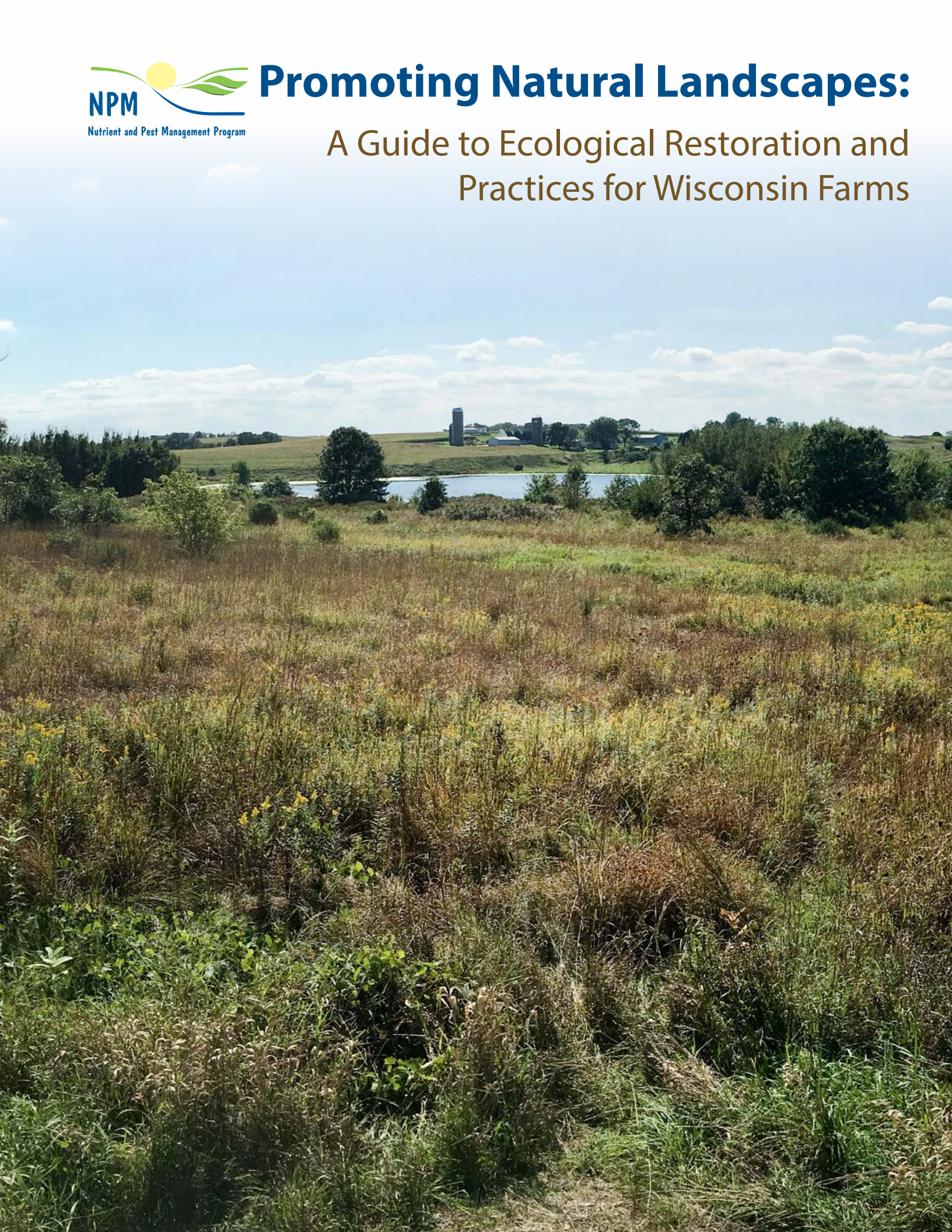
NPM
Nutrient and Pest Management Program

Promoting Natural Landscapes:

A Guide to Ecological Restoration and Practices for Wisconsin Farms



Contents

Section 1: Introduction to Conservation

Purpose: This publication is an introduction to theconservation of natural lands that can be managed or restored on privately owned farms in Wisconsin using the Central Sands region as a model system. It is intended to help growers identify conservation opportunities and to explain the management actions that may be used for conservation stewardship.

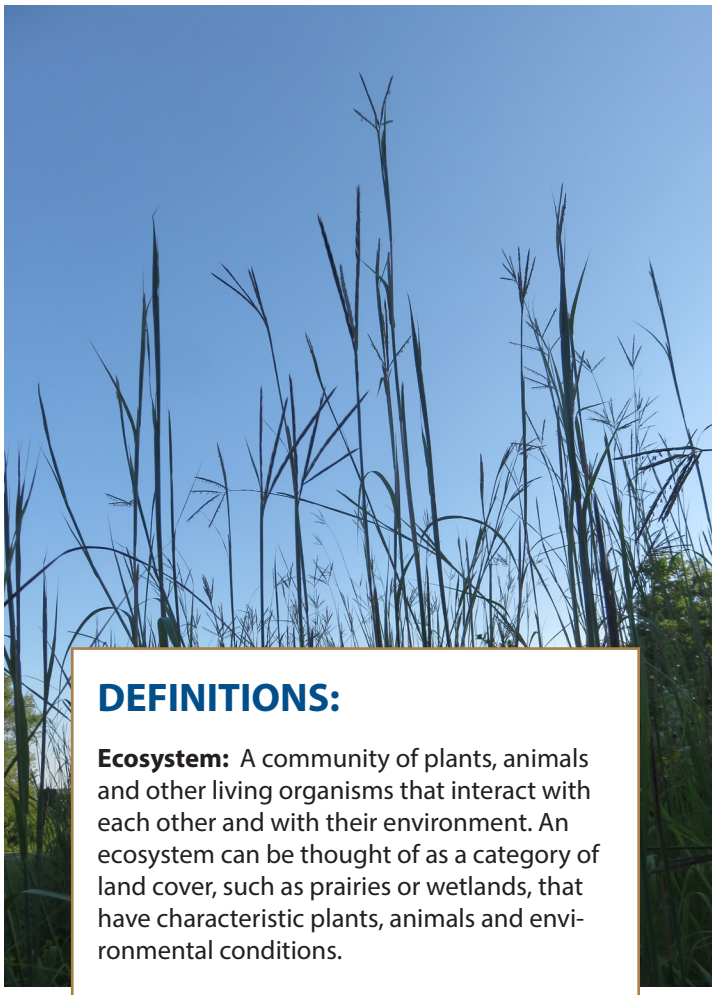
The information was initially developed to guide potato and vegetable growers in Central Wisconsin through a process of identification, conservation planning and restoration of native Wisconsin ecosystems. Other regions will have different opportunities and challenges, but the main elements and principles involved in restoration and conservation will be applicable anywhere.

> The process, practices and documented changes described in this publication can be applied to all Wisconsin farms, and the process and procedures can be adapted to other agricultural landscapes.

Background and description: Many opportunities exist for conservation on private lands in Wisconsin. This publication aims to help identify the steps needed to effectively manage idle and remnant areas for conservation of biodiversity and ecosystem services. Many growers already manage their non-production lands for recreation, hunting or forestry. The restoration activities and processes detailed in this publication complement those efforts by expanding stewardship using science-based practices and approaches. This includes looking at historic land cover; working to protect native plants, animals, and ecosystems; and developing a whole-farm conservation plan.

> Stewardship across many farms creates critical habitat for wildlife by improving the quality of existing land cover and connecting protected areas through private lands' wildlife corridors.

Basics for ecological restoration: Ecological restoration is a science-based process for re-establishing native species and native ecosystems (grasslands, wetlands, forests), and it requires a good understanding of the original species composition. To restore a site, whether the target is prairie, oak woodland or other ecosystems, work should be done with ecologists to develop a practical, long-term management plan. Restoration and stewardship of remnants and re-establishment of native plant communities can produce recreational, aesthetic, and environmental improvements for the landowner.



DEFINITIONS:

Ecosystem: A community of plants, animals and other living organisms that interact with each other and with their environment. An ecosystem can be thought of as a category of land cover, such as prairies or wetlands, that have characteristic plants, animals and environmental conditions.

Biodiversity: Can be defined in many ways, but for the purpose in this publication, it refers to the number and arrangement of regionally appropriate (native) species and ecosystems that can be found within an area.

Ecological restoration: The process of restoring degraded, damaged or destroyed ecosystems; includes site selection, goal-setting, determination of target ecosystems, development of a long-term management plan and implementation of practices to work toward that target goal.

Ecosystem services: Important functions of nature such as flood mitigation, water filtration, groundwater recharge, provisioning of wildlife habitat, soil nutrient cycling, pollination and insect pest predation.

Landscape: A contiguous area of land that is a mosaic of interacting ecosystems.

Remnant: An area that retains a substantial representation of the animals and plants that were present in the original landscape. Many remnants are healthy and remain quite diverse, though remnant quality varies from site to site depending on management history.

Management of non-production lands: Agriculture is the dominant land use in Wisconsin and much of Wisconsin's wetland, grassland and forest resources are found in these agricultural landscapes. Conservation stewardship and ecological restoration of natural areas on privately owned lands can help sustain healthy populations of native wildlife; protect the quality of streams and wetlands; and preserve Wisconsin's outdoor legacy.

Managing natural areas simultaneously for a variety of goals, such as protection of soil, water and biological diversity, requires a sequence of steps that improves the quality of functioning ecosystems. When ecological restoration occurs on many farms in a landscape, outcomes can provide public benefits, such as improved water quality, flood control; protection and growth of native wildlife; and increased groundwater recharge.

Grower management of non-croplands provides evidence of a commitment to conservation and responsible stewardship of the land. Community members and many agricultural markets find these approaches effective and are willing to work with growers on complex issues.

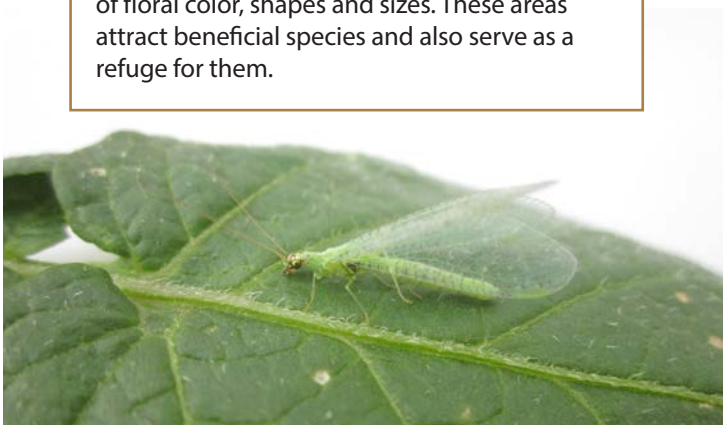
Benefits for growers: Natural areas on farms provide multiple benefits including beneficial insects that can help suppress pests. as well as pollinator species that are needed in many cropping systems.

Perennial vegetation planted along waterways, field edges and corners reduces soil erosion and can capture runoff before it enters surface waters. There is evidence that diverse, native perennial plant cover provides improved water infiltration during spring rain events.

Benefits for communities: Restoration of diverse native ecosystems in rural landscapes creates a mosaic of suitable habitat for a variety of game species, as well as species of regional conservation concern, which includes many songbirds, butterflies, native bees and other pollinators. This farmland stewardship can improve conditions for outdoor recreation and hunting, as well as the aesthetic value of native ecosystems in the landscape.

BENEFICIAL organisms, also called natural enemies, are used to suppress agricultural pests and can be classified into three categories: (1) general predatory insects, (2) parasitic insects and (3) insect pathogens, such as fungi, bacteria or nematodes.

Maintenance of diverse floral habitat in or around a field may increase beneficial species and aid in biological control. Areas can include non-agricultural sites that are ecologically diverse and have multiple species with a diversity of floral color, shapes and sizes. These areas attract beneficial species and also serve as a refuge for them.



Vegetation Definitions

Knowing the regional plant communities and vegetation types is key before embarking on any ecological restoration program. The following types of vegetation may be discovered and distinguishing them is a starting point in the planning process.

Invasive plant species – not wanted!
These are plants that have high rates of spread (through reproduction or rapid growth) and have a tendency to grow in high density. These species can negatively impact ecosystem processes and can be associated with declines in native biological diversity. Invasive species may be native, such as prickly ash, but are more often non-native, such as garlic mustard or spotted knapweed.

Native plant species – usually wanted!
These plants have historically been found in the region. Native species that are usually part of regional biodiversity may have become invasive, particularly in cases where a site has been disturbed, but these plants are usually important parts of regional biodiversity. The presence of native species is often used to assess ecosystem health.

Non-native/exotic plant species – can be a problem, or not?
These species have not been historically found in the region, but many are not management concerns because they do not reach high population levels or are restricted only to areas that receive frequent severe disturbance, such as the margins of roads. Usually, these do not negatively affect ecosystem processes or biological diversity, and they are not considered invasive.

What is a weed?
A weed is any unwanted plant, but only a small number of weed species are invasive. Problem weeds require management.

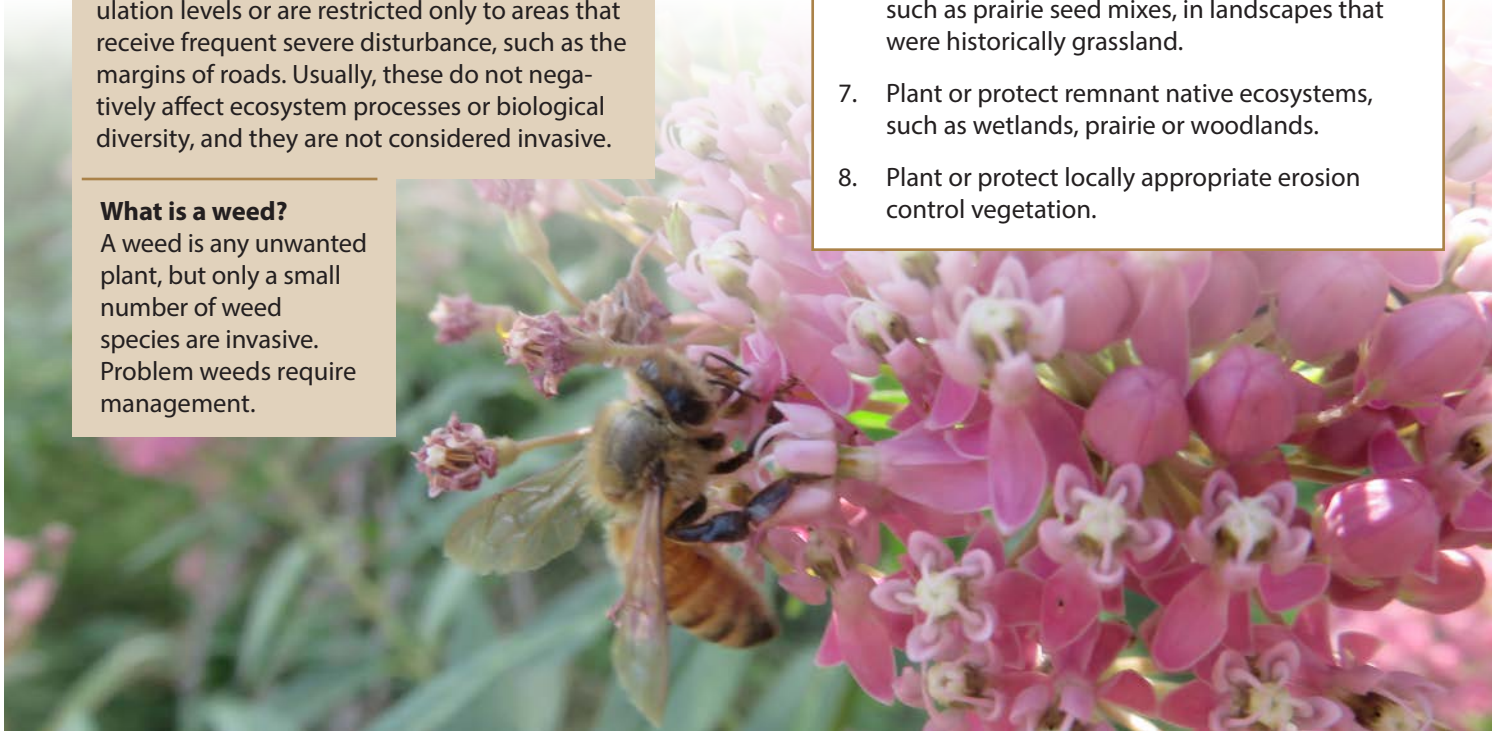
Ecological Restoration and the Link to Sustainability

Sustainability in agriculture is becoming increasingly important to growers, the supply chain and retail markets. In general terms, sustainability is a balance of environmental, social and economic criteria that:

- Ensures profitable returns to growers
- Uses resources wisely to achieve conservation and environmental management goals
- Provides social investments in communities

Ecological restoration and management of non-crop landscapes is part of sustainability. To begin sustainability programs, consider these starting points:

1. Review and record the natural community types found on the farm.
2. Document ecological restoration activities done on the farm.
3. Develop an annual plan of work that outlines management priorities for restoration and conservation activities.
4. Attend ecological, conservation or restoration education/training events.
5. Implement practices to enhance native wildlife or general biodiversity in and/or around farms or within other privately owned lands.
6. Plant diverse native vegetation for pollinators, such as prairie seed mixes, in landscapes that were historically grassland.
7. Plant or protect remnant native ecosystems, such as wetlands, prairie or woodlands.
8. Plant or protect locally appropriate erosion control vegetation.



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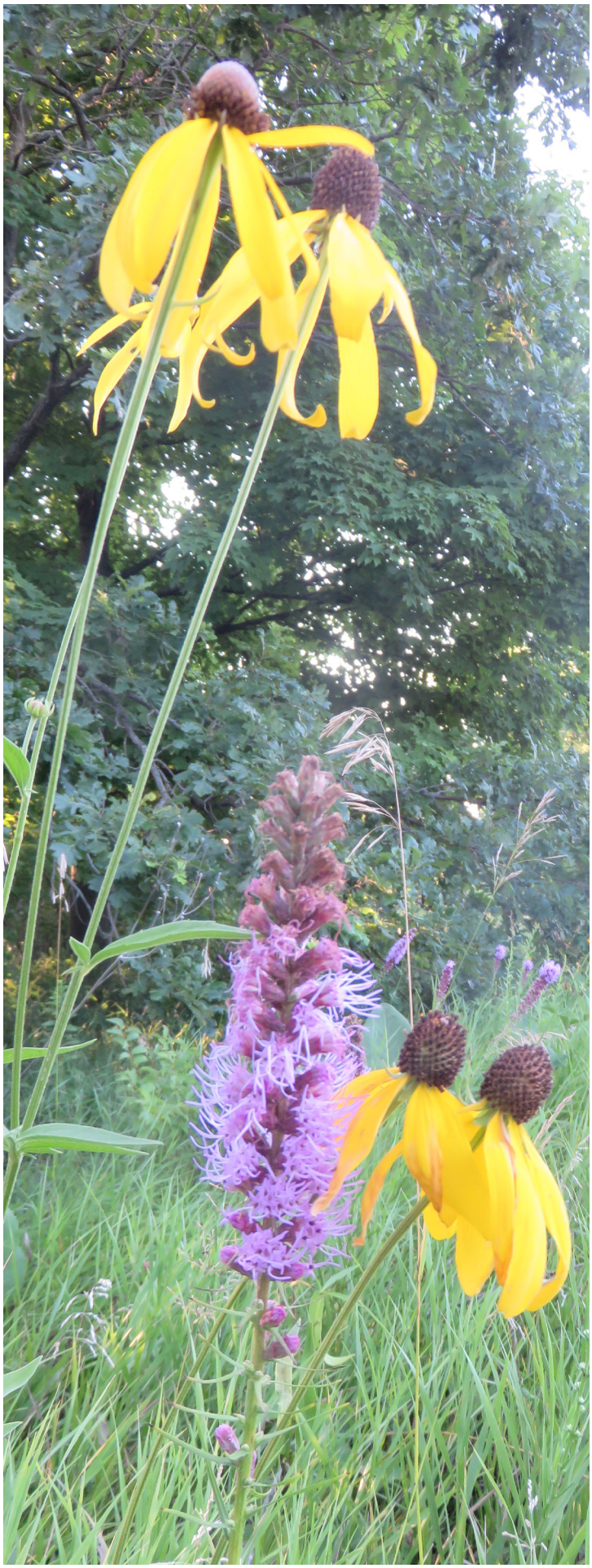


Section 2: Approach & Goals

Traditionally, conservation programs applied to agricultural lands have been separated into those targeting production lands and those targeting non-production lands. Such programs have addressed one resource issue at a time. Greater conservation gains can be achieved by pursuing multiple ecological objectives at the same time to produce long-term ecological benefits and services.

> An ecosystem approach to farm conservation planning allows for traditional natural resources services (including forestry or hunting land improvements) while generating many ecosystem services through protection and management of Wisconsin's native ecosystems.

Landowners can connect their stewardship efforts with existing regional plans to conserve locally important or rare ecosystems or species. Farm-specific ecosystem planning puts landowners in a decision-making role during all steps of the process, allowing for greater consideration of a conservation vision for the land.

> A place-based, whole-farm approach allows for development of a plan that maximizes the potential conservation benefits that can be achieved on the farm in its regional context.

When landowners prioritize stewardship activities based on regional conservation goals, the efforts are additive with the work being done on other private and public properties in the landscape. Landowners and ecologists should be aware of the historic land cover of the area, the opportunities that exist to restore historic ecosystems and the conservation priorities that have been identified for the region.

By assessing the current composition of the non-cropland acres on a farm, existing remnants of historic land cover (such as wetlands, grasslands and woodlands) can be identified and managed to increase their existing biological diversity and ecosystem health. In this way, landowners can build on the natural resource base already present on the farm.

Wisconsin's native ecosystems: Wisconsin's native ecosystems are the natural land cover that was present at the time of European settlement and had historically been found in the state. These ecosystems were described in the early 19th century by land surveyors, and the descriptions of landscape types and covers are documented in surveyors' notes and other Wisconsin reports. These land

covers are scientifically accepted as targets for restoration programs. Historical land records are the best source of detailed accounts of landscapes and are the ideal starting point for determining restoration activities. At times, however, there may be alternative restoration targets that are more appropriate, for example, where the natural hydrology or soils have changed significantly since these land records were created.

Each ecosystem has its own community of interacting plants and animals and specific species depend on the conditions of their corresponding ecosystem for survival. For example, birds can be distinguished by their ecosystem type as certain species can be found in a forested wetland, while others would be found in a prairie.

Understanding the difference among native ecosystems is an important step for determining which ecosystems can be restored on farms. Many times, ecosystems do not fall neatly into discrete types; rather, they vary continuously along gradients that indicate changing environmental and land use conditions. Ecosystem categories, however, are still useful for establishing restoration targets and planning management actions for a particular site.

Three primary factors influence ecosystems and the species that may be found in any particular ecosystem: 1) soil moisture, 2) tree cover, and 3) fire frequency.

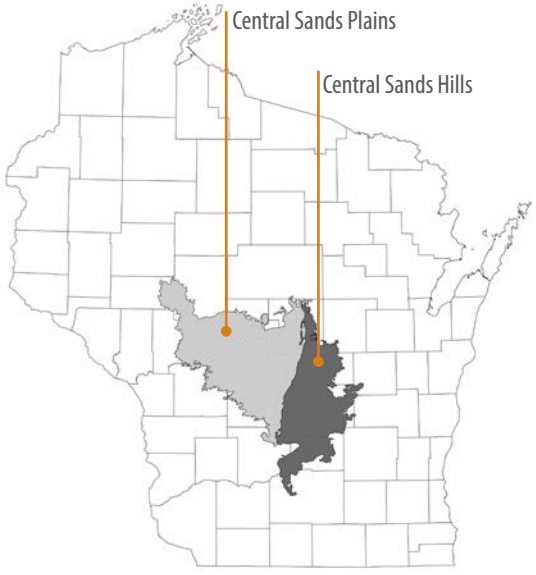
Soil moisture, which is a product of soil type and hydrology, determines whether the plant community will range from wetland to dry upland areas. Tree cover (the density of trees in an area) affects the amount of shade or light that reaches the ground and the plant community composition (which plants and their relative numbers) and structure (the shape and density of the vegetation) that will result. Finally, fire frequency (the number of prescribed burns accomplished in a given time period) influences the plant and animal community by creating conditions that are suitable for some species and unfavorable for others.

Regional Conservation Goals
WI Central Sands

The Central Sand Plains and the Central Sand Hills share similar pre-European settlement land cover; both were dominated by oak and pine forest. The Central Sand Plains (roughly the west half to two-thirds of the Central Sands) included extensive tracks of forested and non-forested wetlands scattered within the upland matrix of drier forest types (oak/pine forest, pine/oak barrens) and smaller pockets of prairie and oak savanna. The Central Sand Hills (eastern part of the Central Sands) had a greater proportion of upland grasslands and oak savanna mixed within the oak/pine forest. Wetland types in this system were smaller and patchier, and a large proportion were open, non-forested wetlands.

Based on historic land cover, current land use and the conditions of remnant ecosystems, the conservation priorities developed for the Central Sands are to protect entire ecosystems and particular species of conservation concern. When assessing farm non-cropland areas, any remnant ecosystem that still retains some of its historic plant or animal community should be considered a key management interest.

Pine/oak forest, oak/pine barrens, oak savanna, and grasslands are all considered regional conservation priorities in the Central Sands. In general, these ecosystems provide habitat for grassland-dependent birds, insects and mammals. Wetland ecosystems are also a priority because of their value as habitat for a diversity of species and because they provide additional ecosystem services.



Section 3: Getting Started

The process: This publication emphasizes an ecosystem approach to farm conservation planning and implementation. Managing for ecosystems is likely to benefit a range of plants and animals more than a plan that targets only one species or management objective. For example, planting a section of milkweed plants may benefit monarch caterpillars, but it won't provide the range of habitat needed by other grassland species, and it won't provide the variety of resources needed by the monarch throughout its life cycle. Working to restore many parts of an ecosystem will generate a range of benefits and the habitat complexity needed to boost landscape biodiversity.

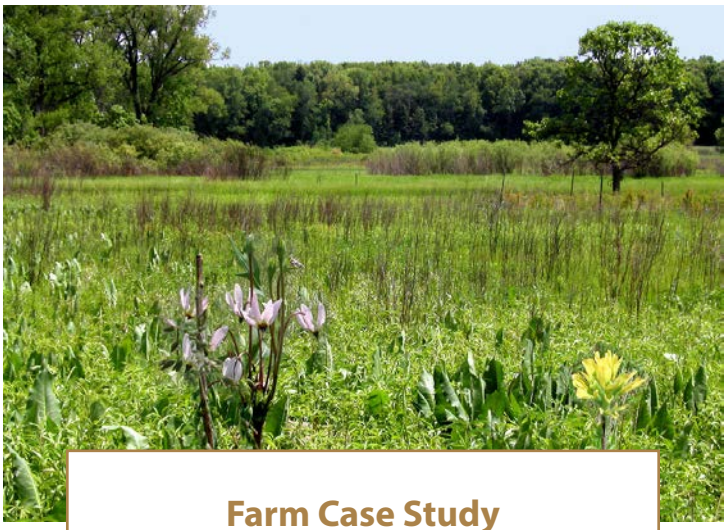
Restored ecosystems are generally more diverse than degraded systems and tend to have greater capacity for providing ecosystem services.

Native ecosystems, by definition, are well-suited to local conditions and provide the greatest opportunity to conserve regional biological diversity. They are appropriate restoration targets because:

- These ecosystems still exist as remnants that without management will likely lose diversity and function over time
- The plant and animal species that depend on these ecosystems are usually regional conservation priorities
- There are detailed records in Wisconsin regarding the spatial extent and species composition of these ecosystems based on work of early surveyors and naturalists

Landowners are generally advised to begin restoring remnant native ecosystems on their privately owned lands. For farms without existing ecological remnants or for landowners who are interested in connecting or increasing the footprint of their conservation areas, re-establishment of native ecosystems is an appropriate strategy.

The process of ecological restoration is best guided by a long-term management plan, coupled with annual prescriptions and assessments that move the targeted site closer to recovery.



Farm Case Study
Ecological Restoration Farm Planning

A grower has decided to create an ecological restoration farm plan. First, they find an ecologist in the local area who is qualified to provide regionally-appropriate advice for the farm. They create a farm map and highlight locations on the farm that are likely to remain non-cropland and undeveloped. Next, they select the highest conservation priorities, sites that contain existing remnant vegetation that are adjacent to or near conservation lands or sites that are of personal conservation interest for the grower.

A restoration target is identified for each of the high-priority sites. On this farm, the targets include restoring riparian wetland along a creek, establishment of a prairie planting near the farm office and management of a section of oak woodland near a county park.

The grower estimates the time and resources available each year and the seasons in which farm personnel are most likely to be free to complete management activities. This schedule is used to create a restoration timeline for each site. The restoration timeline includes a general sequence of management actions, as well as more detailed annual recommendations for when and how each activity should be accomplished.

Each winter, the grower reviews the restoration timeline, reads management notes from the previous year and adds restoration activities to a yearly farm planning calendar while revising the management plans based on restoration experience. The restoration projects may be used as farm promotions, and photographs of the restorations can communicate the farm conservation work to community members and supply chain partners.

Steps in the process: Once landowners decide to manage or restore land, a series of steps that determine where, when and how to begin need to be followed. It is useful to find an ecologist with experience restoring native ecosystems to help guide the process and prioritize lands (see the **Additional Resources** section).

STEP 1: FARM ASSESSMENT

- ☐ Map the farm and conduct a rough inventory of its non-cropped areas
- ☐ Determine whether any existing plant communities are ecological remnants and if they contain species of conservation concern
- ☐ Ask an ecologist to assess the quality of any remnants and discuss how their condition should affect the management priorities of the sites
- ☐ Locate non-cropland areas that are adjacent or near protected lands or large tracts of habitat on nearby-properties

STEP 2: GOAL-SETTING

- ☐ Determine a conservation vision for the land, consider which benefits and what land uses are important
- ☐ Review other local or regional conservation projects and determine which areas are important to the farm and surrounding community
- ☐ Communicate with ecologist to understand how and why they prioritize particular sites for restoration

STEP 3: SITE SELECTION AND PLANNING

- ☐ Create a priority list of management units and select sites feasible for conservation
- ☐ Prioritize sites and determine which to begin managing now and where management will done in the future
- ☐ Develop a restoration plan for each management unit, including assessment of the site's current conditions, the restoration target and the steps required to get there over time

STEP 4: IMPLEMENTATION AND MONITORING

- ☐ Determine the farm's capacity to complete restoration work and whether target outcomes are achievable
- ☐ Determine who would complete the work
- ☐ Finalize what equipment or training is needed and if desired, look for outside funding or other support resources to off-set the costs of ecological restoration
- ☐ Ensure that the implementation plan includes all of the information needed to accomplish the annual work recommended in the site management plan
- ☐ Include a list of annual management actions with clear directions specifying when, how and where the work should be completed
- ☐ Monitor progress to assess the success of restoration programs (walking 2x per year or use monitoring equipment) and note changes in key species within the landscape

WORKING WITH NEIGHBORS

When possible, discuss restoration opportunities with neighbors and local conservation partners. Sharing stewardship responsibilities increases conservation benefits and reduces management costs. Conservation benefits increase significantly with spatial scale. The larger the area, the greater the potential to increase ecosystem services and habitat for a diversity of species.

Section 4: Central Sands Examples

The on-farm ecological restoration process described in this publication was developed for potato and vegetable growers operating in the Central Sands region of Wisconsin. The Wisconsin Department of Natural Resources subdivides the Central Sands into two distinct but related eco-regions, the Central Sand Plains and Central Sand Hills, based on their historic land cover and ecological characteristics (soils, hydrology, biological diversity).

The historic land cover in the Central Sands was a mosaic of upland and wetland habitat types. Regular, frequent fire created conditions in upland sites that supported open grassland and oak/pine ecosystems. Even wetland systems, like sedge meadows and some marshes, burned occasionally, and at times, major peat fires altered the soil. Period fire prevented the spread of shrubs and other woody species in the landscape. Wetter areas in floodplains and along small creeks burned less frequently, allowing the growth of denser, rich forests. From a conservation perspective, managing for this landscape diversity (a mix of ecosystem types) is a key strategy for protecting the variety of plant and animal life found in the Central Sands.

In this section, major ecological systems found in the Central Sands are described and restoration plan templates with sample management action timelines for each ecosystem are provided. These templates are science-based examples but are not intended to replace the technical assistance of a ecologist in farm conservation planning.

ECOSYSTEM SERVICES

Grasslands and **forests** provide important ecosystem services:

- Soil conservation
- Groundwater recharge
- Carbon sequestration
- Soil nutrient cycling
- Habitat for a diversity of plants and animals
- Recreational and aesthetic benefits

Wetlands provide significant ecosystem services:

- Flood mitigation
- Water purification
- Groundwater recharge
- Carbon sequestration
- Soil nutrient cycling
- Habitat for a diversity of plants and animals
- Recreational and aesthetic benefits

General perennial cover connects larger habitat blocks between public/private conservation areas and provides additional ecosystem services:

- Soil stabilization
- Habitat for pollinators and beneficial species
- Wildlife corridors
- Surface runoff and erosion mitigation

Community types (see **Map Appendix** for specific locations)

Forest ecosystems

Forest ecosystems should be managed to maintain desired structure and diversity of the tree and shrub community, control invasive species and protect populations of plants and animals that depend on forested habitat.

FORESTED WETLAND

PINE/OAK FOREST

MESIC FOREST

Grassland ecosystems

Oak savannas, oak/pine barrens and prairies are all considered fire-dependent grassland systems and provide important habitat within the landscape for many songbirds and pollinators, as well as a number of game species including Wild Turkey, Ruffed Grouse, Sharp-tailed Grouse, American Woodcock and white-tailed deer.

OAK SAVANNA

OAK/PINE BARRENS

PRAIRIE

Wetland ecosystems

Restoration of wetland ecosystems is necessary for protecting water quality in agricultural landscapes and for providing habitat for many at-risk species that depend on wetland ecosystems. Wetlands provide more ecosystem services per acre than any other natural land cover, and conservation of existing wetland remnants should be a high priority.

SEDGE MEADOW

RIPARIAN WETLAND

FORESTED WETLAND

Description

Forested wetlands occur on soils that are wet throughout the year with cyclic periods of ecosystem flooding and draw-down. They may include both hardwood and coniferous tree species. Forested wetlands are often associated with river systems or simply occur in low-lying tracts within a larger forest system where the water table is near the surface, and the soils are regularly inundated. This plant community has very low fire frequency.

Conservation status

Most of the forested wetlands occurred in the western and northernmost parts of the Central Sand Plains eco-region, and this is where most of the remnants of these ecosystems are found today. Forested wetlands are the most abundant wetland type in the Central Sands, but they are vulnerable to poor forestry practices, land clearing, nutrient runoff and invasive species. The quality of forested wetlands in the region is often strongly correlated with the size and connectivity of the habitat block. In other words, large forested wetlands that exist near other forested wetlands tend to contain more species of conservation concern and a higher diversity of species overall than smaller and more isolated tracts.

Indicator species

Tree species found in forested wetlands include hardwoods like sugar maple, basswood, ash, elm, box elder, birch, oak and willow, as well as coniferous species like hemlock, fir, spruce, tamarack, pine and white cedar. Dominant understory species include sedges, ferns and wetland grasses. Wildflowers like cardinal flower and fringed loosestrife are also found in the understory.

RESTORATION TEMPLATE :

FORESTED WETLAND

Goal: Restore and maintain the structure, function and diversity of forested wetlands in areas where the ecosystem remains as remnant communities or where restoration is ecologically and economically feasible.

Objective 1: Work with a ecologist to identify any potentially problematic invasive species at the site; develop a plan for scouting and managing the site annually for these plants (and problem animals, if found).

Objective 2: Determine whether the natural hydrology of the site has been altered, and whether restoration of natural hydrology is feasible and important to restoration of the forest. If yes, work with a ecologist to develop an appropriate restoration plan.

Objective 3: Develop a desirable species list that includes herbaceous plants, shrubs and trees and create a timeline for planting these species in areas throughout the restoration site.

Objective 4: If appropriate to the site, reintroduce fire to facilitate control of invasive species and stimulate growth of native forested wetland species.

Activity/Comments	Timing/Season
Year 1	
☐ Consult with ecologist for site assessment that includes notes on site hydrology and biodiversity Create an invasive species "watch list"	April-August
☐ Control invasive plants (as appropriate to species)	Year-round
Year 2	
☐ Develop and implement plan to restore natural hydrology (if appropriate and permitted)	Timing advised by ecologist
☐ Control invasive plants (as appropriate to species)	Year-round
Years 3-4	
☐ Introduce infrequent fire to stimulate native species and control brush and weeds (if appropriate for site)	Early spring/Fall
☐ Interseed understory of site to boost native plant diversity	After burn
Year 5+	
☐ Implement recommended management actions (as advised by an ecologist)	Throughout season
☐ Control invasive plants (as appropriate to species), note weeds on "watch list"	Throughout season

Species of conservation concern

Animal species of conservation concern from forested wetlands in the Central Sands region include birds (Cerulean Warbler, Prothonotary Warbler, Red-shouldered Hawk, Veery and Yellow-billed Cuckoo) and herptiles (four-toed salamander and wood turtle).

Species of conservation concern (clockwise from top left): Cerulean Warbler, Prothonotary Warbler, four-toed salamander and Yellow-billed Cuckoo.

Farm Case Study
Forested Wetland Restoration

A farm has more than 100 acres of forested wetland. It has been unmanaged with the exception of a few narrow driving trails and is used for hunting and recreation. The grower is interested in managing the site for conservation purposes and specifically trying to maintain and improve habitat for songbirds and game species. They begin by contacting an ecologist who visits their site with a map generated from local hydrology, soils and topographical information. Management targets are developed related to invasive species management, biodiversity conservation and enhancement of habitat for birds and other species of regional conservation concern.

Because of the size of the management site and its relatively undisturbed land use history, it has few invasive species and already provides high-quality habitat for many of the bird species of interest to family members. The ecologist suggests a periodic monitoring program to watch for invasive plant species (problem shrubs, wildflowers or grasses that may spread if left uncontrolled), and a plan for management if those species are discovered. The ecologist also recommends establishing a farm wildlife monitoring project using wildlife cameras, so species that are using the forested wetland can be identified.

To protect the site from future disturbance or land use changes, the landowner decides to protect the site with a permanent conservation easement through a local land trust.

Indicator species (left to right): Fringed loosestrife (native) and cardinal flower

PINE/OAK FOREST

Description

In the Central Sands, pine/oak forests are described as northern dry and dry-mesic forests. The dominant tree species found in this ecosystem will vary depending on land use history, soil moisture and other subtle climate factors. Similarly, the canopy coverage and density of the stand will depend on the life history of the dominant species, as well as the frequency of fire. Areas where fire has been suppressed for decades will have a denser number of trees and shrubs, and fewer and sparser plants growing on the forest floor. Generally, the pine/oak forests of the Central Sand Plains (western half of the Sands) are dominated by pines, while the pine/oak forests of the Central Sand Hills (eastern/southern half of the Sands) are dominated by oaks.

Conservation status

In the absence of regular fire, the pine/oak forests are vulnerable to invasion by both non-native and native shrubs and fire-sensitive tree species. Invasion by exotic weeds, like spotted knapweed, leafy spurge and cypress spurge, is a significant problem in dry, sandy forests, particularly for small tracts with a lot of edges along roads or disturbed areas. While the cover of pine/oak forests in the landscape has not necessarily declined since European settlement and may have, in fact, increased with fire suppression, the quality and diversity of the existing habitat blocks have declined over time.

Indicator species

Dominant pine species of pine/oak forests include white, jack and red pine. Typical oak species include Hill's, black, white and red oak. Other associated hardwood species include red maple, trembling aspen and white birch. Prevalent species in the understory include American hazelnut, blueberry, bracken fern, cow-wheat and Canada mayflower.

Species of conservation concern

Animal species of conservation concern from pine/oak forests in the Central Sands region include birds (Acadian Flycatcher, Cerulean Warbler, Eastern Whip-poor-will and Wood Thrush) and a reptile (ornate box turtle).

RESTORATION TEMPLATE:

PINE/OAK FOREST

Goal: Restore and maintain the structure and diversity of native pine-oak forests in areas where the ecosystem remains as remnant communities or where restoration is ecologically feasible.

Objective 1: For a remnant pine/oak forest, reintroduce fire as a regular, natural disturbance to re-establish and maintain pine-oak forest structure and plant diversity.

Objective 2: Manage invasive species by developing a program to scout and manage the site annually for problem weeds.

Objective 3: As advised by an ecologist, interseed with native grass and forb (wildflower) species to boost plant diversity and increase habitat for pollinators and other beneficial insects.

Activity/Comments	Timing/Season
Year 1	
☐ Complete a prescribed burn to control woody vegetation	March-May
☐ Consult with ecologist for a site assessment; create an invasive species "watch list"	June-August
☐ Control invasive plants (as appropriate to species)	Growing season
Year 2	
☐ Complete a prescribed burn to control woody vegetation	March-May
☐ Control invasive plants (as appropriate to species)	Growing season
Years 3-4	
☐ Control invasive plants (as appropriate to species)	Growing season
Year 5+	
☐ Complete prescribed burn every 3-6 years (may need to burn more frequently to control weeds)	Spring/Fall
☐ Monitor and control problem weeds, note weeds on "watch list"	Throughout season
☐ Consider interseeding understory to boost native plant diversity	After burn

Farm Case Study
Pine/Oak Forest Restoration

A grower is interested in managing the pine/oak forests where over the past twenty years, the shrub layer has expanded, and many areas of the forest are no longer accessible. The landowner's primary goal is to open up the shrub layer and improve conditions for hunting and recreation. Management of the site may also increase the quality of the habitat for a variety of songbirds, pollinators and other native species.

In total, the grower has 40 acres of pine/oak forests in three parcels: a 5 acre strip along the farm office, a 25 acre square near a state wildlife area and a 10 acre square in the middle of cropland areas. An ecologist advises the grower to start by managing the largest habitat block. This site offers the best opportunity to create adequate habitat for game and other animal species; it is relatively large and compact and near a protected area.

The landowner and the ecologist walk the site, recording the presence and cover of any problem species, noting any plant species of conservation interest. The primary management challenges are the thick shrub layer and populations of spotted knapweed in the understory. The ecologist recommends the landowner begin by contracting with a prescribed burn crew to complete a burn of the site in the spring. The ecologist recommends three spring burns over five years to control shrubs and then prescribed burns every three to five years after that, depending on the site conditions. As the grower's comfort with prescribed fire increases, they can also reintroduce fire to the smaller pine/oak forests on the property to improve their conditions.

Additional management includes targeted foliar application of herbicide to patches of spotted knapweed in the growing season after the burns. Mowing of flowering spotted knapweed is used as a back-up control strategy to minimize weed seed production. Over time, the grower observes a decline in the shrub layer with prescribed fire, and he occasionally cuts sections of shrubs and applies herbicide to the cut stumps. Slowly, the oak/pine forests open up, and conditions improve for a variety of native wildlife. The plant community also changes, as new flowering species take advantage of the openings in the shrub layer, and the diversity of the managed area increases.

Species of conservation concern (clockwise from top left): Acadian Flycatcher, Wood Thrush and ornate box turtle.

Indicator species (clockwise from top): American hazelnut, cow-wheat and jack pine.

MESIC FOREST

Description

Mesic forests (a mid-point between wet and dry) in Central Wisconsin do not occur in large contiguous blocks but rather in pockets where soil conditions support a plant community that requires rich, moist (not permanently wet) soils. Though it may burn under some conditions, fire is not necessary to maintain this ecosystem.

Conservation status

Mesic forest is of conservation interest because where it occurs, it supports diverse communities of plant species that are regionally rare. This ecosystem tends to occur on upper terraces along riparian areas in the Central Sands, so restoration can benefit water quality and protection of wildlife corridors. Land conversion and invasion by non-native shrubs and other species are major threats.

Indicator species

Dominant tree species in this ecosystem include sugar maple, red maple, elms, basswood, aspen and ash. Understory species of conservation interest include a variety of spring ephemerals, such as wildflower species that flower before the tree canopy has fully expanded in the late spring. Spring ephemerals include bloodroot, spring beauty and Dutchman's breeches.

Species of conservation concern

Animal species of conservation concern from mesic forests in the Central Sands region include birds (Least Flycatcher and Wood Thrush) and herptiles (four-toed salamander and wood turtle).

RESTORATION TEMPLATE:

MESIC FOREST

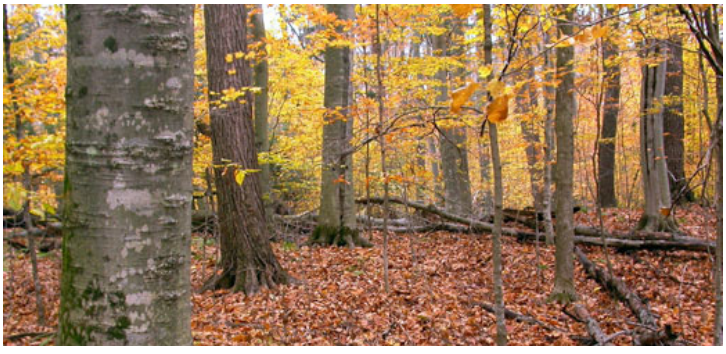
Goal: Restore and maintain the structure and diversity of mesic forests in the areas where the ecosystem remains as remnant communities or where restoration is ecologically appropriate.

Objective 1: Manage invasive species by developing a program to scout mesic forest remnants for invasive shrubs and herbaceous weeds and develop an appropriate management plan for controlling and removing these species.

Objective 2: Seed and/or transplant native forest wildflowers in the management area with particular attention to patches where weed and shrub removal has left bare patches where weeds will re-establish.

Objective 3: Maintain an annual targeted shrub and weed control program to restore mesic forest structure and function.

Activity/Comments	Timing/Season
Year 1	
☐ Consult with ecologist for site assessment; create an invasive species "watch list"	March-May
☐ Control invasive plants (as appropriate to species)	Year-round
☐ Introduce fire to control shrub cover (infrequently, if appropriate for site and conditions)	Fall or early spring (before wildflowers bloom)
Year 2	
☐ Control invasive plants (as appropriate to species)	Year-round
Years 3-4	
☐ Control invasive plants (as appropriate to species)	Year-round
☐ Interseed and/or transplant native mesic forest plants to boost plant diversity	As appropriate to planted species
Year 5+	
☐ Monitor and control problem plants, note weeds on "watch list"	Year-round
☐ Continue interseeding and/or transplanting mesic forest plants to boost plant diversity	As appropriate to planted species



Indicator species (clockwise from top):
Dutchman's breeches, bloodroot and spring beauty

Species of conservation concern (clockwise from top left):
Least Flycatcher, Wood Thrush and four-toed salamander.

OAK SAVANNA

Description

Oak savannas are grassland communities with widely spaced, open-grown oak trees and a ground layer of grasses and wildflowers that tolerate varying degrees of shade. The middle story of shrubs is usually absent or minimal. Communities classified as oak savannas can have a wide range of tree densities, ranging from 1 tree to more than 10 trees per acre.

Conservation status

Oak savannas were a dominant ecosystem across much of the eastern and southern Central Sands landscape prior to European settlement.

Indicator species

Oak species are the dominant canopy trees, while American hazelnut is a one of the few native shrub species associated with this ecosystem. Oak savanna indicator species in the understory include false foxgloves, golden Alexanders, New Jersey tea and bottlebrush grass. Prairie and some woodland grasses form the dominant vegetative cover in the understory of oak savannas.

Species of conservation concern

Animal species of conservation concern from oak savannas in the Central Sands region include birds (Brown Thrasher and Vesper Sparrow), herptiles (Blanding's turtle, western slender glass lizard and wood turtle) and a small mammal (Franklin's ground squirrel).

RESTORATION TEMPLATE:

OAK SAVANNA

Goal: Restore and maintain the structure and diversity of native oak savanna in areas where the ecosystem remains as remnant communities or where restoration is ecologically feasible.

Objective 1: In remnant oak savannas, reintroduce fire as a regular, natural disturbance to re-establish and maintain oak savanna structure and plant diversity.

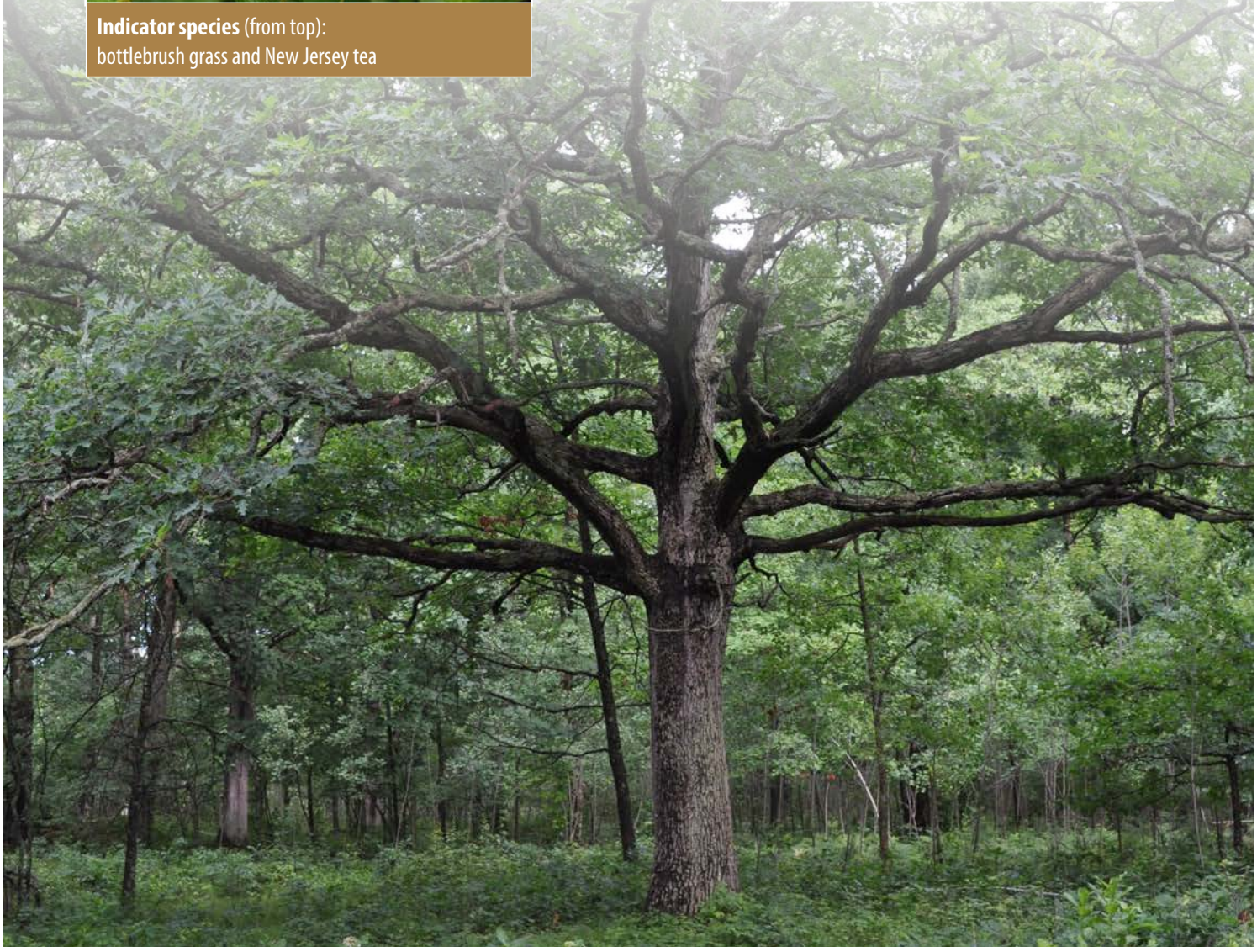
Objective 2: Develop a list of potentially problematic invasive species at the site; scout and manage the site annually for problem weeds. Control and maintain invasive species and shrubby vegetation.

Objective 3: As advised by an ecologist, interseed with native grass and forb (wildflower) species to boost plant diversity and increase habitat for pollinators and other beneficial insects.

Activity/Comments	Timing/Season
Year 1	
☐ Complete a prescribed burn to control woody vegetation	March-May
☐ Consult with ecologist for a site assessment; create an invasive species "watch list"	June-August
☐ Control invasive plants (as appropriate to species)	Growing season
Year 2	
☐ Complete a prescribed burn to control woody vegetation	March-May
☐ Control invasive plants (as appropriate to species)	Growing season
Years 3-4	
☐ Control invasive plants (as appropriate to species)	Growing season
Year 5+	
☐ Complete a prescribed burn every 3-6 years (may need to burn more frequently to control weeds and brush)	Spring/Fall
☐ Monitor and control problem weeds, note weeds on "watch list"	Throughout season
☐ Consider interseeding understory of site to boost native plant diversity	After burn

Species of conservation concern (clockwise from top left): Vesper Sparrow, Brown Thrasher, Blanding's turtle and Franklin's ground squirrel.

Indicator species (from top): bottlebrush grass and New Jersey tea



OAK/PINE BARRENS

Description

Barrens are open grassland systems that occur on infertile, dry, sandy soils and are dominated by grasses, low shrubs, scrub trees and scattered large trees. Black oak and jack pine are major canopy species of oak/pine barrens in the Central Sands. Like other grassland ecosystems in Wisconsin, fire is an important natural disturbance that maintains the open grassland structure and promotes growth and reproduction of barren-adapted plants.

Conservation status

Fire suppression has led to significant declines in quality and coverage of this community type in the Central Sands. Conservation of oak/pine barrens is a priority for the Central Sand Plains eco-region.

Indicator species

Barrens are important habitat for the endangered Karner blue butterfly, and ecological restoration of this ecosystem presents an opportunity to create habitat for Kirtland's Warbler (also endangered). Barrens are habitat for dwarf milkweed (state threatened) and Fernald's sedge (state special concern).

Species of conservation concern

Animal species of conservation concern from oak/pine barrens in the Central Sands region include those listed for oak savanna, as well as the federally endangered Karner blue butterfly.

RESTORATION TEMPLATE:

OAK/PINE BARRENS

Goal: Restore and maintain the structure and diversity of native oak-pine barrens in areas where there are remnant communities or where restoration is ecologically feasible.

Objective 1: For a remnant oak-pine barrens, reintroduce fire to re-establish and maintain oak-pine barren structure and plant diversity.

Objective 2: Develop a list of potentially problematic invasive species at the site; scout and manage the site annually for problem weeds. Control and maintain invasive species and shrubby vegetation.

Objective 3: As advised by an ecologist, interseed with native grass and forb (wildflower) species to boost plant diversity and increase habitat for pollinators and other beneficial insects.

Activity/Comments	Timing/Season
Year 1	
☐ Complete a prescribed burn to control woody vegetation	March-May
☐ Consult with ecologist to provide site assessment; create an invasive species "watch list"	June-August
☐ Control invasive plants (as appropriate to species)	Growing season
Year 2	
☐ Complete a prescribed burn to control woody vegetation	March-May
☐ Control invasive plants (as appropriate to species)	Growing season
Years 3-4	
☐ Control nvasive plants (as appropriate to species)	Growing season
Year 5+	
☐ Complete a prescribed burn every 3-6 years (may need to burn more frequently to control weeds)	Spring/Fall
☐ Monitor and control problem weeds	Throughout season
☐ Consider interseeding understory to boost native plant diversity	After burn

Farm Case Study
Oak/Pine Barrens Restoration

A landowner owns an 80 acre tract of unmanaged oak/pine barrens. On nearby properties where management has been underway for years, the landowner observed the positive effects of prescribed fire, including the decrease in brushy vegetation; the growth and spread of grasses and wildflowers; and the use of these less shrubby, open sites by birds, deer and butterflies.

The landowner meets with an ecologist who recommends a plan for burning the site with a trained burn crew. The ecologist suggests a management assessment following a spring burn. Assessing the site following a burn will make a plant inventory easier, and the response to fire will provide clues about how much work must be done to restore its diversity and function.

In the spring, the prescribed burn is completed. The landowner walks the property with the ecologist a few weeks later, noting and mapping areas with problem species that should be managed, as well as species of conservation interest.

A long-term management plan for the oak/pine barrens is developed. The primary management goals are a 3-5 year fire frequency to control shrubs, control spotted knapweed in the oak/pine barrens area and interseed sections with native wildflowers to boost diversity and pollinator habitat.

Species of conservation concern (clockwise from top left): Vesper Sparrow, Brown Thrasher, Karner blue butterfly and Kirtland's Warbler.

Indicator species (clockwise from top): Carolina puccoon, dwarf milkweed and wild blueberry

PRAIRIE

Description

Prairies are open grassland with dominant native grasses, a few sedges and a diversity of wildflowers. Prairie communities vary based on soil type and hydrology, resulting in a gradient ranging from dry prairies and sand barrens to mesic (tallgrass) prairie to wet prairies and meadows. While dry prairies are typical in the Central Sands (in some cases supporting native cactus and other drought-tolerant species), there are also numerous examples of mesic and wet prairies in areas where the groundwater is close to the surface or where grasslands occur near marshes and streams. Wet prairies grade into wetlands where surface water persists. Historically, prairies in the Central Sands would have occurred as pockets within larger tracts of oak savanna, oak forest and oak/pine barrens. Prairie species would also have been common in the understory of savanna and barren communities.

Conservation status

Many remnant prairies remain on steep slopes or on poor soils. Prairie restoration is of interest to private landowners because it presents an opportunity to link tracts of remnant and protected prairies.

Indicator species

As with oak savannas, grasses are the dominant species in prairies. Dry prairies are dominated by little bluestem and side-oats grama grass; mesic and wet prairies are typified by tall grasses, such as big bluestem (mesic) and Canada bluejoint grass (wet). A diversity of prairie wildflowers provides flower and seed resources throughout the year for insects and other animals.

RESTORATION TEMPLATE:

PRAIRIE

Goal: Establish site-appropriate prairie vegetation that is similar in composition and structure to pre-European settlement prairies of the Central Sands or that provides suitable habitat for regional at-risk plant and animal species.

Objective 1: Establish and maintain native, site-appropriate prairie plant species (the seed mix may vary depending on soil type, topography and hydrology), including sufficient wildflower diversity to provide flower resources throughout the growing season.

Objective 2: Control invasive species and woody vegetation.

Objective 3: Develop a list of potentially problematic invasive species at the site and scout/manage the site annually for problem weeds.

Activity/Comments	Timing/Season
Year 1*	
☐ Clear area for planting (broadcast herbicide application or applicable options at green-up 2-3 times per year)	Beginning in May/June
☐ Consult with ecologist to check site; check for problem weeds and create "watch list"	September/ October
☐ Plant site appropriate prairie mix (no-till for soil protection with a no-till drill)	November
Year 2	
☐ Mow with flail mower when plants reach 12 inches tall, mow to 6 inches	Late April/early May
Year 3	
☐ Complete prescribed burn to stimulate prairie growth	April
☐ Monitor and control problem weeds, note weeds on "watch list"	Throughout season
Year 4	
☐ Monitor and control problem weeds, note weeds on "watch list"	Throughout season
Year 5	
☐ Complete prescribed burn to stimulate prairie growth	April
☐ Interseed low-diversity prairie to boost wildflower diversity remnants	After burn
☐ Monitor and control problem weeds, note weeds on "watch list"	Throughout season
Year 6+	
☐ Monitor and control problem weeds, note weeds on "watch list"	Throughout season
☐ Complete prescribed burn every 3 years (may need to burn more frequently to control weeds)	Spring/Fall

*Restoration timeline for existing prairie remnants begins at Year 3.

Species of conservation concern

Prairie animals of conservation concern include at-risk grassland birds, such as the Grasshopper Sparrow and the Field Sparrow. Prairies also provide habitat for Blanding's turtle, bull snake and the prairie vole. Large tracts of prairie and connected grasslands provide important habitat for species with extensive ranges, such as the Greater Prairie Chicken and the Northern Harrier.

Species of conservation concern (clockwise from top left): Grasshopper Sparrow, prairie vole and Greater Prairie Chicken.

CONSERVATION SPOTLIGHT

GRASSLAND BIRDS

Why are grassland birds important?

Grassland birds are an integral part of grassland ecosystems. They disperse native seeds, are important prey species for raptors and other predators and in agricultural areas their consumption of insects, provides valuable pest control services.

Grassland birds require large, open, grass-dominated plant communities with relatively few shrubs and other woody plants. Prairies, oak savannas and sedge meadows provide habitat for grassland birds.

What can be done on farms?

Although the open structure of the plant community is important for grassland birds, the particular plant species mix is less important. Pastures, hay fields and alfalfa fields can all provide valuable grassland bird habitat if they are not disturbed (mowed) during vulnerable periods in spring and summer.

Growers can increase the area and quality of existing grassland cover throughout the year to provide greater nesting and foraging opportunities. Income can be derived from harvesting and selling grassland seed mixes.

Wetland ecosystems

SEDGE MEADOW

Description

Sedge meadows are open, treeless plant communities dominated by sedges (grass-like plants with triangular stems) with organic, wet soils and seasonally standing water. Sedge meadows are wet in the spring and early summer but may be nearly dry by the end of the growing season. These natural water fluctuations are important for the health of the ecosystem and its inhabitants.

Conservation status

Sedge meadows have declined since European settlement. Without fire, sedge meadows are often invaded by shrubs and trees. Altered regional hydrology has increased the susceptibility of sedge meadows to invasion by non-native or upland plant species.

Indicator species

More than half of the vegetation cover of sedge meadows is sedge species, many of which may form distinct mounds or tussocks. Prevalent native wildflowers include marsh bellflower, swamp aster and monkey-flower.

Species of conservation concern

Animal species of conservation concern from sedge medows in the Central Sands region include birds (American Bittern, Bobolink and Northern Harrier), and a reptile (Blanding's turtle).

RESTORATION TEMPLATE:

SEDGE MEADOW

Goal: Restore and maintain the structure and diversity of sedge meadow ecosystems in areas where they remain as remnant plant communities.

Objective 1: Reintroduce fire to maintain open sedge meadow structure and encourage growth and persistence of native sedge meadow species. Prescribe burns applied to sedge meadow systems should be conducted with assistance from an ecologist due to the risk of peat fires.

Objective 2: Control runoff from adjacent agricultural lands through buffers or in-field management activities that minimize soil and nutrient flow into sedge meadows.

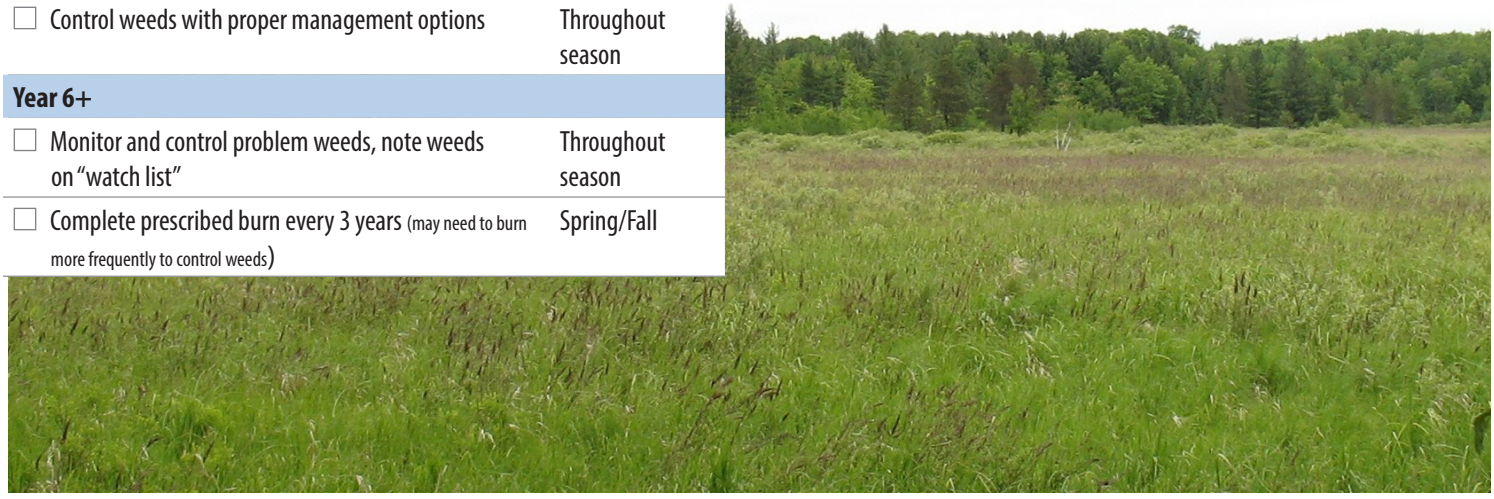
Objective 3: Control invasive species and shrubby vegetation. Pay particular attention to aggressive perennial weeds like reed canary grass, purple loosestrife and common reed. Prevention by controlling new infestations is more cost-effective than management after a weed is established.

Objective 4: Restore and maintain a diverse wetland ecosystem with native sedge, grass and wildflower species. If native sedge or wildflower diversity is low, use interseeding or plant plugs to boost diversity over time.

Indicator species (clockwise from top): monkey-flower, marsh bellflower and lesser purple fringed orchid

Activity/Comments	Timing/Season
Year 1	
☐ Evaluate need for prescribed burn to control woody vegetation	Spring or Fall
☐ Consult with ecologist for site assessment and inventory	May-August
☐ Control invasive plants (as appropriate to species)	Control invasive plants
☐ Establish buffers and in-field practices where needed between wetland and cropland	As appropriate to practice
Year 2	
☐ Control invasive plants (as appropriate to species)	Growing season
☐ Maintain buffer (if buffers were planted)	Growing season
Year 3	
☐ Complete prescribed burn to control woody vegetation	Spring or Fall
☐ Control invasive plants (as appropriate to species)	Growing season
☐ Maintain buffer (if buffers were planted)	Growing season
Year 4	
☐ Interseed with native sedge meadow specie to boost diversity with grasses, sedges and wildflowers	As advised by ecologist or seed provider
☐ Monitor and control problem weeds, note weeds on "watch list"	Throughout season
Year 5	
☐ Assess need for prescribed burn to control woody vegetation	Spring/Fall
☐ Interseed or plug transplants to boost diversity	As advised by ecologist or seed/plant provider
☐ Monitor and control problem weeds, note weeds on "watch list"	Throughout season
☐ Control weeds with proper management options	Throughout season
Year 6+	
☐ Monitor and control problem weeds, note weeds on "watch list"	Throughout season
☐ Complete prescribed burn every 3 years (may need to burn more frequently to control weeds)	Spring/Fall

Species of conservation concern (clockwise from top left): American Bittern, Bobolink and Blanding's turtle



RIPARIAN WETLAND

Description

Riparian wetlands are the aquatic and terrestrial communities in and adjacent to moving stream and river systems. These ecosystems connect wet bottomland forests and marshes with drier upland forest and grassland communities. Riparian zones often vary significantly in soil moisture and tree cover within a short distance. This variability creates species-rich plant and animal communities in relatively small areas. The groundwater recharge and water filtration benefits of riparian zones also makes these critically important conservation areas.

Conservation status

Stream and river conditions in Wisconsin vary considerably throughout the Central Sands. Restoration of more natural stream hydrology and establishment of buffer zones that minimize runoff into streams are both important for maintaining or re-establishing natural riparian conditions.

Indicator species

Riparian understory and plant communities vary depending on the tree cover and streamflow. Tree species associated with forested riparian and floodplain areas include hardwoods (green ash, river birch, silver maple, American elm) and conifers (hemlock, black spruce, tamarack). Common understory plants include marsh marigold, a variety of sedges/wetland grasses and many species of wetland ferns.

Species of conservation concern

Animal species of conservation concern vary in riparian areas depending on the stream flow and size of the riparian zone. Birds associated with riparian areas along major rivers include Bald Eagle and Osprey, fish include the lake sturgeon and mudpuppy, and reptiles include the midland smooth softshell turtle. Riparian stream systems are home to brook trout and northern cricket frog and, when habitat areas are large enough, Red-shouldered Hawks.

Farm Case Study
Stream Restoration Project

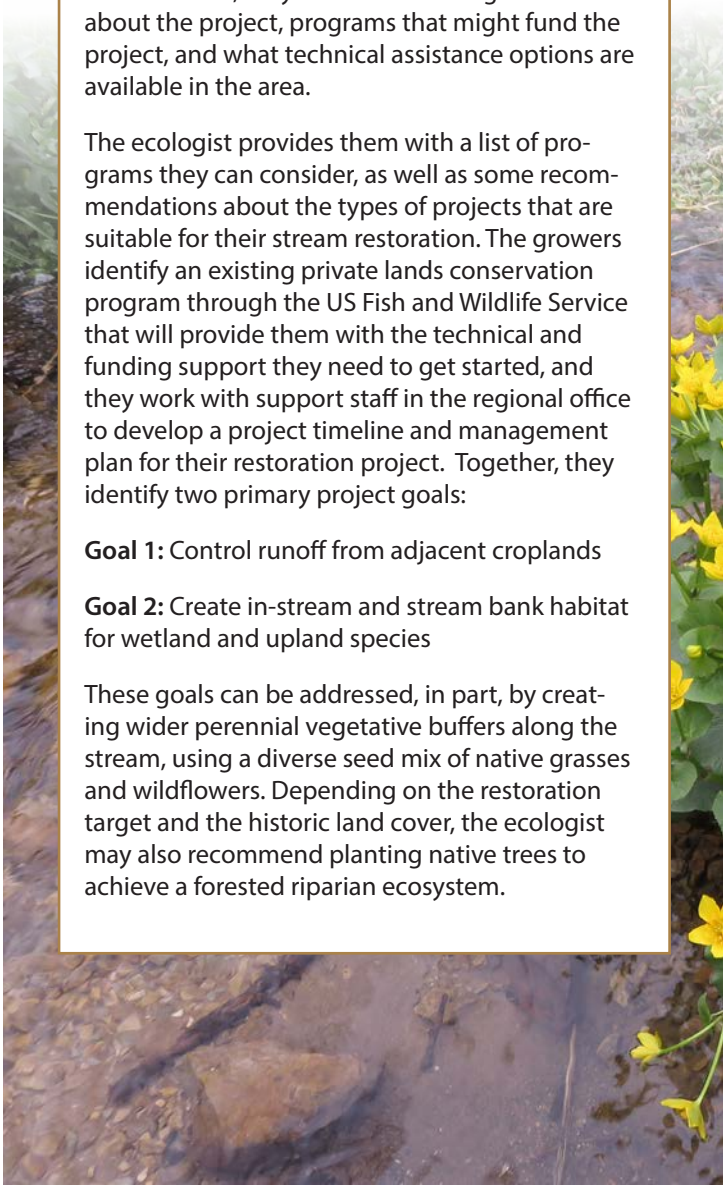
Two growers are interested in restoring sections of a stream that run through their properties. The stream has narrow banks with patchy weeds and grasses and erosion problems along steep bank sections. First, they contact an ecologist for advice about the project, programs that might fund the project, and what technical assistance options are available in the area.

The ecologist provides them with a list of programs they can consider, as well as some recommendations about the types of projects that are suitable for their stream restoration. The growers identify an existing private lands conservation program through the US Fish and Wildlife Service that will provide them with the technical and funding support they need to get started, and they work with support staff in the regional office to develop a project timeline and management plan for their restoration project. Together, they identify two primary project goals:

Goal 1: Control runoff from adjacent croplands

Goal 2: Create in-stream and stream bank habitat for wetland and upland species

These goals can be addressed, in part, by creating wider perennial vegetative buffers along the stream, using a diverse seed mix of native grasses and wildflowers. Depending on the restoration target and the historic land cover, the ecologist may also recommend planting native trees to achieve a forested riparian ecosystem.



RESTORATION TEMPLATE:

RIPARIAN WETLAND

Goal: Protect and restore riparian ecosystems to improve water quality and wetland habitat for a diversity of plant and animal species. Riparian areas serve as excellent wildlife corridors for connecting habitat blocks within a landscape.

Objective 1: Control runoff from adjacent croplands by adding or maintaining diverse perennial vegetative buffers along streams and through strategic use of in-field conservation practices.

Objective 2: Where possible, restore natural stream hydrology to improve water quality and create optimal habitat for in-stream fish and other species.

Objective 3: Identify local opportunities to link riparian restoration projects across property boundaries.

Species of conservation concern (from top): northern cricket frog and brook trout

Activity/Comments	Timing/Season
Year 1	
☐ Identify a trained wetland ecologist to assess the site and develop a site-appropriate restoration plan	
☐ Consult with ecologist to check site and develop both problem and desirable species lists	Year-round, as appropriate to species
☐ Control invasive species (as appropriate to species)	Growing season
Year 2	
☐ Develop timeline for restoration activities, include timeframe for re-establishment of natural hydrology and vegetation (if applicable)	
☐ Secure necessary permits and/or other approvals for wetland restoration work	
☐ Implement in-field conservation measures to improve stream water quality	As appropriate to practice
Year 3	
☐ Begin implementation of riparian restoration plan (plan may include stream management or for high-quality sites, simpler plans to control invasive species and boost diversity through strategic plantings)	As appropriate to plan
☐ Ensure in-stream restoration work is coupled with buffer enhancement to control runoff while implementing in-field conservation practices to control soil loss	As appropriate to practices
☐ Control invasive species (as appropriate to species)	As appropriate to species

Activity/Comments	Timing/Season
Year 4	
☐ Continue implementation of riparian restoration plan	As appropriate to plan
☐ Control invasive species (as appropriate to species)	As appropriate to species
Year 5	
☐ Explore opportunities to expand the riparian restoration area to adjacent properties, possibly in collaboration with neighbors	As appropriate to plan
☐ Continue implementation of riparian restoration plan	As appropriate to plan
☐ Control invasive species (as appropriate to species)	As appropriate to species

ENHANCING FARM POLLINATOR HABITAT

Many growers are interested in creating permanent pollinator habitats on their farm. Creating good pollinator habitat and restoring native ecosystems can be done simultaneously and include:

- Areas which maintain existing prairie or native wildflower cover
- Areas adjacent to or near diverse stands of wildflowers (these may be on neighboring private or public lands)
- Locations that are unlikely to be used or needed for other purposes, like areas that will not be used for future cropland or building areas

Once the landowner has mapped a list of the potential locations where pollinator habitat could be established, then re-establishment or restoration of pollinator habitat can begin.

Prairie is a standard restoration target for establishing pollinator habitat because it provides a diversity of flowering plants in bloom throughout the growing season. In particular, prairie is an excellent target for restoration on field corners and roadsides. However, other ecosystems, including native wetlands, barrens, oak savannas and forested communities, also provide important habitat for Wisconsin pollinators.

To develop pollinator sites, there are three steps:

1. **Site preparation:** Eliminate as many of the perennial and annual weeds from the site as possible.
2. **Planting:** Select a regionally-appropriate, diverse seed mix to provide a variety of plant species and colors throughout the season.
3. **Management:** Minimize seed production of weed species and promote germination of the planted species.

For detailed restoration plans, explore the templates provided in this publication. Work with an ecologist who can answer any questions during the planning and implementation.

CONSERVATION SPOTLIGHT

INSECT POLLINATORS

Why are insect pollinators important?

Most flowering plants on earth (more than 80%) depend on insect pollinators for reproduction by seed. Insect pollinators, which include bees, flies, beetles, butterflies, moths and wasps, are essential to the health and function of native plant communities and the animals that depend on them. Since many fruit and vegetable crops require insect pollinators, conservation of pollinator habitat generates valuable economic benefits in agricultural landscapes.

How can we maintain pollinators?

Conserve and manage existing remnants of native plant communities, whether they are grasslands, wetlands or woodlands. These remnants often contain species of native wildflowers that provide food and nesting locations for insect pollinators throughout their life cycles.

Increase floral diversity by adding more native wildflowers to existing low-diversity natural areas, plant edge or fallow locations with a pollinator seed mix or use flowering cover crops to create in-field resources for native pollinators.

Pollinator Protection Plan: The Wisconsin Department of Agriculture, Trade, and Consumer Protection developed a Wisconsin Pollinator Protection Plan to help landowners get information about pollinators and conservation efforts to preserve pollinator health. It can be viewed at: https://datcp.wi.gov/Documents/PPPARMPub257.pdf

SEED QUALITY

When starting a restoration program, source seed from locations that ensure high-quality, non-contaminated mixes. Invasive plant species' seeds have been accidentally planted into conservation areas due to seed source contamination, resulting in invasive weed problems.

Section 5: Restoration in Action

There are a number of tools and techniques that can be used to protect and enhance the diversity and function of both remnant and restored native ecosystems. To achieve the best results, it is recommended that a combination of techniques be used. Restoration is a long-term process and requires regular management to achieve site conservation objectives. Landowner commitment to stewardship of native ecosystems is important because many of these sites are dependent on prescribed fire to preserve their ecological integrity, and persistent management is required to manage invasive species.

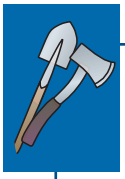
MECHANICAL REMOVAL OF VEGETATION

Why do it?

Some native ecosystems require tree thinning to reach the desirable canopy density (trees/acre) described in the site management plan. Without thinning, shade-tolerant understory plants out-compete the light dependent grasses and wildflowers of open grassland, wetland and woodland ecosystems. Mechanical removal of trees and shrubs is used as a first step in conversion of woodland to savanna. The opening of the tree canopy promotes herbaceous growth so that the site will support understory burning. For invasive herbaceous plants, pulling or mowing can be an easy, useful control method when the population is relatively small or to quickly reduce seed production by invasive plants.

How to do it

Work with an ecologist to identify and mark patches, shrubs or trees to remove. Mechanical removal of woody vegetation is commonly done with weed trimmers, loppers, brush pullers and chain saws. The time and labor requirements of using hand tools can be considerable and using large equipment (tractors, brush hogs, loggers) may be a better choice. The trade-off is that large equipment is typically non-selective, tramples vegetation and disturbs the soil that may encourage growth of weedy vegetation. To reduce the potential for invasive plants to become established, select the proper season for removing vegetation, plan for repeat treatments and determine the situations under which application of herbicide is a necessary second step.



KEY POINTS: Mechanical Removal of Vegetation

- Develop a detailed plan
- Designate trees or other plants to be removed
- Choose between hand tools or use of large equipment
- Time removal to minimize disturbance and maximize effectiveness of management action
- Repeat process as needed to achieve restoration goals
- Monitor species and ecosystem changes

Assistance numbers and websites:

Local County's Department of Natural Resources forester listed in phonebook or at the Wisconsin Department of Natural Resources

Wisconsin Department of Natural Resources, Forest Management site at http://dnr.wi.gov/topic/forestmanagement

What outcomes will be seen?

As with prescribed fire, mechanical removal of woody species produces immediate habitat structural differences and an increase in the light reaching the ground vegetation. Annual mowing or pulling of patches of herbaceous weed species before they produce seeds each year will result in noticeable reductions in weed cover and ultimately, will reduce the weed seed bank. This process may take time, and it is important to prevent new populations of weeds from becoming established. The best way to find new weed patches before they become a problem is from site visits and hikes through the restoration area.

PRESCRIBED BURNING/ FIRE

Why do it?

Historically, frequent fire was natural and essential in maintaining many native plant communities in Wisconsin. Without fire, the regional landscape and its vegetation structure changes and reduces habitat suitability for a variety of native plants and animals. With proper timing, prescribed burning controls many undesirable woody plants and herbaceous weeds while invigorating native, fire-dependent plants. Fire improves reproductive success of plants and allows for an increase in diversity and density of herbaceous plants overtime. Prescribed burning can also be used to prepare a site for planting or seeding and improve habitat for species that require open grasslands, wetlands and woodlands.

How to do it

A comprehensive fire plan for the site (also called the burn unit) needs to be developed with the help of an ecologist. An effective prescribed burn plan addresses both natural resource and safety concerns and meets the legal requirements of the project area. The prescribed burn plan includes the following:

- A map and public land survey (legal description for the site)
- A burn prescription, including weather conditions under which burning can occur at the site safely
- An implementation plan describing how the burn will be completed safely
- A list of equipment and personnel needed to complete the burn
- A list of public officials and neighbors who must be notified prior to the burn

KEY POINTS: Prescribed Burning/Fire

- Time burns properly to control undesirable species
- Develop a comprehensive fire plan
- Obtain burn permits
- Burn initially to prepare a site for planting as described in restoration plans
- Burn at additional time intervals for site maintenance
- Monitor species and ecosystem changes

Assistance numbers and websites:

University of Wisconsin-Stevens Point Fire Crew for prescribed fire assistance to private landowners in qualifying locations. See www.uwsp.edu/stuorg/fire or contact by phone, (715)-346-2897 or email, firecrew@uwsp.edu

Wisconsin Prescribed Fire Council has contacts for private contractors, training opportunities for landowners and educational materials. See: http://www.prescribedfire.org

Which native ecosystems in Wisconsin were historically maintained by periodic fire?

Most ecosystems in Wisconsin burned at one time or another, but fire for some recurred regularly. Pine/oak forest, oak savanna, oak/pine barrens, prairie and sedge meadow were all maintained by cyclic fire intervals prior to European settlement. In the absence of regular fire, these ecosystems convert to shrub-dominated and closed forest systems. Many fire adapted species, like jack pine, depend on fire for reproduction and growth.

What outcomes will be seen?

Regular application of prescribed fire in remnant or restored native ecosystems will result in a gradual thinning of the shrub layer and an opening of the tree canopy. As more light reaches the ground, landowners can expect to see the emergence or spread of populations of native wildflowers and grasses. Fire-dependent (jack pine) and shade-intolerant (white, bur and black oaks) tree species will produce more seedlings. Animal species that are dependent on an open vegetation structure will also be more apparent. It is important that prescribed fire is used in combination with invasive species management and interseeding or revegetation of low-diversity, degraded sites.

VEGETATION MANAGEMENT

Why do it?

Establishing or maintaining native plant communities typically requires control of invasive species. In remnant sites that have long been unmanaged, populations of invasive species may be large enough to suppress native biodiversity and change ecological processes. On sites where revegetation of the entire native plant community is planned, the area must be prepared for seeding or transplanting by first eliminating the existing vegetation. Integrated weed management strategies (including herbicides) are important tools.

How to do it

Monitor, mow and manage weed species and when needed, properly time and apply herbicides for precise weed management.

The particular herbicide chosen will depend on the target species, any environmental concerns, the time of year and the application method. For most invasive species, there are recommended application techniques and herbicides. Application timing will vary within the year, so proper planning is essential.

What outcomes will be seen?

When weeds or woody cover occurs in large patches or idle areas, herbicide applications in combination with mechanical control options are efficient ways to control and reduce undesirable vegetation. When herbicide is applied properly, existing remnant vegetation is spared and the cover and presence of weeds or woody species can be significantly reduced. In response, many native plants will begin to spread into these management areas, and the conditions of the site will move closer to the desired restoration goal.

KEY POINTS: Vegetation Management

- Apply herbicides to control invasive plants and unwanted weed species
- Identify invasive plants
- Select proper control techniques
- Minimize impacts to desirable vegetation
- Monitor species and ecosystem changes

Assistance numbers and websites:

Invasive Plants Association of Wisconsin (IPAW), a membership organization providing resources, news, local contacts. See www.ipaw.org

Wisconsin Department of Natural Resources, http://dnr.wi.gov/topic/Invasives/

Herbidide applications	Description
Basal bark	Technique used for small trees or shrubs. Herbicide is applied from the base of the trunk in a band around the entire stem, up to a height of 12-15" above the ground. **Pros:** Effective treatment for many problem invasive woody species. Minimal site impacts when herbicide is applied when desirable species are dormant. **Cons:** Time consuming in dense stands of woody invasive species. Requires oil-based carrier for herbicide to penetrate bark.
Cut stump	Deciduous shrubs or small trees are cut low to the ground, and herbicide is applied directly to cut stump surface. **Pros:** Minimizes application to non-target or desirable species. **Cons:** Time consuming in large areas with serious shrub infestations.
Foliar spray	Herbicide application to growing leaves of target species. **Pros:** When backpack, ATV and other mobile sprayers are used, a time efficient approach for controlling invasive weeds. **Cons:** Increased risk of negatively impacting desirable vegetation. Foliar spray is best done early in the growing season, when non-native species are actively growing and native species are dormant or in areas with minimal desirable vegetation.

ESTABLISHMENT OF NATIVE VEGETATION

Why do it?

Native plant communities provide the structure and resources that support native animals and provide many ecosystem services. In managing a conservation area, a landowner may choose to plant appropriate native species to boost diversity and restore function within an existing remnant, or in the case of a re-establishment project, plant native vegetation into landscapes.

How to do it

It is important to work with an ecologist to assess the site and create a step-by-step management plan for vegetation establishment projects. The process includes controlling any existing undesirable vegetation, prepping the site (depending on its current condition) by burning, applying a herbicide and/or tilling existing vegetation prior to planting, and using appropriate equipment for the scale and purpose of the re-establishment project.

What outcomes will be seen?

Establishing vegetation with native plantings produces great changes to a site within a short time period. The first noticeable native wildflowers in a prairie planting are typically established by the second growing season. With proper weed management, a diversity of species will produce colorful wildflowers by year three. Wetland plantings often involve a combination of seeds and seedling transplants, and with good care and watering, seedlings are often well established by the second growing season. Similarly, tree plantings as a part of a forest, woodland or savanna restoration produce immediate structural changes, and interseeding or planting a native groundlayer mix adds structural and floral diversity to restoration areas.

KEY POINTS: Establishment of Native Vegetation

- Select priority area
- Determine cost and timing
- Develop plan for the plant species
- Collect or purchase seed from nearby sources
- Prioritize seed sources from region
- Prepare a seed bed
- Eliminate invasive species
- Complete all actions on management plan
- Monitor species and ecosystem changes

Assistance numbers and websites:

Cost share assistance may be available for site preparation, seed, planting, or other restoration activities. All activities utilizing outside assistance should adhere to a grower's annual plan of work.

U.S. Fish & Wildlife Service, landowner assistance office for advice on restoring habitat. Call (608) 221-1206 ext. 21 or see http://www.fws.gov/midwest/WisconsinPartners

Establishment	Description
Interseeding	Native herbaceous species (grasses and wildflowers) are broadcast or drilled into an existing native remnant or restoration to increase diversity. This approach works best following a prescribed burn and after any invasive species at the site have been adequately suppressed.
Seeding	A native seed mix is broadcast or drilled into bare soil or a stand of dead grass. If there is existing dead vegetation, it should be mowed or burned so that the planted seed makes adequate contact with the soil.
Transplanting	Live plants are transferred into an existing remnant or ecological restoration. This approach may be used for a variety of reasons. Transplanted species may provide important structure or forage for animal species of conservation concern or be plant species that are of conservation concern and are missing from the local or regional landscape.

Section 6: Farm Stewardship & Sustainability

Population growth will increase the demand for agricultural products from farms and rural landscapes. At the same time, the agricultural land base is a key source of ecosystem services. Balancing these needs will require creative conservation and agricultural approaches, and growers should have a role in shaping these solutions.

Long-term farm conservation planning

Long-term farm conservation planning provides a process for integrating ecological restoration of native Wisconsin ecosystems into farm land use and management decisions. Guided by science, a long-term farm plan can advance a grower's conservation vision for the land by linking it with regional priorities for protection of natural resources and biological diversity.

> Growers need to be at the center of this planning process to help develop a vision for how the farm will look and decide what resources it will support over time.

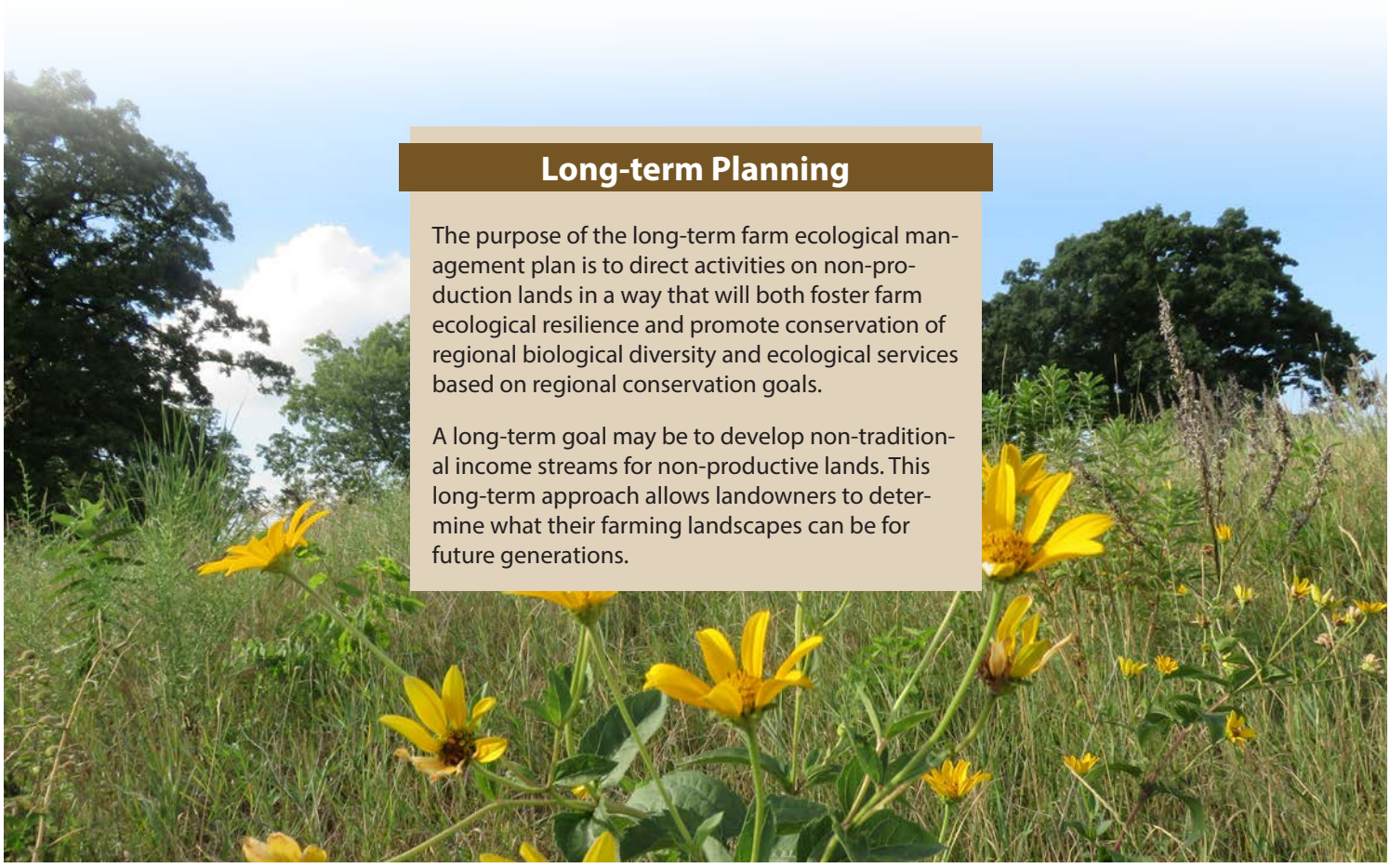
The long-term plan can include both short-term and generational conservation goals, with incremental annual steps that a grower can take to meet those goals. Landscapes are dynamic; they change each year and more dramatically over a lifetime. Regular stewardship is necessary for maintaining the quality and health of on-farm ecosystems.

Current research directions

Ecosystem management is complex and must account for multiple issues, including conservation of species biodiversity and management techniques that maintain healthy landscapes. Research is improving the understanding of how ecosystem services can be enhanced within agricultural systems.

> The long-term ecosystem management approach allows landowners to engage in new and active research projects that can help guide future ecological approaches. Engaged landowners will be at the forefront of this exciting work!

Current research directions include measurement of trade-offs between land use and ecosystem services production; development and assessment of ecosystem services marketplaces; and investigation of the effects of conservation practices across the cropland/non-cropland boundary.



Long-term Planning

The purpose of the long-term farm ecological management plan is to direct activities on non-production lands in a way that will both foster farm ecological resilience and promote conservation of regional biological diversity and ecological services based on regional conservation goals.

A long-term goal may be to develop non-traditional income streams for non-productive lands. This long-term approach allows landowners to determine what their farming landscapes can be for future generations.

Notes:

Section 7: Programmatic Resources Available

Below are several state or federal programs with resources that are available to landowners who are looking to cost-share their restoration projects. Detailed information about these programs can be found on the following pages. Additional federal, regional or local programs may be available.

Name of Program	Program Source	Program Objectives	Program Length	Reference Site
ALL ECOSYSTEMS				
Agricultural Conservation Easement Program (ACEP)	USDA-NRCS	Land easements to protect farmland or wetlands	30 years +	http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/
Conservation Reserve Program (CRP)	USDA- FSA	Farmed lands that can be used for conservation programs	10-15 years	http://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/index
Conservation Reserve Enhancement Program (CREP)	USDA- FSA	Conservation within specific state or regional goals including improving water quality and wetland habitat	14-15 years	http://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/Conservation/PDF/crepwifactsheet.pdf
Conservation Stewardship Program (CSP)	USDA-NRCS	Improved conservation performance for producers already involved in conservation activities	5 years	http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/
Environmental Quality Incentives Program (EQIP)	USDA-NRCS	Implementation of agricultural conservation practices including pollinator services	Depends on plan	http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/
Partners for Fish & Wildlife	U.S. Fish & Wildlife Service	Restoration of fish and wildlife habitat	10+ years	http://www.fws.gov/midwest/partners/getinvolved.html
FOREST ECOSYSTEMS				
Healthy Forests Reserve Program (HFRP)	USDA-NRCS	Restoration of forest on private lands	10+ years restoration, 30+ years easement	http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/
Managed Forest Law (MFL)	WDNR	Management of forest with detailed plans	Variable	http://dnr.wi.gov/topic/ForestLandowners/mfl/index.html
Wisconsin Forest Landowner Grant Program (WFLGP)	WDNR	Planning and stewardships of forests	Variable	http://dnr.wi.gov/aid/forestlandowner.html

Resources to help plan and implement conservation programs

Wisconsin Department of Natural Resources (WDNR) holds a lottery for private landowners who are interested in a conservation report for their property. Recommendations are provided for improving property habitat and for planning and implementation of stewardship practices. http://dnr.wi.gov/topic/EndangeredResources/lcr.html

Private ecological restoration contractors or other natural resource professionals can help with restoration activities from planning to implementation. http://forest.wisc.edu/sites/default/files/pdfs/publications/105.pdf

State and local land trusts are available in certain areas within the state. They protect natural resources by buying lands of high conservation value or by acquiring conservation easement agreements with landowners. Details can be found in local areas.

All Ecosystems

Agricultural Conservation Easement Program (ACEP) is administered by the U.S. Department of Agriculture's Natural Resources Conservation Service (USDA/NRCS) and provides two options for conservation in rural landscapes; 1) agricultural land easements that protect farmland (cropland, rangeland, pasture and shrubland) from conversion for other uses; and 2) wetland easements for preservation and restoration wetland ecosystems. Agricultural land easement proposals are reviewed for lands already in cropland, rangeland, pasture, shrubland or nonindustrial private forest land. Land eligible for wetland easements must be farmed or converted wetland than can be successfully restored within cost limits. Easements can be permanent, 30 year easements or term easements for the maximum allowable duration under state laws.

Funding is available in two ways, 1) purchase of the easement (100% for permanent easements; 50-75% of the easement value for 30 year and term agreements); or 2) ecological restoration costs for wetland easements (75-100% cost share for permanent easements; 50-75% cost share for 30-year easements).

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/

Conservation Reserve Program (CRP) is a program of the USDA/FSA through which growers remove environmentally sensitive land from agricultural production in exchange for a yearly rental payment. The landowner establishes perennial cover to meet the goals of the contract, and receives technical assistance and cost-share for stewardship work.

CRP applies to cropland (including field edges and corners) that has been planted to a commodity in four of the previous six years and is eligible or suitable for conservation practices approved under the program. Contract can be from 10-15 year terms. Program payments include yearly rental fees paid under the easement and cost-share payments for implementation of conservation practices.

http://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/index

Conservation Reserve Enhancement Program (CREP) is administered by the USDA/FSA in partnership with county conservation departments. CREP is a targeted conservation program that directs CRP funds toward specific state or regional conservation goals. The current CREP project in Wisconsin is intended to improve water quality and wetland habitat in Wisconsin.

Land enrolled in CREP must be in one of project counties in Wisconsin. In the Central Sand Plains and Central Sand Hills eco-regions, these counties include parts of Portage, Wood, Waushara, Marquette, Columbia and Green Lake. Enrolled land must meet the eligibility requirements for CRP and meet program goals. Contracts for CRP are for 14-15 year terms. A one-time signing incentive payment is given to the landowner based on the terms of the contract. In addition, practice incentive, cost-share payments and an annual rental payment is available.

http://www.fsa.usda.gov/Assets/USDA-FSA-Public/usda-files/Conservation/PDF/crepwifactsheet.pdf

Conservation Stewardship Program (CSP) is administered by the USDA/NRCS and targets agricultural producers who are already investing in conservation practices on their farms. Participants in the program earn higher payments for higher conservation performance. Farm projects may target soil, air, water quality/quantity, habitat restoration and/or energy conservation.

Private agricultural lands, including cropland, grassland, pasture, rangeland and nonindustrial forest land, are eligible for funding, and funding is available to all producers regardless of size or crops produced. Contracts run for five year terms via one of two options: 1) annual payments for installing new conservation practices and maintaining existing practices, or 2) supplemental payments for adopting a resource-conserving crop rotation.

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/

Forest Ecosystems

Environmental Quality Incentives Program (EQIP) is a program of the USDA/NRCS and provides funding for financial and technical assistance related to planning and implementation of conservation practices on agricultural land and non-industrial forest land. Practices must address conservation of soil, water, air, biological diversity or related natural resources. Pollinator conservation projects are a priority for Wisconsin EQIP funds.

Agricultural producers with adjusted gross income (AGI) less than $900,000 and in compliance with highly erodible land and wetland conservation requirements are eligible for funding. Growers must work with NRCS to develop an EQIP plan of operations that addresses at least one natural resource concern.

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

Partners for Fish & Wildlife is administered by the U.S. Fish and Wildlife Service (USFWS) and is a voluntary agreement through which the USFWS provides technical assistance and cost-share incentives in exchange for restoration of fish and wildlife habitat on private lands. In the Midwest, wetlands, grasslands, forests and stream corridors are priority restoration projects.

Private lands are eligible. Priority is given to projects that benefit threatened and endangered species; migratory birds or migratory fish; complement USFWS lands; reduces landscape habitat fragmentation; and promotes stewardship on permanently protected conservation lands. A minimum 10 year conservation easement is required.

Through this program, cost-share is available for ecological restoration practices, and the landowner may provide matching cost-share that is in-kind (can include labor or use of farm equipment, rather than receipts for payments).

http://www.fws.gov/midwest/partners/getinvolved.html

Healthy Forests Reserve Program (HFRP) is run out of the USDA/NRCS and provides funding for protection and restoration of forests on private lands to promote recovery of endangered or threatened species, preserve/enhance biodiversity and enhance carbon sequestration.

Privately owned lands are eligible, and 10 year restoration agreements coupled with 30 year or permanent easements for specific conservation actions are required.

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/

Managed Forest Law (MFL) is a program of the WDNR and provides landowner incentive intended to encourage sustainable forestry on private land. In exchange for sound forest management, the landowner pays reduced property taxes.

Private lands with a minimum of 10 acres of contiguous area of which at least 80% is forested are eligible. When applying for the MFL program, landowners must submit a management plan written by a certified plan writer. The plan includes landowner objectives and details about sound timber and wildlife management and protection of water quality.

http://dnr.wi.gov/topic/ForestLandowners/mfl/index.html

Wisconsin Forest Landowner Grant Program (WFLGP) is administered by the WDNR and is a cost-share program for stewardship planning and implementation on private Wisconsin forests.

Private lands with at least 10 but not more than 500 acres of contiguous non-industrial forest are eligible. Applicants must have a forest stewardship plan or apply to have one prepared through the WFLGP. Eligible projects will receive an award letter for the terms of the contract, and the landowner submits receipts for costs incurred under the cost-sharing agreement. Enrolled landowners can be reimbursed up to 50% of the cost of eligible practices. *For more information:* Applications can be submitted at any time through the local DNR forester.

http://dnr.wi.gov/aid/forestlandowner.html

Notes:

Section 8: Recommended Resources

Ecological Health/Biodiversity

How to Conserve Biodiversity on the Farm: Actions to Take on a Continuum from Simple to Complex. Baumgartner, J.A. 2016. Wild Farm Alliance. http://www.wildfarmalliance.org/biodiversity_continuum

Central Sand Hills Ecological Landscape and Central Sands Plains Ecological Landscapes. Wisconsin Department of Natural Resources. 2015. *In:* The Ecological Landscapes of Wisconsin: An Assessment of Ecological Resources and a Guide to Planning Sustainable Management. Madison, WI: WDNR. PUB-SS-1131K 2015. 84 pp.

Chapter 9: Sand Hills: http://dnr.wi.gov/topic/Landscapes/documents/1805Ch9.pdf

Chapter 10: Sand Plains: http://dnr.wi.gov/topic/landscapes/documents/1805Ch10.pdf

Grasslands

Prairie Primer. Nichols, S., Entine, L., and E. Howell. 64 pp. http://learningstore.uwex.edu/Assets/pdfs/G2736.pdf

Savanna Oak Foundation, Inc, Website with details on oak savanna identification, ecological restoration, desired and problem species, and application of prescribed fire. http://www.oaksavanna.org/

Forests

Woodland Visions – Appreciating and Managing Forests for Scenic Beauty. Klessig, L. Madison, WI: University of Wisconsin-Madison. 40 pp. http://learningstore.uwex.edu/Assets/pdfs/G3762.pdf

My Healthy Woods: A Handbook for Family Woodland Owners. Swenson, S. 2009. Baraboo, WI: Aldo Leopold Foundation. 80 pp. http://www.aldoleopold.org/Programs/myhealthywoods.shtml

Expanding Sustainable Forestry on Wisconsin Woodlands. Rickenbach, M., Knoot, T., Silbernagel, K., Nielsen, C., and A. Hellman. 2013. Madison, WI: University of Wisconsin-Extension. http://learningstore.uwex.edu/Assets/pdfs/G3996.pdf

Wetlands

Wetland Restoration Handbook for Wisconsin Landowners. Thompson, A.L. and C.S. Luthin. 2010. 2nd edition. Madison, WI: Wisconsin Department of Natural Resources Bureau of Integrated Science Services. http://dnr.wi.gov/topic/wetlands/handbook.html

Introduction to Wisconsin Wetlands: Plants, Hydrology and Soils. 1979. USGS and Wisconsin Geological and Natural History Survey. Madison, WI. 19 pp. http://learningstore.uwex.edu/Assets/pdfs/ES12.pdf

My Healthy Wetland: A Handbook for Wetland Owners. Beilfuss, K and T. Hames. 2014. Wisconsin Wetlands Association and the Aldo Leopold Foundation. 95 pp. http://wisconsinwetlands.org/MyHealthyWetlandHandbook.htm

Invasive Species

A Field Guide to Terrestrial Invasive Plants in Wisconsin. Boos, T., K. Kearns, C. LeClair, B. Panke, B. Scriver, and B. Williams. 2010. Wisconsin Department of Natural Resources. http://dnr.wi.gov/topic/invasives/documents/wi%20inv%20plant%20field%20guide%20web%20version.pdf

Invasive Plants of the Upper Midwest: An Illustrated Guide to Their Identification and Control. Czarapata, E.J. 2005. Madison, WI: University of Wisconsin Press. 215 pp. https://uwpress.wisc.edu/books/3601.htm

Invasive Plant Control Database: Midwest Invasive Plant Network. http://mipncontroldatabase.wisc.edu/

Herbicide Effectiveness on Invasive Plants in Wisconsin. Renz, M. 2013. Madison, WI: University of Wisconsin-Madison. http://learningstore.uwex.edu/Assets/pdfs/A3893.pdf

Management of Invasive Plants in Wisconsin [set]. Renz, M. and B. Panke. 2013. Madison, WI: University of Wisconsin-Extension. 148 pp. http://learningstore.uwex.edu/Management-of-Invasive-Plants-in-Wisconsin-set-P1680.aspx

BioControl and Pollinator Planting

The Xerces Society for Invertebrate Conservation. Website with numerous publication and details on pollinator protection. http://www.xerces.org/

The Wisconsin Pollinator Protection Plan. Locke, C., E. Meils, and M. Murray. 2016. Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP). https://datcp.wi.gov/Pages/Programs_Services/PollinatorProtection.aspx

Supporting Native Bees: Our Essential Pollinators. Steward, C. 2012. Madison, WI: University of Wisconsin Extension. 8 pp. http://learningstore.uwex.edu/Assets/pdfs/G4001.pdf

Notes:

Section 9: Map Appendix

About the maps

The maps depict the pre-European settlement distribution of each natural community type featured in this document.

The top graphic is the historic distribution of the natural communities for the Central Sands region, and the bottom graphic is the historic distribution for Wisconsin.

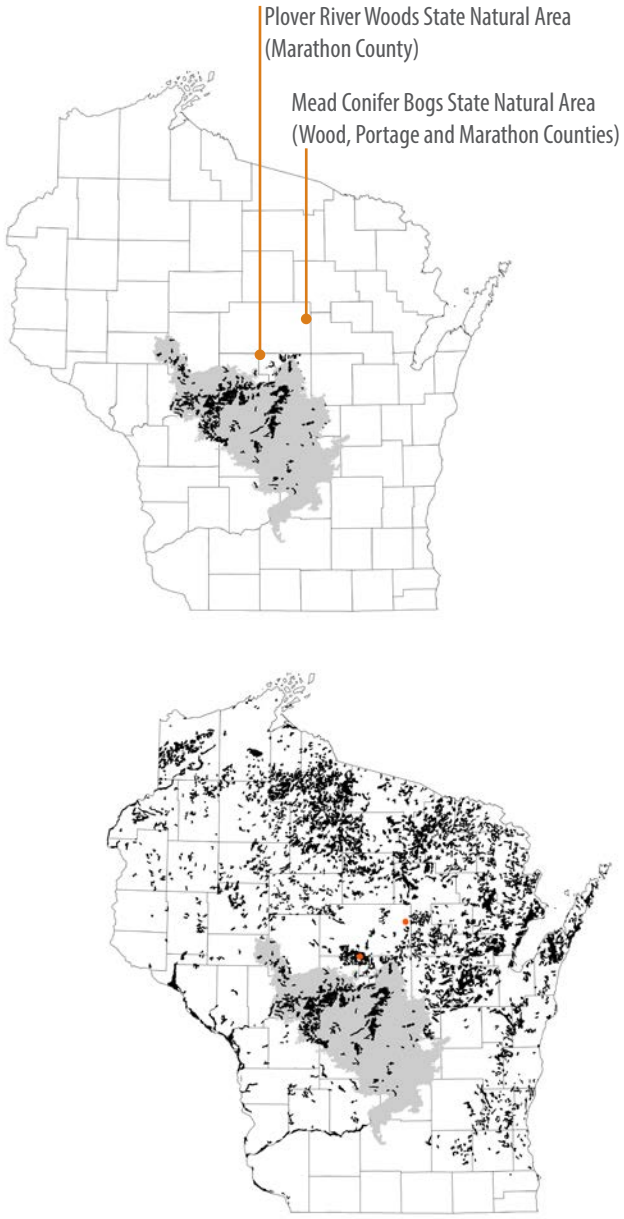
Examples of each natural community are also indicated on the maps; these are protected properties that can be explored by the public.

Data and map layer sources:

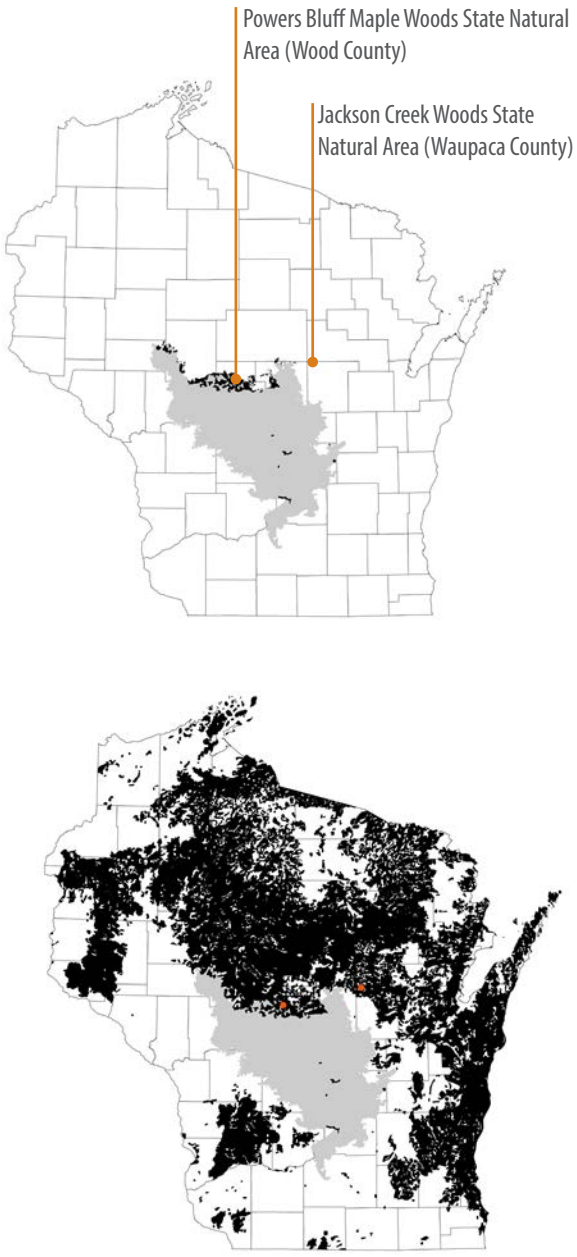
Finley, R. 1976. *Original vegetation of Wisconsin*. Map compiled from U.S. General Land Office notes. U.S. Forest Service, North Central Forest Experimental Station, St. Paul, Minnesota.

WDNR. 1990. *Original Vegetation Cover of Wisconsin: Vector Digital data*. Digitization of Finley (1976) data by Dr. Steven Ventura and University of Wisconsin-Madison students. Madison: WI.

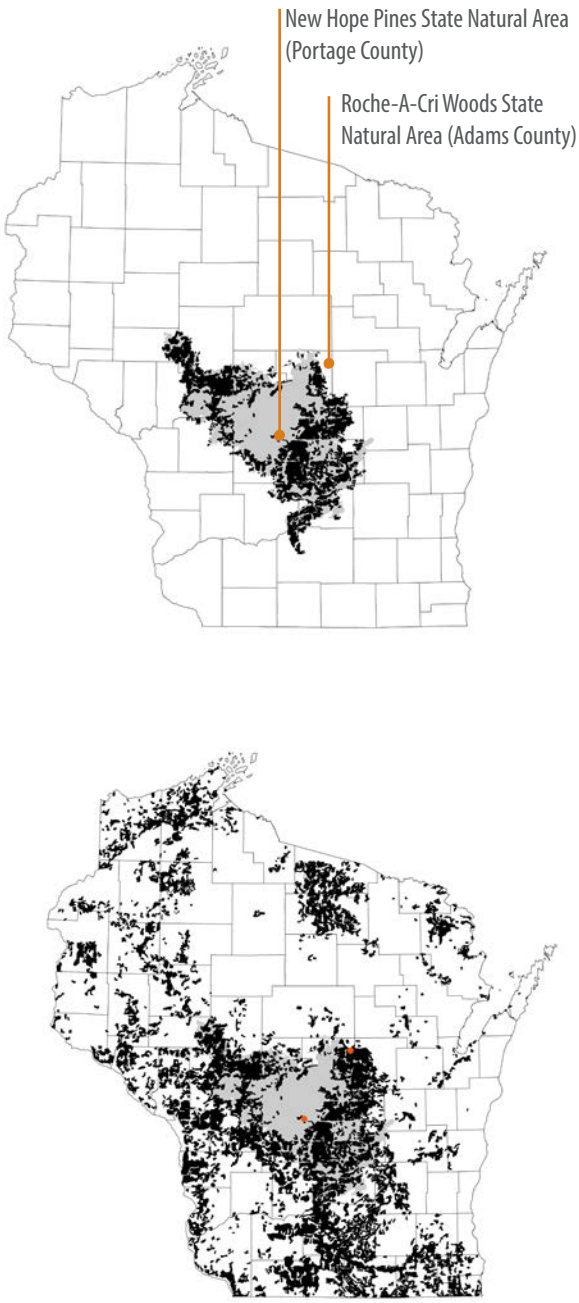
Forest Ecosystems



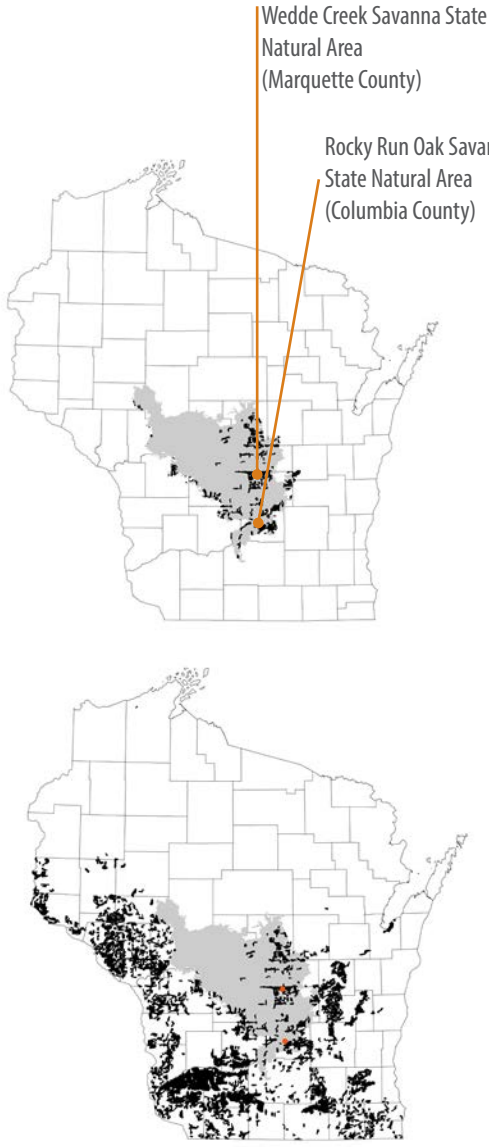
Forested Wetland Distribution
Central Sands Area (top map), Entire State (bottom map)



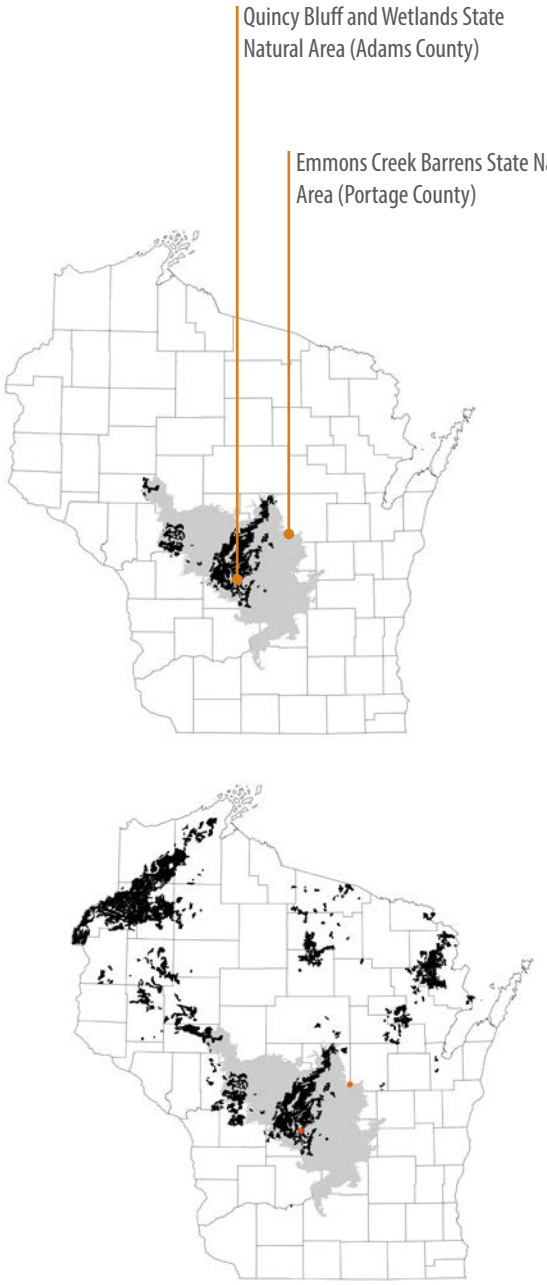
Mesic Forest Distribution
Central Sands Area (top map), Entire State (bottom map)



Pine/Oak Forest Distribution
Central Sands Area (top map), Entire State (bottom map)



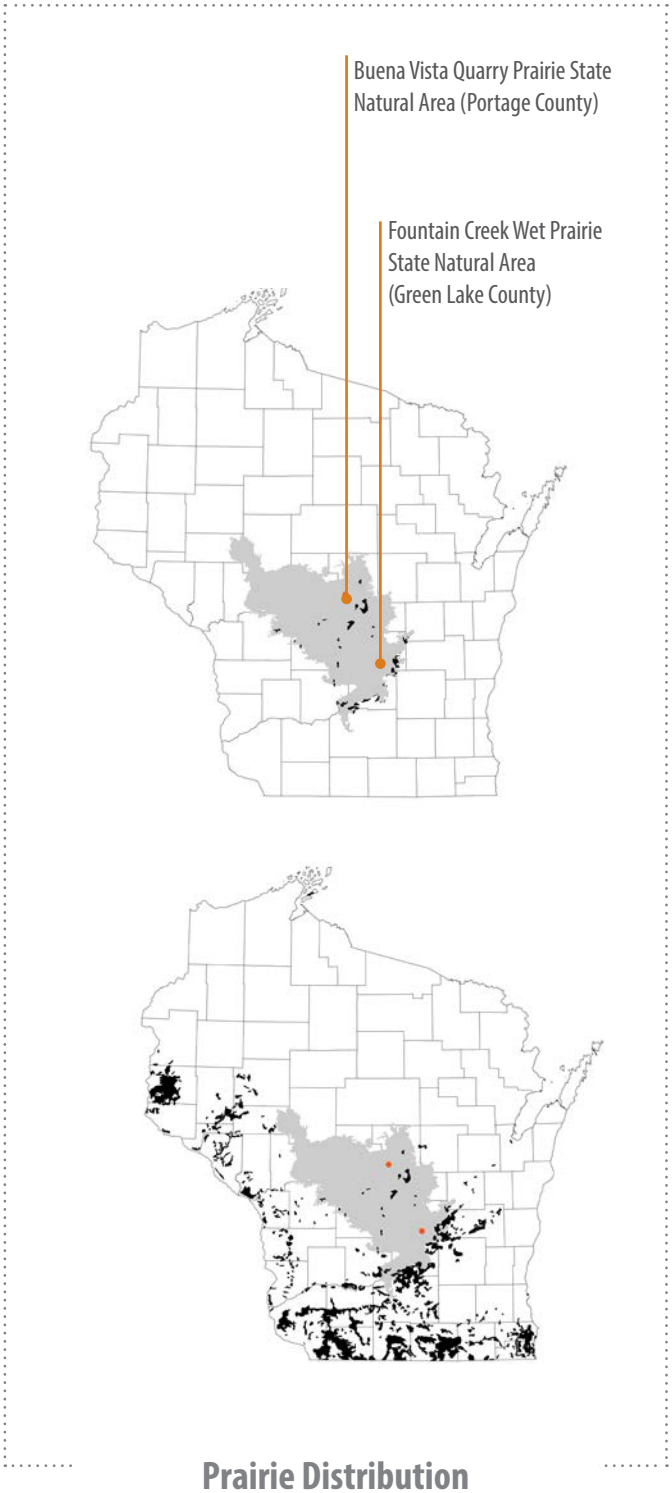
Oak Savanna Distribution
Central Sands Area (top map), Entire State (bottom map)



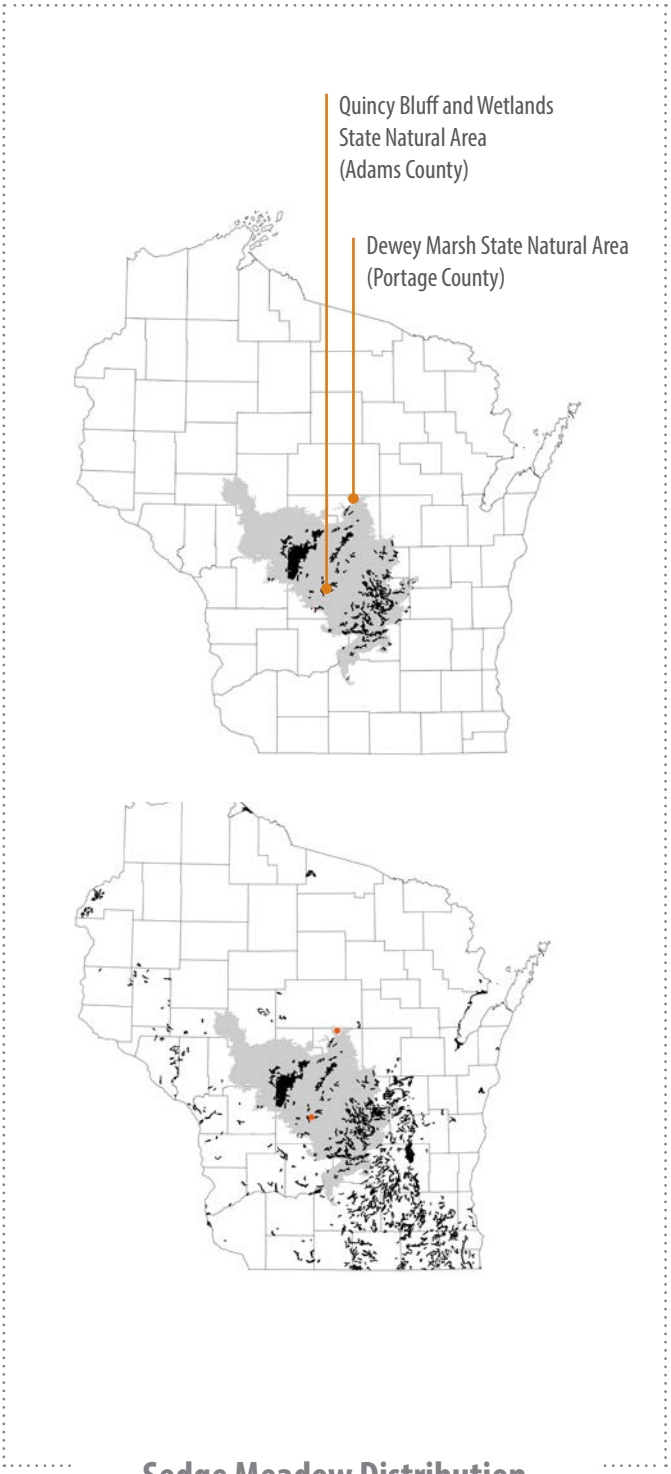
Oak Pine Barrens Distribution
Central Sands Area (top map), Entire State (bottom map)

Grassland Ecosystems *(continued)*

Wetland Ecosystems *(no map for Riparian)*



Prairie Distribution
Central Sands Area (top map), Entire State (bottom map)



Sedge Meadow Distribution
Central Sands Area (top map), Entire State (bottom map)

References

Apfelbaum, S.I. and A. Haney. 2010. *Restoring Ecological Health to Your Land*. Washington, DC: Island Press. 261 pages.

Asbjornsen, H., V. Hernandez-Santana, M.Z. Liebman, J. Bayala, J. Chen, M.J. Helmers, C.K. Ong, and L.A. Schulte. 2012. *Targeting Perennial Vegetation in Agricultural Landscapes for Enhancing Ecosystem Services.* Renewable Agriculture and Food Systems 29: 101-125.

Cochrane, T.S. and H.H. Iltis. 2000. *Atlas of the Wisconsin Prairie and Savanna Flora.* Technical Bulletin 191. Madison, WI: Department of Natural Resources and University f Wisconsin-Madison Herbarium. 226 pp.

Donald, P.F. and A.D. Evans. 2006. *Habitat Connectivity and Matrix Restoration: The Wider Implications ff Agri-Environment Schemes.* Journal of Applied Ecology 43: 209-218.

Finley, R.W. 1976. *The Original Vegetation of Wisconsin*. USDA Forest Service Map.

Fischer, J. and D.B. Lindenmayer. 2007. *Landscape Modification and Habitat Fragmentation: A Synthesis*. Global Ecology and Biogeography 16: 265-280.

Haines, A., L. Markham, D. McFarlane, E. Olson, R. Roberts and L. Stoll. 2010. *Wisconsin Land Use Megatrends.* Center for Land Use Education, University of Wisconsin-Extension

Hey, D.L. and N.S. Philippi. 1995. *Flood Reduction Through Wetland Restoration: The Upper Mississippi River Basin as a Case History*. Restoration Ecology 3: 4-17.

Jarchow, M.E., I. Kubiszewski, G.L. Drake Larsen, G. Zdorkowski, R. Costanza, S.R. Gailans, N. Ohde, R. Dietzel, S. Kaplan, J. Neal, M.R. Petrehn, T. Gunther, S.N. D'Adamo, N. McCann, A. Larson, P. Damery, L. Gross, M. Merriman, J. Post, M. Sheradin, and M. Liebman. 2012. *The Future of Agriculture and Society in Iowa: Four Scenarios.* International Journal of Agricultural Sustainability 10(1): 76-92.

Landis, D.A., S.D. Wratten, and G.M. Gurr. 2000. *Habitat Management to Conserve Natural Enemies of Arthropod Pests in Agriculture.* Annual Review of Entomology 45: 175-201.

Locke, C., E. Meils, and M. Murray. 2016. *The Wisconsin Pollinator Protection Plan.* Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP). https://datcp.wi.gov/Documents/PPPARMPub257.pdf

Mallinger, R.E. and C. Gratton. 2015. *Species Richness of Wild Bees, but not the Use of Managed Honeybees, Increases Fruit Set of a Pollinator-Dependent Crop.* Journal of Applied Ecology 52(2): 323-330.

Park, M.G., E.J. Blitzer, J. Gibbs, J.E. Losey, and B.N. Danforth. 2015. *Negative Effects of Pesticides on Wild Bee Communities Can Be Buffered by Landscape Context.* Proceedings of the Royal Society B 282: 20150299.

Pleasants, J. and K. Oberhauser. 2013. *Milkweed Loss in Agricultural Fields Because of Herbicide Use: Effect on the Monarch Butterfly Population.* Insect Conservation and Diversity 6(2): 135-144.

Potts, S.G., J.C. Biesmeijer, C. Kremen, P. Neumann, O. Schweiger, and W.E. Kunin. 2010. *Global Pollinator Declines: Trends, Impacts and Drivers.* Trends in Ecology and Evolution 25(6): 345-353.

Rao, M.N. and Z. Yang. 2010. *Groundwater Impacts Due to Conservation Reserve Program in Texas County, Oklahoma.* Applied Geography 30: 317-328.

Schilling, K.E. 2009. *Investigating Local Variation in Groundwater Recharge Along a Topographic Gradient, Walnut Creek, Iowa, USA.* Hydrogeology Journal 17: 397-407.

Schulte, L.A., M. Liebman, H. Asbjornsen, and T.R. Crow. 2006. *Agroecosystem Restoration Through Strategic Integration of Perennials.* Journal of Soil and Water Conservation 61(6): 164A-169A.

Tschumi, M., M. Albrecht, C. Bartschi, J. Collatz, M. Entling, and J. Jacot. 2016. *Perennial, Species-Rich Wildflower Strips Enhance Pest Control and Crop Yield.* Agriculture, Ecosystems, and Environment 220: 97-103.

Turner, R.E. and N.N. Rabalais. 2003. *Linking Landscape and Water Quality in the Mississippi River Basin For 200 Years.* BioScience 53(6): 563-572.

Udawatta, R.P., H.E. Garrett, and R. Kallenbach. 2011. *Agroforestry Buffers for Nonpoint Source Pollution Reductions from Agricultural Watersheds*. Journal of Environmental Quality 40: 800-806.

University of Wisconsin-Madison. 1990. *Original Vegetation Cover of Wisconsin* [vector digital data]. 1:500,000 scale. Madison, WI: Wisconsin Department of Natural Resources. ftp://dnrftp01.wi.gov/geodata/orig_veg_cover/

USDA Economic Research Service. 2014. *Annual Cash Receipts by Commodity, U.S. and States.* http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/

USDA-National Agricultural Statistics Service (NASS). 2015. *State Agriculture Overview: Wisconsin.* https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=WISCONSIN

USDA National Agricultural Statistics Service. 2014. 2012 Census of Agriculture: Wisconsin State and County Data. Vol. 1(49), Geographic Area Series.

Whittingham, M.J. 2011. *The Future of Agri-Environment Schemes: Biodiversity Gains and Ecosystem Service Delivery?* Journal of Applied Ecology 48: 509-513.

Wisconsin Department of Natural Resources. 2015. *Central Sand Hills Ecological Landscape (Chapter 9). In: The Ecological Landscapes of Wisconsin: An Assessment of Ecological Resources and a Guide to Planning Sustainable Management.* Madison, WI: WDNR. PUB-SS-1131K 2015. 84 pp.

The Xerces Society. 2003. *Pollinator Conservation Handbook.* 145 pp.

The Xerces Society. 2011. *Attracting Native Pollinators: Protecting North America's Bees and Butterflies.* Burns, D., Editor. North Adams, MA: Storey Publishing.

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28	Pollinator	Mimi Broeske	
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32	Bumble bee on lupine	Alison Duff	
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