Appendix B St. Croix Bluffs Stewardship Plan

Overview

This appendix provides select excerpts from Section V – Ecological Stewardship/Water Resources Management from the St. Croix Bluffs Master Plan (2002). Only aspects pertinent to the regional trail are provided, with the entire master plan on file with and available for review through Washington County Parks and the Metropolitan Council.

SECTION V - ECOLOGICAL STEWARDSHIP / WATER RESOURCES MANAGEMENT

Section V Natural Resources Stewardship and Water Resources Management

Overview

Natural resources stewardship refers to the thoughtful care of ecological systems to preserve their natural qualities and character.

Natural resources stewardship refers to the thoughtful care of ecological systems to preserve or enhance their natural qualities, which are intrinsic to the park's value as a place of natural beauty and respite from the built form. The forthcoming stewardship plan provides a framework for restoring and managing the natural resources within the park.

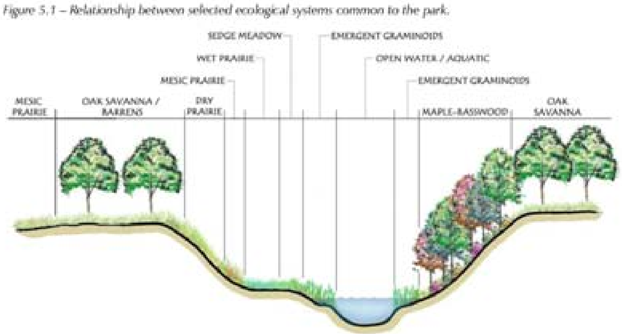
The stewardship plan relies heavily on human intervention as a surrogate for the natural cycles that no longer exist due to past land uses, introduction of invasive alien plants, and cessation of natural phenomenon (e.g., fire) since settlement first occurred. The plan also establishes a vision for water resources management that relies on natural processes, rather than engineered solutions, to manage stormwater runoff.

A Historically Diverse Landscape

Although challenging, realizing a more diverse and healthy natural landscape is achievable and sustainable under a well-defined stewardship program.

Figure 5.1 illustrates the basic relationships between the ecological systems historically found in this region and across the park.

Figure 5.1 – Relationship between selected ecological systems common to the park.



ST. CROIX BLUFFS REGIONAL PARK MASTER PLAN 5.1

As shown, the diversity of plant assemblages was historically very broad, ranging from aquatic zones along the river and in lowland areas to upland oak savanna and prairie systems. Although challenging, realizing a more diverse and healthy natural landscape is achievable and sustainable under a well-defined stewardship program.

Achievability and Sustainability of Ecological Stewardship Programs

It is important to recognize that restoring and managing ecological systems must be done in a manner that is both achievable and sustainable.

It is important to recognize that restoring and managing ecological systems must be done in a manner that is both achievable and sustainable. Achievable refers to what is scientifically *and* economically feasible. Sustainable refers to the level to which restoration and management programs can be scientifically *and* economically sustained over an extended period of time. The following considers achievability and sustainability from the two distinct but interrelated perspectives of ecology and economy (human/economic capital).

Ecological Perspective

A successful program requires a full understanding of the ecological problems being faced and a defined course of action that is based on science.

From an ecological perspective, what is achievable and sustainable is defined in scientific terms based on testing and research. Scientifically, human intervention through well thought-out programs that are carefully implemented over a period of time can help to reverse the current downward trend in the ecological quality of the park's natural systems (as measured by biodiversity and general ecological health). A successful program requires a full understanding of the ecological problems being faced and a defined course of action that is based on science. As defined in this section, human intervention will be required given the current state of alteration that has occurred.

Although dramatic improvements can be made in some cases, restoring the landscape to pre-settlement conditions is not realistic from a scientific perspective. Past impacts to the land since man first settled and introduction of invasive alien plants simply preclude this possibility. However, it is achievable to restore and manage ecosystems to sustainable and productive levels that result in considerable human and ecological value that can be perpetuated for generations to come. The key point here is that Washington County and the regional community must set realistic goals and expectations as to what can be achieved and sustained through restoration and management programs.

Economic (Human/Economic Capital) Perspective

From an economic perspective, what is achievable and sustainable is based on the amount of human and economic capital that Washington County and the Metropolitan Council can commit to ecological programs now and in the future.

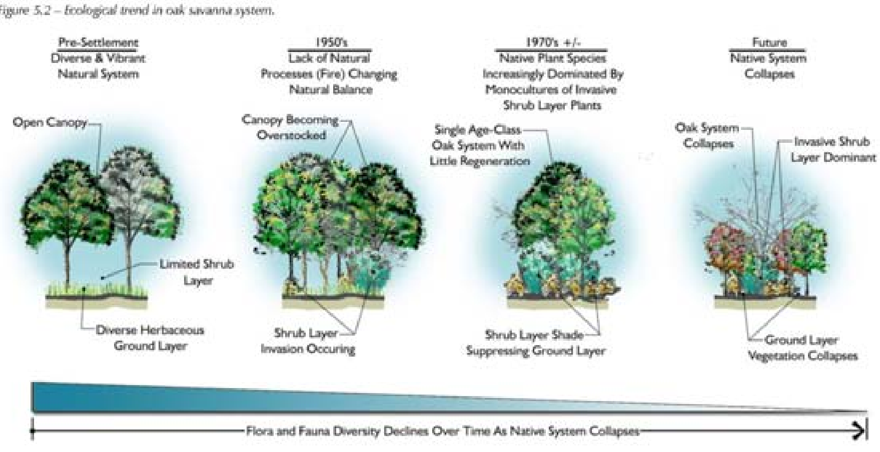
From an economic perspective, what is achievable and sustainable is based on the amount of human and economic capital that Washington County and the Metropolitan Council can commit to ecological programs now and in the future. The importance of this cannot be overstated in that the long-term viability of any ecological program undertaken is directly related to the long-term commitment made to it in terms of human and economic resources. Ultimately, how the collective community values land stewardship and ecological health relative to other quality of life issues will define the extent to which ecological programs can be successfully implemented. Recognizing this, it is critical that Washington County and the Metropolitan Council time ecological programs in a pragmatic and paced manner that keeps pace with available economic resources.

Spectrum of Opportunity for Restoration of Ecological Systems

Without human intervention and conscientious stewardship, it is expected that the overall trend of the ecological systems within the park will be toward continued decline, as measured by bio-diversity and general ecological health. Figure 5.2 graphically illustrates the current trend in a typical oak savanna system found in this and many other midwestern regions.

Without human intervention and conscientious stewardship, it is expected that the overall trend of the ecological systems within the park will be toward continued decline.

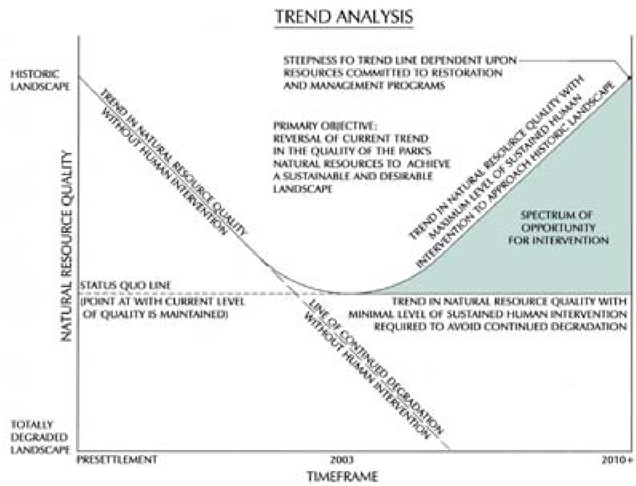
Figure 5.2 – Ecological trend in oak savanna system.



This example is reflective of what is happening to varying degrees in all of the ecological systems found within the park. Although some of the ecological degradation will have lasting affects, there are also many opportunities to forestall further degradation and make substantial progress toward achieving a more sustainable and healthier landscape for future generations to enjoy. Figure 5.3 graphically illustrates the current overall trend in ecological quality, as well as defining the spectrum of opportunity for reversing this trend.

There are many opportunities to forestall further degradation and make substantial progress toward achieving a more sustainable and healthier landscape for future generations to enjoy.

Figure 5.3 - Trend Analysis



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he goal of the stewardship program is to first identify restoration and management needs in detailed scientific terms and then define strategies that can reverse these trends. The framework presented here recommends that Washington County seek to achieve a sustainable landscape quality, which is defined as the point at which the parks division can *indefinitely* maintain a certain acceptable level of resource quality within the context of realistic limits – which is contingent upon two primary factors:

- Public understanding of and commitment to natural resource preservation and stewardship programs.
- Undertaking ecological restoration and management programs that are scientifically sound.

Natural Resource Stewardship Philosophy

The plan outlined here promotes an ecosystem-based approach to restoration and management.

The framework presented here promotes an ecosystem-based approach to restoration and management. An ecosystem is essentially where things live and represents an interacting group of physical elements (soils, water, plants, animals, etc.) that inhabit a particular place. All of these elements and their interactions need to be considered in developing goals and plans for management. Ecosystem-based management views people as part of the community, and that maintaining a healthy ecosystem is the best way to meet human needs as well as those of other organisms in the community. General goals of this philosophy are to:

- Protect or enhance the health of the ecosystems in St. Croix Bluffs Regional Park.
- Enhance the biological diversity of its native habitats.
- Provide an appropriate balance between resource preservation and recreational use.

Through a well-defined stewardship program and a concerted, ongoing effort by Washington County, a certain level of confidence can be gained that the current ecological conditions and trends can be reversed and a more sustainable and higher quality landscape achieved. Note, however, that stewardship programs also need to be flexible due to the changing nature of the living systems addressed by the plan. For these reasons, the framework presented here should be viewed as being neither conclusive nor absolute. It is a starting point in an ongoing process that relies on monitoring and research to provide feedback on program effectiveness.

Ecological Prototypes for Unaltered and Altered Ecological Systems

Ecological prototypes are defined along topographic, soil type and hydrological gradients from high-dry uplands to lowlands and river or lake edges.

In this context, ecological prototypes refer to vegetative species models for the various natural systems found within the park. Prototypes assist restoration and management efforts by helping compare existing conditions against measurable criteria for healthy systems and in recognizing possible causative agents that result in ecological changes. By recognizing what a healthy system looks like, specific targets or models for management and restoration programs can be developed and implemented.

Ecological prototypes are defined along topographic, soil type and hydrological gradients from high-dry uplands to lowlands and river or lake edges. Based on an initial review of the park, both unaltered and altered ecological prototypes can be found – although unaltered systems are limited to isolated pockets. In unaltered areas, depending on soil types and hydrology, different plant and animal communities have developed over long periods of time and have persisted even to present day under less than ideal circumstances. On these same soil types, alteration of land use and hydrology along with cessation of natural processes have created changes in the plant (and animal) communities. Each of the unaltered and altered types of plant and animal communities fall within a definable ecological prototype, or in sum cases, in the ecotonal (i.e., transitional) area between prototypes.

The following descriptions define some of the more typical and definable prototypes for healthy (unaltered) and unhealthy (altered) ecological systems found within the park. Figure 5.1 on page 5.1 provided a character sketch of how these selected prototypes relate to each other. Lacking greater technical evaluation and in-field research, the prototypes presented here serve as a starting point as Washington County moves forward with its stewardship program. Although these prototypes are not exhaustive, they do articulate the fundamental qualities between healthy and unhealthy ecological systems found within the park.

Historic Oak Savanna

Healthy Systems

General Structure
- Semi-open to open tree canopy
- Multiple age classes of trees
- Dominant cover of native grasses, sedges, and forbs
- Natural oak regeneration
- Sporadic native shrub layer
- High light levels interspersed with partial/isolated shade

Soils Profile/Topography/Hydrology
- Well drained silt, clay and sand loams, gravelly sands, alluvium glacial features
- Higher and dry sites, and moist, well drained soils

Indicator Species of Healthy System
- Bur oak
- Northern pin oak
- White oak
- Savanna groundlayer species

Associated Species
- Pennsylvania sedge
- Silky and Virginia wild rye
- Bottlebrush grass
- Other sedges
- American hazelnut
- Little bluestem

Unhealthy Systems

General Structure
- Continuous, closed canopy
- Dense layer of non-native shrubs
- Bare, eroding soil
- Low light levels, predominant dense shade
- No oak regeneration
- Few or no young age classes of trees
- Lack of native groundcover vegetation
- Encroachment by development or agriculture
-

Indicator Species of Unhealthy System
- European buckthorn
- Tartarian honeysuckle
- Black locust
- Boxelder
- European brome, Kentucky bluegrass, and other non-native grasses
- Agricultural weed species and brambles

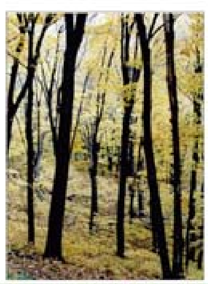
Protection and Management Considerations

Causes of Change
- Cessation of historic fire regimes
- Destruction due to urban development
- Invasion of competing non-native shrubs
- Encroachment of adjacent development with associated pollutants
- Intensive grazing and agricultural practices
- Change in hydrologic regime (drier or wetter)

Restorative Capacity
- Highly restorable under well-designed and implemented restoration and management program
- Highly disturbed sites may require replanting of native species, especially ground cover, if native seed bank is absent

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection beyond that of existing wetland ordinances
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Maple-Basswood Forest



Healthy Systems

General Structure
- Mixed canopy of oaks, ash, maple, and basswood
- Predominated by cool season grass and sedge ground cover

Soils Profile/Topography/Hydrology
- Found in isolated or protected locations, steep draws, and on landscape islands
- Topography ranges from level ground to rolling and steep grades
- Loam and fine sandy loam

Indicator Species of Healthy System
- Basswood
- Sugar maple
- Red oak
- Green ash
- Ironwood
- Woodland sedges
- Spring wildflowers (trilliums and spring beauty)

Associated Species
- Sedges, such as Pennsylvania sedge
- Shrubs, such as pagoda dogwood

Unhealthy Systems

General Structure
- Shift to even canopy, with limited age groups of trees
- Dense understory
- Bare soil after spring ephemerals die back
- Noticeable soil erosion

Indicator Species of Unhealthy System
- Boxelder
- European buckthorn
- Canary grass
- Motherwort
- Thistles
- Burdock
- Rough bedstraw
- Stinging nettles

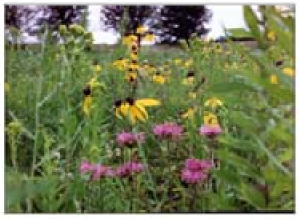
Protection and Management Considerations

Causes of Change
- Cessation of light ground fires
- Loss of seedbank and erosion
- Weed invasion and agricultural practices
- Altered hydrology, whether drier or wetter
- Logging disruption of composition, structure, light, and nutrient regimes
- Livestock grazing causing weeds and tree damage

Restorative Capacity
- Highly restorable under well-designed and implemented restoration and management program
- Highly disturbed sites may require replanting of native species if native seed bank is absent

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Upland Prairie Systems



Healthy Systems

General Structure
- High biodiversity – plants, insects, birds, and other animals
- High diversity of native plant species
- Predominance of warm-season grass species
- Natural succession and progression toward conservative species
- Full to nearly full sun
- Drought tolerant

Soils Profile/Topography/Hydrology
- Moderate to well drained, fine textured sands and sandy loams
- Higher and dry sites, most often associated with flat terraces or gentle slopes

Indicator Species of Healthy System
- Big bluestem
- Little bluestem
- Side-oats grama
- Purple prairie clover
- Leadplant
- Sky blue aster
- Prairie coreopsis
- Partridge pea
- Flowering spurge
- Blue giant hyssop
- Compass plant
- Prairie dock

Associated Species
- Literally hundreds of associated species

Unhealthy Systems

General Structure
- Low biodiversity – plants, insects, birds, other animals
- Predominance of weedy, non-native vegetation
- Absence of ecological functions
- Loss of water infiltration
- High soil erosion potential
- Invasion by woody species
- Nutrient enrichment
- Tile drained or ditched, resulting in altered hydrology

Indicator Species of Unhealthy System
- European brome and other non-native grasses
- Ragweed
- Mare's tail
- Queen Anne's lace
- Canada thistle
- Wild parsnip
- Woody species such as sumac, black cherry, boxelder, and Siberian elm

Protection and Management Considerations

Causes of Change
- Introduction of post settlement agriculture practices and livestock grazing
- Soil disturbance from urban development
- Cessation of periodic fire
- Invasion of competitive, non-native plants
- Change in hydrologic regime (wetter or drier)

Restorative Capacity
- Highly restorable under well-designed and implemented restoration and management program
- Highly disturbed sites may require replanting of native species if native seed bank is absent

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection beyond that of existing wetland ordinances
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Wet Prairie Remnants

Healthy Systems

General Structure
- Patchy, patterned plant communities reflecting soil and hydrological gradients
- High biodiversity – plants, insects, birds, and animals
- High diversity of native grasses and forbs
- Predominance of native grass, sedge, and forb species of low, moist-to-wet soils
- Natural succession and progression toward conservative species
- High groundwater table and often groundwater-based hydrology
- Full to nearly full sun

Indicator Species of Healthy System
- Prairie cordgrass
- Canada bluejoint
- New England aster
- Virginia mountain-mint

Associated Species
- Extensive variety of other native grasses, sedges, and forbs

Soils Profile/Topography/Hydrology
- Shallow organic soils
- Soils are saturated in the spring and dry out as year progresses

Unhealthy Systems

General Structure
- Altered hydrology due to de-watering
- Heavy invasion by woody growth
- Invasion by non-native reed canary grass
- Homogenous vegetation and low pattern of diversity

Indicator Species of Unhealthy System
- Reed canary grass
- European buckthorn
- Glossy buckthorn
- Overstocked dogwoods
- Purple loosestrife
- Stinging nettles
- Redtop

Protection and Management Considerations

Causes of Change
- Draining of soils for agriculture tillage
- Cessation of wild fire and overgrazing
- Hydrologic changes due to urban development and a change to surface water rather than groundwater dependent hydrology
- Nutrient enrichment from dewatered substrates and offsite introduction
- Salt and fertilizer loading

Restorative Capacity
- Potential to be restorable under well-designed and implemented restoration and management program in cases where off-site factors can be controlled
- Highly disturbed sites may not be realistically restored due to extent of past degradation and uncontrollable off-site factors
- Restoration may require replanting of native species if native seed bank is absent

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection, with a particular focus on upland buffer systems and natural infiltration systems
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Sedge Meadow Remnants

Healthy Systems

General Structure
- High biodiversity – plants, insects, birds, and animals
- High diversity of native sedges and forbs
- Domination by sedges, rushes, reeds and grasses

Soils Profile/Topography/Hydrology
- High groundwater table
- Shallow to moderate organic substrates

Indicator Species of Healthy System
- Tussock sedge
- Lake sedge
- Canada bluejoint
- Wool grass
- Marsh milkweed
- Swamp aster
- Sawtooth sunflower

Associated Species
- Swamp dock

Unhealthy Systems

General Structure
- Altered hydrology due to de-watering or too much water
- Heavy invasion by woody growth
- Invasion by non-native reed canary grass

Indicator Species of Unhealthy System
- Glossy buckthorn
- Reed canary grass
- Overstocked dogwoods
- Purple loosestrife

Protection and Management Considerations

Causes of Change
- Sediment, nutrient and contaminant loading from disturbed uplands
- Soil disturbance from development
- Cessation of periodic fire
- Invasion of competitive, non-native plants
- Change in hydrologic regime (wetter or drier)

Restorative Capacity
- Potential to be restorable under well-designed and implemented restoration and management program in cases where off-site factors can be controlled or mitigated
- Highly disturbed sites may not be realistically restored due to extent of past degradation and uncontrollable off-site factors
- Restoration may require replanting of native species if native seed bank is absent

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection, with a particular focus on upland buffer systems and natural infiltration systems
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Emergent Graminoids (Sedges, Grasses, and Rushes)

Healthy Systems

General Structure
- Shallow, open water communities
- Water depths less than 2 meters (6.6 feet)
- Emergent, submergent, floating and floating-leaved aquatic vegetation
- Presence of habitat and communities of waterfowl, amphibians, fish, furbearing mammals and invertebrates

Soils Profile/Topography/Hydrology
- Sand and gravels or shallow bedded organic matter

Indicator Species of Healthy System
- Bur-reed
- Arrowhead
- Bulrushes
- Water plantain
- Pondweeds
- Water lilies
- Coontail

Associated Species
- Various sedges and native shrubs

Unhealthy Systems

General Structure
- Sustained high water levels or drastic level changes
- Nutrient, sediment and toxic chemical loading from uplands and roadways
- Dominance by cattail, giant reed grass, and reed canary grass

Indicator Species of Unhealthy System
- Purple loosestrife
- Cattail
- Giant reed grass
- Reed canary grass
- Eurasian water milfoil
- Duckweed
- Excessive bulrushes
-

Protection and Management Considerations

Causes of Change
- Increased runoff due to upland development
- Damming and impoundment of waters
- Industrial and agricultural runoff
- Nutrient enrichment

Restorative Capacity
- Potential to be restorable under well-designed and implemented restoration and management program in cases where off-site factors can be controlled or mitigated
- Highly disturbed sites may not be realistically restored due to extent of past degradation and uncontrollable off-site factors
- Restoration may require replanting of native species if native seed bank is absent

Protection Strategy
- Adopt land development practices that place a high priority on ecological protection, with a particular focus on upland buffer systems and natural infiltration systems.
- Implement an annual, long-term restoration and management plan
- Protect historic hydrologic regime/systems

Refinement of Ecological Prototypes

As part of the prototype refinement process, Washington County Parks is encouraged to utilize the Minnesota Department of Natural Resources' Minnesota Land Cover Classification System (MLCCS) where it has application as part of the stewardship program. This classification system, which is very extensive, is useful for defining natural ecosystems (although it is a bit more limiting in addressing developed or agricultural systems). Whereas this classification system was used for the *Natural Resource Inventory for Denmark Township* as defined in Section III and provides the baseline information needed to guide the master planning purposes, additional refinement using the MNDNR system will be required as the master plan moves from planning into implementation.

Effect of Healthy and Unhealthy Ecological Systems on Wildlife

As would be expected, there is a marked affect on the species richness of wildlife when ecological systems become degraded.

As would be expected, there is a marked effect on the species richness of wildlife when ecological systems become degraded. What is perhaps not expected is the degree of decline that can entail. To illustrate this point, the forthcoming table defines the decline of breeding bird species between healthy and unhealthy ecological systems.

Breeding Bird Species Associated with Healthy Ecological Systems

Prairie	Sedge Meadow	Emergent	Savanna	Lakes
Bobolink	Yellow warbler	Herons	Flicker	Tern
Blue bird	Willow fly catcher	Rails	Bluebird	Cormorant
Brown-headed cowbird	Yellow throat	Ducks, grebes	G. crested flycatcher	Merganser
Grasshopper sparrow	Red winged blackbird	Swamp sparrow	Robin	Duck
Vesper sparrow	Goldfinch	Red winged blackbird	Catbird	Grebe
Western meadow lark	Swamp sparrow	Sora rail	Cardinal	Coot
Song sparrow	Short/long billed marsh wren	Mallard	Blue jay	
Gold finch	Kingbird	Grackle	W. B. nuthatch	
King bird		Canada goose	Warbling vireo	
		Yellow headed blackbird		
		Kingbird		
20-30 species	**15-20 species**	**30-40 species**	**20-30 species**	**20-30 species**

Breeding Bird Species Associated with Unhealthy Ecological Systems

Corn Field	Cattail and Canary Grass	Degraded Savanna	Lakes
Horned lark	Red winged blackbird	Robin	Mallard
House sparrow	Mallard	Cardinal	Canada goose
	Canada geese	Starling	Coot
	Herons		
4-6 species	**5-10 species**	**5-10 species**	**5-10 species**

As the last table clearly illustrates, the decline in bird species can be quite steep as ecological systems transition from biologically healthy to unhealthy. When considering the needs of wildlife, healthy, natural ecological systems provide the essential components for wildlife to flourish. Unhealthy systems, on the other hand, do not provide for the basic needs of wildlife because many of these components are lacking.. Figure 5.4 defines the essential components of wildlife habitat.

When these components are lacking or degraded relative to a healthy system, the diversity of wildlife found within the park will be diminished.

Figure 5.4 – Sixteen components of wildlife habitat. (Source: Landscaping for Wildlife, published by the MNDNR)

When these components are lacking or degraded relative to a healthy system, the diversity of wildlife found within the park will diminish. While certain species of wildlife can flourish under degraded conditions, they often do so at the expense of other species that historically would have frequented the park.

Natural Resources Stewardship Program

The stewardship program establishes the long range vision for restoring and managing the natural ecological systems within the park.

The stewardship program establishes the long range vision for restoring and managing the natural ecological systems within the park. This includes defining:
- The long range vision for natural resources within the park.
- A restoration and management strategy to achieve that vision.
- The typical phases associated with implementing the strategy.
- The standard restoration techniques used within each phase of implementation.

The following considers each of these aspects of the stewardship program – each of which being critical to creating a vibrant natural landscape quality that is indefinitely sustainable.

Long Range Vision for Natural Resources Within the Park

As defined in Section IV, the park was historically dominated by oak savanna (barrens) systems, with several other systems also being common to the area. The long range vision for the park is to reestablish these systems to the extent possible within the context of inherent ecological and economic limitations.

Although there are many ecological nuances within the park, there are three dominant ecological systems that define its overall natural character. This includes:
- **Oak savanna dominated system** – encompasses the upland areas outside of the ravines and steeper slopes down to the river. Prototypes that may be found within this system include:
  - Oak savanna (dominant system).
  - Upland prairie (areas in transition to savanna system).
  - Ecotonal areas (i.e, transition zone between distinct ecological systems) may also include species associated with maple-basswood systems. Wet prairie and sedge meadow systems may also be present where depressions are found within the savanna system.
- **Maple-basswood dominated system** – encompasses the ravines and steeper slopes down to the river. Prototypes that may be found within this system include:
  - Maple-basswood (dominant system).
  - Ecotonal areas may also include species associated with oak savanna and upland prairie systems. Wet prairie and sedge meadow systems may also be present where lowland areas merge with the steeper slopes.
- **Lowland dominated system** – encompasses the limited depressional areas at the base of ravines and drainageways down to the river. Prototypes that may be found within this system include:
  - Wet prairie, sedge meadow, and emergent graminoids are dominant systems.
  - Ecotonal areas may also include species associated with maple-basswood systems. Lowland forest species may also be found in the ecotonal areas.

Figure 5.5 on the next page illustrates these three major systems.

Restoration and Management Strategy

The restoration and management strategy establishes an overall road map toward the realization of a more healthy and vibrant natural landscape.

The restoration and management strategy establishes an overall road map toward the realization of a more healthy and vibrant natural landscape. Realistically, implementing the program will require a multi-phased approach spread out over an extended period of time and lock-stepped with funding appropriations and scientific expertise.

The baseline strategy is to segment the park into manageable units and subunits that can be sequentially restored to higher quality sustainable systems – ultimately resulting in complete restoration of the park. The primary management units are closely aligned with the dominant ecological systems as illustrated in figure 5.1. Within each of these units are subunits of a size that can be effectively managed on a year-to-year basis. This strategy ensures that in any given year restoration activities will be well balanced – ranging from very intensive restoration work in one or two units to less intensive (but vital) ongoing maintenance work in other units that have been previously restored. Importantly, restoration of any new units should only occur when funding for ongoing maintenance of previously restored units can be assured. Otherwise, the value of any new restoration initiatives will be greatly diminished, and perhaps unsuccessful, if the long-term maintenance program is not in place to manage the resource once its been restored.

Phases of the Strategy

The actual restoration of a given unit will occur in phases. Each phase will have distinct objectives toward attaining more diverse and healthy ecological systems within the park. The phased approach also allows for close monitoring of program successes and ensuring that resources invested in the program are appropriately allocated to their greatest value.

In general, three major phases are envisioned for the stewardship program, as defined in the following table.

Phasing Program Table

Phase	Overview	Additional Comment
Phase I – Testing and Education Phase	Broadens understanding of restoration needs, options, and opportunities. Also increases local residents' knowledge and understanding of restoration issues. This phase is especially important during the initial implementation phase. As the program matures over time, the need to do extensive testing prior to restoring larger tracks is diminished due to knowledge gained over that time. However, testing of restoration approaches will always remain part of the program as new conditions are encountered.	Small test or demonstration plots are the backbone of the initial testing program. Testing should occur in each ecological unit to test a cross-section of conditions found and to provide wider public exposure to the program. These tests will help determine which restoration practices are best suited for the setting. Likely test and demonstration plots include: • Reduction of invasive shrub cover -- to increase light to the ground layer and stimulate growth. • Regeneration of oak forests -- to stimulate new growth. • Reduction of cool season grasses (and associated duff) -- to stimulate native species soil seed banks. • Reduction of noxious weeds and woody plants -- to give competitive edge to native plant species, instead of invasive, non-native plants (i.e., garlic mustard, buckthorn, tartarian honeysuckle, and reed canary grass). • Reintroduction of ground cover plants and seed -- to reestablish native seeds. • Establishment of native plant nurseries and gardens -- for educational purposes. • Establishment of community outreach programs -- so residents establish a personal stake in the stewardship program. Education plays a key role in the successful implementation of stewardship programs. The public's understanding of what is occurring becomes paramount to their support for the stewardship program. Although primarily for research purposes, the testing programs also serve as in-the-field educational tools. Direct exposure to restoration practices and their impact on the surrounding environment will give park visitors working knowledge of stewardship programs. This approach sets the stage for Phases II and III of the restoration and management plan.
Phase II – Remedial Phase	Involves the major restoration and management tasks and consequently is the more expensive phase. Its focus is on returning the land to the biological and structural conditions necessary for a healthy ecological landscape to emerge and prosper.	The remedial phase employs a variety of restoration techniques in a major effort to restore vegetation and habitat structure and biological diversity and restore ecological and bio-geochemical functions. Tasks undertaken during this phase include reducing introduced nonnative and other undesirable trees and brush, removal of previous debris and substrate fill areas, addressing erosion and other problems, and other general tasks. In some cases, this phase may involve machine/mechanical planting of native plants, including larger trees and other plants. The period of time required to conduct the remedial restoration phase depends on the level of work effort required, condition of the ecological systems, opportunities and constraints (e.g., access, weather, biological response), and level of funding available for the program.
Phase III – Maintenance Phase	Represents the routine tasks that are conducted annually at strategic times to maintain specific ecological and biological objectives set for each unit and subunit.	After significant investments during Phase II, the stewardship program shifts to a lower level of intervention during the maintenance phase. This is inherently less costly and provides an excellent opportunity for long-term citizen and student involvement as volunteers. Once established, the maintenance phase is guided by both regular management techniques and by strategies that are implemented on a rotational basis through identified subunits. It is during the maintenance phase that the restoration plan would become part of the park's general operations and maintenance function. Along with this comes routine training and education of maintenance staff.

Overview of Restoration and Maintenance Techniques

Of the techniques listed, prescribed burning is the single most useful and important management method required for restoring native plant communities.

As the previous table defines, the stewardship program requires undertaking specific tasks to meet performance criteria and achieve improvements to the ecological systems within the park. Forthcoming is an overview of specialized, yet relatively straightforward, techniques used to carry out specific restoration tasks. Of the techniques listed, prescribed burning is the single most useful and important management method required for restoring native plant communities. The other techniques and strategies are most often used to prepare a site for prescribed burning or as a means to reintroduce proper conditions and species into sites. It is important to underscore that these techniques are used as part of a well-thought out program that considers scientific practicality, costs, and safety.

Prescribed Burning

Prescribed burning is generally defined as: *"the highly controlled use of fire under optimal weather and environmental conditions to achieve specific ecological objectives"*

Wildfire and fires started by indigenous people have for centuries played an important role in the evolution of many biological systems throughout North America. It is now recognized by the scientific community just how essential the role of fire is in maintaining grasslands, wetlands, savannas, barrens, and numerous forest types. It is also recognized that fire suppression can result in gross changes in the aspect, appearance, and ecological functions of these natural systems.

As an example, fire suppression is often followed by a decline in the richness and diversity of native plants and animal species, increased litter, shading, phytotoxin build-up in substrates, decreased availability of essential nutrients and increased homogeneity in habitat structure and spatial heterogeneity. Reduced nutrient cycling and increasing domination by few species often results. In some ecosystems, shifts in wildlife and increases in shade tolerant and less flammable plant species accompany fire suppression, with detrimental effects.

Although prescribed burning has been a primary prairie management tool for some time, it is now recognized that fire also plays a major role in restoring and maintaining other ecological systems as well. Simply stated, no other technique comes close to the impact that this naturally occurring phenomenon has on restoring and preserving natural ecological systems. It is a fundamental component of a restoration program to which there is no reasonable substitute. Conducted by trained personnel, prescribed burning has proven to be very safe and effective.

Weeding and Brushing

Preparing the site for prescribed burning will likely be necessary on sites that have significant restoration needs, especially in locations where invasive species, like buckthorn, are dominant. Weeding and brushing are the primary techniques used where there is dense brush and little combustible fuel. Manual reduction of existing dense shrub growths will be required to open up these areas.

Once the site is opened up, prescribed burning can be used much more effectively. In some systems, weeding and brushing coupled with prescribed burning can successfully liberate long dormant native seed banks and "jump start" the restoration program.

In cases where the direct use of fire is hampered due to non-native cool season grasses being present, pre-burn treatments may be necessary, including:

- Very careful and discriminate use of herbicides -- used where the evergreen growth of some cool season grasses precludes the use of fire. Direct plant contact with a select herbicide has provided quick and safe initial control of these grasses.
- Low mowing of the grasses (0.5 to 1 inch height) -- can reduce green foliage and, after drying, litter can be used as fuel to sustain a low-level fire.

Although the use of herbicides is always kept to a minimum, their use is a fundamental aspect of creating the conditions necessary for restoring native plant communities. Carefully selected herbicides have very low toxicity to humans and wildlife and will not present a threat when used properly. It is applied at prescribed rates by trained and licensed field specialists.

In general, herbicide is applied to cool season grasses after they have reached a height of 5-8 inches and display a new flush of green, actively growing foliage. For invasives like buckthorn, herbicides are applied directly to cut stems and stumps to kill of the root structure. Prescribed fire usually follows 5-15 days after the herbicide treatment or after the mowed grasses are dry enough to burn, which varies depending on weather conditions.

Seed Harvesting and Disbursement / Planting

Field observations suggest that some seed banks may remain present within the park's soils, especially in areas where remnant native plant communities still exist. If carefully fostered, these seed banks can be a major facet of the restoration program and greatly reduce cost and time necessary to reestablish native systems. However, seeds and plants from local sources will also be required to ensure that sufficient quantity and quality exists to undertake a successful restoration program. This is especially the case in the oak savanna and prairie systems, where much of the seed bank may have been lost due to past agricultural uses. In these instances, directly reintroducing native plant species will be necessary to reestablish healthy ecological systems.

For native species that are no longer present within the park, alternative sites for seed harvesting, propagation, cultivation, and collection will have to be identified for eventual redistribution within the park. Wherever possible, seeds and plants should come from sites that are as close to the park as possible, with the outside limit being a 150 mile radius from the park. In the long-term, once native communities are reestablished, the park itself will be its own source for seeds and plants.