban contexts.
   a. Conduct research on the biodiversity and wildlife habitat value of oaks in urban sites.
   b. Illustrate differences in potential maximum value of factors, such as carbon storage and energy reduction for oaks versus other species.
   c. Include habitat features, such as native groundcover, snags and coarse wood, in natural settings within urban parks when possible.

BOX 12 PROJECT QUERCUS™

Project Quercus™ began in the same manner in which it thrives in today—as a collaboration of a diverse group of individuals. In 2006, The Land Conservancy of McHenry County (TLC) brought representatives from municipalities, tree care services, nurseries and non-profit organizations together to discuss a pattern that they were observing in oak ecosystems: old oaks were beginning to senesce, and there were no new oaks to replace them. Without action, oaks would no longer be the dominant species in McHenry County, so the group vowed to find ways to ensure oak dominance into the future. TLC then founded Project Quercus™, a set of programs that protect existing woodlands, educate the public about their importance, and plant the next generation of oaks.

Living with Trees Awards: This program recognizes individuals, organizations and businesses that are doing an outstanding job managing oaks.

Oak Keepers: Trained volunteers survey woodlands on private lands. Landowners are often unaware of the age and state of their trees. Upon learning that their trees were over 200 years old, many took caring for their oaks more seriously.

Acorn Roundup: Every autumn, Project Quercus™ requests that homeowners collect acorns from their oaks, which are then propagated by Glacier Oaks Nursery for future community plantings *(See Box 16)*.

Community Plantings: Trees grown from collections during the Acorn Roundup are planted with schools and municipalities on conservation easements.

Project Quercus™ has also done research to quantify different strategies for reforestation plantings. This research was completed as a part of the Chicago Wilderness Oak Ecosystems Recovery Project. The project tested three common tree planting techniques: 1) direct planting of acorns, 2) planting container-grown seedlings, and 3) planting bare-root whips. Staff and volunteers monitored the success of each technique to determine which yielded the highest return on investment of time and resources (Table 8). Plantings will continue to be monitored to document second and third year survival rates. Additional bare-root seedling plantings will be conducted and compared to survival rates in initial plantings.

Every Project Quercus™ program has multiple purposes. Not only do Oak Keepers survey and study oaks on private lands, but they teach landowners about the importance of oak woodlands. The Living with Trees Award does reward individuals and organizations for being good stewards, but it also raises the profile of oak management to the wider public. Project Quercus™ is a framework of strategies and programs that could be emulated elsewhere, and the process of identifying needs and initiating projects to address a community's specific challenges can be broadly applied. The experience and framework of Project Quercus™ in McHenry County will be an invaluable resource and will provide templates for development of a regional oak recovery program.

Table 8. Survival rate after one year of three different planting methods and the calculated cost per successful tree.

	Survival rate after one year	Cost per tree
Acorns	<1%	$120.00
Container grown seedlings	92%	$31.65
Bare root whips	~100%	$2.20

BOX 13 BURNHAM CORRIDOR HABITAT RECLAMATION

The Lake Michigan shoreline is an extremely important habitat for migrating bird species, and the parks that line the lake in the City of Chicago are an important component of this flyway. A strip of land between Lake Shore Drive and the Canadian National Railroad had been underutilized for decades (Fig. 16). The site was a refuge for invasive and weedy species and was polluted with garbage, making it of little use for wildlife. The Chicago Park District (CPD) endeavored to reclaim the site as a forested area that would support native flora and fauna.

As a first step, CPD cleared weedy and invasive trees and shrubs, which were chipped and spread out as mulch. This mulch helped prepare the site for planting by retaining soil moisture and reducing the reestablishment of invasive species. Hundreds of large trees, including cottonwoods, maples and honey locusts were left on site to ameliorate site conditions.

Planting a large site from scratch is a massive undertaking. The first hurdle was to source the many trees that would be planted. The CPD decided to plant small seedlings (whips) instead of larger trees. Whips can be grown in a single year, greatly reducing the time needed to secure the stock for the project. The district planted around 50,000 of these small trees (Table 9). The CPD prioritized planting oaks at this site, as they offer premier habitat for migrating birds and other wildlife (See Box 2). However, the Burnham Corridor lies on lake fill, and the soils are very different than what would be encountered in natural areas. The park district, therefore, chose a wide variety of oak species in hopes that some would thrive in the site's challenging conditions.

Another challenge in planting a site de novo is creating age class diversity. The CPD planted a large number of trees that are the same age. This could create problems in the future, as all of these trees will grow, reproduce and eventually die on the same time scale. To increase age diversity CPD planted shrubs and hundreds of 1.5" to 2.5" DBH trees two years prior to planting. They will plant more trees in the coming years, in addition to shrubs and ground level flora.

Figure 15. Oak saplings two months after planting.

Table 9. Species planted in the Burnham reclamation.

Oak species	Percentage	Non-oak species	Percentage
Swamp white	35%	*Sugar maple*	9%
Red	12%	*Red maple*	6%
Pin	5%	*Crabapple*	5%
Chinquapin	5%	*Redbud*	5%
White	5%	*Tupelo*	3%
Scarlet	5%		

6. Utilize parks and municipal forests as corridors between natural areas.
   a. Create a continuous canopy of native tree species and patches of natural habitat in neighborhoods and parks bordering natural areas.
   b. Focus on areas that could address connectivity and fragmentation issues, as suggested by mapping and analysis of regional oak ecosystems.
7. Engage community residents with the story of regional oak legacy through connections in parks and urban tree plantings.
   a. Provide information about the legacy oak ecosystem features in neighborhoods and parks when present.
   b. Conduct community oak planting events as part of an "OAKtober" event.
8. Develop and promote an engaged volunteer community that is focused on maintaining health of oaks and other native species planted in urban sites.
   a. Build on TreeKeepers and Project Quercus™ programs to create a regional "oak-keepers" program *(See Box 12)*.
9. Provide training opportunities for public land owners and managers to enhance management strategies.
   a. Promote the Community Trees Network mentoring program to assist peer to peer knowledge exchange.
   b. Promote CRTI Urban Forestry Training program for non-professionals who work in public forestry.
   c. Train public land managers and owners how to use and interpret forest composition, Green Infrastructure Vision, and oak mapping to incorporate into their urban forest management and comprehensive plans.

Reforestation and Reclamation

Although much of the land base in highly developed areas, such as the Chicago metropolitan region, is not available for tree planting or forest management, there can be significant opportunities for adding canopy through reuse of abandoned land *(See Box 13)*.

Post-industrial and post-agricultural sites could be utilized to establish oak trees or new oak ecosystems. Vacant lots in urbanized residential areas could provide opportunities to increase canopy cover and even establish small groves of trees that could provide some ecosystem functions. However, there is considerable uncertainty surrounding the process and potential for success of reclaiming urban sites as oak ecosystems. Degraded soils, high levels of invasive species, extreme heat island effects, and high pollution levels make such sites a difficult place for any trees to grow, oaks included. Such plantings may require investments of resources, both in upfront site preparation and long-term maintenance. These challenges vary across gradients in site degradation and urban density and also depend on the goals of the project (i.e. establishing a few oak trees on a site versus a functioning oak ecosystem). When reclamation or reforestation projects are successful they could add to the oak canopy and ecosystem land base at a regional scale and could be especially useful in connecting or buffering existing, remnant ecosystems. Additionally, urban reclamation projects could work as an education and engagement tool for urban populations and create a greater understanding of the importance of oak ecosystems regionally.

Strategies and Example Tactics

1. Evaluate site preparation techniques and develop best management practices for different types of sites.
   a. Conduct research on soil amelioration.
   b. Develop strategies for reducing invasive species dominance in reclaimed sites.

2. Test different types of planting stock and methods of planting to match site characteristics and project goals.
   a. Include a variety of strategies and work in an adaptive management framework.
   b. Conduct benefit-cost analysis of different stock types in relation to site and organizational resources *(See Box 12)*.
   c. Assess volunteer versus professional planting.

3. Implement research and monitoring programs to quantify "success" of projects in different senses and potential habitat and biodiversity value of different types of projects.

4. Utilize volunteers in planting and site preparation to promote community engagement.

5. Learn from models in other areas or ecosystem types where reclamation is more common, such as prairies or wetlands, to understand how to create functioning oak ecosystems. Utilize successional processes.

6. Contract with nurseries to ensure availability of planting stock.

7. Assess opportunities on a wide variety of sites and ownerships, such as transportation/utility corridors and Rails to Trails projects. Integrate vacant lots in communities in concert with development of urban agricultural spaces.

Private Lands

Although management focused on publicly owned land must be a priority in sustaining oaks in the Chicago region, a very large proportion of the land base in the region is privately owned, including approximately 70% of remnant oak ecosystems. These lands also need to be addressed in regional planning focused on maintaining oaks, especially in buffering and connecting existing oak ecosystems on public land and increasing oak representation in urban areas.

Residential lots and corporate campuses are sometimes better suited to oaks than municipally managed sites. Therefore, making oaks more readily available and desirable to property owners and landscapers will be an important component of urban oak management. The wide variety of landowners and property types represented in the category of "private lands" complicates outreach and engagement efforts, but there are many existing organizations focused on reaching these audiences whose expertise could be leveraged to promote oaks. Connecting with professionals such as landowners, urban planners and landscape contractors and architects will be essential to sustaining oaks in the region.

Strategies and Example Tactics

1. Engage the native gardening/landscaping audience.
   a. Continue and expand programs such as Conservation@ Home and TreeKeepers *(See Box 14)*.
   b. Develop tools to help homeowners decide whether oaks are a good fit for their yards.
   c. Engage gardeners and homeowners through farmer's markets, plant sales, and other events.

2. Target landscape architects and large landowners or organizations that manage multiple properties.
   a. Corporate/institutional/commercial campuses, agricultural landowners, homeowner associations, golf courses, cemeteries.
   b. Work with landscape architects to recognize values associated with oaks, different ways to incorporate oaks into landscapes, and to promote oaks to clients.

BOX 14 CONSERVATION@HOME

Conservation@Home encourages native landscaping and sustainable design on residential property and certifies environmentally-friendly properties. It encourages the use of native species and aims to increase habitat for insects and birds. The project was started by The Conservation Foundation in Kane, Kendall, DuPage and Will counties. It has since been expanded to Lake County, the Barrington area and McHenry County.

Conservation@Home is founded on direct interaction with property owners. When a homeowner applies for the certification, a representative from Conservation@Home visits the property to assess its attributes. They assess the prevalence and diversity of native species, stormwater management and limited use of chemicals in lawns and gardens. They emphasize planting and protecting oaks, as oaks offer more habitat for wildlife and ecosystem services than most tree species. Conservation@Home also notes areas for improvement, including the presence of invasive species or overabundant turf grass.

These one-on-one interactions are a great way to affect real change in the way that homeowners view and care for their properties. Conservation@Home has found that homeowners are generally unaware of the invasive species in their gardens and are often happy to remove them. They also frequently reduce the use of fertilizers and pesticides after consultation.

Much of Conservation@Home's success comes from word of mouth. Once one property on a block becomes certified, other homeowners get curious and strive to get the accolade as well. As successive homes gain the certification, swaths of land become valuable habitat for native birds, insects and mammals.

Conservation@Home works to create more ecologically sound gardens on residential land and has a great impact on the region. However, some of the largest landowners in the region are commercial. The Conservation Foundation, therefore, created a certification for businesses, churches and schools. Conservation@Work encourages responsible landscaping similar to Conservation@Home, but it is scaled to work on these larger properties. These programs together are changing the way that the Chicago region manages private property.

For more information about the program, visit their website at **www.theconservationfoundation.org**.

Native landscaping and wildlife habitat

BOX 15 HISTORIC OAK PROPAGATION PROJECT

The Historic Oak Propagation Project (HOPP) was initiated by Openlands and The Morton Arboretum. It began with west suburban TreeKeepers who were interested in protecting and preserving oaks in Oak Park, Illinois. Oak Park is aptly named. When the town was founded it was shaded by many oaks. However, as elsewhere in the region, these oaks are reaching the end of their lifespan, and there are few young oaks to replace them. HOPP aims to preserve the legacy of these trees by collecting their acorns and propagating them.

The HOPP program endeavors to engage the public in the oak legacy of their area. Volunteers gather acorns, which are grown into young trees and are then distributed into the community. Hundreds of acorns were collected starting in 2008 from some of the largest pre Euro-American settlement oaks that grow along the streets in Oak Park, including a witness tree noted in the original land surveys of the Chicago region in the 1830s.

Many of the earliest trees were planted in the yards of Oak Park residents. In order to adopt the tree, residents paid a small fee, and signed a contract stating that they will water and care for it. HOPP also gives advice about where to plant the tree so that it will be successful. The adoption process gives the residents a sense of responsibility for the oaks, and the adopted oaks have been cared for with great diligence (photos below). The tree also comes with a fence for protection and a metal tag that states the year that the acorn was propagated and the address of the parent tree. These tags are an important component of the program that connects the young tree to the history of the landscape by linking it back to its parent tree.

A few oaks have been donated to schools, where students help plant and care for them. School plantings can reach a large number of students, who can bring this information back to their homes. In the future, HOPP hopes to create a curriculum that teachers can follow to propagate oak trees in the classroom, so that students can see the process from start to finish. The HOPP model could easily be replicated in other areas with or without remnant canopy oak trees.

Resident showcases her adopted oak seeding (left) and the same oak as a sapling (right), doing well three years later.

3. Develop ordinances or incentives to protect and preserve oaks on private property, especially legacy oaks.
   a. Tree protection ordinances.
   b. Historic oak districts.
   c. Create tax breaks or other financial incentives for planting long-lived native trees, such as oaks.

4. Develop and distribute marketing tools focused on the abundant values and stories associated with oaks in the Chicago region that would:
   a. Connect with the oak heritage of the region/locality *(See Box 15)*.
   b. Assess biodiversity and wildlife habitat value.
   c. Determine climate mitigation values.
   d. Report energy savings from large trees.

5. Ensure that oaks are available to property owners and landscapers.
   a. Engage nursery industry *(See Pages 17–18)*.
   b. Develop an "Oak Bank" for use by local organizations in adoption programs.

6. Encourage stewardship on privately owned oak natural areas.
   a. Promote conservation easements and conservation reserve programs focused privately owned oak ecosystems.
   b. Coordinate management of fragmented natural areas across ownership.
   c. Offer property tax relief to encourage the retention of critical oak ecosystems.

Nursery Production

An essential part of maintaining oaks as a component of the Chicago region forest will be ensuring that planting stock is promoted and available to property owners of all types. This will include making sure that a variety of species and planting stock types are available to cover the spectrum of different land uses and planting strategies. For example, volunteer-based planting efforts will necessitate small, easily planted stock, while most landscape architects would prefer to plant large caliper trees that offer immediate visual impact. These objectives could be in competition if not coordinated at a regional-scale among all stakeholders.

Nursery operators also need to be assured that there will be a demand for trees that they produce before they begin the long process of growing those trees. Current levels of production of oaks would not support the types of expanded planting programs that will need to be implemented in the future to maintain oak canopy dominance in the region.

Strategies and Example Tactics

1. Ensure a consistent supply of oaks of different species and sizes to satisfy demand across users and sites.
   a. Contract growing—CRTI contract tree growing workshops and Suburban Tree Consortium.
   b. Diversify species mix, especially to include urban adapted oaks and southern or other future-climate adapted species.
   c. Track and document sourcing for those that require local genotypes.
   d. Collect acorns throughout the region for use by nurseries both public and private.

2. Market oaks in the region to create demand in new markets, such as private landowners, to support sales by local nurseries *(See Box 16)*.

3. Do research to assess the current market—both supply and demand—for oak species, sizes, sources. Estimate potential future growth.

4. Explore breeding and development of cultivars for use in urban sites.

5. Encourage planting strategies, such as root bags that improve oak establishment.

Educating about restoration at a public event

BOX 16 GLACIER OAKS NURSERY

Oaks can be challenging to grow and market. They grow more slowly than other species, require extra steps to germinate, and care is required to encourage vigorous root growth. Many nurseries are wary of growing oaks, because they do not perceive demand for the trees. However, Glacier Oaks Nursery specializes in growing oaks and other native trees. They overcame the hurdles by using locally collected seed, creating quality products and collaborating with customers, communities and groups that plant and care for the trees.

Glacier Oaks grows and transplants using methods that train and maximize fibrous root systems. Careful monitoring of soil pH and nutrient levels, along with judicious and timely pruning, promotes fibrous roots and healthy tree production. They are careful not to over water or fertilize the trees, which could inhibit the development of their natural responses to drought.

It takes around five years to grow an oak to the selling size of a two-inch caliper. To overcome the delay, Glacier Oaks grows thousands of acorns each year and makes them available to different markets at various sizes. Many young seedlings are donated to Project Quercus™ or sold to conservation areas and other natural areas. Other trees are sold at municipal plant sales at two to three years old. Select groups are transplanted and grown to two-inch caliper and larger for municipal landscapes.

Glacier Oaks works with conservation organizations, such as McHenry County Conservation District and The Land Conservancy of McHenry County's Project Quercus™ *(See Box 12)*. Partnering with agencies that specialize in education and community involvement has improved public awareness of the value and importance of our native oaks and has fostered a commercial demand for the trees.

Little oaks

(Above) Container bur oak at Glacier Oak Nursery

Outreach and Education

Outreach and education to the public, private landowners, and nature area managers is of primary importance. It is this knowledge and education that will support all of the other focal areas. Many resources and structures exist in the Chicago region to convey the value and importance of trees and forests in the urban region, and these should be fully leveraged to deliver the same message, specific to oaks and oak ecosystems. For example, the CRTI, by virtue of its collaborative structure, can provide a wide range of knowledge and expertise to many audiences. Building on existing resources and programs, developing additional resources, and expanding cooperation between organizations should be a primary goal of efforts focused on sustaining oaks in the future Chicago Wilderness region *(See Box 12)*.

Strategies and Example Tactics

1. Engage stakeholders, including non-traditional audiences.
   a. Work on "myth-busting" negative ideas surrounding the use of oaks in landscaping and urban sites.
   b. Develop corporate partnerships.

2. Directly engage public, especially property owners, in activities surrounding oak recovery.
   a. Develop regional and statewide "OAKtober" events to promote the value and importance of oaks.
   b. Develop ideas and resources surrounding idea of Chicago region oak "heritage" or "legacy" *(See Box 15)*.
   c. Conduct volunteer activities and workdays with TreeKeepers and other groups *(See Box 13)*.
   d. Create "Homeowner's Guide to Oaks" for communities and other organizations to use.
   e. Direct outreach to communities and stakeholders prior to natural areas management *(See Box 8)*.
   f. Work with native gardening and landscaping communities to promote use of oaks *(See Box 14)*.
   g. Utilize citizen and student science in monitoring for all strategies.

3. Utilize media to promote oak regeneration.
   a. Develop media (stories, radio/podcasts, film) focused on the oak "legacy" of the Chicago region.
   b. Promote ecosystem service values of oaks and oak ecosystems, including stormwater management and wildlife habitat.

4. Develop lesson plans and other educational resources based around oaks, oak ecosystems, and their value for a variety of audiences—school age and beyond.

black-throated green warbler

REFERENCES

Abrams, M. D. 1992. Fire and the Development of Oak Forests. BioScience 42:346–353.

Abrams, M. D. 2003. Where has all the white oak gone? Bioscience 53:927–939.

Aldrich, P., and G. Parker. 2005. Confirmation of oak recruitment failure in Indiana old-growth forest: 75 years of data. Forest Science 51:406–416.

Bailey, R. G. 1995. Descriptions of ecoregions of the United States. Department of Agriculture, Forest Service.

Behan-Pelletier, V., and G. Newton. 1999. Linking soil biodiversity and ecosystem function - The taxonomic dilemma. BioScience 49:149.

Belsky, A. 1992. Effects of grazing, competition, disturbance and fire on species composition and diversity in grassland communities. Journal of Vegetation Science 3:187–200.

Black, B. a, C. M. Ruffner, and M. D. Abrams. 2006. Native American influences on the forest composition of the Allegheny Plateau, northwest Pennsylvania. Canadian Journal of Forest Research 36:1266–1275.

Borchert, J. 1950. The climate of the central North American grassland. Annals of the Association of American Geographers 15:1–39.

Bowles, M., S. Apfelbaum, A. Haney, S. Lehnhardt, and T. Post. 2011. Canopy cover and groundlayer vegetation dynamics in a fire managed eastern sand savanna. Forest Ecology and Management 262:1972–1982.

Bowles, M., M. Hutchison, and J. McBride. 1994. Landscape pattern and structure of oak savanna, woodland, and barrens in northeastern Illinois at the time of European settlement. Proceedings of the North American Conference on Barrens and Savannas:65–73.

Bowles, M. L., M. D. Jones, C. B. Burke, J. L. McBride, T. J. Bell, and C. Dunn. 2005. Temporal instability in Chicago's upland old growth forests. Chicago Wilderness Journal 3:5–16.

Brose, P., D. Dey, R. Phillips, and T. Waldrop. 2012. A Meta-Analysis of the Fire-Oak Hypothesis: Does Prescribed Burning Promote Oak Reproduction in Eastern North America? Forest Science:1–13.

Buchanan, M. L., and J. L. Hart. 2012. Forest Ecology and Management Canopy disturbance history of old-growth Quercus alba sites in the eastern United States: Examination of long-term trends and broad-scale patterns. Forest Ecology and Management 267:28–39.

Buée, M., M. Reich, C. Murat, E. Morin, R. H. Nilsson, S. Uroz, and F. Martin. 2009. 454 Pyrosequencing analyses of forest soils reveal an unexpectedly high fungal diversity. New Phytologist 184:449–456.

Carreiro, M. M., R. L. Sinsabaugh, D. A. Repert, and D. F. Parkhurst. 2000. Microbial enzyme shifts explain litter decay responses to simulated nitrogen deposition. Ecology 81:2359–2365.

Cavers, P. B., M. I. Heagy, and R. F. Kokron. 1979. The biology of Canadian weeds. 35. *Alliaria petiolata* (M. Beib) Cavara and Grand. Canaidan Journal of Plant Science 59:217–229.

Curtis, J., and R. McIntosh. 1951. An upland forest continuum in the prairie-forest border region of Wisconsin. Ecology 32:476–496.

Curtis, J. T. 1959. The vegetation of Wisconsin: an ordination of plant communities. University of Wisconsin Press.

Davies, K., C. Margules, and J. Lawrence. 2000. Which traits of species predict population declines in experimental forest fragments? Ecology 81:1450–1461

Day, S., and P. E. Wiseman. 2010. Tree Root Ecology in the Urban Environment and Implications for a Sustainable Rhizosphere. Arboriculture & Urban Forestry 36:193–204.

Dey, D. C., and G. Hartman. 2005. Returning fire to Ozark Highland forest ecosystems: effects on advance regeneration. Forest Ecology and Management 217:37–53.

Dey, D. C., W. C. Parker, O. Forest, and A. Red. 1997. Performance of Underplanted Red Oak 14:120–125.

Drever, C. R., G. Peterson, C. Messier, Y. Bergeron, and M. Flannigan. 2006. Can forest management based on natural disturbances maintain ecological resilience? Canadian Journal of Forest Research 36:2285–2299.

Duchesne, L., R. Ouimet, and D. Houle. 2002. Basal area growth of sugar maple in relation to acid deposition, stand health, and soil nutrients. Journal of Environmental Quality 31:1676–1683.

Dukes, J., and H. Mooney. 1999. Does global change increase the success of biological invaders? Trends in Ecology & Evolution 14:135–139.

Dwyer, J. F., E. G. Mcpherson, H. W. Schroeder, and R. A. Rowntree. 1992. Assesing the benefits and costs of the urban forest. Journal of Arboriculture 18:227–234.

Ellsworth, J. W., and B. C. McComb. 2003. Potential Effects of Passenger Pigeon Flocks on the Structure and Composition of Presettlement Forests of Eastern North America. Conservation Biology 17:1548–1558.

Fahey, R. T., M. L. Bowles, and J. L. McBride. 2012. Origins of the Chicago urban forest: composition and structure in relation to pre-settlement vegetation and modern land-use. Arboriculture & Urban Forestry 38:181–193.

Helmreich, B., R. Hilliges, A. Schriewer, and H. Horn. 2010. Runoff pollutants of a highly trafficked urban road–Correlation analysis and seasonal influences. Chemosphere 80:991–997.

Heneghan, L., C. Clay, and C. Brundage. 2002. Rapid decomposition of buckthorn litter may change soil nutrient levels. Ecological Restoration 20:108–111.

Heneghan, L., F. Fatemi, L. Umek, K. Grady, K. Fagen, and M. Workman. 2006. The invasive shrub European buckthorn (*Rhamnus cathartica*, L.) alters soil properties in Midwestern U.S. woodlands. Applied Soil Ecology 32:142–148.

Hicks, R. R. 2000. Humans and fire: a history of the Central Hardwoods. Pages 3–18 Proceedings: workshop on fire, people, and the central hardwoods landscape. USDA Forest Service general technical report NE-274. US Department of Agriculture, Forest Service, Northeastern Research Station, Newton Square.

Holzmueller, E. J., J. W. Groninger, C. M. Ruffner, and T. B. Ozier. 2011. Composition of oak stands in the Illinois Ozark Hills 2 decades following light harvesting and no cutting. Northern Journal of Applied Forestry 28:50–53.

IPCC. 2013. Climate Change: The Assessment Reports of the Intergovernmental Pane on Climate Change. Cambridge University Press Cambridge, UK.

Iverson, L. R., A. M. Prasad, S. N. Matthews, and M. Peters. 2008. Estimating potential habitat for 134 eastern US tree species under six climate scenarios. Forest Ecology and Management 254:390–406.

Johnson, P. S., S. R. Shifley, and R. Rogers. 2009. The ecology and silviculture of oaks. CABI.

Knapp, A. K., J. M. Blair, J. M. Briggs, S. L. Collins, D. C. Hartnett, L. C. Johnson, E. G. Towne, M. John, and L. Scott. 2008. The Keystone Role of Bison in North American Tallgrass Prairie.

Bioscience 49:39–50.
Knight, K. S., J. S. Kurylo, A. G. Endress, J. R. Stewart, and P. B. Reich. 2007. Ecology and ecosystem impacts of common buckthorn (*Rhamnus cathartica*): a review. Biological Invasions 9:925–937.
Ko, L., and P. Reich. 1993. Oak tree effects on soil and herbaceous vegetation in savannas and pastures in Wisconsin. American Midland Naturalist 130:31–42.
Kolb, T. E., and K. C. Steiner. 1990. Growth and biomass partitioning of northern red oak and yellow-poplar seedlings: effects of shading and grass root competition. Forest Science 36:34–44.
Kramer, A. T., J. L. Ison, M. V Ashley, and H. F. Howe. 2008. The paradox of forest fragmentation genetics. Conservation Biology 22:878–85.
Leitner, L. a., C. P. Dunn, G. R. Guntenspergen, F. Stearns, and D. M. Sharpe. 1991. Effects of site, landscape features, and fire regime on vegetation patterns in presettlement southern Wisconsin. Landscape Ecology 5:203–217.
Lesser, W. H. 1993. Prehistoric human settlement in the upland forest region. In: Upland forests of West Virginia, Stepheson, S. L. Pages 231–260. McClain Print. Company.
Lorimer, C. G. 1993. Causes of the oak regeneration problem. Oak Regeneration: Serious Problems, Practical Recommendations, USDA Forest Service General Technical Report SE-84, Southeastern Forest Experiment Station, Asheville, North Carolina:14–39.
Lorimer, C. G. 2003. The decline of oak forests. BioScience 53:915.
MacCleery, D. W. 1992. American forests: a history of resiliency and recovery. Diane Pub Co.
Mankin, P. C., and R. E. Warner. 1997. Mammals of Illinois and the Midwest: Ecological and conservation issues for human-dominated landscapes. Pages 135–153 Conservation in highly fragmented landscapes. Springer.
McBride, J., and M. Bowles. 2007. Searching The Public Land Survey For Illinois Natural History. Report to Chicago Wilderness and Illinois Conservation Foundation.
McShea, W. J., and W. M. Healy. 2002. Oak forest ecosystems: ecology and management for wildlife. Johns Hopkins University Press.
McShea, W., H. Underwood, and J. Rappole. 1997. The science of overabundance: deer ecology and population management. Wildlife Society Bulletin 25:578–580.
Michael, J., and W. Tietje. 2008. Bird Use of Lone Oak Trees in Vineyard vs. Savanna in Central-Coastal California Woodland—A Pilot Study. Transactions of the Western Section of the Wildlife Society 44:37–42.
Musiani, M., and P. C. Paquet. 2004. The Practices of Wolf Persecution, Protection, and Restoration in Canada and the United States. BioScience 54:50.
Nowacki, G. J., and M. D. Abrams. 2008. The Demise of Fire and "Mesophication" of Forests in the Eastern United States. BioScience 58:123.
Olff, H., and M. Ritchie. 1998. Effects of herbivores on grassland plant diversity. Trends in ecology & evolution 13:261–265.
Pielou, E. C. 2008. After the ice age: the return of life to glaciated North America. University of Chicago Press, Chicago.
Pollock, J., K. Glennemeier, and D. Stotz. 2004. Migrant bird habitat study. Chicago Audubon Society:1–11.
Pouyat, R. V., M. J. McDonnell, and S. T. A. Pickett. 1995. Soil characteristics of oak stands along an urban-rural land-use gradient. Journal of Environmental Quality 24:516–526.
Prasad, A. M., L. R. Iverson, S. Matthews, and M. Peters. 2007. A Climate Change Atlas for 134 Forest Tree Species of the Eastern United States [database].
Prati, D., and O. Bossdorf. 2004. Allelopathic inhibition of germination by *Alliaria petiolata* (Brassicaceae). American Journal of Botany 91:285–288.
Pyne, S. J. 1982. Fire Primeval. The Sciences 6:14–20.
Rodewald, A., and M. Abrams. 2002. Floristics and avian community structure: implications for regional changes in eastern forest composition. Forest Science 48:267–272.
Rooney, T. P., and D. A. Rogers. 2011. Colonization and Effects of Garlic Mustard (*Alliaria petiolata*), European Buckthorn (*Rhamnus cathartica*), and Bell's Honeysuckle (*Lonicera* × *bella*) on Understory Plants After Five Decades in Southern Wisconsin Forests. Invasive Plant Science and Management 4:317–325.
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.
Rooney, T. P., S. M. Wiegmann, D. A. Rogers, and D. M. Waller. 2004. Biotic Impoverishment and Homogenization in Unfragmented Forest Understory Communities. Conservation Biology 18:787–798.
Russell, F., D. Zippin, and N. Fowler. 2001. Effects of white-tailed deer (*Odocoileus virginianus*) on plants, plant populations and communities: a review. The American Midland Naturalist 146:1–26.
Schmit, J. P., J. F. Murphy, and G. M. Mueller. 1999. Macrofungal diversity of a temperate oak forest: a test of species richness estimators. Canadian Journal of Botany 77:1014–1027.
Spetich, M. A. 2004. Upland oak ecology symposium: a synthesis.
Stinson, K., S. Campbell, J. R. Powell, B. E. Wolfe, R. M. Callaway, G. C. Thelen, S. G. Hallett, D. Prati, and J. N. Klironomos. 2006. Invasive plant suppresses the growth of native tree seedlings by disrupting belowground mutualisms. PLoS biology 4:e140.
Strole, T. A., and R. C. Anderson. 1992. White-tailed deer browsing: species preferences and implications for central Illinois forests. Natural Areas Journal 12:139–144.
Stromayer, K., and R. Warren. 1997. Are overabundant deer herds in the eastern United States creating alternate stable states in forest plant communities? Wildlife Society Bulletin 25:227–234.
Tallamy, D. W. 2007. Bringing nature home. Portland, Oregon: Timber Press.
Thomas, B. A., and R. A. Spicer. 1987. The evolution and palaeobiology of land plants. London: Croom Helm ix, 309p.- illus.. ISBN 931146070.
Ware, G. 1990. Constraints to tree growth imposed by urban soil alkalinity. Journal of Arboriculture 16:35–38.
Wilderness, C. 2004. Chicago Wilderness Green Infrastructure Vision: Final Report.
Wood, E. M., A. M. Pidgeon, F. Liu, and D. J. Mladenoff. 2012. Birds see the trees inside the forest: The potential impacts of changes in forest composition on songbirds during spring migration. Forest Ecology and Management 280:176–186.
Young, A., T. Boyle, and T. Brown. 1996. The population genetic consequences of habitat fragmentation for plants. Trends in Ecology & Evolution 11:413–418.

ACKNOWLEDGMENTS

Many efforts have been pursued to document the status of natural communities throughout the Midwest. The US Fish and Wildlife Service has looked at wetland communities and documented their status over the years. Federal, state and non-government organizations have documented the status of prairies and grasslands. Oak-dominated ecosystems have recently become a focus of land managers throughout the range of oak species.

In 1995, US Environmental Protection Agency sponsored a conference that finalized the Oak Savanna and Woodland Recovery Plan, which identified several priorities to look at the restoration and re-creation of oak ecosystems in the Midwest. This effort is highly reliant upon the 1995 plan, and we are very appreciative of the authors and collaborators.

In 2004, McHenry County Conservation District and the Land Conservancy of McHenry County mapped the historical and current day (2005) distribution of oak ecosystems and developed a plan to restore populations of oak trees in McHenry County. Building off of this concept, Lake County Forest Preserve District, through funding from the US Fish and Wildlife Service, mapped the distribution of oak ecosystems in Lake County (2010). These mapping efforts led to discussion about mapping the oak ecosystems throughout the Chicago Wilderness region.

In 2011, a group of land managers and scientists decided to complete the spatial analysis of oak ecosystems in the Chicago Wilderness region. Between 2012 to 2014, through a grant from the US Forest Service Northeastern Area State and Private Forestry Federal Assistance Program, scientists from The Morton Arboretum, Lake County Forest Preserve District and other conservation partners collaborated to create a plan for oak ecosystems: Oak Ecosystem Recovery Plan: Sustaining Oaks in the Chicago Wilderness Region. The plan and accompanying GIS data and analysis is a major milestone in our understanding of oak ecosystems across northeastern Illinois.

Many thanks to the following for sharing their time and expertise in writing and reviewing this publication.

Funders
US Forest Service
US Fish and Wildlife Service

Lead Collaborators
Lake County Forest Preserve District
The Morton Arboretum

Design and Layout
Allison Frederick, Lake County Forest Preserve District
Astrid Koch, Astrid Designs

Partners
Barrington Area Conservation Trust
The Conservation Foundation
Chicago region Trees Initiative
Conserve Lake County
Forest Preserves of Cook County
Forest Preserve District of DuPage County
Forest Preserve District of Kane County
Forest Preserve District of Will County
Illinois Department of Natural Resources
Illinois Nature Preserves Commission
Kane County Development Department
Kendall County Forest Preserve District
The Land Conservancy of McHenry County
McHenry County Conservation District
Openlands

Reviewers
Abigail Derby-Lewis, The Field Museum
Allison Frederick, Lake County Forest Preserve District
Ben Haberthur, Forest Preserve District of Kane County
Byron Tsang, Chicago Park District
Cathy McGlynn, Northeast Illinois Invasive Plant Partnership
Chip O'Leary, Forest Preserves of Cook County
Chris Mulvaney, Chicago Wilderness
Conner Shaw, Possibility Place Nursery
Daniella Pereira, Openlands
Dave Griffith, Illinois Department of Natural Resources
Debbie Maurer, Lake County Forest Preserve District
Ed Collins, McHenry County Conservation District
Erik Neidy, Forest Preserve District of DuPage County
Jason Zylka, Forest Preserve District of Will County
Jim Kleinwachter, The Conservation Foundation
John Dwyer, The Morton Arboretum
John Rogner, US Fish and Wildlife Service
John Sentell, Lake Forest Openlands Association
John Taft, Illinois Natural History Survey
Julie Samuels, Historic Oak Propagation Project
Karen Miller, Kane County Development Department
Kathyrn Jonas, Historic Oak Propagation Project
Kelsey Atkinson, The Morton Arboretum
Lisa Haderlein, The Land Conservancy of McHenry County
Louise Clemency, US Fish and Wildlife Service
Lydia Scott, The Morton Arboretum
Maggie Zoellner, Kettle Moraine Land Trust
Mary McClelland, Glacier Oaks Nursery
Megan Dunning, The Morton Arboretum
Nancy Williamson, Illinois Department of Natural Resources
Sarah Surroz, Conserve Lake County
Scott Meister, Forest Preserve District of DuPage County
Stephen Packard, Audubon—Chicago Region
Steve Byers, Illinois Nature Preserves Commission
Steven Ludwig, Village of Algonquin
Sue Harney, Dundee Township Open Space District
Tricia Bethke, The Morton Arboretum
Zhana Yermakov, Chicago Park District

IMAGES

Front cover: Majestic oak
Photographer: Caleb Phelps
The Morton Arboretum
Title page: (Left) Red-headed woodpecker, *Melanerpes erythrocephalus*
Lake County Forest Preserve District
(Center) Bur oak seedling in autumn, *Quercus macrocarpa*
Lake County Forest Preserve District
(Right) Volunteer planting an oak within a monitoring plot
Photographer: Allison Frederick
Lake County Forest Preserve District
Pg 2: Oaks of the Chicago region
The Field Museum
Pg 5: Bowes Creek Woods Forest Preserve
Forest Preserve District of Kane County
Pg 9: Wood frog, *Rana sylvatica*
Photographer: Allison Frederick
Lake County Forest Preserve District
Blue-spotted salamander, *Ambystoma laterale*
Photographer: Greg Schechter
Black-billed cuckoo, *Coccyzus erythropthalmus*
Photographer: Wolfgang Wander via Wikipedia
Red-headed woodpecker, *Melanerpes erythrocephalus*
Lake County Forest Preserve District
Northern flicker, *Colaptes auratus*
Photographer: Dave Menke
Pg 10: The Grandmother Tree
Photographer: Ed Collins
The Land Conservancy of McHenry County
Little oaks
The Morton Arboretum
Pg 11: Illinois Wildlife Action Plan
Illinois Statewide Forest Resource Assessment and Strategies
Illinois Department of Natural Resources
Chicago Wilderness Biodiversity Recovery Plan
Chicago Wilderness
Pg 12: Volunteers rescue a 400-year-old white oak
The Land Conservancy of McHenry County
Pg 14: Non-native European buckthorn invasion in an open oak woodland at Almond Marsh Forest Preserve
Photographer: Leslie Berns
Lake County Forest Preserve District
Pg 15: Gypsy moth egg cases on bark of an oak tree
Photographer: Milan Zubrik
Forest Research Institute, Slovakia, Bugwood.org
Pg 16: Protected oak seedling
Photographer: Dena van der Wal
WRD Environmental
Pg 18: Autumnal red oak leaf
Lake County Forest Preserve District
Pg 19: Great horned owls nesting in a snag
Lake County Forest Preserve District
Pg 20: Big bur oak tree in an open natural area
Chicago Wilderness
Pg 22: "The Sun and The Oak"
Photographer: Thomas, Photommo via Flickr
Pg 23: Fish-eye lens photos of the canopy at Captain Daniel Wright Woods Forest Preserve at 15% (top) and 35% (bottom) light transmission
Photographers: Debbie Maurer and Robert Fahey
Lake County Forest Preserve District
The Morton Arboretum
Pg 24: Black-billed cuckoo silhouette
Illustrator: Allison Frederick
Maps of Waterfall Glen
Forest Preserve District of DuPage County
Pg 25: Oaks of the Chicago region
The Field Museum
Pg 26: The Village of Algonquin's Municipal Nursery
The Village of Algonquin Public Works Department
Pg 28: Oak saplings
Photographer: Jason Steger
Chicago Park District
Pg 30: Porch surrounded by native plantings
American goldfinch male and female on yellow coneflower
The Conservation Foundation
Sign in yard highlighting Conservation@Home certification
Conserve Lake County
Pg 31: Resident showcasing an adopted oak
Photographer: Erika Hildegard Photography
Pg 32: Environmental educator at Restore Galore public event
Lake County Forest Preserve District
Pg 33: Little oaks at Glacier Oaks Nursery in Harvard, Illinois.
Pg 34: Black-throated green warbler
Photographer: Tim Lenz
Back cover: Group of children in the shade of a large oak
The Land Conservancy of McHenry County
Camp Algonguin red oak
The Land Conservancy of McHenry County
Source: Ed Colliins
Acorns that have been collected
Photographer: Steve Wenzel
The Land Conservancy of McHenry County
Source: Lisa Haderlein

The concept for this plan was inspired by:

Ed Collins of the McHenry County Conservation District and his project to map remnant oak communities for McHenry County in 2005.

Lead collaborators:

The Morton Arboretum
Lake County Forest Preserve District

Special thanks to the following partners for their significant contributions:

Barrington Area Conservation Trust
The Conservation Foundation
Chicago Region Trees Initiative
Conserve Lake County
Forest Preserves of Cook County
Forest Preserve District of DuPage County
Forest Preserve District of Kane County
Forest Preserve District of Will County
Illinois Department of Natural Resources
Kane County Development Department
Kendall County Forest Preserve District
The Land Conservancy of McHenry County
McHenry County Conservation District
Openlands

Funding for this project was provided by:

USDA Forest Service
US Fish & Wildlife Service

Photos courtesy of:

Carol Freeman
The Conservation Foundation
Conserve Lake County
The Field Museum
Forest Preserves of Cook County
Forest Preserve District of Kane County
Illinois Natural History Survey
Lake County Forest Preserve District
The Land Conservancy of McHenry County
McHenry County Conservation District
The Morton Arboretum
The Village of Algonquin
WRD Environmental

Chicago Wilderness

312.580.2137 • info@chicagowilderness.org
www.chicagowilderness.org

The Morton Arboretum

Lake County Forest Preserves