LAKE VIEW CONSERVANCY
RESTORATION & MANAGEMENT PLAN

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The area northeast of Lake Mendota in 1937. The Lake View Sanatorium and grounds appear in the upper photo. Note outlying areas in the lower photo, where grazing and other land management practices maintained a semblance of the historic savanna landscape. (Photo courtesy of Patricia Esch).

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Photos on front cover (clockwise from top): Butterflies feeding on sap flowing in early spring from cut boxelder stump; AES crew member and volunteer monitoring spring burn in one of four study plots; dead-standing red oaks providing habitat for cavity nesting birds; new white oak seedlings appear following the first burn in Test Plot 4; Sun Prairie Boy Scouts volunteer to install thousands of native plant plugs in the test plots.

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1 Preface

The Lake View Conservancy Restoration and Management Plan is a working document designed to serve as a reference and resource base for Dane County Parks' staff, volunteers, and other individuals and organizations involved in restoring and managing the Conservancy's significant natural resources. This Plan does not address in any detail restoration of identified cultural resources associated with the former Lake View Sanatorium Campus; however, local interest in these cultural elements exists. Should a cultural restoration plan be developed, an effort should be made to integrate it with the ecological plan, to provide a comprehensive, and consistent management program for the Lake View Conservancy property.

This Plan is the culmination of a four-year baseline assessment and test plot analysis program initiated in 1999 by the County, in cooperation with the Friends of Lake View Woods, to understand the extent of deterioration of the Conservancy's prominent oak woodland community (Lehnhardt et al. 1999; Lehnhardt et al. 2003). In recent decades, the woodland community, often referred to as Lake View Woods, has been invaded extensively by exotic shrubs and has experienced a widespread decline of the native woodland understory. In addition, many of Lake View Woods' mature red oaks have been lost or damaged due to oak wilt disease, high winds, and natural senescence. A major objective of the recent work has been to determine the effort required to recover a reasonably achieved level of ecological health and diversity to the woodland community, with modest long-term management requirements. Local concern about the removal of exotic shrubs, use of fire and herbicides, and other intervention methods proposed to be used in remedial actions prompted the County to fund a two-year research and demonstration program, involving volunteer stewardship training and education, to develop the scope of the Plan. The results of this two-year study are summarized in this document and will be presented in detail in a separate technical report.

In addition, the Plan provides a summary of the natural resources of the property, an overview of the justification, goals, and objectives for initiating restoration intervention in Lake View Woods, and an outline of strategies and techniques proposed for implementing remedial and long-term management of selected natural resources.

While the goals of the Plan are intended to remain relevant over the long-term, some flexibility must be allowed in the application of strategies and techniques put forth here, as natural communities often respond unpredictably to restoration intervention following a long history of the combined effects of human disturbance and more subtle environmental changes. Regularly scheduled monitoring and reporting will be critical, to inform land managers of the need to make adjustments to achieve the identified restoration and management goals and performance milestones. It is also recommended that the Plan be reviewed and revised periodically (every ten-fifteen years), to ensure its relevance to the restoration and management needs of Lake View Conservancy and the goals and objectives of Dane County Parks' land management and volunteer stewardship programming.

2 Overview

2.1 Plan Rationale

Early accounts of the Dane County landscape and subsequent scholarly interpretations tell us that "oak openings" or savannas with a prairie-like understory had the greatest distribution of any other plant association in the County at the time of the early land surveys (Curtis, 1959; Ellarson, 1949). In the decades following European settlement, remnant savanna communities, persisting in a dissected and highly modified landscape, were quickly transformed into closed canopied woodlands, with little of the former diverse native understory remaining.

Lake View Woods is one of these fractured pieces of the native landscape, spared the plow and the developer, but changed dramatically nonetheless by other human land uses, particularly by those that interfered with the natural dynamics that maintained the historic savanna/prairie landscape, most notably recurring fire. Perhaps one of the more ecologically devastating changes has resulted in recent decades from the invasion of the woodland understory by a host of exotic shrubs and trees. The overwhelming shade and soil-altering effects of these woody invaders have accelerated the decline of the oak-dominated canopy and have reduced the already ravaged native understory flora to a sparse assemblage of the most tolerant "weedy" survivors.

Fortunately, the growing field of restoration ecology has led to the development of techniques and practices for rehabilitating and managing degraded natural systems. These techniques are quickly becoming part of the "tool kit" of land managers and of trained volunteer land stewards, who are increasingly taking on the responsibility of reclaiming many of our abused remnant natural communities, in partnership with private and public agencies. In the case of Lake View Conservancy, a small force of neighbors, known today as the Friends of Lake View Conservancy, in partnership with Dane County Parks, initiated protection of the property through a re-zoning action that provided Conservancy status. More recently, these individuals and others from the surrounding neighborhoods partnered with the County and private contractors to conduct an experimental restoration program in Lake View Woods, to better understand the effects of commonly practiced restoration techniques and to develop a cohesive stewardship program. The Management Plan presented here is the result of that effort. More importantly, the neighborhood has rallied once again, re-energized and committed to nurturing a healthy woodland habitat for wildlife and to providing opportunities for the community to enjoy and learn about the natural world in their backyard (Nelson Eisman 2002).

The purpose of the Plan is to provide a framework and set of implementation tools for reversing the trend of degradation in Lake View Woods and ensuring the long-term viability of the oak woodland community (see later discussions in *Paragraphs 3.3 and 3.5.1*). In order to accomplish this, the Plan, in conjunction with previous studies conducted in 1999 and in test plots in 2001 and 2002, provides baseline information about Lakeview's oak woodland system and past land use disturbances, and provides recommendations for the restoration and enhancement of the woodland system using the most appropriate and economically efficient techniques and tools.

The Plan is intended to serve as a resource for managers, staff and volunteers involved in Lake View Woods' ongoing management. However, the ultimate success of the Plan will depend on the availability of funding, public response to the work proposed, and the commitment of County staff and volunteer stewards to meet its stated objectives.

2.2 Guiding Principles, Goals & Objectives

2.2.1 Restoration Philosophy & Approach

1. Ecological Restoration: A process of intentionally altering a site to establish a defined, indigenous, historic (pre-settlement-like) ecosystem. At Lake View Woods, this Plan proposes to employ ecological restoration techniques to achieve pre-settlement conditions, only to the extent possible, given the degree of degradation of the native plant community and the desire to conduct a cost-efficient restoration program.

2. Ecosystem Health: A state of integrity and sustainability of all elements and functions of a natural community, including stable soils, diverse plant and animal communities, an ability to retain and infiltrate water, and a capacity to change and adapt to disturbance. This Plan proposes to achieve a higher state of Ecosystem Health, to the extent possible, within the constraints of the site conditions and the program budget.

3. Adaptive Management: A flexible management strategy responsive to the inherent variability in a natural community's response to restoration intervention; a process of evaluation, adjustment, refinement and change. This Plan proposes to achieve the highest degree of restoration benefits possible through a program of monitoring and close attention to the response of the woodland community to restoration intervention activities.

2.2.2 Long-term Goals

1. To maintain Lake View Conservancy as a natural and cultural centerpiece for the Lake View Neighborhood, as well as an important natural resource for Dane County.

2. To protect and enhance the oak woodland community through an ongoing restoration, management, and monitoring program, which includes volunteer stewardship training and public education, focused on enjoyment, appreciation and protection of the natural environment.

2.2.3 Specific Objectives

1. To restore the natural oak woodland community of Lake View Conservancy to a healthy state that allows a sustained, low-maintenance, low-cost commitment.

2. To restore and manage natural vegetation communities so that native biodiversity and ecological functions are restored wherever possible.

3. To enhance habitat features to attract and sustain wildlife.

4. To develop an awareness and understanding of Lake View Conservancy's ecological and cultural significance.

5. To enliven a sustainable relationship between the community and nature by involving citizens, organizations and agencies in the restoration effort.

6. To monitor and adapt management prescriptions as necessary to achieve the goals of this Plan.

2.3 Summary of Actions & Strategies

2.3.1 Prescribed Burning

Fire is a natural process that is essential to the recovery of the oak woodland system at Lake View Woods, and has already been applied in the test plots with a great deal of success. It is the least costly restoration and long-term management tool, and can be conducted by well-trained volunteers under the direction of professional burn specialists.

The Plan proposes to:

- Continue to implement prescribed burns and develop a long-term fire management strategy for clearly defined management units, with clearly defined burn prescriptions.
- Initially apply fire to areas where sufficient oak leaf litter is concentrated, and where brushing treatments have occurred and a sufficient fine fuel load has been established through re-vegetation efforts.
- Train willing volunteers to safely assist in prescribed burns, and continue to educate the public on the ecological benefits of fire.
- Monitor and document the effects of prescribed burn treatments, and adjust the burn prescription and management strategy accordingly.

2.3.2 Controlling Exotic Plant Species

A nearly continuous exotic shrub layer, primarily of common buckthorn (*Rhamnus cathartica*) and Tartarian honeysuckle (*Lonicera tatarica*), currently constitutes the single most important cause of the collapse of the native understory flora at Lake View Woods, and is the chief impediment to the reintroduction of fire to this system. The strategy at Lake View Woods will be to remove this exotic shrub layer, to allow the light necessary to reinvigorate the native groundcover vegetation, where the native seed bank is intact, and to allow reintroduction of plant species that will provide the fine fuels to carry fire throughout the woodland.

The Plan proposes to:

- Reduce the cover and seed source of exotic shrubs and trees as much as possible (70-90% reduction) within the woodland, as well as encourage through education the replacement of exotic shrubs with more ecologically desirable native counterparts in adjacent properties.
- Conduct exotic shrub removal in phases to accommodate the available funds allocated to the project.
- Continue shrub removal from the existing test plot areas and along internal trails, to maintain the restoration process currently underway in those locations and to enhance access to new treatment areas.
- Maintain an appropriate buffer at the interface with neighboring landowners, allowing them time to adjust to the change and possibly gain their cooperation in extending the treatments to the property boundary and beyond, if desired.
- Monitor the effectiveness of removal and control methods and adjust these methods accordingly.
- Monitor re-sprouting treated stems and re-treat as necessary.
- Train volunteers to identify exotic species, as well as train them in the control and management techniques necessary to maintain a healthy woodland system and sustain the effects of initial costly treatments.
- Replace exotic shrubs with a diversity of native shrubs and fruiting trees appropriate for the woodland community, to restore structural diversity and nesting and feeding opportunities for nesting and visiting bird species.
- Educate the public on the importance of controlling exotic shrubs and trees.

2.3.3 Re-establishing Native Plant Communities & Species

While restoration techniques, such as removal of exotic shrubs and use of fire, are expected to re-invigorate existing native plant assemblages present in Lake View Woods, reintroduction of native propagules will be required in areas where natural seed banks usually present in the soil are lacking.

The plan proposes to:

- Use well established seeding and planting techniques to enhance native biodiversity, increase native plant cover, and improve habitat quality for plant and animal life.
- Re-introduce native plant species appropriate for the southern Wisconsin woodland community types identified at Lake View Woods, based on the best knowledge of the flora and composition of these communities.
- When possible, apply a reasonable geographic limit for the collection of wild and commercially-grown native seed, in this case the physiographic province (i.e. natural area division) in which Lake View Woods is located [Division 5 Southern Ridges and Lowlands: (5C) oak savanna and prairie (Hole and Germain 1944)].
- Encourage the use of volunteer wild-collected seed from existing sources on-site and from appropriate nearby off-site locations, to minimize the added cost of purchasing seed for commercial sources and to minimize the effort required to hand-collect seed from remote locations.
- Initiate restoration along the main trails at Lake View Woods, where existing diversity and cover are the greatest, to invigorate the production of seed for use in expanding this zone of diversity to adjacent depauperate areas.
- Use short-lived non-native species, such as annual rye grass, only where necessary to establish fine fuels, such as in areas where groundcover vegetation and oak leaf litter are sparse, to carry fire in the early stages of restoration.
- Identify off-site locations that are easily accessible and with similar community composition to the target restored woodland communities at Lakeview, for conducting supervised volunteer off-site seed collection.

2.3.4 Restoring Rare Native Plant Populations

Because Lake View Woods is an isolated habitat fragment, it is difficult for native plants from elsewhere to naturally offset population decline. Rare plants are generally the first species to be lost within an isolated area and the last, if ever, to re-colonize them.

The Plan proposes to:

- Monitor the populations of rare species identified in the 1999 baseline study, specifically yellow giant hyssop, and watch for the re-appearance of other rare species throughout the restoration and management program.
- Propagate rare species from approved locally collected seed, outplant into suitable sites, and enhance the size of existing populations of rare plants.
- Manage threats to rare plants, such as invasive species, trampling, lack of natural disturbances and loss of specific growing requirements.
- Use trail closures, barriers and signage to reduce trampling and discourage the collection of wildflowers.

2.3.5 Restoring Native Shrubs and Small Trees

Tall, shrubby vegetation is part of the natural woodland community structure and provides important bird habitat for migrant and resident songbirds in the spring. Where shrub cover has been eliminated by removal of exotic shrubs, a diverse native shrub component of acceptable densities should be re-established.

The Plan proposes to:

- Protect existing native shrub cover and diversity.
- Re-introduce a selection of native shrub and small tree species known to be native to the region and to the target woodland communities, such as American hazelnut, bladdernut, witch hazel, Iowa crab, hawthorn, and wild plum.
- Regularly monitor the presence and cover of exotic shrubs, and remove these to the extent possible using the most economical and effective methods available.
- Educate the public on the far-reaching ecological consequences of invasive exotic shrubs, particularly the loss of native plant and animal diversity and the increasing costs of restoration over time, with the collapse of the native seed bank.

2.3.6 Stimulating Oak Regeneration

Early assessments (Landmark Research Inc. 1988; Dane County Regional Planning Commission 1982) and more recent studies (Lehnhardt and others 1999) have cited the decline of the mature white and red oak canopy in Lake View Woods. Stressors include shading caused by an overcrowded tree canopy, and age-related susceptibility to disease and wind damage.

The Plan proposes to:

- Re-introduce natural disturbance processes, such as fire, to stimulate oak reproduction.
- Remove competing exotic shrubs and trees.
- Thin the young tree canopy of shade-tolerant/shade-producing species, such as white ash, boxelder, and wild black cherry to allow light levels necessary for oak seedling germination, establishment, and advanced growth (30-50% of full sunlight).
- Plant oaks in locations where oak acorn production is low or non-existent.
- Protect planted trees from fire, until they reach a size tolerant of occasional exposure to cool spring fires.

2.3.7 Increasing Breeding Bird Diversity and Population Sizes

There is a widespread perception that restoration of small-sized habitat fragments is ineffective and possibly even counter-productive for conserving grassland and forest birds, due to increased nest predation and brood parasitism in edge dominated stands (Heske and others 2000). Recent research in Illinois indicates that bird species breeding in disturbance dependent shrublands and oak savannas may be far less sensitive to tract size than forest or grassland breeding birds (Brawn and others 2002).

The Plan proposes to:

- Increase the area of disturbance dependant habitat, moving the structure and composition of Lake View Woods as closely as possible in the direction of its pre-settlement savanna-like conditions, to increase nesting opportunities for birds that are less area-sensitive.
- Educate the public on the importance of restoring small urban habitat fragments for wildlife.
- Conduct annual bird censuses to monitor the effects of restoration on breeding and visiting bird populations.

- Expand the annual bird surveys to include adjacent forested neighborhood tracts and backyard feeding stations, to determine the effective habitat size of the woodland community.
- Close unnecessary trails (secondary trails) to minimize disturbance to interior woodland areas.

2.3.8 Removing Debris and Spoils and Filling Excavated Pits

Human disturbances in Lake View Woods have included dumping of trash and refuse, excavation of small pits and mounds, and dumping of spoils of various kinds.

The Plan proposes to:

- Restore the topography and soils in disturbed areas as closely as possible to their original conditions to enhance establishment and long-term success of native plant and animal communities.
- Remove or cover the old dumpsite with local soil, if possible, or, if necessary, a suitable alfisol (forest soil type) from off-site, and re-vegetate wit the seed and plant mix recommended for the Management Unit (Figure 5).
- Fill all excavated pits with local soil, if possible, and re-vegetate as above.
- Remove soil mounds constructed in unofficial trails (Figure 3) and use in filling nearby pits. Return the topography as closely as possible to the original grade and re-vegetate with an appropriate seed and plant mix recommended for the Management Unit.

2.3.9 Managing Dead Standing Trees For Habitat

Standing dead trees and downed logs and woody debris provide important shelter and food sources for cavity nesting and insect-feeding wildlife and woodland decomposers, and are crucial to the overall health of the forest ecosystem.

The Plan proposes to:

- Leave all dead standing trees for wildlife habitat, except those identified as hazard or diseased trees (see *Section 2.3.10* below).
- Close and re-vegetate secondary, un-maintained foot trails to increase area available for cavity tree habitat.
- Educate the public regarding the importance of cavity trees to wildlife, and the necessity of removing hazard and selected diseased trees for the public safety.

2.3.10 Enhancing Public Safety

Obstructed views created by dense underbrush, pose a potential safety risk for the visiting public and encourage vandalism. Opening views through the removal of dense exotic shrubs will increase visibility and a sense of well being, as well as increase overall health of the woodland community.

The Plan proposes to:

- Create attractive open-woodland vistas, with greatly enhanced native understory displays of wildflowers resulting from the increased light.
- Remove poison ivy only where it proliferates along main trails. Currently, poison ivy populations are insignificant in most areas of Lake View Woods.
- Remove dead trees and branches that pose a hazard to the public utilizing the primary managed trails in Lake View Conservancy. (The trees will be removed by the County according to the City Tree Ordinance, under the direction of the City of Madison Forester.)

2.3.11 Maintaining Public Trails & Closing Unnecessary Trails

The existing primary trails in Lake View Woods are important avenues for visitors enjoying the woodland interior for a variety of passive recreational uses, including dog-walking, bird watching, and botanizing.
The Plan proposes to:

- Maintain all primary trails for public use and enjoyment.
- Close and re-vegetate secondary un-maintained trails to minimize unnecessary trampling, prevent local soil erosion, reduce opportunities for exotic species invasion, and minimize disturbance to nesting woodland bird species.
- Post permanent, attractive signage to encourage use and enjoyment of official trails and respect for the woodland's natural environment.

2.3.12 Restoring Dry-mesic Forest Understory to Portions of the Picnic Area

Currently, the entire picnic area is managed by mowing. Restoring portions of the picnic area to native woodland grasses, sedges, and wildflowers would reduce the annual budget for this costly maintenance task, and also minimize damage to oak trees from inadvertent mower damage to the base of the trees and from the affects of root compaction.

The Plan proposes to:

- Restore native woodland understory vegetation to selected areas of the picnic area, particularly to areas above the root zone of most or all of the trees. This can also be done as naturalized native woodland plantings to achieve a more formal appearance if desired.
- Use grass, sedge, and wildflower species of the adjacent dry-mesic forest community in Lake View Conservancy.
- Once established, apply similar burn management treatments to these areas as for the adjacent dry-mesic forest community, but avoid the application of fire near the base of trees, particularly conifers with low-growing branches.
- Use these plantings as an opportunity to interpret for the public the native woodland flora of Lake View Conservancy.

3 Site Context

3.1 Physical Setting

Lake View Conservancy is a small, 17-acre oak woodland remnant situated atop a high bedrock promontory on the northeast side of Lake Mendota, one of several glacial ice block lakes connected by the Yahara River (see map location in *Exhibit 1*). The woodland is surrounded immediately on three sides by residential neighborhoods with mature trees, many of them large open-grown oaks. To the south, the Dane County Human Services Department is housed in the former Lake View Sanatorium buildings. The extensive sloping grounds of this facility are largely maintained as mowed lawn to Northport Avenue (see photo in *Exhibit 2*). As a natural and cultural centerpiece for the surrounding neighborhoods, the Conservancy woodlands and the mowed campus grounds are popular destinations for walking pets and other passive recreational activities. The spectacular view afforded over Lake Mendota from the campus lawn makes this a popular gathering spot for watching the annual "Rhythm and Booms" fireworks displays. In the larger setting, Lake View Woods is situated between the extensive wetland and river systems of Cherokee Marsh and the Yahara River to the north, and Lake Mendota's large water body to the south, making it a significant land divide between these two systems. Other parks and open space areas are located within a short distance of the Conservancy, including Warner Park, Cherokee Marsh Conservation Park, the Cherokee Country Club, as well as several other smaller neighborhood parks (*Exhibit 1*).

3.2 Topography & Soils

The Lake View hill is relatively flat-topped, with its highest point approximately 1,163 feet above sea level. Slopes recede in all directions, with dry exposed conditions on south and west-facing slopes and cool shaded conditions on north and northeast facing slopes providing a variety of growing conditions for plant and animal communities. The Conservancy is situated within the Yahara-Mendota watershed of the Rock River Basin, which drains three-fourths of the water sources of Dane County (Glocker and Patzer 1978).

The predominant soil type of the Conservancy, as mapped by the Soil Survey of Dane County (Glocker, et al. 1978), is Whalan silt loam. Whalan soils are moderately deep, well-drained soils that occupy steep slopes, where the underlying dolomite bedrock is close to the surface (2-4 feet below the surface). Being close to bedrock sometimes results in the soils becoming stony or rocky in places. Whalan soils formed in silt-capped glacial till material under deciduous tree cover, which contributes to its mineral, chemical, and water-holding capacity properties. These are droughty soils subject to rapid runoff, particularly where vegetative cover is sparse or absent. This condition is termed highly erodable and thus the hazard of drought and erosion is severe. Stabilizing Whalan soils with adequate fine-rooted vegetation, such as grasses, sedges, and other herbaceous plants, is imperative to prevent soil loss and water quality problems downstream.

3.3 Natural History

Lake View Conservancy lies at the western edge of Wisconsin's Eastern Ridges and Lowlands geological province, a belted plain of alternating weak and resistant stratified limestone, dolomite, and sandstone bedrock layers of Paleozoic origin (Schultz 1986; Martin 1965). The Conservancy occupies a high promontory above Lake Mendota of resistant Lower Magnesian limestone, capped by glacial till of the Wisconsin continental glacier. Martin mapped this hill as a drumlin feature.

Ellarson (1949) described and mapped the historic vegetation of Dane County, based on mid-19th century land surveys. According to his map, Lake View Woods occurred in an area dominated by "oak opening", which his analysis gave as having the greatest distribution of any other plant association in the County at the time of the early surveys. This disturbance-dependent association was primarily occupied by widely spaced,

fire-resistant bur and white oaks, with an understory of oak and hazel brush, however prairie grasses and wildflowers were the true dominants (Curtis 1959). Black oak was reportedly not uncommon in oak openings, but was more readily killed or damaged by fire, and thus was often present as resprouted stems or "grubs" and rarely attained the larger sizes of its associates. Other tree species rarely mentioned by the early surveyors, included hickory, cherry, and aspen. Ash, basswood, elm, and black walnut were not reported from oak openings (Ellarson 1949).

Stands of rich mesic woods of sugar maple and basswood were rare in the County. Ellarson mapped three of these small "sugar groves", on the northeast or east side of Madison's chain of lakes. One of these stands (the present day community of Maple Bluff, not far from Lake View Woods) was mapped along the northeast shoreline of Lake Mendota and extended just beyond Governor's Island (see a portion of Ellarson's map re-created in Lehnhardt and others 1999). Along with maple and basswood, this association consisted of other tree species less tolerant of fire disturbance, such as white ash, elm, black walnut, butternut, hornbeam, and blue beech. A rich assemblage of spring ephemerals was characteristic of this community. Some of the tree and understory species of this community are found in Lake View Woods today, with the subsidence of fire disturbance.

With settlement, Dane County's vast prairie and savanna landscape was quickly dissected and fragmented by roads, agricultural fields, homesteads, and towns. Curtis (1959) noted that the distribution of more densely treed oak woodlands in Southern Wisconsin greatly expanded under the management of farmers, who kept small wood lots for firewood, fence posts, and building material, as well as for pasturing livestock. Many farmers continued to use fire to manage their land, but the overall effect was a conversion to closed canopied forested woodlots. More recently, many types of woodland, including Lake View Woods, have become heavily infested with exotic shrubs and other plants, such as garlic mustard. These land conversions have left us with highly disturbed and unstable systems that will likely never fully achieve their former stature, diversity, and productivity, even with the help of well-meaning humans.

3.4 Human Use History

A Phase I Environmental Study of the Conservancy grounds was conducted in the summer of 1999 (Salkin, Archaeological Consulting and Services, Inc.). This study showed that limited development has occurred in Lake View Conservancy since the property was platted as a subdivision in 1855. A portion of Lake View hill was used as a quarry through the late 1800's (see map in *Exhibit 5*). Other early landowners utilized the woodlot for pasturing and raising livestock. A cement foundation remains as evidence of this activity (*Exhibit 5*). By 1931, under Dane County ownership, a portion of the hill was developed as the Lake View Sanatorium complex and grounds. The water tower was constructed in 1935. The woodlands served as a recuperative environment for patients, featuring elaborately landscaped ponds, spillways, fountains, and flowered walkways; the nearby nurses dorm featured a swimming pool, extensive gardens, and a skating rink (Nelson Eisman personal communication). The sanatorium remained in operation until 1966. Today, the main building houses the Dane County Department of Human Services offices. In 1992, the Wisconsin Historic Review Board determined the Lake View Sanatorium property eligible for the National Register of Historic Places, under both the areas of significance of history and of architecture.

In recent years, the Lake View Neighborhood Association formed an advocacy group to petition the County and City of Madison to protect the woodland from impending development. They were successful, and today Lakeveiw Woods is designated as a Conservancy within Dane County's Open Space and Parks Plan. Cellular phone antennas installed on the water tower provide a source of funds, which are used in part to manage the woodland and trails.

The Office of the State Archaeologist recognizes a Native American earthwork, known as the Lake View Woods Mound, on the Conservancy property (see map in *Exhibit 7*). Salkin (1999) indicates that, while this oval berm structure is similar to those associated with Early and Middle Woodland cultures, there is

evidence that the structure is more recent. Nevertheless, until the identity of the earthwork is confirmed with further archaeological studies, its status as a protected feature must be honored. As such, any disturbance activities occurring in the area must maintain a minimum 5-foot buffer of the mound, and any proposed ecological work, such as removal of woody vegetation, should be coordinated with the Burial Sites Preservation Office.

3.5 Natural Communities

3.5.1 Overview

The baseline study conducted by Applied Ecological Services, Inc. (Lehnhardt and others 1999) provides the most recent assessment of existing conditions and botanical analysis of the major plant communities found in Lake View Conservancy (see *Exhibit 5, Ecological Land Cover & Cultural Features* and *Table 1, Plant Species List*). This analysis was used as the basis for approximating target restored community types using the Wisconsin Natural Heritage Inventory's recognized Natural Communities Classification (Epstein and others 2001), which is derived from Curtis' Vegetation of Wisconsin (1959). Brief descriptions of the target restored ecological community types are provided below following a description of existing community conditions. The mapped distribution of the target communities is presented in *Exhibit 7*. Target plant community species lists are presented in *Exhibit 11*.

Lake View Woods' current vegetation is characteristic of the dry and dry-mesic forests of the prairie-forest floristic province of southern Wisconsin south of the climatic *tension zone* (transitional zone between northern and southern Wisconsin floristic provinces) (Curtis 1959). Southern dry and dry-mesic forests are predominately oak forests (Hole and Germain 1994, Curtis 1959). As discussed previously, early surveyor accounts, however, suggest most of Dane County was oak savanna at the time of settlement (Ellarson 1949); in fact, it is believed that savanna constituted one of the most widespread communities in the entire state in presettlement times (Curtis 1959). Early land surveyors recorded savanna where the trees averaged 200 feet apart and where many trees were as far as a quarter of a mile from a witness corner (Curtis 1959). Later discussions by Curtis (1959) indicate that when the fires were stopped following settlement, oak openings filled with saplings and brush within a decade and within twenty-five to thirty years, dense oak forests were present. Since the understory floras of oak savannas studied by Curtis (1959) are found to contain a mixture of prairie and forest species, it is not surprising to find these species dominating today under Lake View Woods' closed forest canopy, although several species indicative of former open conditions are present here, including the state threatened yellow giant hyssop (*Agastache nepetoides*).

Today at Lakeview, the dry-mesic association dominated by red oak is located on well-drained soils on south and west slopes, while the dry association dominated by white oak is on thin, dry soils found on the ridge top. Cool, shaded conditions on the north and northeast slopes support a more mesic association of trees and understory vegetation. In recent decades, the woodland canopy has been taken over by ash and black cherry and the understory by exotic shrubs, accompanied by an almost virtual collapse of the native understory vegetation, except in the sunniest locations along trail breaks and in canopy gaps. Disease and high winds have damaged and destroyed many of the old red oaks. The City tree ordinance requires that hazard and diseased trees be removed for public safety and to protect property, and many of the damaged red oaks have been removed as a result.

Regardless of the historic justification for returning Lake View Woods to its original "oak opening" structure and composition, the goal of today's restoration of Lake View Woods will not be to take on this ambitious task, given the degree of fragmentation, disturbance, and significant loss of the original prairie/savanna understory flora. Rather, it is the goal of this Plan to reinvigorate the existing vegetation, depending to a large extent upon the existing remnant flora and using modest reintroductions of appropriate species. It is also the goal of this Plan to establish conditions, to the extent possible, which will favor the regeneration of the characteristic oaks that are steadily being lost. With the return of regular

firing, it is anticipated that the driest areas of Lake View Woods might eventually become more savanna-like in structure and composition.

3.5.2 Southern Mesic Forest

This community, which comprises approximately 3.2 acres of Lake View Woods, is located on the cool, shaded northeast-facing slopes (see map in *Exhibit 7*). Soils are classified as well-drained Whalan silt loam, formed in silt-capped glacial till, with bedrock at 2-4 foot depths. The tree canopy is dominated by a relatively young growth of white ash (*Fraxinus americana*) and boxelder (*Acer negundo*), with a few other associates, including American elm (*Ulmus americana*), and a few older red elm (*Ulmus rubra*), hackberry (*Celtis occidentalis*), and butternut (*Juglans cinerea*). The understory consists of a nearly continuous shrub canopy of exotics common buckthorn (*Rhamnus cathartica*) and Tartarian honeysuckle (*Lonicera tatarica*). The herb layer is severely shade suppressed, and bare soil areas are extensive. Sparsely vegetated areas consist largely of scattered woody seedlings of the shrub and dominant tree species, along with a few disturbance tolerant species such as enchanter's nightshade (*Circaea lutetiana canadensis*) and white avens (*Geum canadense*). With restoration the canopy may include sugar or black maple (*Acer saccharum* or *A. nigrum*), basswood (*Tilia americana*), red elm (*Ulmus rubra*), and red oak (*Quercus rubra*), with an understory of low shrub density and low-stature (<18") herbaceous vegetation. Shrubs may include bladdernut (*Staphylea trifolia*), witchhazel (*Hamamelis virginiana*), and alternate-leaved dogwood (*Cornus alternifolia*). The herb layer may support an array of spring ephemerals, such as spring beauty (*Claytonia virginica*), toothwort (*Dentaria laciniata*), and Dutchman's breeches (*Dicentra cucullaria*), and many other grasses, sedges, forbs, and ferns, such as long-awned wood grass (*Brachyelytrum erectum),* graceful sedge (*Carex gracillima*), wild leek (*Alisma triviale*), mayapple (*Podophyllum peltatum*), blue cohosh (*Caulophyllum thalictroides*), bloodroot (*Sanguinaria canadensis*), and spinulose shield fern (*Dryopteris spinulosa*), among other species. Bird species characteristic of this community include cerulean warbler, red-eyed vireo, ovenbird, woodpecker (hairy and red-bellied), and other insectivorous birds. Some of these species are presently breeding and nesting in Lake View Woods (see discussion in *Paragraph 3.6*).

3.5.3 Southern Dry-Mesic Forest

Conditions supportive of southern dry-mesic forest are found on approximately 9.4 acres of Lake View Woods, particularly on higher exposure, mid-and lower west and south-facing slopes (see map in *Exhibit 7*). Whalan silt loam soils, also found in these locations, may be slightly better drained on shaded northern aspects. Many of Lakeview's large red oaks are found in this community, although many are dead or damaged. White oak (*Quercus alba*) is an important canopy associate. Younger canopy trees are predominantly of wild black cherry (*Prunus serotina*), white ash, with occasional individuals or small stands of other tree species, such as bigtooth aspen (*Populus grandidentata*), butternut (*Juglans cinerea*), and American elm. Black locust (*Robinia pseudoacacia*), an invasive tree introduced from farther south, has invaded this community (*Exhibit 7*, *Area #4*), and white mulberry (*Morus alba*) and boxelder are widespread in the area north of the old cement foundation (see *Exhibit 5, Cultural Features #7*), likely disturbed by fenced livestock. The understory of the dry-mesic forest community consists of a nearly continuous shrub and woody vine layer of common buckthorn and honeysuckle, along with a few other native shrubs, such as chokecherry (*Prunus virginiana*), black haw (*Viburnum prunifolium*), downy arrowwood (*Viburnum rafinesquianum*), alternate leaved dogwood (*Cornus alternifolia*), riverbank grape (*Vitis riparia*), Virginia creeper (*Parthenocissus quinquefolia*), yellow honeysuckle (*Lonicera prolifera*), and moonseed vine (*Menispermum canadense*). The sparse to absent herb layer consists mostly of woody seedlings of ash, buckthorn, and other local trees and shrubs. With restoration, exotic trees and shrubs will be significantly reduced, and white ash, cherry, and elm thinned from the tree canopy to increase understory light conditions to levels supportive of oak regeneration (30-50% of full sunlight). Native shrubs will be protected, and additional shrub species, such as American hazelnut (*Corylus americana*) and alternate-leaved dogwood, will be reintroduced. The restored herb layer will be of moderate-stature (~18"), and consist of a variety of grasses, sedges, and wildflowers, such as bottlebrush grass (*Hystrix patula*), short-headed bracted sedge (*Carex cephalophora*), wild geranium

(*Geranium maculatum*), pointed tick trefoil (*Desmodium glutinosum*), and bellwort (*Uvularia grandiflora*). Bird species characteristic of this community include wood thrush, American redstart, blue-gray gnatcatcher, and veery. All but the veery have been reported in recent bird surveys in Lake View Woods, and these current residents are expected to increase slighty in number with restoration of the native understory. Mammals and birds, such as squirrels, deer, chipmunks, and blue jays that rely on acorns and other nut mast will increase in number, with successful restoration of the oak woods canopy.

3.5.4 Southern Dry Forest

Southern dry forest occupies approximately 2.3 acres of the ridge top and upper slopes at Lake View Woods (*Exhibit 7*), where Whalan silt loam soils are shallowest and driest. White oaks (*Quercus alba*) dominate the canopy with associates red oak and shagbark hickory (*Carya ovata*). Wild black cherry is an important understory tree. Honeysuckle and buckthorn, along with native gray dogwood (*Cornus racemosa*), form a conspicuous but less dense shrub layer than other locations on the hill. The herblayer nevertheless is shade-suppressed, but continues to support patchy stands of native vegetation, including wild geranium and jack-in-the-pulpit (*Arisaema triphyllum*). With restoration, oak regeneration will increase, particularly as the shrublayer and younger canopy trees are thinned and kept under control with periodic fire. Shrubs and small fruiting trees will continue to be important, but will consist of a variety of native species, including American hazelnut, hawthorn (*Crataegus* spp.), wild plum (*Prunus americana*), and Iowa crab (*Malus ioensis*). The restored diverse herblayer will increase in stature to >18", with common species including feathery false solomon's seal (*Smilacina racemosa*), wild geranium, pale-leaved sunflower (*Helianthus strumosus*), common wood sedge (*Carex pensylvanica*), and shinning bedstraw (*Galium concinnum*). Birds expected to return or increase in number include colorful species, such as scarlet tanager, downy woodpecker, rose-breasted grosbeak, cardinal, blue jay, and red-headed woodpecker. Habitat for nut-loving mammals including gray, flying, and fox squirrels, deer and chipmunk will increase. Over time, the regular use of fire may move dry and dry-mesic forest to a more savanna-like community. Recent research (Brawn and others 2001) indicates that birds that favor disturbance-dependent habitat such as savanna or shrublands, are less area-sensitive than forest species. This supports the restoration of smaller habitat fragments where this structure and disturbance regime can be maintained.

Table 1. Common and scientific names of plants found at the Lake View Conservancy (Lehnhardt and others 1999). Nt=native, Ad=adventive (introduced), B=biennial, P=perennial, A=annual, H=herbaceous (non-woody plants), W=woody, FORB=broad-leaved herbaceous plants other than grasses on grass-like plants, CRYPTOGAM=plants not producing seeds, such as ferns and mosses. * Invasive or undesirable exotic species requiring special management attention.

Scientific Name	Common Name	Physiog	Scientific Name	Common Name	Physiog
Acalypha rhomboidea	THREE-SEEDED MERCURY	Nt A-FORB	Cornus racemosa	GRAY DOGWOOD	Nt SHRUB
Acer negundo	BOX ELDER	Nt TREE	Crataegus mollis	DOWNY HAWTHORN	Nt TREE
Actaea rubra	RED BANEBERRY	Nt P-FORB	*DACTYLIS GLOMERATA	ORCHARD GRASS	Ad P-GRASS
Agastache nepetoides	YELLOW GIANT HYSSOP	Nt P-FORB	Dentaria laciniata	TOOTHWORT	Nt P-FORB
Agrimonia gryposepala	TALL AGRIMONY	Nt P-FORB	Dioscorea villosa	WILD YAM	Nt H-VINE
Agrostis perennans	THIN GRASS	Nt P-GRASS	Dryopteris spinulosa	SPINULOSE SHIELD FERN	CRYPTOGAM
Allium tricoccum	WILD LEEK	Nt P-FORB	Epilobium coloratum	CINNAMON WILLOW HERB	Nt P-FORB
Ambrosia artemisiifolia elatior	COMMON RAGWEED	Nt A-FORB	*EPIPACTIS HELLEBORINE	HELLEBORINE ORCHID	Ad P-FORB
Amphicarpaea bracteata	UPLAND HOG PEANUT	Nt P-FORB	Erigeron annuus	ANNUAL FLEABANE	Nt B-FORB
Anemone quinquefolia	WOOD ANEMONE	Nt P-FORB	Erigeron pulchellus	ROBIN'S PLANTAIN	Nt P-FORB
*ARCTIUM LAPPA	GREAT BURDOCK	Ad B-FORB	Erythronium albidum	WHITE TROUT LILY	Nt P-FORB
*ARCTIUM MINUS	COMMON BURDOCK	Ad B-FORB	Eupatorium purpureum	PURPLE JOE PYE WEED	Nt P-FORB
Arisaema triphyllum	JACK-IN-THE-PULPIT	Nt P-FORB	Fraxinus americana	WHITE ASH	Nt TREE
Asclepias exaltata	POKE MILKWEED	Nt P-FORB	Fraxinus pennsylvanica	RED ASH	Nt TREE
Aster laevis	SMOOTH BLUE ASTER	Nt P-FORB	Galium aparine	ANNUAL BEDSTRAW	Nt A-FORB
Aster lateriflorus	SIDE-FLOWERING ASTER	Nt P-FORB	Galium concinnum	SHINING BEDSTRAW	Nt P-FORB
Aster puniceus	BRISTLY ASTER	Nt P-FORB	Geranium maculatum	WILD GERANIUM	Nt P-FORB
Athyrium filix-femina michauxii	LADY FERN	CRYPTOGAM	Geum canadense	WOOD AVENS	Nt P-FORB
*BERBERIS THUNBERGII	JAPANESE BARBERRY	Ad SHRUB	*GLECHOMA HEDERACEA	CREEPING CHARLIE	Ad P-FORB
Bidens frondosa	COMMON BEGGAR'S TICKS	Nt A-FORB	Hackelia virginiana	STICKSEED	Nt B-FORB
Campanula americana	TALL BELLFLOWER	Nt A-FORB	*HEMEROCALLIS FULVA	ORANGE DAY LILY	Ad P-FORB
Carex blanda	COMMON WOOD SEDGE	Nt P-SEDGE	*HYPERICUM PERFORATUM	COMMON ST. JOHN'S WORT	Ad P-FORB
Carex cephalophora	SHORT-HEADED BRACTED SEDGE	Nt P-SEDGE	Impatiens capensis	ORANGE JEWELWEED	Nt A-FORB
Carex gracillima	PURPLE-SHEATHED GRACEFUL SEDGE	Nt P-SEDGE	Juglans cinerea	BUTTERNUT	Nt TREE
Carex pensylvanica	COMMON OAK SEDGE	Nt P-SEDGE	Juncus tenuis	PATH RUSH	Nt P-FORB
Carex rosea	CURLY-STYLED WOOD SEDGE	Nt P-SEDGE	*LAMIUM AMPLEXICAULE	HENBIT	Ad A-FORB
Carex sparganioides	LOOSE-HEADED BRACTED SEDGE	Nt P-SEDGE	*LEONURUS CARDIACA	MOTHERWORT	Ad P-FORB
Carex tenera	NARROW-LEAVED OVAL SEDGE	Nt P-SEDGE	LEPIDIUM CAMPESTRE	FIELD CRESS	Ad B-FORB
Carya cordiformis	BITTERNUT HICKORY	Nt TREE	Lepidium virginicum	COMMON PEPPERCRESS	Nt A-FORB
Carya ovata	SHAGBARK HICKORY	Nt TREE	*LIGUSTRUM VULGARE	COMMON PRIVET	Ad SHRUB
Caulophyllum thalictroides	BLUE COHOSH	Nt P-FORB	Lonicera prolifera	YELLOW HONEYSUCKLE	Nt W-VINE
Celastrus scandens	CLIMBING BITTERSWEET	Nt W-VINE	*LONICERA TATARICA	TARTARIAN HONEYSUCKLE	Ad SHRUB
Celtis occidentalis	HACKBERRY	Nt TREE	Matteuccia struthiopteris	OSTRICH FERN	CRYPTOGAM
CHENOPODIUM ALBUM	LAMB'S QUARTERS	Ad A-FORB	Menispermum canadense	MOONSEED	Nt W-VINE
CHENOPODIUM MURALE	NETTLE-LEAVED GOOSEFOOT	Ad A-FORB	MENTHA X CARDIACA	LITTLE-LEAVED MINT	Ad P-FORB
Circaea lutetiana canadensis	ENCHANTER'S NIGHTSHADE	Nt P-FORB	*MORUS ALBA	WHITE MULBERRY	Ad TREE
*CIRSIUM ARVENSE	FIELD THISTLE	Ad P-FORB	*MUHLENBERGIA RACEMOSA	UPLAND WILD TIMOTHY	Ad P-GRASS
*CIRSIUM VULGARE	BULL THISTLE	Ad B-FORB	*NARCISSUS PSEUDONARCISSUS	DAFFODIL	Ad P-FORB
*COMMELINA COMMUNIS	COMMON DAY FLOWER	Ad A-FORB	*NEPETA CATARIA	CATNIP	Ad P-FORB
Cornus alternifolia	PAGODA DOGWOOD	Nt TREE	Osmorhiza claytonii	HAIRY SWEET CICELY	Nt P-FORB

Scientific Name	Common Name	Physiog	Scientific Name	Common Name	Physiog
Oxalis stricta	COMMON WOOD SORREL	Nt P-FORB	*SOLANUM DULCAMARA	BITTERSWEET NIGHTSHADE	Ad W-VINE
Parietaria pensylvanica	PELLITORY	Nt A-FORB	Solidago canadensis	CANADA GOLDENROD	Nt P-FORB
Parthenocissus inserta	THICKET CREEPER	Nt W-VINE	Solidago gigantea	LATE GOLDENROD	Nt P-FORB
*PLANTAGO MAJOR	COMMON PLANTAIN	Ad P-FORB	Solidago ulmifolia	ELM-LEAVED GOLDENROD	Nt P-FORB
Plantago rugelii	RED-STALKED PLANTAIN	Nt A-FORB	Sphenopholis intermedia	SLENDER WEDGE GRASS	Nt P-GRASS
*POA PRATENSIS	KENTUCKY BLUE GRASS	Ad P-GRASS	*STELLARIA MEDIA	COMMON CHICKWEED	Ad A-FORB
Podophyllum peltatum	MAY APPLE	Nt P-FORB	*TARAXACUM OFFICINALE	COMMON DANDELION	Ad P-FORB
Polygonum pensylvanicum	PINKWEED	Nt A-FORB	Tilia americana	AMERICAN LINDEN	Nt TREE
Polygonum virginianum	WOODLAND KNOTWEED	Nt P-FORB	*TRIFOLIUM HYBRIDUM	ALSIKE CLOVER	Ad P-FORB
Populus deltoides	EASTERN COTTONWOOD	Nt TREE	Triosteum perfoliatum	LATE HORSE GENTIAN	Nt P-FORB
Populus grandidentata	LARGE-TOOTHED ASPEN	Nt TREE	Ulmus americana	AMERICAN ELM	Nt TREE
Prunella vulgaris	Self heal	Nt P-FORB	Ulmus rubra	SLIPPERY ELM	Nt TREE
Prunus serotina	WILD BLACK CHERRY	Nt TREE	Urtica procera	TALL NETTLE	Nt P-FORB
Prunus virginiana	CHOKE CHERRY	Nt SHRUB	Veronica peregrina	PURSLANE SPEEDWELL	Nt A-FORB
Quercus alba	WHITE OAK	Nt TREE	Viburnum rafinesquianum	DOWNY ARROW-WOOD	Nt SHRUB
Quercus rubra	RED OAK	Nt TREE	Viburnum lentago	NANNYBERRY	Nt SHRUB
Ranunculus abortivus	SMALL-FLOWERED BUTTERCUP	Nt A-FORB	*VIBURNUM OPULUS	EUROPEAN HIGHBUSH CRANBERRY	Ad SHRUB
Ranunculus recurvatus	HOOKED BUTTERCUP	Nt A-FORB	Viburnum prunifolium	BLACK HAW	Nt SHRUB
*RHAMNUS CATHARTICA	COMMON BUCKTHORN	Ad SHRUB	Viola pubescens	YELLOW VIOLET	Nt P-FORB
Rhus radicans	POISON IVY	Nt W-VINE	Viola sororia	COMMON BLUE VIOLET	Nt P-FORB
Rhus typhina	STAGHORN SUMAC	Nt TREE	Vitis riparia	RIVERBANK GRAPE	Nt W-VINE
Ribes americanum	WILD BLACK CURRANT	Nt SHRUB	Xanthoxylum americanum	PRICKLY ASH	Nt SHRUB
Ribes missouriense	WILD GOOSEBERRY	Nt SHRUB			
*ROBINIA PSEUDOACACIA	BLACK LOCUST	Ad TREE			
*ROSA MULTIFLORA	MULTIFLORA ROSE	Ad SHRUB		Total Species	144
Rubus allegheniensis	COMMON BLACKBERRY	Nt SHRUB		Total native species	109 (76%)
Rubus idaeus strigosus	RED RASPBERRY	Nt SHRUB			
Rubus occidentalis	BLACK RASPBERRY	Nt SHRUB	Native	Adventive	
RUMEX CRISPUS	CURLY DOCK	Ad P-FORB	19 tree	2 tree	
Sambucus canadensis	ELDERBERRY	Nt SHRUB	12 shrub	6 shrub	
Scrophularia lanceolata	EARLY FIGWORT	Nt P-FORB	8 W-vine	1 W-vine	
Scrophularia marilandica	LATE FIGWORT	Nt P-FORB	2 H-vine	0 H-vine	
Smilacina racemosa	FEATHERY FALSE SOLOMON'S SEAL	Nt P-FORB	40 P-forb	13 P-forb	
Smilacina stellata	STARRY FALSE SOLOMON'S SEAL	Nt P-FORB	2 B-forb	4-B-forb	
Smilax ecirrhata	UPRIGHT CARRION FLOWER	Nt P-FORB	14 A-Forb	5 A-forb	
Smilax lasioneura	COMMON CARRION FLOWER	Nt H-VINE	2 P-grass	4 P-grass	
Smilax tamnoides hispida	BRISTLY CAT BRIER	Nt W-VINE	0 A-grass	0 A-grass	
Parthenocissus quinquefolia	VIRGINIA CREEPER	Nt W-VINE	7 P-sedge	0 P-sedge	
*PHALARIS ARUNDINACEA	REED CANARY GRASS	Ad P-GRASS	0 A-sedge	0 A-sedge	
Phryma leptostachya	LOPSEED	Nt P-FORB	3 Cryptogam		
Pilea pumila	CLEARWEED	Nt A-FORB			
Pinus banksiana	JACK PINE	Nt TREE			

3.6 Faunal Groups

Recent investigations of wildlife groups utilizing Lake View Conservancy have focused largely on the diversity of breeding and visiting bird species (Hoffman 1982; Apfelbaum in Lehnhardt et al. 1999, 2003) (see listing of bird species in *Table 2*). Survey results have varied, with counts ranging from 20 – 29 species, mostly of song birds, with approximately 75% of those utilizing the woodland and adjacent areas for breeding and nesting (see Table 6 in Section 4.4). The highest counts have been reported following two years of restoration treatments in test plots, representing approximately 15% of the site. This increase suggests that full-scale restoration of Lake View Woods may improve habitat for breeding and migratory birds, particularly with re-establishment of a native, patchy shrub and sapling layer, rather than the continuous layer of buckthorn and honeysuckle now present, and with restoration of a continuous native ground story vegetation, rather than the sparsely vegetated, shade-suppressed conditions also present. Some research has shown that large reserves (greater than 2,470 acres) support more viable populations of forest birds, compared to small reserves (Heske et al. 2000). Birds nesting in small tracts often have low reproductive success because of higher rates of nest predation and brood parasitism, which occur most often along woodland edges (Brawn et al. 2002). In small tracts, such as Lake View Woods, edge effects can be apparent up to several hundred feet from the forest edge, leaving little forest interior for area sensitive birds (note the area sensitive birds found at Lake View Woods indicated in *Table 2*). However, recent research also suggests that smaller tracts of disturbance dependant communities such as savanna can be productive of bird species that are not area sensitive (Brawn et al 2002).

A comprehensive survey of Lake View Conservancy's mammals, amphibians, reptiles, and other groups have not as yet been undertaken during the current program, although it is hoped that some of these groups, such as butterflies, may be surveyed in the future. Casual observations of mammals observed throughout this study and reported by residents from the Conservancy and surrounding neighborhoods have included sightings and signs of gray squirrel, white tailed deer, opossum, woodchuck, bat, rabbit, mice, red fox, and raccoon, and it is likely that several other small urban-tolerant mammals utilize the site, such as skunk, rats, and possibly coyote. A small, but growing, deer herd of five to six individuals is known to occupy the woods during the winter months (Ken LePine, personal communication). A recent neighborhood report of numerous flying squirrels at a backyard bird feeder suggests this species may be common in the Conservancy (Olson 2003). Commonly observed butterflies in the Conservancy include morning cloak, red admiral, question mark, yellow swallowtail, and red spotted purple.

Table 2. Birds on record at Lake View Conservancy since 1982 (includes breeding season and winter sightings). *Area sensitive forest birds, possibly most vulnerable to habitat decline (Ehrlich et al. 1988). Conif.=conifer trees, decid.=deciduous trees, inverts=invertebrates.

Common Name	Primary Breeding/Nesting Habitat	Primary Food	Last Record
American Crow	Woods, orchards/conif. & decid. trees	Omnivore, nest predator	2002
*American Redstart	Open decid & mixed woods/decid trees	Insects	2001
American Robin	General, urban /decid & conif trees	Insects, fruit, other inverts	2002
Black-capped Chickadee	Decid. & mixed woods/cavities	Insects, seeds, fruit	2002
Blue Jjay	Decid. & mixed woods, urban/conif. trees	Omnivore, nest predator	2002
*Blue-gray Gnatcatcher	Generalist, forest, woods, scrub/decid. trees	Insects, spiders	2002
Brown Creeper	Pine forests/conif. trees	Insects, nuts, seeds	1982
Brown Thrasher	Brush, forest edge, clearings/shrubs	Omnivore	1999
Brown-headed Cowbird	Grassland, forest edge/decid. trees, shrubs	Insects, seeds	2001
Cedar Waxwing	Woods, forest edge/decid. & conif. trees	Fruit, insects, flowers, sap	2002
Chipping Sparrow	Forest, savanna, brush/conif & decid trees	Insects, seeds	2002
Coopers Hawk	Riparian woodland/decid. trees	Birds, small mammals	2002
Dark-eyed Junco	Conif. & decid. forest, savanna/ground	Insects, spiders, seeds	1982
Downy Woodpecker	Decid. & mixed woods/cavities in snags	Insects, fruit, seeds, sap	2002
*Eastern Wood pewee	Decid. & mixed forest, edges/decid. trees	Insects	2002

European Starling	Generalist/decid. trees, buildings	Insects, other inverts	2001
American Gold Finch	Old fields, savannas, woods/shrubs	Seeds	2002
Golden-crowned Kinglet	Open conif. forest/conif. trees	Insects, fruit, seeds	1982
Gray Catbird	Dense brush, wood edges/shrubs	Insects & other inverts	2002
*Great-crested Flycatcher	Decid. forest edge, woods/cavities	Insects, berries	2002
Hairy Woodpecker	Decid., conif. forest, woods/cavities	Insects, sap	1982
House Finch	Urban woods, shrubland/decid. trees	Seeds, fruit, sap	2002
House Sparrow	Farms, wood edges, urban/cavities	Seeds, insects, fruit	2002
House Wren	Savanna, shrubland, urban/cavities	Insects & other inverts	2002
Mourning Dove	Farms, woods/decid. & conif. trees, ground	Seeds, grain	2002
Northern Cardinal	Brush, urban/shrubs	Insects, seeds, fruit	2002
Pine Siskin	Conif., mixed forest, woods/conif. trees	Seeds, insects	1982
Purple Martin	Savanna, farms/cavities in snags	Ants & other insects	2002
Red-bellied Woodpecker	Decid., mixed woods, urban/cavities, snags	Insects, nuts, fruit	2002
*Red-eyed Vireo	Decid. forest, woods/shrubs	Insects, fruit	2002
Red-headed Woodpecker	Decid. woods, savannas/cavities in snags	Omnivore, nest predator	1982
Red-tailed Hawk	Woods, savannas/decid. trees, cliffs	Rodents, birds, reptiles	1982
Eastern Screech Owl	Savanna, decid. forest, scrub/cavities, snags	Insects, small mammals	1982
Sharp-shinned Hawk	Woods, mixed forest/conif. trees	Birds	1982
Tree Sparrow	Shrublands/ground in tundra	Insects, seeds	1982
Tufted Titmouse	Forest, woods, scrub/cavities, decid. trees	Insects, seeds, fruit	2002
White-breasted Nuthatch	Decid., mixed forest, woods/snags, cavities	Insects	2001
White throated Sparrow	Conif., mixed forest, edge/ground north	Insects, seeds, fruit	1982
*Wood Thrush	Decid., mixed forest near water/decid. trees	Insects, fruit	2001
Yellow-bellied Sapsucker	Mixed decid. conif. forest/cavities	Insects, sap	1982
Yellow-shafted Flicker	Open ground below tree line/cavities, snags	Insects	2002

3.7 Endangered Resources

A small population of less than a dozen stems of yellow giant hyssop (*Agastache nepetoides*) was discovered at the time of the 1999 baseline investigations, along the north side of the site. This population has since spread vigorously from the original locations into brushed areas of adjacent test plots, suggesting a well-distributed seed bank awaiting favorable open conditions. As more of the Conservancy opens up and becomes capable of sustaining light ground fires, this species should enjoy optimum conditions throughout the site. No other state or federally listed species records are known from the Conservancy or vicinity (Bureau of Endangered Resources database reviewed in 1999). Periodic botanical inventories are recommended to monitor the existing populations of yellow giant hyssop and to be alert to other species that may appear throughout the restoration and management program. As conditions in the site stabilize, it may be possible to consider reintroductions of appropriate conservative and rare species, with the cooperation of County and State rare plant specialists.

3.8 Critical Resource Issues

Critical resource issues have been discussed in detail in previous sections of this report. In summary, this plan focuses on the following issues and provides specific actions and strategies to address these issues:

- Presence of remnant, degraded native oak forest and oak savanna communities in need of restoration and management intervention.
- Decline and loss of mature oaks, due to oak wilt, storm damage, and natural aging, and lack of oak regeneration and recruitment to the canopy due to unfavorable site conditions.
- Invasions by exotic tree, shrub, and herbaceous species, which are successfully or potentially out-competing native species. (See species marked with * in *Table 1*.)

- Shade suppression from overdeveloped woody tree and shrub canopies, resulting in limb dieback on older oaks, collapse of understory diversity and cover, and unstable soils. All of these conditions favor invasive and weedy species.
- Smothering of native vegetation by refuse and spoils deposits.
- Degraded wildlife habitat opportunities resulting from all of the above conditions.
- Downed, dead-standing, and otherwise damaged trees, providing wildlife opportunities, but posing public safety issues
- Presence of a State listed plant species yellow giant hyssop (*Agastache nepetoides*), requiring monitoring and special management attention. (This species has increased in number following burning and brushing treatments during the test plot program, in Test Plot 1).

4 2000-2002 Restoration Test Plot Program

4.1 Overview

The following section briefly summarizes the findings of a two-year Restoration Test Plot Program, conducted from late 2000 through 2002, to evaluate the woodland community response to a variety of restoration intervention treatments and to demonstrate these effects to the public and provide public participation in the restoration process. Public input and participation are integral to developing and implementing a comprehensive, effective, and cost-efficient restoration and management program for Lake View Woods.

The results of the test plot study are presented in detail in a separate technical report.

4.2 Test Design & Methods

Four .75 to 1-acre test plots were established in locations in Lake View Woods, representing varying site and disturbance conditions. Each plot was divided into six sub-plots, each receiving a combination of restoration treatments involving burning, brushing, herbicide application, and reintroduction of native herbaceous species as seed and live plant plugs. *Exhibit 6* presents the test plot layout and treatment applications, as well as provides a description of conditions in each test plot prior to treatment. All test plots were monitored in 2001 and 2002 for responses to treatment. In 2002, volunteers assisted with data collection.

Brushing and Thinning - Treatments were initiated in the winter of 2000 and 2001, with all Subplot A and Subplot B areas brushed of targeted exotic and over-abundant native shrubs and thinned of young selected tree species (boxelder, white mulberry, cherry, and ash) up to 6 inches in diameter at breast height (dbh). Larger stems of target trees were girdled and left standing. Cut material was chipped and applied to trails on-site. Subsequent to brush removal, all cut stems and girdled trees in all Subplot A areas were chemically treated with a glyphosate formulation (Garlon 4A) in a 25% solution with diluent blue, a mineral oil carrier. Follow-up brushing, thinning, and herbicide treatments were conducted in late winter 2002.

Prescribed Burning – Mid-spring (mid-April) fires were applied to all Subplot areas of each test plot having adequate fine fuels in both 2001 and 2002. Fires were managed to avoid igniting the significant downed woody debris in Test Plots 1 and 3.

Seeding and Planting – Seed of 22 native savanna/oak woodland species were hand collected at Token Creek Park and Lake View Conservancy by volunteers in fall 2000 for reintroduction into all A1, B1, and C1 Subplots. A portion of the collected seed was greenhouse propagated and grown out in deep-rooting 38-size plug containers. A total of 1000 live plugs were planted into all A1, B1, and C1 Subplots. Seed from an additional 13 species purchased from a local native seed nursery were introduced into the Subplots. Volunteer stewards were actively involved in all phases of the seeding and planting treatments. Installation of the live plugs was executed in cooperation with the Sun Prairie Boy Scouts as an Eagle Scout project.

Vegetation Monitoring – All Subplot treatments were monitored during the 2001 and 2002 growing season by measuring the following variables: 1) herbaceous layer species frequency, percent cover, and importance, 2) shrub stem density and canopy intercept, 3) tree canopy intercept, stem density, and basal area. In addition, shrub stem mortality, survivorship, and re-sprouts were tallied along a transect bisecting Subplot treatments A, B, and C. All Subplots were surveyed for total species presence.

Seedbank Study – Soil samples were collected from each Test Plot (Subplots A, B, C) and grown out in two grow/harvest cycles in a controlled greenhouse setting. All species were identified and seedling frequencies tallied.

Light Level Measurements – Light levels were systematically measured in the test plots using a hand-held quantum meter (Basic Quantum Meter, Model BQM by Spectrum Technologies, Inc.), which approximates the light wavelenghts important for plant photosynthesis. Readings were taken in ten locations across each treatment subplot (A, B, and C), averaged, and compared to light level readings in adjacent open conditions (parking lot under the water tower). The goal of restoration in Lake View Woods is to reduce shading in the understory, thus increasing light levels supportive of woodland and savanna ground cover vegetation, and of oak seedling germination and establishment (30-50% of full sunlight).

Bird Survey – Birds were surveyed twice during the breeding season from four sample point locations (see bird sample point locations in *Exhibit 6*) selected to represent the diversity of habit types present, and spaced to minimize redundancy of observations. Two survey points (2 and 3) were proximate to test plot treatments, and two survey points were not (1 and 4). Survey methods tallied the number of bird species heard vocalizing or observed perched or in flight over one-minute intervals at each survey point location, until no new species were heard or observed (usually 15-20 minutes). Birds audible from immediately adjacent wooded and open neighborhood properties were recorded in the survey.

4.3 Results & Discussion

Brushing & Thinning – As expected, the number of live shrub stems decreased significantly in the brushed subplots, due to the overwhelming presence of exotic shrub species targeted for removal versus desirable native shrub species. Re-sprouting occurred initially in all subplots where cutting and girdling of stems was not followed by an application of a glyphosate herbicide; however, significant mortality to re-sprouts occurred in Test Plots 3 and 4, where subsequent fires were more intense and evenly distributed. Canopy thinning targeted the most abundant tree species up to six inches in diameter at breast height, namely wild black cherry, white ash, boxelder, and white mulberry. Light meter readings conducted in year two detected significant increases in light levels in all brushed and thinned subplots compared to un-brushed subplots; however, desired light levels of 30-50% of full sunlight were achieved in only 5% of the readings, suggesting that additional thinning may be necessary to create conditions suitable for oak regeneration and advanced growth. Burning in un-brushed subplots was generally unsuccessful, except where oak leaf litter formed a continuous cover (Test Plot 4). In this instance the shrub canopy was significantly stressed after the first fire and subsequent firing resulted in some stem mortality. It is expected that in the presence of sufficient oak leaf litter, shrub mortality by regular burning alone would allow sufficient control of buckthorn and honeysuckle, however, burning at that frequency would prevent advanced growth of oak seedlings, which need a period of at least ten to fifteen years to reach a size less vulnerable to damage by fire.

Prescribed Burning – Burn distribution varied in the test plots depending on the concentrations of fine fuels in the form of combustible leaf litter. Oak leaf litter carried the hottest, most consistent fires, while the leaf litter of most other tree and shrub species had decomposed beyond combustibility over the winter months. Consequently, in the first year, the greatest burn coverage occurred in Test Plot 4, with minor coverage occurring in all other test plots. Subsequent seeding and planting and stimulation of the seed banks in some areas resulted in greater distribution of fire in all test plots in year two. It is possible that burning in fall may be necessary to utilize the leaf litter generated by more mesic tree species in some areas of the woods.

Seeding and Planting – The following species were introduced into half of each test plot in the form of live plugs. Grass species were also introduced as seed. Of the 35 species introduced, 18 have been regularly observed in the test plots after two years (see species mark with * in *Table 3*), with brushed subplots averaging just under ten species. A few of the species planted have also emerged from the soil seed bank in non-seeded and planted areas, and were difficult to discern from planted species, such as Jack-in-the-pulpit (*Arisaema triphyllum*) and mayapple (*Podophyllum peltatum*), and thus were not counted. Planted and seeded grasses produced seed in the first year, in many cases, and now provide the most conspicuous cover, particularly in Test Plots 2 and 3, and sunnier portions of Test Plot 4, close to the trail. In all cases, plugs introduced into un-brushed, burn-only portions of the test plots experienced the greatest mortality by the end of the second year, with as few as one species observed under heavy shade, but as many as 7, where fire reduced the shrub canopy allowing more light to the ground story.

Table 3. Species introduced as seed and plants into test plots at Lake View Conservancy. Species marked with * have been observed in the test plots by the end of year 2 of the study.

No.	Scientific name	Common name
1	**Agastache nepetoides*	Yellow giant hyssop
2	*Arisaema triphyllum*	Jack-in-the-pulpit
3	**Bromus pubescens*	Woodland brome
4	**Cacalia muhlenbergii*	Great Indian plantain
5	*Campanula americana*	Tall bellflower
6	**Carex pensylvanica*	Common oak sedge
7	**Caulophyllum thalictroides*	Blue cohosh
8	*Claytonia virginica*	Spring beauty
9	*Cryptotaenia canadensis*	Honewort
10	*Desmodium glutinosum*	Pointed tick trefoil
11	**Elymus villosus*	Silky wild rye
12	**Elymus virginicus*	Virginia wild rye
13	**Eupatorium purpureum*	Woodland joe-pye weed
14	**Eupatorium rugosum*	White snakeroot
15	*Euphorbia corollata*	Flowering spurge
16	*Gentiana flavida*	Yellowish gentian
17	**Geranium maculatum*	Wild geranium
18	*Geum triflorum*	Prairie smoke
19	**Hypericum pyramidatum*	Great St. John's wort
20	**Hystrix patula*	Bottle brush grass
21	*Osmorhiza claytonii*	Hairy sweet cicely
22	**Penstemon calycosus*	Smooth beard tongue
23	*Phryma leptostachya*	Lopseed
24	*Podophyllum peltatum*	Mayapple
25	*Polygonatum biflorum*	Solomon's seal
26	*Polygonum virginianum*	Woodland knotweed
27	**Ratibida pinnata*	Yellow coneflower
28	*Rosa carolina*	Pasture rose
29	*Rudbeckia subtomentosa*	Sweet black-eyed Susan
30	**Rudbeckia triloba*	Brown-eyed Susan
31	**Scrophularia lanceolata*	Late figwort
32	*Smilacina racemosa*	False Solomon's seal
33	*Smilax herbacea*	Carrion flower
34	**Solidago ulmifolia*	Elm-leaved goldenrod
35	**Verbena urticifolia*	White vervain

Vegetation Monitoring – One of the objectives of vegetation monitoring was to measure the response of the understory vegetation to light increases resulting from removal of the exotic shrub canopy and reduction of the young tree canopy. As anticipated, subplots receiving the full complement of treatments - brushing, including herbicide applications to cut stumps, burning, seeding, and planting, and subplots with all treatments, except herbicide - had the greatest average number of native species and the greatest native herbaceous cover by the end of the two-year study; although the number of re-sprouting stems and their canopies began to increase significantly by year two in all subplots, where cut and girdled stems were not treated with herbicide. Even in areas where fire stressed or killed some shrubs (< 2" diameter stems), subplots that were not brushed had the lowest native diversity, and attempts to re-introduce seeds and plants in these areas were unsuccessful. These results suggest that re-introduction of costly seeds and plants should not occur until, at minimum, the exotic shrub canopy is removed and re-sprouting stems are under control. Additional canopy thinning of productive young non-oak species (wild black cherry and white ash) to increase light levels to 30-50% of full sunlight would be expected to enhance ground cover establishment and vigor. A general trend in brushed and burned subplots is an increase in bare soil in year one, followed by a decrease in year two. This pattern reflects the reduction by fire of the dominant woody ground cover (i.e. seedlings of exotic shrubs, mesic tree seedlings, and woody vines) in year one, and an increase in herbaceous cover in year two following seeding and planting. Cover by fine litter (leaves, small twigs, and duff) and coarse litter (woody material > .75 inches across) shows a general trend of decreasing in all subplots since 1999, with use of fire. Fine litter rebounds slightly in year two of the study with an increase in fine litter of herbaceous plant materials in brushed and burned subplots. Another objective of monitoring was to measure the response from the existing soil seed banks, to determine the need for re-introductions of seed and plants. In general, the response from the native seed bank was spotty by year two of the study. Test plots located on the north side of the site (Test Plots 1 and 2), where slope aspects are northerly or northwesterly and conditions more mesic, had the greatest relative response from the seed banks, particularly of native sedges and a few forbs, including yellow giant hyssop (*Agastache nepetoides*). This seed bank response is consistent with the results of the seed bank study conducted in the greenhouse.

Seed Bank Study – Over all test plots sampled, a total of 35 species were recorded in the seed bank study, a little over half (54%) were non-native species. Of the total species, those with the highest seedling production were largely native weedy species: path rush (*Juncus tenuis*) (74 seedlings) and common wood sorrel (*Oxalis stricta*) (52 seedlings), followed by non-natives white mulberry (*Morus alba*) (21 seedlings) and motherwort (*Leonurus cardiaca*) (18 seedlings). Of these species white mulberry showed the greatest frequency, appearing in three of the four test plots, although in relatively low numbers outside of Test Plot 1, where a large number of mature trees were removed during canopy thinning treatments. Surprisingly, the highest species diversity and most abundant native seed banks were found on the north side of the site in Test Plots 1 and 2, considered to be the most disturbed portion of Lake View Woods. Common buckthorn (*Rhamnus cathartica*) had relatively low seedling numbers in the seed bank study, however seedlings of this species remain important in the herbaceous layer in most test plots, with high relative importance values in the sampled quadrats. Seed bank study results suggest that native species re-introductions will be necessary in some parts of the woodland, with the north part of the woodland having sufficient seed banks for the less conservative species, with the exception of yellow giant hyssop (*Agastache nepetoides*), a state threatened plant. Sedges appearing in the seed bank study, especially *Carex cephalophora,* are now growing quite abundantly in Test Plot 2.

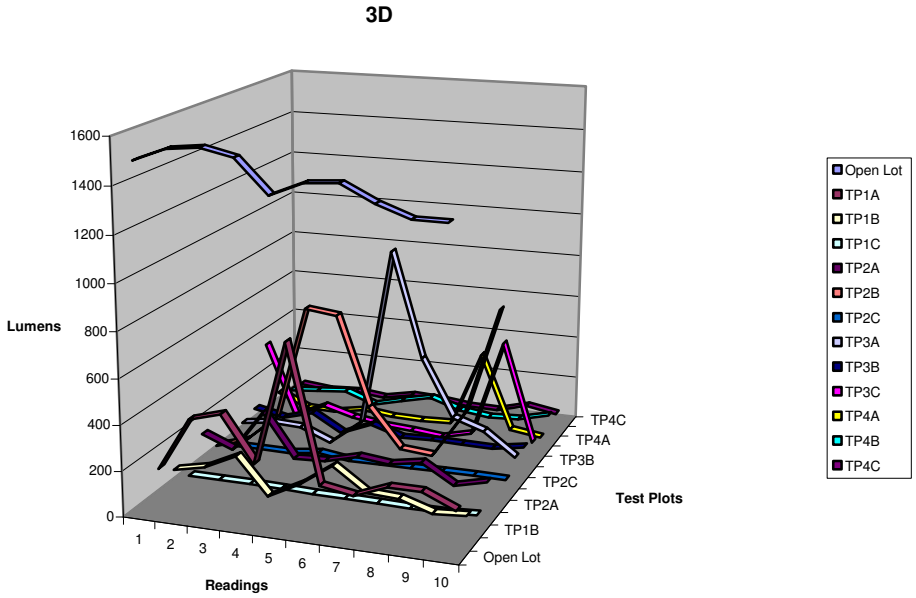
Table 4. Seed bank study results.

				TP 1	TP 2	TP 3	TP 4	Totals
Species	**Native**	**Adventive**	**Habit**	**#Sdlgs**	**#Sdlgs**	**#Sdlgs**	**#Sdlgs**	**#Sdlgs**
Acnida altissima	X		Forb	1				**1**
Agastache nepetoides	X		Forb	3				**3**
Carex blanda	X		Sedge		2			**2**
Carex cephalophora		X	Sedge		6		1	**7**
Carex sp.		X	Sedge		2			**2**
Chenopodium murale		X	Forb	3	4			**7**
Circaea lutetiana canadensis	X		Forb	2	1			**3**
Digitaria sanguinalis		X	Grass	2				**2**
Erigeron canadensis		X	Forb				1	**1**
Erigeron philadelphicus		X	Forb		2			**2**
Geum canadense	X		Forb	10	2			**12**
Juncus tenuis	X		Rush	8	66			**74**
Leonurus cardiaca		X	Forb	18				**18**
Medicago lupulina		X	Forb		3			**3**
Morus alba		X	Tree	15		3	3	**21**
Oxalis stricta	X		Forb	42	10			**52**
Panicum dichotomiflorum	X		Grass		1			**1**
Poa compressa		X	Grass		1			**1**
Populus grandidentata	X		Tree	2	2	3		**7**
Potentilla norvegica	X		Forb		10			**10**
Ranunculus abortivus	X		Forb	2	2			**4**
Ranunculus recurvatus	X		Forb	1	3			**4**
Rhamnus cathartica		X	Shrub		5		1	**6**
Rubus allegheniensis		X	Shrub			1	1	**2**
Rubus idaeus strigosus		X	Shrub			1	1	**2**
Sambucus canadensis	X		Shrub		2			**2**
Scrophularia marilandica	X		Forb	5	9			**14**
Smilax lasioneura		X	Forb			1		**1**
Solanum americanum	X		Forb	10	2			**12**
Taraxacum officinale		X	Forb	1		1		**2**
Trifolium repens		X	Forb		1			**1**
Verbascum thapsus		X	Forb	2	2			**4**
Viola sororia	X		Forb	2				**2**
Unknown species #8		X		1				**1**
Unknown species #9		X		1				**1**
Totals (35 species, including 2 unknowns)	**16 (46%)**	**19 (54%)**	**20 Forb** **3 Grass** **3 Sedge** **1 Rush** **4 Shrub** **2 Tree**	**131**	**138**	**10**	**8**	**287**

Light Level Measurements – Light level readings show patchy light conditions developing in all brushed subplots (*Figure 1*). However, few readings achieve the minimum 30% of full sunlight recommended for oak seedling germination and establishment (Rauscher et al. 1996). The highest average light levels were measured in Test Plots 1 (20% of full sunlight) and Test Plot 2 (25% of full sunlight). These areas had greater canopy gaps following removal of white mulberry and boxelder, relative to other test plots, where

the tree canopy was more intact and continuous (Test Plots 3 and 4). The greatest number of newly emerging oak seedlings, however, were observed in Test Plot 4 by year two of the study, where average light level readings were only 5% of full sunlight, but where oak stem densities and oak acorn production was highest, and where fires were more intense and more evenly distributed. Continued monitoring of test plot areas should assess the survivorship of new oak seedlings, and determine if additional thinning in some areas is warranted. Areas with adequate light levels but poor oak mast production should be seeded with acorns collected from the site.

Table 4. Light level analysis showing patchy light gaps (spikes in the colored bands) forming in brushed portions of the test plots, relative to consistently low light levels in un-brushed areas (flat bands on the floor of the graph). The isolated band at the top of the graph represents measurements recorded in full sunlight in the adjacent parking lot. (Graph prepared by Nelson Eisman)



Bird Survey – A total of 29 bird species, common to oak woodland and suburban settings, were recorded during the breeding bird surveys conducted in Lake View Woods throughout the 1999 baseline study and the 2001-2002 test plot study periods. Table 5 presents a summary of the data collected during the study period (see discussions in *Sections 2.3.7, 3.6, and 7.7*). The data indicate a slight increase in the number of species observed and in the frequency of sightings at each sample point by year two of the test plot treatment study (compare totals at the bottom of *Table 5*). This small increase, however, might be explained by factors other than the effects of the restoration treatments, given the relatively small area of the woodland affected by the test plot treatments. At a minimum, it suggests that restoration treatments have not had a negative impact on bird use of the woodlands, and may have contributed to the slight increase. Continued annual surveys should be conducted, to determine the long-term effects of restoration on breeding and visiting bird use of Lake View Woods.

Table 6. Summary of bird survey data collected for three years (1999, 2001, and 2002) from four sample point locations in Lake View Woods (see bird sample point locations in *Exhibit 6).* Two survey points (BP2 and BP3) were proximate to test plot treatments, and two survey points were not (BP1 and BP4). Frequency (freq) is a measure of the total number of sample point locations from which a species is observed.

Species	Status	1999	1999	1999	1999	freq	2001	2001	2001	2001	freq	2002	2002	2002	2002	freq	TOTALS
		BP1	BP2	BP3	BP4		BP1	BP2	BP3	BP4		BP1	BP2	BP3	BP4		
American crow	V	1	1	1	1	4	1	1	1	1	4	1	1	1	1	4	12
American redstart	V					0		1			1					0	1
Blue-gray gnatcatcher	V					0		1			1					0	1
Brown-headed cowbird	V					0		1			1					0	1
Chipping sparrow	V					0					0				1	1	1
Gold finch	V					0					0		1			1	1
Purple martin	V	1				1	1				1					0	2
SUBTOTALS		2	1	1	1	5	2	4	1	1	8	1	2	1	2	6	19
American robin	B			1	1	2			1	1	2		1	1	1	3	7
Black-capped chickadee	B	1		1	1	3	1	1	1		3	1	1		1	3	9
Blue jay	B		1	1	1	3		1	1	1	3			1		1	7
Brown thrasher	B		1		1	2					0					0	2
Cedar waxwing	B	1				1	1				1	1		1	1	3	5
Coopers Hawk	B				1	1			1		1					0	2
Downy woodpecker	B		1		1	2			1	1	2		1	1		2	6
Eastern wood pewee	B		1	1	1	3			1	1	2	1	1	1	1	4	9
European starling	B	1				1	1	1		1	3					0	4
Gray catbird	B		1	1	1	3		1			1			1		1	5
Great-crested flycatcher	B	1	1	1		3	1	1	1		3	1	1	1	1	4	10
House finch	B					0					0	1			1	2	2
House sparrow	B				1	1				1	1	1	1		1	3	5
House wren	B	1	1		1	3	1	1		1	3	1	1	1	1	4	10
Mourning dove	B				1	1					0		1		1	2	3
Northern cardinal	B	1	1	1	1	4	1	1	1	1	4	1	1	1	1	4	12
Red-bellied woodpecker	B		1			1			1	1	2			1		1	4
Red-eyed vireo	B	1	1	1	1	4	1	1	1	1	4	1	1	1	1	4	12
Tufted titmouse	B					0			1		1		1		1	2	3
White-breasted nuthatch	B		1	1		2			1		1					0	3
Wood thrush	B					0		1			1					0	1
Yellow-shafted flicker	B			1		1					0			1	1	2	3
SUBTOTALS		7	11	10	13	41	7	9	12	10	38	9	11	12	13	45	124
TOTALS		9	12	11	14	46	9	13	13	11	46	10	13	13	15	51	143

4.4 Conclusions

The following conclusions have been drawn regarding the major effects of restoration treatments at Lake View Woods, based on the results of the test plot study:

- Firing in the test plots has been of sufficient intensity, where oak leaf litter provides continuous fuel and produces sufficiently high temperatures, to stress and even kill small diameter (1/4-3/4 inch) stems of woody growth, including re-sprouting cut, but chemically un-treated, stems. Firing should continue to be used to initiate reduction of the shrub canopy, where oak leaf litter is sufficient (generally, the south end of the site and upper north slope), while cutting and herbicide treatments should be applied to areas, where oak leaf litter is sparse or absent.

- Removal of exotic shrubs and trees and thinning of the understory canopy have achieved increased light levels, resulting in an increase in oak seedling production in two of the test plots (Test Plots 3 and 4). Light meter readings, however, suggest light levels remain below the target 30-50% of full sunlight conditions, necessary for germination and advanced growth of oaks. Monitoring for oak seedling survivorship should be made part of an annual vegetation monitoring effort in all treatment areas. In treatment areas where oak acorn production is minimal, due to the absence of mature canopy oaks, acorns should be hand broadcasted from collections made on site or from approved neighborhood locations.
- Soil seed banks are insufficient in many locations to provide adequate soil-stabilizing cover and species diversity following brushing and burning treatments, and therefore appropriate seed and plant materials should be introduced into treatment areas. Some desirable species are present in sufficient numbers on site, to provide a seed source for collections and propagation.
- Restoration treatments have not had a negative impact on the number of species of visiting and nesting birds, and in fact, may have had a positive impact on bird use (see discussion in *Section 4.4, Bird Surveys*). Annual bird surveys should be conducted to monitor the long-term effects of restoration in Lake View Woods.

5 Restoration Philosophy & Approach

The approach to restoring natural systems proposed by this Plan is based on the belief that through a well-defined restoration and management program, degraded natural systems in the context of a disturbed landscape can be restored to a higher sustainable level of ecological health, which can be perpetuated indefinitely into the future. The success of such a program must depend on careful and efficient implementation of the tasks, close monitoring and accounting of critical performance milestones, community education, and a concerted, ongoing effort by land managers and other stakeholders. The following guiding principles are supportive of this philosophy and approach:

5.1 Ecological Restoration

Ecological Restoration – As defined by the Society for Ecological Restoration, *restoration* is "the process of intentionally altering a site to establish a defined, indigenous, historic (presettlement-like) ecosystem. The goal of this ecosystem is to emulate the structure, function, diversity and dynamics of the specified ecosystem. In other words, the intent is to repair or re-establish entire functioning ecosystems. Ecological Restoration also encompasses management practices that are intended to maintain ecological integrity." In highly disturbed settings and where funding and labor resources are limited, achieving full recovery of a complex and highly biologically productive historic landscape may be an unreasonable goal. Nevertheless, restored systems should reflect, to the extent possible, the historic systems, but be modified as necessary to be appropriate for the current soil and hydrological conditions. As an example, hydrologic conditions that historically supported wet prairie or sedge meadow communities today may be more supportive of shallow marsh plant assemblages, due to the presence of artificial impoundments or excavated ponds, and large quantities of directed surface runoff from adjacent developed uplands. Likewise, historic soils may be removed or buried under deep sediment deposits. Unless these problems can be mitigated, restoration must be suited to these new conditions. Additionally, adherence to strict guidelines for reintroduction of species from local genetic strains may be unreasonable in all cases. Where available, however, local seed sources should be collected and utilized or acquired from reputable seed dealers in the locale or region (see discussion in *Section 7.3*).

5.2 Ecosystem Health

A guiding principle used to evaluate the need for management intervention or restoration is *ecosystem health*. It is a concept becoming more widely applied to problems of environmental management, where sustainable systems are achieved through an integration of the biological integrity of ecosystems and the needs and values of people who use them (Gaudet et al., 1997). The most symbolic and easiest to understand goals for achieving ecosystem health (as defined by this paradigm) are inherent in the following indicators of a healthy ecological system:

1. Stable soils. With few exceptions, all vegetated systems in the world have stable soil systems. In general, unstable soils are a good indicator of failing ecological system health, and can be very costly to repair. In oak woodlands, unstable soils generally result from densely shaded ground that prevents the growth of soil stabilizing herbaceous plants such as grasses and sedges.

2. Dominance by sustainable populations of native plants. Plant communities historically were dominated by species that existed or slowly moved into the various regions of the world, responding to climate change as a principle agent associated with their geographic movement. Now, humans introduce (inadvertently and advertently) plants at rapid rates. Many introduced plants represent a threat to native plant and animal communities.

3. Quality water, at appropriate rates and volumes. Poor water quality and high rates and volumes of runoff are associated with human disturbance of soils and vegetation systems on uplands, and with

drainage of wetlands that hold water and slowly release it. Healthy systems tend to retain water better than degraded areas.

4. Capacity to change and adapt to disturbance. The ability of ecological systems to restructure or reassemble after disturbance is a key ingredient to healthy systems. Degraded or unhealthy systems tend to become more degraded after disturbance. Although the land may be vegetated, it may be by weedy plants and animals rather than by diverse native plant and animal communities.

5. Diverse plant and animal communities. Native plant communities are in general comprised of many species that contribute to the character and structure of the habitat that supports animal communities. Unhealthy plant communities tend to be of low diversity, often dominated by one or a few plant species, and tend to support a depauperate animal community.

Fundamental aspects for successful restoration and long-term management of healthy stable ecological systems usually include the following human-focused goals:

6. Stewardship relationship and commitment between people and ecological resources – not a status quo, *laissez faire* attitude. It is the connection between people and the ecological resource that will determine the future fate of the resource. In highly altered areas, remaining ecological system remnants are highly vulnerable to impacts by surrounding land-uses. At these locations in particular, people need to have an active role in the management, restoration, and monitoring of these ecological systems.

7. A commitment of funds and policies to land protection, ecological health, restoration, management and monitoring programs. Political will and funding can relate directly to the investment people are willing to make in natural resources and stewardship. Successful natural resources restoration and management programs have high levels of support.

8. Adaptability of management strategies to new information. Natural systems may respond favorably, unfavorably, or with no change to management and restoration tasks. Following nature's lead, and modifying the management and restoration program to account for specific responses to the restoration program, provides a basis for an adaptive program. Program changes would be based on monitoring data, indicating better approaches to address ecological problems.

9. A commitment to design with prudence, humility, and open eyes, to learn from the ecological system and not foreclose on future options or needs. Natural systems must be handled carefully and with humility. Programs that are focused on learning from the system are often successful. Hard and fast programs with no opportunity to learn or adapt are often unsuccessful.

5.3 Restoration & Management Phasing

Beyond the initial evaluation and planning stages, the implementation of an effective restoration and management program is typically carried out in two phases: a remedial phase and a long-term management phase.

> The *remedial phase* is the period during which major efforts to restore vegetation and habitat structure and biological diversity are undertaken, to begin the process of restoring or re-invigorating ecological and bio-geochemical functions. Tasks undertaken during this phase include mechanical and chemical removal of exotic invasive species, reduction of other undesirable trees and brush, re-introduction of fire, removal of dams or breaking of tiles, removal of debris, spoils, and fill, treatment of erosion and contamination problems, and manual or mechanical installation of native seeds and plants, including larger shrubs and trees. Consequently, the remedial phase

requires the greatest short-term financial commitment and level of human effort. The period of time required to conduct the remedial restoration phase depends on the level of effort required, the condition of the ecological systems, opportunities and constraints (i.e., access, weather, biological response), and the level of funding available for the program. This phase is anticipated to take 10 or more years at Lake View Conservancy.

Once the initial ecological and biological objectives are achieved, the restoration program shifts to a *long-term management phase*, guided by both regular management techniques and by strategies that are implemented on a rotational basis through identified management units. Tasks would include periodic use of fire, occasional use of chemical and mechanical removal of invasives, and modest enhancement seeding and planting. Although this phase of the program can be viewed as a routine maintenance program conducted annually at strategic times to achieve and maintain specific ecological and biological objectives, management decisions must remain responsive to the guiding principle of *adaptive management* (defined below). Additionally, the long-term management phase will require an ongoing effort designed to achieve a desirable and sustainable ecological system within the context of available funding, volunteer resources, and the commitment of all stakeholders. It is during this phase that the restoration plan would become part of the Park's general operations and maintenance function, involving routine training and education of maintenance staff and volunteers.

5.4 Adaptive Management

Natural community responses to restoration treatments can be quite dynamic and unpredictable, following a long history of the combined effects of human disturbance and climatic changes. For this reason, management strategies need to be flexible and allowed to change over time to respond to natural communities as they adjust to restoration intervention treatments. Careful monitoring and evaluation of community responses are critical steps in an adaptive management process. This allows for measured changes in the timing and application of specific treatments to better improve the overall performance of the site.

For these reasons, a plan should not be viewed as being conclusive or absolute. It is a starting point in an ongoing process that relies on monitoring to provide feedback on program effectiveness and for evaluation of the need for and justification for changes in the management plan. This process of evaluation, adjustment, refinement and change is adaptive management, and it is fundamental to the effective restoration and management of natural communities.

5.5 Performance Milestones

The Plan proposes to guide the success of the restoration and management program in meeting its goals and objectives by defining a set of performance benchmarks or milestones. Many of the milestones focus on the measurable performance of the vascular plant communities, assuming that if the plant communities meet these minimal standards, then other aspects of the ecological system will benefit as a result, including water quality, wildlife, and the human community. Realizing these performance benchmarks indicates that a desirable end is being achieved -- namely a more stable, sustainable woodland community with qualities that more closely resemble pre-settlement conditions.

With strong public support and adequate resources, many of the performance milestones listed below are achievable in many areas of Lake View Conservancy by the end of a 10-year restoration program. Highly degraded areas may take longer to achieve the minimum targets. In any event, with regular on-going management, these levels of performance will likely be achieved, sustained and even surpassed in all areas of the Conservancy. At appropriate times, standardized ecological evaluation methods outlined later in this

plan are recommended to be used to monitor restoration responses, to ensure that all identified restoration objectives are being met.

Implementation of the 10-year Restoration and Management Plan proposes to:

- Reduce cover by exotic trees and shrubs (black locust, common buckthorn, Tartarian honeysuckle, & white mulberry) by a minimum of 80%. Achieve 90% mortality of all treated stems.
- Achieve 30-50% of full sunlight, or a level necessary to achieve oak regeneration & groundcover performance, in at least 75% of the treated woodland areas throughout the sites (as measured using light meters held at a height of 1 meter above the ground).
- Reduce as necessary wild black cherry, white ash, boxelder, & American elm, to achieve 30-50% of full sunlight conditions.
- Implement prescribed burning on a regular basis, using appropriate burn cycles & burn intensities to achieve diversity, cover, & structure performances.
- Achieve a minimum of 75 species native to the target restoration communities; achieve a minimum of 80% total groundcover; achieve a cover value in meter square quadrat samples of 50-70% grasses and sedges, and 30-50% cover of native forbs.
- Maintain populations of yellow giant hyssop (*Agastache nepetoides*) & reintroduce appropriate native rare species in cooperation with the County & Wisconsin Bureau of Endangered Species.
- Achieve native shrub & small tree species at rates appropriate to the target communities.
- Increase oak seedling cover to levels that allow detectable advanced growth within 15-20 years.
- Increase bird species richness & numbers 10-20% above current levels.
- Achieve full remediation & re-vegetation of disturbed soils (pits, spoils, etc.).
- Remove hazard trees per the City Ordinance requirements; maintain a minimum of 3 dead-standing trees per acre for wildlife outside of a 50-foot safety zone on either side of the main trail.
- Maximize an open-woodland vista along main trails; achieve increased visibility throughout the sites up to 60% of all sight line positions at distances of 200-400 feet, using a two square foot white card held at a 2 meter height).
- Remove poison ivy found along main trails.
- Maintain the main trails with wood chips produced on site or from off-site, except for wood chips containing exotic species material. Post permanent interpretive signage at main trail entrances explaining the restoration principles & goals.
- Repeat baseline monitoring at all transects in year 5 & year 10. Report the findings to the County & public.

6 Management Units & Treatment Prioritization

The Plan divides Lake View Conservancy into management units that provide for the most systematic and cost-efficient application of a series of remedial restoration treatments over a ten-year period. The management units are presented in a set of exhibits (*Exhibits 8-10*), each featuring maps with delineated treatment zones and a proposed 10-year schedule for implementing treatments. Acreages are identified in each map unit to allow accurate costing of burning and brushing treatments and calculation of seeding and planting rates. Scheduling of treatments is prioritized to optimize treatment effectiveness and to ensure the greatest ecological benefit. *Exhibit 11* presents recommended species lists appropriate for seed and plant re-introductions into identified forest community types. Each management unit exhibit is described briefly as follows:

- *Exhibit 8* identifies four burn zones (Zones I-IV), using the main trails and selected secondary trails conveniently to serve as firebreaks. The burn zones will serve as a unifying framework for organizing all other restoration and management treatments, and therefore they are mapped in color and appear in all other management unit exhibits. The prescribed burn zones loosely fit the forest community types identified in *Exhibit 7*, and will allow fire to be applied safely and systematically, as conditions allow, at varying rates that hopefully will most closely resemble the historic fire frequencies. The burn zones are the largest of the management units, simply because fire is the least costly treatment per area unit compared to brushing, seeding and planting, and fire is usually the most cost effective treatment, given sufficient fine fuels are present. For this reason, Zone IV, which has little ground cover vegetation or oak leaf litter, is scheduled for burning in year 10, to allow other treatments to condition the site for more optimal burning conditions.
- In *Exhibit 9*, the burn zones are sub-divided into ten brushing zones (Y1-Y10, representing years 1-10). Each zone is roughly an acre to two acres in size, to minimize the annual expense for this costly treatment. Scheduling of brushing treatments are prioritized to address the greatest threat to the resource or the greatest opportunity to benefit the resource, therefore in Y1 removal of concentrations of black locust will minimize its spread into areas not currently infested. Brushing treatments in Y2 and Y3 will connect previously brushed test plot areas and optimize growing conditions in areas where the greatest diversity currently exists, along trails and in the planted test plots. It is desirable to apply fire as soon as possible following brushing to kill the flush of newly germinated exotic shrub seedlings that typically occur as a response to increased light conditions.
- *Exhibit 10* identifies seeding and planting zones, which reflect the target ecological communities identified in *Exhibit 7*, thus the map units are labeled SMF, SDMF, and SDF, to represent Southern Mesic Forest, Southern Dry-mesic Forest, and Southern Dry Forest. The seeding and planting zones overlay the burn and brushing zones, and scheduling of seed and plant installations are generally timed to follow brushing and burning treatments. In some cases, seeding and planting will be necessary to condition a treatment area for burning, such as in areas where oak leaf litter, which, in the absence of grasses, serves as a more reliable fuel than other types of deciduous leaf litter, is sparse.

7 Restoration Techniques & Guidelines

This section outlines the major areas of focus for restoration tasks in Lake View Conservancy. Each area of focus is described and general guidelines are provided to help direct restoration efforts. In addition, key actions and strategies are provided for each area of focus to help direct the specific work being done in Lake View Woods. A summary of these actions and strategies is also presented in *Section 2.3 pages 4-8*.

7.1 Prescribed Burning Activities, Impacts & Mitigation

Fire is a natural process that is essential to the recovery of the oak woodland system at Lake View Woods, and has already been applied in the test plots with a great deal of success. It is the least costly restoration and long-term management tool, and can be conducted with the assistance of well-trained volunteers under the direction of professional burn specialists and well-equipped burn crews. The approach at Lake View will be to conduct small annual burns in selected management units (*Exhibit 8*), defined by artificial fire breaks (existing trails) and, to the extent possible, by the identified community type (dry, dry-mesic, or mesic forest). The burns will be conducted more frequently at first due to the anticipated spotty distribution of effective burns, until fuel loads develop sufficiently. Spotty fires are not necessarily undesirable, allowing a more patchy vegetation structure to develop and limiting the impact to small populations of insects and other fauna. However, annual burns will be necessary to insure that the effects of fire will eventually be applied to most areas of the woodland at some point in time. Once a satisfactory fuel load condition has been achieved in the woodland, a cycle of 2-3 consecutive burns followed by a period of 10 or more years can be expected to maintain a healthy oak woodland system.

7.1.1 Impacts to Vegetation

Burns conducted in Test Plots in Lake View Woods in 2001 and 2002 had varying results that depended on the amount and distribution of fine fuels and the presence of remnant vegetation and soil plant propagules (seeds, tubers, rhizomes, etc.) and introduced seed and plants. Areas that contained heavy concentrations of oak leaf litter generated the hottest fires and in these areas young stems of common buckthorn and honeysuckle were noticeably stressed, with some stem mortality occurring after the second burn. The response from the ground cover vegetation was surprisingly low in these areas, except where seed and plants had been re-introduced. The greatest response from the ground cover was in moister soils on the north and northeast side of the woodland (Test Plot 2), where a number of native remnant sedges and forbs flourished following two consecutive burns. Oak seedlings appeared in areas with both heavy concentrations of leaf litter and remnant native vegetation.

During the remedial phase of restoration, prescribed burns will be conducted preferably in the early spring (early to mid April) when optimal conditions for burning are most likely to occur. Early spring burning benefits the woodland community by:

- Controlling exotic shrub seedlings, which often flourish for several years following exotic shrub canopy removal,
- Releasing nutrients for immediate uptake by emerging vegetation,
- Inhibiting the growth of thin-barked, woody exotics such as common buckthorn and honeysuckle, and
- Enhancing early soil warming.

Fall burns may be desirable or necessary, when weather or scheduling preclude a spring burn. Prescriptions for a fall burn will maximize safety and minimize smoke.

7.1.2 Impacts to Wildlife

It is generally expected that prescribed burning will have an overall positive effect on native wildlife communities, and the impact on mammals will be minimal. Larger mammals and mature birds can safely move away from fire. Squirrels are well out of reach of the fire just a short distance above the ground in trees. Small ground mammals, such as mice can out run a fire line or find shelter in the ground or under large logs, and will be expected to experience subsequent population growth after a fire due to the increase in suitable ground cover as habitat and food. However, spring burning can negatively impact ground nesting birds or those that build their nests in low-branching shrubs such as exotic honeysuckle. Currently, the absence of ground cover in most areas of Lake View Woods does not favor ground-nesting species. Nevertheless, to avoid potentially burning eggs and newborns of nesting species, spring fires should be scheduled for mid to early April. Migrant and resident butterflies will benefit from prescribed burning by increasing the native plant diversity and the number of plants that may serve as larval hosts and nectar sources for adults.

7.1.3 Key Actions & Strategies for Prescribed Burning

- Conduct annual prescribed burns in management units as laid out in the 10-year remedial restoration phase schedule, and develop a long-term fire management strategy, to be applied once remedial phase objectives are achieved. Apply a burn cycle rotation appropriate for each forest community type:
    1. Dry and dry-mesic forest communities, 2 to 3 consecutive years at approximately 10-year intervals.
    2. Mesic forest communities, once or twice every 15 to 20 years.
- Schedule spring burns in early to mid April to avoid injury to low-nesting bird species, and to maximize safe burning conditions, i.e. cooler temperatures and moist conditions.
- Notify the immediate neighborhood and acquire the necessary City of Madison burn permits well in advance of the scheduled burn.
- Prepare burn prescriptions that minimize smoke in the neighborhood.
- Use prescribed burning to achieve vegetation management objectives such as enhancing the growth of native species, stimulating oak regeneration, and controlling exotic plant species. Specific targets associated with these objectives include:
    1. Woodland stand structure with light gaps and understory ambient light levels that support ground layer vegetation and oak tree production (30-50% of full sunlight).
    2. Patchy distribution of 5 age classes of oaks: seedlings, saplings, young trees, mature trees, and over-mature trees.
    3. Continuous native grass, sedge and forb ground story that incorporates spatial variability.
- Initiate fire management in areas where sufficient oak leaf litter is concentrated, and subsequently where brushing treatments have occurred and a sufficient fine fuel load has been established through re-vegetation efforts.
- Train willing volunteers to safely assist in prescribed burns, and continue public education and outreach on the ecological benefits of fire through articles in the Northside News and other local media.
- Monitor and document the effects of prescribed burn treatments, and adjust the burn prescription and management strategy accordingly.

7.2 Controlling Exotic Plant Species

The problems associated with exotic plant species and efforts to control them are well known to natural areas managers and other workers restoring natural communities. Invasive, exotic species such as common buckthorn (*Rhamnus cathartica*) are known to out compete and displace native shrubs and herbs (Heneghan et al. 2002). Much research has looked at the effects of removing exotic shrub species on native vegetation recovery (Banker et al. 2002; Kasmer and Shefferson 2002; Laatsch and Anderson 2000; Gould and Gorchov 2000). Laatsch and Anderson noted a significant increase in herbaceous species cover accompanied by a decrease in exotic woody growth with removal of exotic shrubs and firing; however there was no increase in native species diversity. Banker and others found that following removal, the exotic shrub canopy was replaced by garlic mustard, an invasive exotic herbaceous species; however, following ten years of management the woodland was recovering. Other workers have looked at the effects of exotic shrubs on breeding bird populations, and found that nesting occurred earlier and lower in exotic shrubs, with increased nest predation resulting (Whelan and Schmidt). Research by Heneghan and his colleagues (2002) suggest that the rapid rate at which common buckthorn litter decomposes may enrich the soil in ways that may foster its dominance within a woodland ecosystem, and may also cause the collapse of the soil arthropod community (mites, spiders, etc.), if litter quantities are diminished too early in the growing season.

At Lake View Woods, a nearly continuous exotic shrub layer, primarily of common buckthorn and Tartarian honeysuckle (*Lonicera tatarica*), currently constitutes the single most important cause of the collapse of the native understory flora, and is the chief impediment to the reintroduction of fire to the woodland understory. Other woody exotic species are present in varying concentrations and influence the ecology of the woodland community. These species include black locust (*Robinia pseudoacacia*), white mulberry (*Morus alba*), multiflora rose (*Rosa multiflora*), European highbush cranberry (*Viburnum opulus*), Japanese barberry (*Berberis thunbergii*), and common privet (*Ligustrum vulgare*). The strategy at Lake View Woods will be to remove exotic shrubs and trees, to increase light in the understory and to begin to reinvigorate the native groundcover vegetation. Exotic shrub removal followed by fire is expected to stimulate the greatest response from the ground cover vegetation, particularly where suppressed existing vegetation and the native seed bank is intact. Where there is little response from the ground cover vegetation following shrub removal, and where there is little combustible leaf litter, native seeds and plants will be reintroduced to eventually provide the fine fuels to carry fire throughout the woodland.

A number of non-native herbaceous species are also present in Lake View Woods (see marked species in *Table 1*). It is expected that most of these species will diminish in importance with restoration, using fire as the principle control method. Remarkably, garlic mustard (*Alliaria petiolata*) has not proliferated on the site, and is observed only occasionally along the trail. This species, when observed, should be removed immediately by careful hand pulling, bagged, and disposed of off-site. Careful monitoring of treated garlic mustard sites should become routine, as this species is a prolific seeder and populations can expand exponentially in a short period of time.

7.2.1 Physical and Chemical Control of Invasive Species

Standard methods used to remove woody growth employ mechanical and chemical means. By far the most costly and labor intensive is mechanical removal, using chain saws and other cutting tools followed by manual staging of cut materials for burning or chipping on site. The use of non-persistent, low toxicity herbicides (i.e., glyphosate) applied to cut stumps is the most efficient and realistic approach to follow-up treatment to mechanical removal, to diminish large infestations of woody growth. Chemical applications may also be employed solely as a basal bark application to the standing stems. Where possible, mechanical removal will be limited at Lake View to areas where removal followed by seeding and planting will be necessary to restore fine fuels. In other locations, concentrations of oak leaf litter will be sufficient to carry

fall and spring fires, and chemical removal alone followed by fire will likely be successful in restoring enough light to the ground to stimulate seed germination and plant growth.

7.2.1 Key Actions & Strategies for Controlling Exotic Plant Species

- Reduce the cover and seed source of all identified exotic shrubs and trees as much as possible (70-90% reduction) within the woodland, as well as in adjacent properties with landowner cooperation.
- Conduct exotic shrub and tree removal within prioritized management units (see *Exhibit 9*) to accommodate the available funds allocated to the project.
- Initiate brushing in the heavy concentrations of black locust (*Exhibit 9, Y1*) removal from the existing test plot areas and along internal trails, to maintain the restoration process currently underway in those locations and to enhance access to new treatment areas.
- Apply fire as soon as possible to brushed areas to control new seedling establishment, and continue burning as necessary to control subsequent flushes of new seedlings emerging from the long-lived exotic seedbank (up to five years or longer) and from reintroductions by birds.
- Maintain an appropriate visual buffer at the interface with neighboring landowners, allowing them time to adjust to the change and seek their approval in extending the treatments to the property boundary and beyond, if they desire.
- Establish native plant cover as soon as possible in treated areas to enhance the use of fire and to limit the re-establishment of invasive species in these areas.
- Monitor the effectiveness of removal and control methods and adjust these methods accordingly.
- Monitor re-sprouting of cut and treated stems and re-treat as soon as possible.
- Train volunteers to identify exotic species, as well as train them in the control and management techniques necessary to maintain a healthy woodland system and to sustain the effects of initial costly treatments. Develop a volunteer handbook with visual and descriptive keys of both mature and seedling stages of exotic species to assist volunteers engaged in early detection and treatment.
- Replace exotic shrubs with a diversity of native shrubs and fruiting trees appropriate for the woodland community, to restore structural diversity and nesting and feeding opportunities for breeding and visiting bird species.
- Educate the public on the importance of controlling exotic shrubs and trees, and encourage the use of native plants in gardens and landscaping in the surrounding neighborhoods.

7.3 Re-establishing Native Plant Communities & Species

Recent studies have documented the severely degraded condition of the native herbaceous ground cover vegetation in Lake View Conservancy (Lehnhardt et al. 1999). This decline is believed to be due largely to overwhelming shade produced by the young tree and exotic shrub canopies in combination with other local environmental changes. By contrast, more open trail settings with increased available light support a greater cover and diversity of herbaceous native species. Restoration techniques, such as removal of exotic shrubs and use of fire, are expected to re-invigorate existing native plant assemblages and native seed banks present in some areas of Lake View Woods. The results of the test plot studies, however, indicate that reintroduction of native seeds and plants will be necessary in some areas, where native vegetation and propagules are found to be lacking. General guidelines for species selection and seeding and planting rates have been developed for these instances, and they are presented in *Exhibits 10 and 11*. Species lists are derived in part from a knowledge of the existing native flora in the woodland and surrounding neighborhood, as well as from the review of historic and current documentation of the vegetation and flora of Dane County and southern Wisconsin (Epstein and others, 2001, Cochrane and Iltis 2000, Curtis 1959,

Ellarson 1949), and to some degree from the review of other similar regional flora (Swink and Wilhelm 1994).

7.3.1 Site Preparation & Seed Sources

Re-introduction of seeds and plants will be timed to optimize establishment and minimize competition with exotic species. The ideal scenario will be to remove and treat targeted woody growth, apply fire to kill emerging exotic shrub seedlings, mineralize the soil, and test the potential for stimulating an existing native seed bank, followed by seeding and planting where necessary. Where fine fuels are insufficient for firing, a minimum of seeding and planting will be required to establish a fuel matrix. The seed mix in this instance may include short-lived non-native grasses to augment the fuel matrix until native vegetation can become sufficiently established.

7.3.1 Key Actions & Strategies for Re-establishing Native Plant Communities & Species

- Use well established seeding and planting techniques to enhance native biodiversity, increase native plant cover, and improve habitat quality for plant and animal life.
- Re-introduce native plant species appropriate for the southern Wisconsin woodland community types identified at Lake View Woods, based on the best knowledge of the flora and composition of these communities.
- When possible, apply a reasonable geographic limit for the collection of wild and commercially-grown native seed, in this case the physiographic province (i.e. natural area division) in which Lake View Woods is located [Division 5 Southern Ridges and Lowlands: (5C) oak savanna and prairie (Hole and Germain 1994)].
- Strive to mimic natural vegetation structural, compositional, and distributional patterns and processes in designing seeding and planting techniques. For example, grasses and sedges should provide a predominant soil-stabilizing matrix, with a diversity of forbs and ferns seeded and planted evenly or in drifts or patches, and allowed to re-distribute themselves over time through natural competition in the presence of periodic fire disturbance. Native woody plants should be introduced to provide the structure and food sources necessary to support wildlife needs (plantings in groups of 10 or so and spaced not more than 120 meters apart, and in relative densities appropriate for the community type, see descriptions in *Exhibit 7*)
- Encourage the use of volunteer wild-collected seed from existing sources on-site and from appropriate nearby off-site locations (with permission), to minimize the added cost of purchasing seed for commercial sources and to minimize the effort required to hand-collect seed from remote locations. A species list and collecting schedule is being developed for the site.
- Initiate restoration along the main trails at Lake View Woods, where existing diversity and cover are the greatest, to invigorate the production of seed for use in expanding this zone of diversity to adjacent depauperate (low-diversity) areas.
- Use short-lived non-native species, such as annual rye grass, only where necessary to establish fine fuels, such as in areas where groundcover vegetation and oak leaf litter are sparse, to carry fire in the early stages of restoration.
- Identify off-site locations that are easily accessible and with similar community composition to the target restored woodland communities at Lakeview, for conducting volunteer off-site seed collection.

7.4 Restoring Rare or Conservative Native Plant Populations

Because Lake View Woods is an isolated habitat fragment, it is difficult for native plants from elsewhere to naturally offset population decline. Rare plants are generally the first species to be lost within an isolated area and the last, if ever, to re-colonize them. It will not be an important goal early in the restoration process to reintroduce very conservative or rare species. Rather, it will be the goal over the next ten years to reestablish an overall healthy ecosystem utilizing, as much as possible, the existing seed banks on the site. It is desirable to first stimulate the existing soil seed banks, since some plants can lie dormant in the soil for many years until conditions favorable for germination and growth return. Reintroduction of appropriate rare species may be desirable once the site has been conditioned to support them. The state threatened species, yellow giant hyssop (*Agastache nepetoides*) is already present on the site, and its populations have increased significantly following brushing and burning in Test Plot 1 (*Exhibit 6*, also see *Exhibit 5*). This species, as well as other Lake View species characteristic of open woodland and savanna settings (late horse gentian, poke milkweed, elm-leaved goldenrod) is expected to continue to increase in importance on the site, under the Plan's proposed burning and brushing regime.

7.4.1 Key Actions & Strategies for Restoring Rare Native Plant Populations

- Monitor the populations of rare species identified in the 1999 baseline study, specifically yellow giant hyssop, and watch for the re-appearance of other rare species throughout the restoration and management program.
- Inventory and map locations of new sightings of rare or conservative plant species.
- Maintain seed banks to conserve genotypes, and exchange seed with other similar sites in Dane County.
- Propagate rare species from approved locally collected seed, outplant into suitable sites, and enhance the size of existing populations of rare plants if appropriate.
- Manage threats to rare plants, such as invasive species, trampling, lack of natural disturbances and loss of specific growing requirements.
- Use trail closures, barriers and signage to reduce trampling and discourage the collection of wildflowers.

7.5 Restoring Native Shrubs & Small Trees

Tall, shrubby vegetation is part of the natural woodland community structure and provides important bird habitat for migrant and resident songbirds in the spring. Where shrub cover has been eliminated by removal of exotic shrubs, a diverse native shrub component of acceptable densities should be re-established.

7.5.1 Key Actions & Strategies for Restoring Native Shrubs & Small Trees

- Protect existing native shrub cover and diversity.
- Re-introduce a selection of native shrub and small tree species known to be native to the region and to the target woodland communities, such as American hazelnut, bladdernut, witch hazel, Iowa crab, hawthorn, and wild plum.
- Regularly monitor the presence and cover of exotic shrubs, and remove these to the extent possible using the most economical and effective methods available.

- Educate the public on the far-reaching ecological consequences of invasive exotic shrubs, particularly the loss of native plant and animal diversity and the increasing costs of restoration over time, with the collapse of the native seed bank.

7.6 Stimulating Oak Regeneration

Early assessments (Landmark Research Inc. 1988; Dane County Regional Planning Commission 1982) and more recent studies (Lehnhardt and others 1999) have cited the decline of the mature white and red oak canopy in Lake View Woods. Stressors include shading caused by an overcrowded tree canopy, and age-related susceptibility to disease and wind damage. Regeneration and recruitment of younger oaks is not occurring in much of Lake View Woods, and a shift is occurring, rather, to a predominance of shade-tolerant trees and a dense exotic shrub canopy. This trend is the result of long-term human land use practices that have interrupted a range of ecological processes, from landscape scale disturbances such as fire, to much smaller scale processes affecting the cycling of nutrients and carbon. Given the far-reaching extent of these changes, this trend is not likely to reverse itself, without human restoration intervention.

7.6.1 Key Actions & Strategies for Stimulating Oak Regeneration

- Re-introduce natural disturbance processes, such as fire, to stimulate oak reproduction.
- Remove competing exotic shrubs and trees.
- Thin the young tree canopy of shade-tolerant/shade-producing species, such as white ash, boxelder, and wild black cherry to allow light levels necessary for oak seedling germination, establishment, and advanced growth (30-50% of full sunlight).
- Plant oaks in locations where oak acorn production is low or non-existent (north end of site).
- Protect planted trees from fire, until they reach a size tolerant of occasional exposure to cool spring fires (10-15 intervals, following remedial restoration phase).

7.7 Increasing Breeding Bird Diversity & Population Sizes

Bird surveys conducted during the breeding season, over the past 4-year study period at Lake View Woods, have recorded a total of 29 birds species (*Table 2*), approximately 75% of which are believed to use the woodland and surrounding wooded neighborhood for breeding and nesting. The number of bird species has shown a slight increase by the end of the restoration test plot study. There is a widespread perception that restoration of small-sized habitat fragments is ineffective and possibly even counter-productive for conserving area-sensitive bird species, such as grassland and forest birds, due to increased next predation and brood parasitism in edge dominated stands (Heske and others 2000). Recent research in Illinois, however, suggests that bird species of disturbance dependent shrublands and oak savannas may be far less sensitive to tract size than forest or grassland breeding birds and, thus, may be able to support viable populations in smaller tracts of these community types (Brawn and others 2002). This research suggests that, over time, should areas of Lake View Woods take on a more open, savanna-like aspect, it may become more productive of birds, despite its limited size.

7.7.1 Key Actions & Strategies for Increasing Breeding Bird Diversity & Population Sizes

- Increase the area of disturbance dependant habitat, moving the structure and composition of Lake View Woods as closely as possible in the direction of its pre-settlement savanna-like conditions, to increase nesting opportunities for birds that are less area-sensitive.
- Educate the public on the importance of restoring small urban habitat fragments for wildlife.
- Conduct annual bird censuses to monitor the effects of restoration on breeding and visiting bird populations.
- Expand the annual bird surveys to include adjacent forested neighborhood tracts and backyard feeding stations, to determine the effective habitat size of the woodland community.
- Close unnecessary trails (secondary trails) to minimize disturbance to interior woodland areas.

7.8 Removing Debris & Spoils & Filling Excavated Pits

Human disturbances in Lake View Woods have included dumping of trash and refuse, excavation of small pits and mounds, and dumping of spoils of various kinds. These disturbances represent potential hazards to the visiting public and have significant ecological implications, by creating abrupt changes in the local topography, altering soil structure, soil chemistry, and soil biota, and increasing the likelihood of invasion by weedy and exotic species. The locations of the most significant disturbance features have been mapped (Figure 3).

7.8.1 Key Actions & Strategies for Removing Debris & Spoils & Filling Excavated Pits

- Restore the topography and soils in disturbed areas as closely as possible to their original conditions to enhance establishment and long-term success of native plant and animal communities.
- Remove or cover the old dumpsite with local soil, if possible, or, if necessary, a suitable alfisol (forest soil type) from off-site, and re-vegetate wit the seed and plant mix recommended for the Management Unit (Figure 5).
- Fill all excavated pits with local soil, if possible, and re-vegetate as above.
- Remove soil mounds constructed in unofficial trails (Figure 3) and use in filling nearby pits. Return the topography as closely as possible to the original grade and re-vegetate with an appropriate seed and plant mix recommended for the Management Unit.

7.9 Managing Dead Standing Trees For Habitat

Standing dead trees and downed logs and woody debris provide important shelter and food sources for cavity nesting and insect-feeding wildlife and woodland decomposers, and are crucial to the overall health of the forest ecosystem. Forest managers recommend leaving three to four dead standing trees (snags) per acre for wildlife habitat (Holaday 2001). Where standing dead trees pose a hazard to the public utilizing the primary managed trails in Lake View Woods, the trees will be removed by the County according to the City Tree Ordinance, under the direction of the City of Madison Forester. Likewise, oak trees determined to be infested with oak wilt will be removed per the City Ordinance. Downed woody debris is abundant in Lake

View Conservancy due to windthrow of large trees and downed branches. It is anticipated that with the return of periodic fires, high concentrations of accumulated woody debris will begin to decompose at more rapid rate.

7.9.1 Key Actions & Strategies for Managing Dead Standing Trees for Habitat

- Leave all dead standing trees for wildlife habitat, except those identified as hazard or diseased trees (see *Section 7.10* below).
- Close and re-vegetate secondary, un-maintained foot trails to increase area available for cavity tree habitat.
- Educate the public regarding the importance of cavity trees to wildlife, and the necessity of removing hazard and selected diseased trees for the public safety.
- Work closely with Parks and City Forestry staff to develop better practices governing dead wood retention in the Conservancy.

7.10 Enhancing Public Safety

Obstructed views created by dense underbrush, pose a potential safety risk for the visiting public and encourage vandalism. Opening views through the removal of dense exotic shrubs will increase visibility and a sense of well being, as well as increase overall health of the woodland community.

7.10.1 Key Actions & Strategies for Enhancing Public Safety

- Create attractive open-woodland vistas, with greatly enhanced native understory displays of wildflowers resulting from the increased light.
- Remove poison ivy only where it proliferates along main trails. Currently, poison ivy populations are insignificant in most areas of Lake View Conservancy.
- Remove dead trees and branches that pose a hazard to the public utilizing the primary managed trails in Lake View Conservancy. (The trees will be removed by the County according to the City Tree Ordinance, under the direction of the City of Madison Forester.)

7.11 Maintaining Public Trails & Closing Unnecessary Trails

The existing primary trails in Lake View Woods are important avenues for visitors enjoying the woodland interior for a variety of passive recreational uses, including dog-walking, bird watching, and botanizing. Primary trails are maintained by Dane County Parks as wood chipped surfaces, requiring periodic attention to reapply fresh material, which is often generated on-site from tree and shrub removal operations. A number of informal secondary trails or dirt footpaths are also present, and are not maintained by Dane County Parks. These bare soil areas are natural vectors for disturbance tolerant species, including invasive exotic species.

7.11.1 Key Actions & Strategies for Maintaining Public Trails & Closing Unnecessary Trails

- Maintain all primary trails for public use and enjoyment.
- Close and re-vegetate secondary un-maintained trails to minimize unnecessary trampling, prevent local soil erosion, reduce opportunities for exotic species invasion, and minimize disturbance to nesting woodland bird species.
- Post permanent, attractive signage to encourage use and enjoyment of official trails and respect for the woodland's natural environment.

7.12 Restoring Dry-mesic Forest Understory to Portions of the Picnic Area

Currently, the entire picnic area is managed by mowing. Restoring portions of the picnic area to native woodland grasses, sedges, and wildflowers would reduce the annual budget for this costly maintenance task, and also minimize damage to oak trees from inadvertent mower damage to the base of the trees and from the affects of root compaction.

7.12.1 Key Actions & Strategies for Restoring Dry-mesic Forest Understory to Portions of the Picnic Area

- Restore native woodland understory vegetation to selected areas of the picnic area, particularly to areas above the root zone of most or all of the trees. This can also be done as naturalized native woodland plantings to achieve a more formal appearance if desired.
- Use grass, sedge, and wildflower species of the adjacent dry-mesic forest community in Lake View Conservancy.
- Once established, apply similar burn management treatments to these areas as for the adjacent dry-mesic forest community, but avoid the application of fire near the base of trees, particularly conifers with low-growing branches.
- Use these plantings as an opportunity to interpret for the public the native woodland flora of Lake View Conservancy.

8 Ongoing Volunteer Stewardship Activities

Throughout the Restoration Test Plot Program, volunteer stewards were encouraged to participate in a number of activities associated with restoration and monitoring. Activities included assisting with prescribed burns, native seed collection, plant propagation, plant installation, bird surveys, and vegetation and light level monitoring. Additional activities are expected to be added to the volunteer steward program at Lake View Conservancy. Following is a list of activities anticipated to occur on an annual basis:

- Native seed collection and plant propagation
- Vegetation monitoring
- Breeding bird census and Audubon Christmas Bird Count
- Butterfly census (Annual American Butterfly Association census)
- Exotic species control work days
- Prescribed burns
- Photo documentation and production of a documentary video of the restoration process

9 10-Year Restoration & Management Schedule

Exhibit 12 presents the *Master Schedule for Restoration, Monitoring, and Volunteer Activities.* A ten-year schedule has been developed as a time frame for implementing the Plan's remedial phase. This time frame will allow the ecological changes associated with restoration intervention to be monitored more effectively and will minimize the annual time commitment for volunteers and Parks staff, as well as contracting labor costs, as needed. The schedule format identifies each restoration action, responsible parties (contractor, volunteer, and Parks staff), and the location, unit area, and time budgets for each year of the 10-year plan. Time and area unit estimates are summed annually and at the end of the ten-year remedial phase.

It is recommended that contracts be let on a three-year basis, to allow the Plan's goals, objectives, programming and funding to be re-examined and adjusted as necessary to reflect the knowledge gained throughout the remedial restoration program.

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