

A Framework for Wetland Resources Management in the Capital Area



DRAFT

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A FRAMEWORK FOR WETLAND RESOURCES MANAGEMENT IN THE CAPITAL AREA

I. EXECUTIVE SUMMARY

The *Dane County Water Quality Plan* is the official areawide water quality management plan for Dane County, Wisconsin as authorized under Wis. Adm. Code NR 121. The purpose of the Plan is to provide a policy framework and guidance for federal, state, and local water quality management programs in the region. The Plan has been continually revised, updated and expanded since its initial adoption and certification in 1979. The Plan currently includes 11 technical appendices containing detailed data and supporting information in a variety of water resource management subject areas (e.g., ground and surface water resources, point and non point source pollution, environmental corridors, etc.). Whereas the subject of wetlands has been included indirectly, our understanding, perceptions, and management actions have evolved significantly in recent years – warranting more focused consideration of management needs and conservation approaches. The purpose of this *Framework for Wetland Resources Management in the Capital Area*, therefore, is to identify the current resource information gaps, the steps and inventories needed to fill these gaps, and the institutional cooperation and coordination needed for developing and implementing a regional *Wetland Resources Management Plan* as a specific element of the *Dane County Water Quality Plan*.

Wetlands are among the most complex and least understood natural community types. One of the greatest threats to wetlands has been the incremental and piecemeal destruction often described as “death by a thousand cuts.” The loss of wetland resources has become a national problem. Once regarded as mosquito-infested wastelands, we now realize the significant value they provide in terms of water quality and flood protection, wildlife habitat and recreation, open space and scenic beauty, among many other valuable services and amenities. In Dane County, over half of the wetlands have been lost over the last century. Many of those that remain have been degraded. This has resulted in the loss of important wetland functions and values. It has become increasingly recognized that all wetlands have value – particularly since there are fewer of them remaining. One can assume that the existing fabric of federal, state, and local wetland permits is adequate to protect wetlands within their jurisdictions. However, while it is true that these permits address some *direct impacts* to wetlands (e.g., filling, dredging, draining), the *indirect impacts* are customarily not addressed through these permits. Efforts are needed at the local level to protect, enhance, and restore the wetland resources throughout the region, not only protecting them from future threats but also *increasing* the many values which they provide.

Historically the focus has been on increasing real estate values and agricultural production, and less on the impact to lowland areas. The primary disturbance to wetlands in rural areas has been artificial drainage due to agriculture. Ditching and buried drain tiles, used to remove surface water so the land can be cultivated, alter the wetland's hydrology and can have significant long-term impacts on the wetland overall.



Ditched and Drained Wetland



Stormwater Outfall

In older urban areas the addition of storm water runoff from streets and parking lots, yards, and roofs can also degrade a wetland. These storm sewers often drain directly into wetlands and rivers, unloading excess water volumes, chemicals, fertilizers and other hazardous substances into these natural ecosystems.

In addition, invasive species such as reed canary grass, purple loosestrife, and hybrid cattails are extremely aggressive plants that can out-compete and force out beneficial native plant species, upsetting the natural balance. Their presence in a wetland indicates that some disturbance has allowed the plants to gain entry.

Recognizing this, wetland restoration, protection and enhancement activities have become an increasing priority in Dane County, Wisconsin, and throughout the United States. Various federal, state and local programs have been developed in cooperation with landowners to protect existing wetlands from further harm; offer incentives to restore drained wetlands; and enhance the functions and values of degraded wetlands. These programs are becoming increasingly popular with landowners by offering incentives and payments to restore or leave a wetland in its natural condition, which may be marginal to begin with because it is too wet for more intensive purposes.

Previously ditched and tiled wetlands offer significant restoration opportunities since it is often relatively easy to restore the natural hydrology. This can be accomplished by plugging ditches and breaking tile lines. Natural vegetated buffer strips are also important for protecting wetlands from sediment and other pollutants washing off the land, as well as providing valuable wildlife habitat. Wetlands can also be enhanced through management activities such as selective burning, re-introduction of native vegetation, and invasive species control. Through these efforts Dane County wetlands could provide more of the original resource values and benefits that have been lost or diminished over the last century.

Landowner participation and community support is the key to accomplishing significant wetland protection, restoration, and enhancement in the region. Most land is in private ownership. Significant improvements in wetland quality and quantity could be achieved if private landowners restored or improved wetlands on their properties. This can be aided through partnerships with developers, watershed associations, and conservation groups, along with financial and technical assistance provided by federal, state, and local units of government.



The selection and cost of specific management tools and targeted activities will depend on a number of factors. These factors should be based on an assessment of the site characteristics; an evaluation of the land use, policy, and financial constraints; and focused on a desired management strategy and outcome. Each management opportunity (e.g., willingness of the landowner, availability of funding, historic impacts, position in the landscape, wetland susceptibility, etc.) should be considered both on-site as well as a part of a larger natural resources *system* using the comprehensive wetland resources management planning process outlined in this report.

Comprehensive wetland resources management plans need to be developed and have sufficient detail that local government units can, in collaboration with local stakeholders, identify and prioritize issues of concern and develop targeted projects to address those concerns. Positioned between both the terrestrial and aquatic environments, wetlands provide a natural cornerstone for initiating natural resources protection and improvement projects that touch on so many aspects of our individual lives as well as the quality of life we experience in the region collectively. The primary emphasis should be on water and watershed management including implementation through both short- and long-term work plans and budgets, taking into consideration available opportunities and shared resources. These efforts can address a variety of water resource concerns simultaneously, including water quality protection and improvement, flood management and control, wildlife habitat and outdoor recreation, open space, and scenic beauty, to name just a few.

Development of wetland plans should be locally-led and watershed-based including prioritized, targeted, and measurable implementation actions. This includes acknowledging and building off existing plans and data as well as local government services, programs, and capacities. A key to success will be integrating and leveraging local units of government and community groups to collaborate, create, and implement successful watershed plans and supporting projects. The individually-tailored watershed plans would provide the technical detail and constitute specific geographic elements of a Wetlands Resources Management Plan for the region as a whole, thereby serving as a living/breathing technical appendix to the *Dane County Water Quality Plan*, the areawide water quality plan for the region promulgated under NR 121.

In the end, the management strategy for each wetland will be as unique as the wetland itself. The most appropriate management efforts will be determined and acted upon by considering all the natural resource elements, as well as the partnerships and cooperation

that may be developed among the various stakeholders. The *Framework for Wetland Resources Management in the Capital Area* provides the basis for forming those relationships and taking the necessary actions for protecting, enhancing, and restoring the wetlands of Dane County and, thereby, promoting significant natural resource protections and improvements in the region overall.

Development of wetland plans should be locally-led and watershed-based including prioritized, targeted, and measurable implementation actions.

II. BACKGROUND

A. Wetland Losses

Wetlands are ecosystems typically found where land and water meet on the landscape. They are transitional areas between dry upland and wet aquatic environments. Wetlands may form along the edge of lakes, rivers and streams, in low isolated spots on the landscape, or where groundwater bubbles to the surface through springs and seeps.

Over the past 200 years, more than half of the wetlands in the lower U.S. have been lost and many of the remaining wetlands have been degraded.¹ Most of the drainage activity took place because it was widely believed that wetlands were regarded as “wastelands,” serving no useful purpose. The Federal Swamp Land Act of 1850 encouraged draining wetlands for agricultural use; and the General Mining Act of 1866 protected local rights to use water for mining, agriculture, manufacturing, or other “useful” purposes. It has since been recognized that wetlands, like all other parts of the natural environment, are an integral part of a complex ecological system, providing valuable ecosystem services. The concept of an ecological system is about linkages: everything in the ecosystem is connected directly or indirectly to everything else. It is impossible to alter one element without affecting the ecosystem itself or its other component parts.²

There has been a great deal of research over the years on wetlands and how they affect both flooding and water quality, in addition to other important aspects such as waterfowl and wildlife habitat. Research shows watersheds with fewer wetlands have flashier stream flows and water quality tends to be poorer. Wetlands are important for storing large amounts of water as well as stabilizing sediment, nutrients and other pollutants, keeping them from impacting areas located farther downstream. It is almost always more effective and economical to control pollution at the source, rather than trying to address the

Over 50 percent of the County’s wetlands have been lost along with valuable community services and benefits.

¹ Interagency Workgroup on Wetland Restoration: NOAA, EPA, USACE, USFWS, NRCS. 2003. *An Introduction and User’s Guide to Wetland Restoration, Creation, and Enhancement*. NOAA Silver Spring, MD.

² Bedford, B., E. Zimmerman, J. Zimmerman and Dane County Regional Planning Commission. 1974. *The Wetlands of Dane County, Wisconsin*. Madison, WI.

problem after it has affected area lakes or streams. Wetlands provide a critical buffer in this chain of events between cause and effect.

Wetland areas that have been lost in Dane County are presented on **Map 1**, showing the distribution of present and former wetlands. Over 50 percent of the county's wetlands have been drained and are no longer a component part of the natural ecosystem. Approximately 36,000 acres were reported lost between 1901 and 1936.³ Between 1939 and 1961 the Wisconsin Conservation Department listed 22,678 wetland acres lost.⁴ Recent estimates using GIS indicate a total loss of 63,172 acres, or 54 percent of the original wetland acreage.

According to the U.S. Fish and Wildlife Service, historic losses in wetlands have resulted in increased flooding and habitat loss. These losses and alterations compromise the important benefits provided by wetlands including water quality protection, providing habitat for a wide variety of plants and animals, and reducing flood damage, among others. While protecting the remaining wetland resources is critical to the overall environmental health and well-being of region and the nation, *enhancing, restoring, and creating* wetlands are also essential to help replace the quality and quantity of the aquatic ecosystems as well as the tremendous services they provide.

Therefore, while we are fortunate that we still have about half of our historical wetland acreage, we should also be concerned about the condition of the wetlands remaining. Invasive species such as reed canary grass and hybrid cattails are extremely widespread and often dominant. The expansion of exotic species like purple loosestrife has also caused the decline of many native species and their associated habitats. How can we halt and reverse such losses? Four positive actions can be taken (**Figure 1**):

- Protect the remaining wetlands and manage them to sustain their natural diversity.
- Enhance or improve conditions at wetlands that are losing diversity.
- Restore former wetlands to expand acreage and regain the benefits for habitat, flood control, and water quality
- Create new wetlands to promote watershed protection and help realize a net *gain* in wetland acreage overall.

While **Map 1** illustrates the significant extent of wetland conversion that has occurred throughout Dane County, it can also be used to help target these areas for restoration, protection and enhancement activities by government agencies working with private landowners and citizen groups. Prior-converted and farmed wetlands often provide the best opportunities to restore or enhance wetlands that have been lost or degraded over the last century. Wetland management strategy development is discussed more fully in **Attachment A**.

³ Frolick, A.L. 1941. *Vegetation of the Peat Lands of Dane County Wisconsin*. Ecol. Monogr. 11:117-140.

⁴ Wisconsin Conservation Department. 1961. *Dane County Wetlands*. Wisconsin Wetland Inventory. Madison, WI.

Figure 1

Definition of Categories for Wetland Conservation Activities

Protection/Maintenance – The removal of a threat to, or preventing decline of wetland conditions by an action in or near a wetland. Includes purchase of land or easement, repairing water control structures or fences, or structural protection such as an upland stormwater management facility. This term also includes activities commonly associated with the term preservation. Protection/Maintenance does not result in a gain of wetland acres or function.

Enhancement – The manipulation of the physical, chemical, or biological characteristics of a wetland site (undisturbed or degraded) to heighten, intensify, or improve specific function(s) or for a purpose such as water quality improvement, flood water retention or wildlife habitat. Enhancement results in a change in wetland function(s) and can lead to a decline in other wetland function, but does not result in a gain in wetland acres. This term includes activities commonly associated with the terms enhancement, management, manipulation, directed alteration.

Restoration – The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to former or degraded wetland. For the purpose of tracking net gains in wetland acres, restoration is divided into:

- *Re-establishment*: the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland.^a Re-establishment results in rebuilding a former wetland and results in a gain in wetland acres.
- *Rehabilitation*: the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions of a degraded wetland.^b Rehabilitation results in a gain in wetland function, but does not result in a gain in wetland acres.

Establishment/Creation – The manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist on an upland^c or deepwater^d site. Establishment results in a gain in wetland acres. (This activity should not be confused with “constructed” wetlands for the primary purpose of wastewater or stormwater runoff treatment.)

Condition of the Land Prior to Wetland Conservation Activity

a Former Wetland: An area that once was a wetland but it has been modified to the point it no longer has the hydrologic characteristics of a wetland. The area is considered to be upland. Former wetlands include by definition Prior Converted Wetlands (PC) and, by determination, other areas that no longer meet the jurisdictional criteria for wetlands.

Prior converted wetland (PC): Wetlands that before December 23, 1985, were drained, dredged, filled, leveled, or otherwise manipulated for the purpose of, or to have the effect of, making the production of an agricultural commodity possible. (National Food Security Act Manual)

b Degraded Wetland: A wetland with one or more functions reduced, impaired, or damaged due to human activity. When determining whether or not a wetland is degraded, consider: physical alteration, including the conversion of a wetland from one system (e.g., estuarine or marine) to a different system; chemical contamination; and biological alteration, including the significant presence of non-indigenous invasive species.

c Uplands: Uplands are neither deepwater habitats nor wetlands. They are seldom or never inundated, or if frequently inundated, they have saturated soils for only brief periods during the growing season, and, if vegetated, they normally support a prevalence of vegetation typically adapted for life only in aerobic soil conditions.

d Deepwater Habitat: Deepwater habitats are permanently flooded lands lying below the deepwater boundary of wetlands. The boundary between wetlands and the deepwater habitats of lakes and rivers lies at a depth of 2 meters (6.6 feet) below low water. If emergents, shrubs, or trees grow beyond this depth at any time, their deepwater edge is the boundary.

B. Geology and the Formation of Wetlands in Dane County

The sizes, shapes and distribution of wetlands are affected by geologic history. **Map 2** shows Dane County divided into five physiographic regions according to topography and glacial geology.

1. Wisconsin River Valley

The Wisconsin River Valley is an important and extensive wildlife corridor, only a small portion of which is located in Dane County. This region is dominated by floodplain topography, with the county's only sizeable floodplain forest on alluvial deposits. The flat topography and slow drainage causes wetlands such as sedge meadows to occur a short distance from the river's edge. River floodplain forest, sedge meadow, and shrub carr are the most prominent wetland types. Though much of the floodplain has been grazed or cultivated, it is important to maintain the integrity of the river and the bordering wetlands that remain.



Features

Floodplain topography including floodplain forest, sedge meadow, shrub carr
Part of an important and extensive wildlife corridor through Wisconsin

Impacts

Grazing and cultivation

Goal

Maintain the integrity of the river corridor; protect existing wetlands and restore prior-converted wetlands

2. Valley and Ridge

This is the stream valley topography typical of erosion of bedrock, and is the part of the “Driftless” or non-glaciated area of the state that extends into Dane County. This region exhibits older, dendritic drainage patterns, and its topography is such that wetlands are not abundant. Those wetlands that do occur are located along narrow stream valleys. Since they are often abundantly spring-fed and well-oxygenated, the streams of the Driftless Area offer the county's best trout fishing opportunities.



The stream valley wetlands in Dane County are of the same form as elsewhere along the southern part of the Wisconsin River watershed. However, alluvial deposits along these small narrow valleys are not extensive enough to allow development of floodplain forests. Small deposits are found along the stream banks with sedge meadows and shallow marshes a short distance from the stream. These wetland areas are necessarily narrow and restricted to the flatter locations in their watershed.

With the cessation of fire and a history of grazing and possible sedimentation, some of the sedge meadows have been altered to shrub dominated communities. In many cases, cottonwoods, box elder, and willows have become more abundant along the streambanks and spoil piles along stream ditches. In such narrow valleys where the competition for land is intense, economic necessity has often forced farmers into using marginal pasture for cattle, to the advantage of neither the cattle nor the wetlands. Many of the valleys are still being grazed, thus reducing the value of the wetlands as ecological communities. The most obvious value of these wetlands is for flood control and water quality treatment.



Features

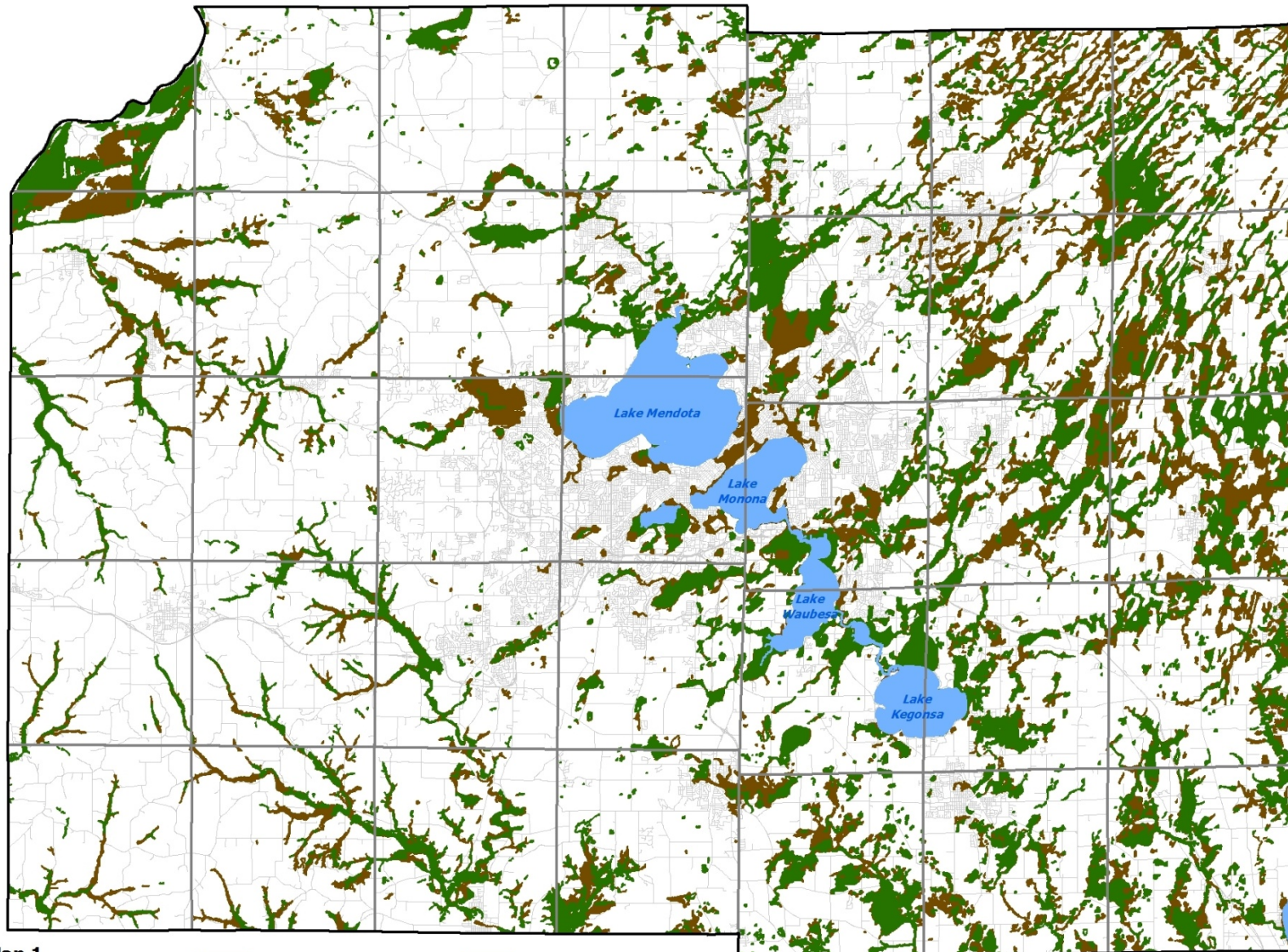
Dendritic topography, wetlands not abundant
Sedge meadow, occasional shallow marsh

Impacts

Grazing and siltation

Goal

Promote watershed protection (both water quality and quantity)



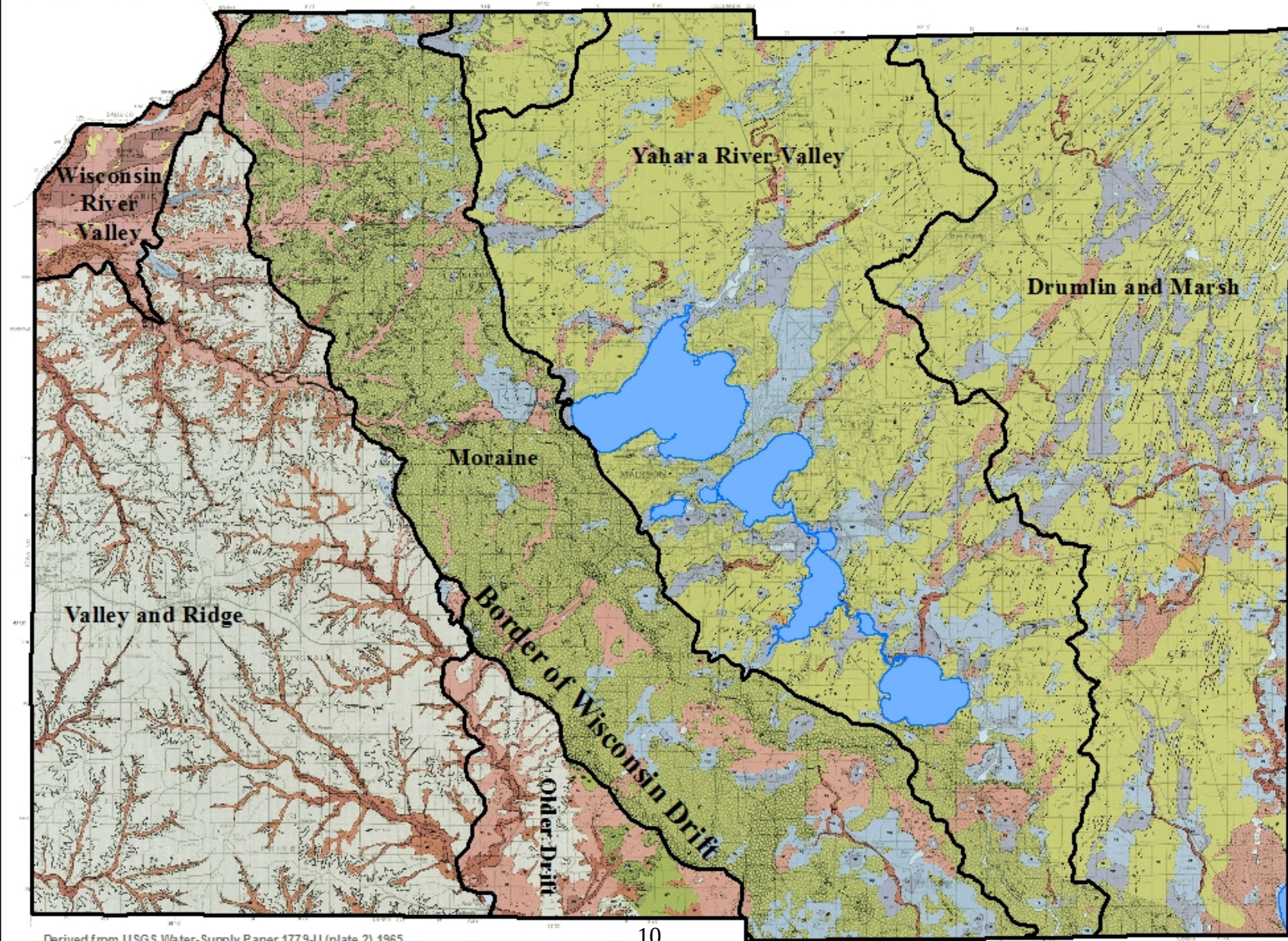
Map 1
Existing & Former Wetlands
Dane County, WI.

Existing Wetlands * **Former Wetlands ****

Feb. 2015

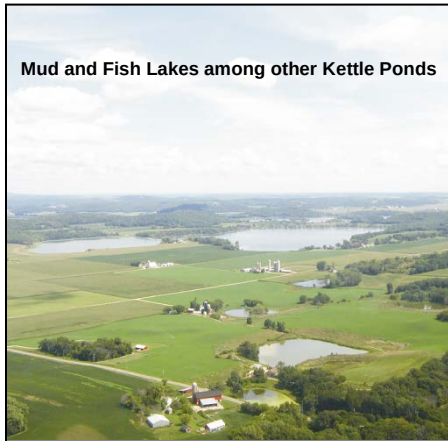
* Derived from the 2010 Wisconsin DNR Mapped Wetland Inventory. ** Potentially restorable wetlands derived from hydric soils contained in the NRCS Dane County Soil Survey, revised 1998, and excluding DNR mapped wetlands.

Map 2. Physiographic Areas and Deposits of Pleistocene Age - Dane County, WI



Derived from USGS Water-Supply Paper 1779-U (plate 2) 1965.
For more detailed information see Pleistocene Geology of Dane County, WI (WGNHs Bull. 9.5, 1997).

3. Moraine



A broad strip of terminal and recessional glacial moraine deposit characterizes this region. The thickness of the sand and gravelly material varies considerably so that much of the terrain is filled with small steep hills and kettle holes, or ice-formed depressions. Consequently, the wetlands of this region are characteristically of the depression type, rather than stream valley. Wetlands here tend to be small, isolated, and often steep-sided. They often occur in groups with gravelly deposits between them. Several deep marshes occur in small, isolated lakes. The steeper-sided kettle holes are frequently too steep to support wetland vegetation. When these occur in proximity to other wetland areas, however, the combination provides valuable

waterfowl habitat.

The major stream system of wetlands which did exist in this region, the Badfish Creek system, has been extensively altered by drainage efforts, channelization, and cultivation. Badfish Creek also receives effluent from the Madison Metropolitan Sewerage District's Nine Springs Treatment Plant. A few isolated pockets of spring-fed tributary streams and relatively undisturbed wetland still exist.

Features

- Small steep hills and kettle holes
- Depression-type wetlands tend to be small, isolated, and steep-sided
- Several deep marshes occur in small, isolated lakes which tend to be high quality

Impacts

- The Badfish Creek system has been extensively altered by drainage, channelization and cultivation

Goal

- Protect high quality features
- Restore and enhance degraded features

4. Yahara River Valley

The Yahara River Valley and its major tributary valleys existed before the recent Wisconsin Glaciation and can be seen on a bedrock topographic map. Much of this valley system is now filled with glacial till, which preserved the drainage pattern but made it shallower and slowed the flow of water. Thus, the size, shape, and distribution of the wetlands in this area are controlled by both the bedrock and glacial deposit patterns. In addition, the riverbed is in contact with the groundwater through permeable



glacial till. If during a flood the level of the river should rise above that of the surrounding water table, there will be a percolation of water away from the river bed to groundwater. Conversely, during a dry period the riverbed will receive groundwater. This, along with a fairly constant discharge from springs and seepages, helps stabilize the river. The combination of shallow gradient, stable water levels, and constantly moist conditions has led to the formation of the large peat deposits which are typical of the Yahara watershed. Wetlands here tend to be large, interconnected, and surrounded by low hills. Generally, groundwater is supplied by rainwater infiltrating in the hills and other “recharge” areas. Springs and seeps in “discharge” areas often promote the buildup of peat in these constantly waterlogged areas.

Since the discharge from the springs and seepages is made alkaline and calcium-rich by both the glacial till and the limestone bedrock, many of these peat meadows are characterized as calcareous “fens” or have portions of fen along the shallow edges. Fens are distinctive in this respect, along with the community of plants and animals they support. There do not appear to be another group of fens in North America as extensive as those in Dane County before drainage and filling began, although calcareous fens do occur throughout other limestone regions of the Midwest.⁵

Some wetlands provide critical nursery habitat for fish. For example, northern pike deposit eggs on mats of aquatic vegetation that occurs along lake fringes and stream headwaters – Cherokee Marsh and Door Creek Wetlands are good examples of this. After hatching, the fry attach themselves to wetland vegetation that provides protection and food. Other species such as walleye, muskellunge, bass, perch, bluegill, and various minnow species also use quality wetlands as nursery habitats. When lake-edge wetlands are destroyed and shorelines become heavily developed, fish populations suffer. Therefore, wetland restoration is vital to the maintenance and improvement of fish habitat.

The wetlands of the Yahara system, along with the waterfowl habitat and fishery values, depend on wise water management. Ditching in the tributary streams and river-edge wetlands has been partially successful in increasing the land area available for agriculture, but at a cost to the river. Increased surface runoff adds sediment, nutrients, and flood waters to the river. Ditching peat, as at Cherokee Marsh, also increases the nutrient load as the peat oxidizes and releases stored nutrients. Aquatic plant and animal communities are set out of balance, wildlife habitat is lost, and the natural qualities of the system deteriorate.

Table 1 shows the wetland area and losses between 1835 and 1974.⁶ These wetland areas were undoubtedly very important for providing habitat for unique plant and animal communities, maintaining water quality, and preventing or reducing the risk of floods. For these reasons and more, restoration of as many wetlands as possible is needed here.

⁵ Bedford, B., E. Zimmerman, J. Zimmerman and Dane County Regional Planning Commission. 1974. *The Wetlands of Dane County, Wisconsin*. Madison, WI.

⁶ Lathrop, R.C., et.al., 1992. *The Fishery of the Yahara Lakes*. Wisconsin Department of Natural Resources Tech. Bull. No. 181.

Table 1 – Wetland area and losses in the watersheds of the Yahara Lakes between 1835 and 1974, with percentage lost since 1835 shown in parentheses.*

Year	Wetland Area (acres)			
	Mendota	Monona	Waubesa	Kegonsa
1835	10,181	4,893	6,202	5,832
1938	7,882 (-23%)	1,829 (-63%)	4,794 (-23%)	4,250 (-27%)
1974	5,090 (-50%)	371 (-92%)	1,680 (-73%)	1,754 (-70%)

* Sources of data:

1835 – Township survey maps (published by the U.S. Surveyor General's Office in 1851 and 1855)

1938 – Wisconsin Conservation Department (1961)

1974 – U.S. Geological Survey topographic maps (printed in 1976).

Features

The glacial filled Yahara Valley has spread and slowed drainage leading to formation of large peat deposits

Wetlands tend to be large and interconnected characterized by sedge meadows and fen plant communities, where suitable conditions exist

Impacts

Historic ditching, draining, and filling for agricultural production and urban development

Siltation and nutrient loading

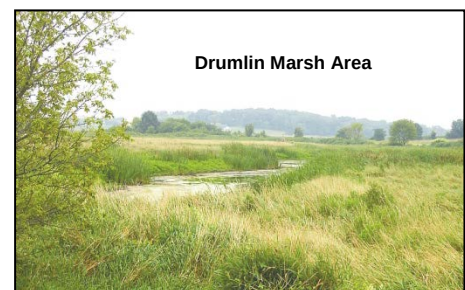
Goal

Reduce nonpoint source pollution from agricultural and urban lands

Restore wetland acreage for flood storage and enhanced wildlife habitat

5. Drumlin and Marsh

This area is similar to the Yahara River Valley except that glacial deposit filled flatter watersheds in the smaller streams and created complex inter-related wetland networks. A field of northeast-southwest oriented drumlins separate wetlands into parallel lobes. The topography is low and rolling, and has lent itself to extensive drainage. **Map 1** depicts the pre-settlement extent of these wetlands.



Once the area of the county richest in peatlands, the Drumlin and Marsh Region has suffered the greatest loss of wetlands. The numerous marshes lying between drumlins could be drained easily by interconnecting networks of ditches, and this was done in blocks of up to 5,000 acres at a time in the years between 1900 and 1926. Most of the networks drain west to Door Creek or east to Koshkonong Creek. Downstream waters and wetlands have borne the

cost in degraded water quality.

Old wetland areas, formed by sedge meadow, fen, or bog can still be identified and located by the presence of peat deposits. A few isolated remnants in fair condition still exist. Many other remnants are ditched, nearly drained, and full of nuisance plants such as nettle, giant ragweed, and reed canary grass.

Drainage attempts have drastically altered the character of the wetlands, but have often left the land still too wet to farm. Thus, the wetlands that remain suffer from lack of water and peat oxidation due to ditching, a history of cultivation in dry years, and invasion of exotic grasses and weeds. Some native wetland vegetation persists in wet “pockets,” but wildlife deficient acreages of reed canary grass, giant ragweed, and nettle are more typical. It should be noted, however, that some of Dane County’s best pheasant habitat is found where this vegetation occurs in combination with dense shrubs.

Other wetland functions that can remain after drainage attempts include spring waterfowl use and some degree of watershed protection from runoff. Some of the shallow areas, when flooded in the spring, come alive with snails and frogs which attract dozens of migrating shorebirds, herons, and waterfowl. These same areas provide flood storage and serve as sediment traps for farm runoff, although ditches counteract these functions and contribute directly to watershed problems. Because of their value for pheasant habitat, these areas have received much attention from the wildlife management section of the DNR.

Features
Similar to the Yahara River Valley except the glacier filled the watersheds of smaller streams
Impacts
Extensive drainage for agricultural production
Goal
Promote wetland restoration, especially wildlife habitat and sediment traps for downstream waters

C. Wetland Characteristics Defined

Wetlands are unique ecosystems that often occur at the transition between aquatic and terrestrial environments. They may be wet year-round or wet only during certain seasons. Some wetland types may not always appear to be wetlands.

The U.S. Army Corps of Engineers regulations for implementing the Clean Water Act define wetlands as follows:

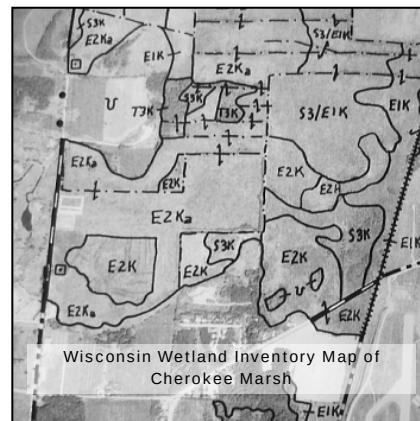
Those areas that are inundated or saturated by surface or groundwater at a frequency and duration to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

The State of Wisconsin defines a wetland in the following manner:

An area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions.

Wetlands that are two acres and larger are outlined and classified on DNR Wisconsin Wetland Inventory Maps. Smaller wetlands are identified by point symbols (↓). The Inventory classifies wetlands according to vegetation, type, hydrology, human influence, and other characteristics.

Although a cattail marsh is among the most recognizable wetlands, many different kinds of wetlands exist in Dane County such as wet prairies, sedge meadows, sphagnum bogs, tamarack swamps, floodplain forests, and alder thickets. Despite the wide variety of wetlands types, three features are common to all:



- **Wetland hydrology** – the presence of water at or just below the surface of the land for at least a portion of the year;
- **Wetland soils** – specific types of soils that developed under saturated (wet) conditions;
- **Wetland vegetation** – distinctive plants adapted to wet conditions.

1. Wetland Hydrology

The hydrology of a particular site is determined by the amount, flow, frequency, duration, and depth of water. It is typically the primary factor driving the other elements of a wetland ecosystem. Wetland hydrology generally exists when an area is wet enough to result in soils that are anaerobic (depleted of oxygen) and support hydrophytic vegetation (plants that are specifically adapted to anaerobic or waterlogged conditions).



Wetland hydrology may exist at sites that are obviously flooded or at sites that are never flooded but have soils that are saturated near the surface. *A site's hydrologic characteristics are the most important factors in determining what kind of wetland will exist and what functions it will perform.* Wetland hydrology can generally be determined by visual observation or other evidence of standing water or saturated soil conditions. In more subtle or difficult situations, measuring ground and surface water elevations may be needed over the course of the year.

Unfortunately, many if not most of Wisconsin's wetlands have been harmed by some form of human activity over the past 100 to 150 years. In general, if the amount and flow of water – at the surface or underground – and the duration of soil saturation in a wetland are changed, the wetland plant and animal communities will likely change as well. Once wetland hydrology is altered, the factors that influence a wetland's plant and animal makeup will also be changed. Knowing how, and to what extent, a wetland is degraded is critical for determining how best to enhance it or restore it to its original condition.

If wetland hydrology can be established at a site, there is a good chance that other wetland characteristics will develop over time. When a project does

Knowing how, and to what extent, a wetland is degraded is critical for determining how best to enhance it or restore it to its original condition.

not develop as planned, or does not develop into a wetland at all, it is most often because the hydrologic characteristics of the site have not been reproduced. Two critical aspects with regard to restoration projects are: 1) the soil elevation in relationship to water levels, and 2) the networks of channels to move water in and out. Incorrect elevations and topographies are some of the most common reasons wetland restoration projects fail to achieve their goals. Therefore, the first step in trouble-shooting wetland projects is to check the hydrologic characteristics of the site.

Water *quality* is equally important to the health of a wetland. Water quality usually refers to how “healthy” the water is for plants, animals, and humans. It can contain a number of dissolved and suspended materials including nutrients (e.g., nitrogen, phosphorus), contaminants (e.g., pesticides, oils) and other constituents (e.g., dissolved oxygen, salts, metals, suspended sediments, trash, etc.). Some chemicals (e.g., nutrients) can be either beneficial or toxic depending on the quantity present. An aquatic area with “good” water quality has the water chemistry that result in healthy populations of native plants and animals. Reference wetlands in relatively undisturbed and pristine condition are used to establish water quality standards for each wetland type. For example, development can upset the natural balance between the ground and surface water inputs to a wetland, along with their different water quality and chemistry, resulting in a shift in plant species and community structure. Fens are wetlands that are particularly vulnerable to stormwater runoff.



2. Wetland Soils

Wetland or “hydric” soils are saturated or waterlogged for all or part of the year. In hydric soils, water fills the air spaces between soil particles and forces the oxygen out causing soils to become anaerobic in the zones closest to the surface. Waterlogged, anaerobic conditions are very hostile to terrestrial

Wetland soils display unique “signature” characteristics that can be readily identified in the field.

plants and these conditions will quickly kill most upland species. As a result, wetlands are dominated by plants that are specifically adapted to these waterlogged soil conditions.



When soils lose their oxygen, they change significantly in structure and chemistry which, in turn, influences the plant and animal species able to survive there. They also display unique “signature” characteristics which can be identified in the field. Wetland soils may be either organic or mineral. Organic soils are made up primarily of plant material, either decomposed (“muck”) or partially decomposed (“peat”). Mineral soils are composed primarily of non-plant materials including sand, silt, and clay. Hydric soils can be identified by their color and structure.

Often organic, anaerobic soils are dark gray to nearly black. In more mineral soils, the chemistry and lack of oxygen affects minerals such as iron and manganese causing distinctive gray color variations. This is opposed to the brighter yellows and oranges typically associated with upland subsoils (those located below the organic “A horizon”). This has much to do with the oxidized form of iron in the soil or ferric oxides, commonly known as rust. So, upland subsoils are generally rust-colored, whereas hydric sub-soils are typically dull gray or black. Color comparisons using Munsell color charts are typically used to help determine whether a soil is hydric. Soil maps produced by the USDA Natural Resources Conservation Service are a good place to begin for local soil information.



3. Wetland Vegetation



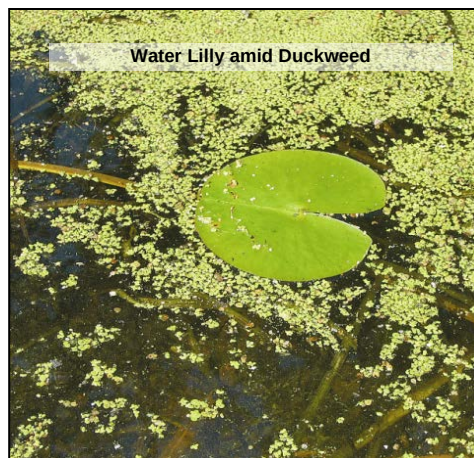
Wetland or “hydrophytic” plants are uniquely adapted to seasonal or year-round saturated soils, with specialized root and stem structures designed to capture and transport oxygen, which is limited in a wet environment. How much water is present for how long, and the specific soil conditions, determine which plants are suited. Saturated conditions also slow the decomposition of organic material such as dead leaves and plants, thereby tying up nutrients and creating organic soils such as muck and peat.

Nutrient, turbidity, and chemical levels such as pH are key parameters determining the composition of a wetland plant community. Another critical element is the relationship of water levels to the ground

Wetland plants are uniquely adapted to living in saturated soil conditions.

elevation. If water is too deep, submergent and emergent vegetation will establish. If the ground elevation is too high, then an upland habitat will form. The types of wetland plants found in a particular area can provide a good indication of the characteristics and quality of the site.

Wetland plants which grow exclusively in wetlands are called “obligate” wetland species; others are “facultative” species as they may be found in both wetlands and drier areas. There are many types and various categories of wetland plants. Plants that grow in the water are called “submergents.” Submergent plants are so well adapted to water that they live completely beneath the surface. Some plants like pondweed and eelgrass have roots that anchor them to the bottom. Others like the coontail are submerged but not rooted. Some aquatic plants have adapted to the water so that their leaves float on top of the water. Floating plants, like water lilies and duckweed, tend to occur in ponds and in places along streams and rivers where there is little or no current.



Common “emergent” plants are the broadleaf arrowhead, named for the arrowhead shape of its leaf, sedges, common cattail, and american lotus. Wetland plants also include shrubs (red osier dogwood, willow) and trees (silver maple, river birch).

Some wetlands may be degraded because they are dominated by invasive non-native species, that is, plants from other regions or countries. These invasive species can completely replace the

natural wetland plant community, either because of their aggressiveness or lack of natural enemies. This alters the ecological functioning of the site. Purple loosestrife, reed canary grass, and common reed grass are examples of non-native invasive wetland plants. The spread of non-native species is a huge ecological problem in the U.S. For many restoration and enhancement projects, significant effort is devoted to removing the invaders so that the native species can be re-established.



Since each species has certain environmental requirements and tolerances, it is possible to use species as indicators of a wetland’s condition. Some indicator species are various shrubs and trees (especially when occurring in dense stands), uncommon or rare plant species, and exotic plant and animal species. For example, shrubs or trees in sedge meadows are disturbance indicators. One can go out on a soil deposit, such as a power line or sewer berm, age the cottonwoods and willows, and estimate closely the date of disturbance. Some wetland species

may be rare now because the conditions they need, such as undisturbed fen or bog, are also rare. This may not have been the case a century ago.

Animal communities also vary with wetland type but, in general, healthy wetlands are rich in wildlife and biologically very productive. Because wetlands exist where land and water meet, they are often used by animals from both wet and dry environments. Many species depend on wetlands for all or part of their lives. Wetlands are also very important in maintaining biodiversity – they are used by over 43 percent of the species listed as endangered or threatened under the Endangered Species Act.⁷



Mating Pair of Sandhill Cranes



Dragonfly

Some of the smallest wetland animals are invertebrates (animals without backbones) such as beetles, water fleas, crayfish, dragonflies, snails, and clams. Invertebrates are an important food source for other animals, both as adults and in their egg and larval forms. They are especially important for supporting much of the wetland food chain. Amphibians, and to a lesser extent reptiles, are very strongly tied to wetlands because many salamanders, frogs, and turtles need both water and drier environments to complete their life cycles. Therefore, undisturbed upland buffers and corridors connecting to adjacent habitats are critical to these species.

Fish are not found in all wetlands, but wherever there is permanent water fish are likely to occur. Fish may move in and out of wetlands as water depths fluctuate. Even wetlands with only seasonal flooding may be temporary habitat for fish from adjacent permanent water bodies. Many fish spawn in wetlands, and wetlands are particularly valuable as nursery areas where young fish can hide from hungry predators until they are big enough or fast enough to survive in open water. Some fish can provide insect control. Other bottom-feeding fish such as carp, however, can destroy submerged plant communities and reduce light levels by stirring up sediment.

Birds are some of the best-known inhabitants of wetlands. Birds occupy a variety of habitats in and around wetlands and are important indicators of wetland functioning. A common wetland dweller, ducks are particularly valuable to people who enjoy hunting or birding. Wetlands are also important to shorebirds (plovers, sandpipers) that feed on mudflats, wading birds (herons, egrets, bitterns) that feed in shallow water, songbirds (red-winged blackbirds, swamp sparrows, marsh wrens) that perch on or nest in tall



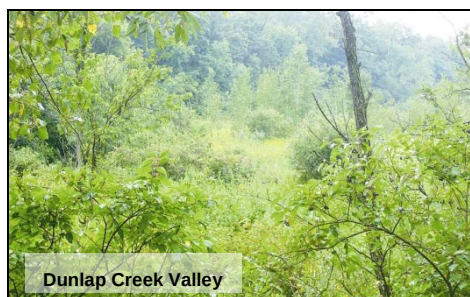
MMSD Lagoon Restoration Project

⁷ Interagency Workgroup on Wetland Restoration: NOAA, EPA, USACE, USFWS, NRCS. 2003. *An Introduction and User's Guide to Wetland Restoration, Creation, and Enhancement*. NOAA Silver Spring, MD.

grasses or shrubs, and other birds such as terns and marsh hawks are all common inhabitants of wetlands.

Finally, mammals such as beavers, raccoons, foxes, minks, shrews, and mice are common residents of wetlands as well, although their tracks are usually seen more often than the animals themselves. Mammals generally need adjacent uplands or upland islands for escape during high water periods. Therefore, undisturbed upland buffers and corridors connecting to adjacent habitats are critical to these species.

D. Wetland Communities and Diversity



The concept of natural community is an important one, generally used for plant groupings. In general, plant communities do not exhibit definite or abrupt boundaries. Plant and animal species tend to overlap and respond to the environment in their own way. Although plant communities do not possess distinct boundaries (animals even less so), they can be broken into groupings for purposes of study and discussion.

One of the factors that makes for a rich *species diversity* in a natural ecosystem (and at the same time makes the ecosystem hard to understand, protect, and restore) is that the various species each have their own functional position in the environment, or niche. A niche is the interaction and relationships a species has with the rest of the ecosystem: what it eats, how, and when; what temperature it prefers; whether it is active by day or night; what plants it uses for cover; nesting; and more. The theory is that species avoid direct competition by avoiding the use of the same resources in the same way at the same time and place. These niches might overlap partly, but not completely. From the standpoint of the ecosystem, the different species complement each other, and resources are utilized more efficiently than they could be by a single species.

Another type of diversity is *structural diversity*. Different emergent species grow at different depths, have different heights, shapes, and rigidity. Shrubs and trees add to this diversity, so if they are not found in large monotypic stands, they have value for promoting animal species diversity. The relationship here is through the niche; for example, swamp sparrows nest in shrubs, coots in emergent vegetation at water level, least bitterns above water level in rigid emergents, grebes on floating wet dead vegetation, and so on.



An important concept related to structural diversity is that of *edge*. Many animal species utilize edges, or boundaries between structurally different vegetation. In wetlands, these can be between two types of vegetation or between vegetation and water. A monotypic stand of cattails, for instance, will support fewer nesting birds than vegetation with irregular, long edges along the water, or other vegetation types. The name for this type of complexity is *interspersion*. Both the extent of vegetation-water interspersion and vegetation-vegetation interspersion have generally suffered due to alteration for human use. For example, agriculture aims at promoting one species on each field, suppressing the unwanted ones with cultivation, pesticides, and herbicides. Diversity is intentionally limited.



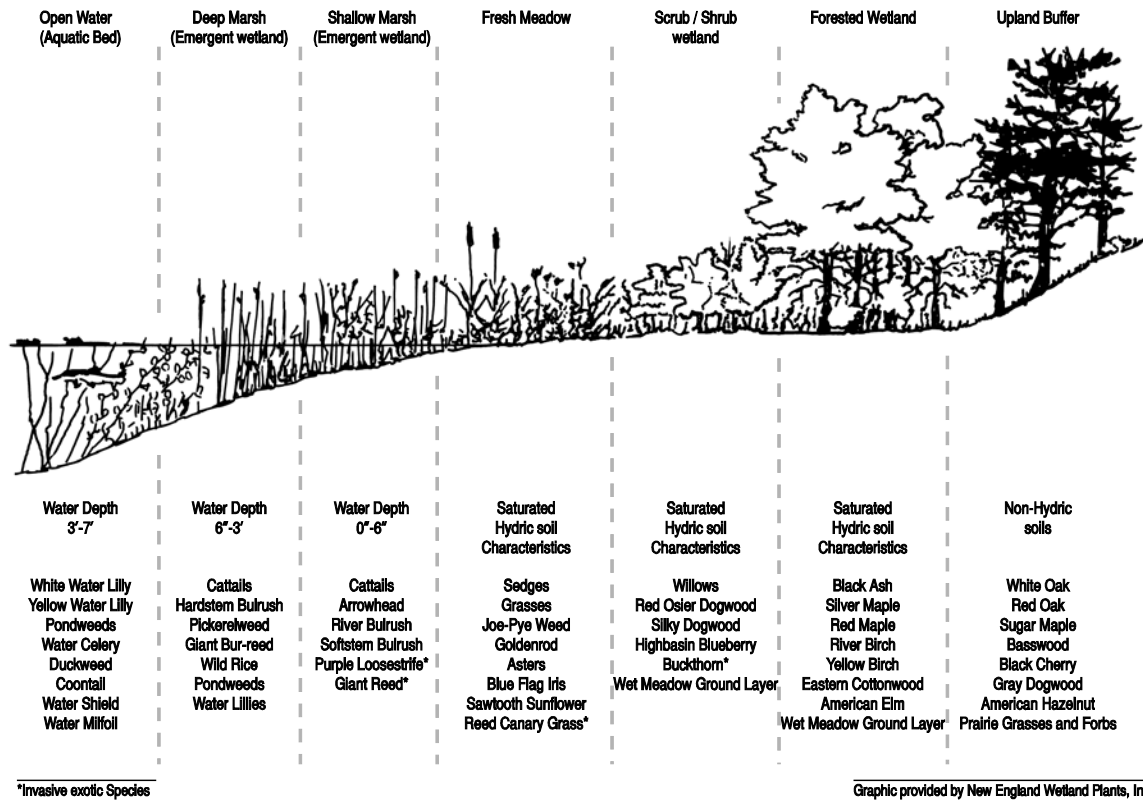
When ecosystems are tampered with, they are generally simplified. The development of ecological complexity takes time, and humans are usually in a hurry. Ecological complexity increases because each species is reacting differently to different conditions and influences. When a person alters a system, he or she has usually only one or two objectives in mind. Side effects are usually ignored because they cannot be understood or because addressing them may interfere with the main objective.

In many open wetlands in the southern areas of the state – shallow marshes, sedge meadows, wet meadows and wet prairies – where the water table has been lowered and where fire has been suppressed, native and non-native shrubs and trees have started to invade. Glossy and common buckthorn are typical aggressive non-native shrubs that establish themselves. Native shrubs and trees that invade disturbed wetlands include: red-osier dogwood, gray dogwood, willows, prickly ash, quaking aspen and box elder.

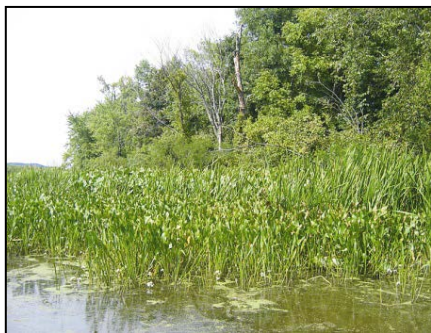
1. Wetland Types

While each wetland is unique, they may be classified by the communities of plants that live there. The wide diversity of wetland plant species includes submerged plants, floating-leaved plants, and emergent plants. Wetland plants also include shrubs (such as willow and bayberry), trees (such as red maple and swamp oak), moss, and many other vegetation types. Generally, the term marsh or meadow applies to a wetland dominated by grass-like plants (such as sedges, reeds, grasses, and cattails) as well as wildflowers. Swamps are wetlands with considerable shrub or tree cover. **Figure 2** shows a representative wetland cross-section transitioning along the hydrologic gradient including aquatic submergent and emergent vegetation, grasses, shrubs, and upland forest cover. The types of wetland plants found in a particular site can provide a good indication of the characteristics and quality of the site.

Figure 2. Typical Wetland Cross Section



Open Water Wetlands occur where there is less than 7 feet of standing water. They differ from marshes in that the water is seldom, if ever drawn down. The aquatic plants in these communities occur at or below the surface and are known as submergent vegetation. Submergent plants are rooted or attached to the bottom of the pond and may have leaves that float at the surface such as water lilies. Because these communities almost always have deep water, they will not support most emergent vegetation (plants that rise out of the water). Typical open water plants include pondweed, water lily, coontail, and duckweed.



Marshes, both deep and shallow, often occur adjacent or blend in to one another on a gradient. They may exist along pond edges, quiet lakeshores and bays or on gently sloping stream banks that are not prone to strong winds or fast-flowing water. Common marsh plants include cattail, bulrush, bur-reed, and pickerel weed. The water level of marshes, especially shallow marshes, may vary considerably from year to year. Shallow marshes may become dry during drought periods. Two categories of marshes can generally be distinguished as follows:

Deep Marshes, with more than 6 inches of standing water, may contain both submergent and emergent plants.

Shallow Marshes, with less than 6 inches of standing water, generally contain only emergent plants.

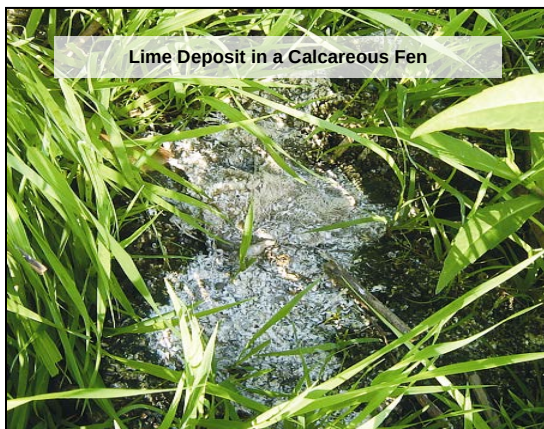
Inland Fresh Meadows are characterized by saturated soils with little to no standing water. They contain a mixture of grasses, sedges and wildflowers, known as forbs. In Wisconsin, four types of inland fresh meadows occur:

Sedge Meadows are dominated by sedges: grass-like plants generally in the plant genus *Carex*. “Sedges have edges” is a useful way to help identify these sharp-leaved, triangular-stemmed plants. Grasses and forbs may be present, but are not as abundant. Sedge Meadows often occur on peat or muck (organic) soils.



Wet Meadows are dominated by grasses and generally a large variety of forbs, such as goldenrod and aster. The invasive and very aggressive reed canary grass often thrives in wet meadows that have been disturbed by drainage or plowing.

Wet (or Low) Prairies are similar to Wet Meadows, although they are somewhat drier. Usually found in the southern part of the state, grasses such as prairie cord grass and particular species of wildflowers characterize this wetland community. Wet prairies are rare now because they were easily drained for agriculture. Only a few pockets remain, notably in Dunlap Hollow, Sugar River, Lodi Marsh (although disturbed), and the Arboretum.



Calcareous Fens generally occur in places where springs or seeps bring calcium-rich groundwater to the surface, turning both soil and water somewhat alkaline. Often white deposits appear on the surface where minerals have precipitated out of the water. Characteristic plants in this community can tolerate the harsh growing conditions. Among the rarest of the state’s wetland communities, calcareous fens contain some of the most threatened and rare plant species, such as the white ladyslipper orchid.

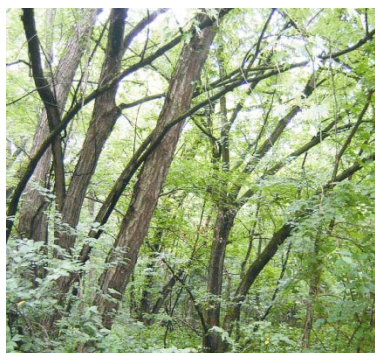
Shrub Swamps are dominated by woody growth less than 20 feet tall. Two general types of shrub swamp are present in Wisconsin as follows:

Shrub Carrs grow on saturated soils throughout the state and are home to red osier dogwood and a number of willow species. The shrub-carr community may encroach on sedge meadows that become drier as a result of drainage or disturbance. The absence of fire also allows shrubs to invade sedge meadows.

Alder Thickets frequently grow along streambanks in northern and central Wisconsin. The tall, multi-stemmed speckled alder dominates this community, and its dense overhanging branches help keep streams cool.



Wooded Swamp refers to forested wetlands often associated with ancient lake basins and old river channels. Two types of wooded swamp occur in the state as follows:

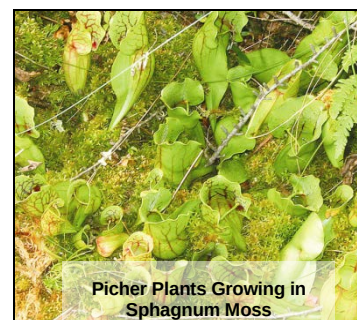


Floodplain Forests are forested wetlands associated with seasonally flooded river floodplains and old river channels (oxbows). This community may experience extremes in depth and duration of flooding, occasionally having standing water in deeper zones well into the growing season. The floodplain forest typically becomes very dry late in the growing season and may resemble an upland community to the untrained eye. Characteristic tree species include silver maple, river birch, eastern cottonwood, black willow, American elm, and swamp oak.

Lowland Hardwood Swamps contain hardwood tree species such as black ash, red maple, and yellow birch. Water often inundates these swamps regularly, such as in spring, and they occur on saturated soils.

Open Bogs contain distinctive plants associated with saturated, nutrient-poor, acidic soils. Two kinds of bog occur in Wisconsin as follows:

Sphagnum Bogs occur in depressions where sphagnum moss forms a thick mat. Over time the sphagnum slowly builds thick organic peat soils. Since groundwater or streams that would normally flush a wetland rarely flow into or through bogs, the soil becomes very acidic. Plants that live in bogs must be adapted to the extremes in acidity. Remarkably, sphagnum moss not only survives in acid conditions but also contributes further to a bog's acidity. Typical bog plants include members of the blueberry family, such as the native cranberry, leatherleaf, bog rosemary, and Labrador tea. Other characteristic species include the insectivorous pitcher plants and sundews, various orchids, and sedges.



Coniferous Bogs are sphagnum bogs that contain tamarack or black spruce trees.

E. Wetland Functions, Values, and Benefits

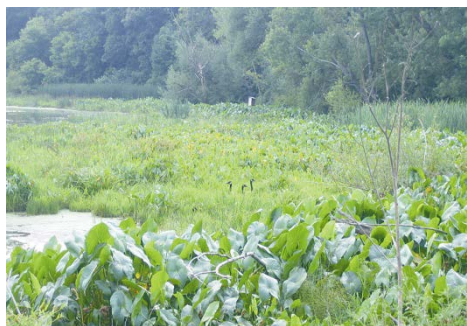
While wetlands provide many functions and services within watersheds, the economic benefits of wetlands were seldom appreciated by growing communities at large. It wasn't too long ago that wetlands were considered mosquito-infested wastelands to be filled, ditched, and drained. These attitudes and beliefs have changed significantly. We now know that the precise functions and ecosystem services provided by wetlands depend on their size, type, and location. Wetlands can improve water quality by removing pollutants, minimize flood damage by slowing and storing floodwaters, and protect shorelines from erosion. Wetlands also supply habitat for birds and wildlife and create unique and significant recreational opportunities. These "free" services are often taken for granted, but they can easily be lost as wetlands are altered or degraded in a watershed. In addition, replacing the lost ecological services of wetlands can be expensive, assuming they can be replaced at all. **Table 2** summarizes wetland functions and describes the various infrastructure needed to replace those services, most of which are extremely expensive. In addition, **Attachment C** includes more specific management activities for specific wetland functions described below.

Table 2. Wetland Functions, Services, and Replacement Options		
Function	Services	Alternatives
Wildlife habitat	Habitat for aquatic, terrestrial, and avian species; protective spawning and nursery areas; support biodiversity; biomass production; connective wildlife corridors; habitat for RT&E species; foraging grounds for migrating birds	Wetland restoration; species stocking
Flood attenuation	Storage capacity to reduce downstream flood volume; slow flow to reduce peak discharges and encourage particulates to settle out; protect downstream property; public safety	Stormwater treatment practices (storage); dikes and levees; advanced floodplain construction design
Pollutant removal	Maintain drinking water quality; process sewage; cycle nutrients; retain sediment, filter runoff; transport organic matter	Water filtration plants; wastewater treatment plants/package plants; stormwater facilities with water quality criteria; inter-watershed transfer; animal waste storage
Shoreline protection	Fringe wetlands provide vegetative bank protection; absorb storm surges	Revetments; streambank stabilization and repair practices; stormwater treatment practices for channel protection
Groundwater recharge and discharge	Maintain baseflow conditions in streams	Deeper wells; alternative water source; injection wells
Recreation, open space and commerce	Recreation, education, and aesthetics (e.g., hunting, angling, bird watching, hiking, canoeing, science curriculum, research opportunities, open space, quality of life); commercial products (peat, timber, fish, shellfish, cranberries, and rice)	Wetland restoration

Source: Center for Watershed Protection, 2007. Wetlands Article #4

1. Fish and Wildlife Habitat

Wetlands are perhaps the most important resource feature in terms of wildlife habitat, fisheries, and species diversity. It is here that the food webs of land and aquatic environments are interwoven and create highly productive ecosystems. By increasing the available habitat, species diversity is increased, which leads to healthier, more vibrant ecological communities overall.



Many animals spend their whole lives in wetlands; for others, wetlands are critical habitat for feeding, breeding, resting, nesting, escape, cover, or travel corridors. Wisconsin wetlands are also spawning grounds for northern pike, nurseries for fish and ducklings, critical habitat for shorebirds and songbirds and lifelong habitat for some frogs and turtles. Wetlands also provide essential habitat for smaller aquatic organisms in the food web, including crustaceans, mollusks, and insects.

Wetlands provide habitat for more aquatic, terrestrial, and avian species on an area basis than any other habitat, making them one of the most ecologically and economically important ecosystems on earth. In fact, more than 35,000 rare plants and animals are found in wetlands in the U.S. alone.⁸ Almost half of all federally threatened and endangered species rely on wetlands directly or indirectly during some stage of their life cycle, and all federally listed amphibian, fish, clam, and crustacean species depend on wetlands. Even degraded urban wetlands can provide some degree of habitat function. The presence or likelihood of endangered species being present are themselves an indicator of the importance and potential ecological health and diversity these areas can support.

Some of the most valuable wetlands for fish and wildlife provide diverse plant cover and open water within large, undeveloped tracts of land. This function may be considered particularly important if the habitat is regionally scarce, such as the last remaining wetland in an urban setting. The more valuable wetlands usually support a greater variety of native plants (high diversity), than sites with little variety or large numbers of non-native species. Also, wetland communities that are regionally scarce are considered particularly valuable.



2. Flood Protection

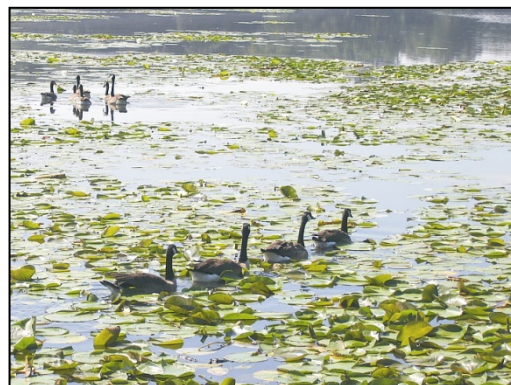
Water flows according to topography, from high elevations to low areas. A watershed encompasses those areas draining to the same surface water features such as a river, stream, or lake. Likewise, “river basin,” “watershed,” or “sub-watershed” are different ways of expressing

⁸ Center for Watershed Protection. 2006. *Direct and Indirect Impacts of Urbanization on Wetland Quality*. Wetlands and Watersheds Article #1.

the same physical feature at different scales. **Map 3** illustrates the major surface water features in Dane County.

Wetlands play a particularly important role in stabilizing the local hydrology within a watershed. During rainfall or snowmelt, wetlands slow water movement, storing excess water. During periods of heavy rainfall, wetlands serve as buffer zones against flood damage. A large volume of water can be held in a wetland area (as much as 326,000 gallons per wetland acre one foot deep) without undue damage to the wetland community, thus protecting downstream properties.

Flood protection may be especially important in cities and villages, where impervious areas (pavements and roofs) from older urban areas contribute to increased runoff volume and velocity. This ability to delay storm and snowmelt runoff can reduce the frequency and severity of flooding downstream. This function can provide significant economic benefits to downstream property owners.



Throughout Dane County, wetlands have been substantially altered over the last century by dredging, ditching, tiling, filling, and road and utility construction. As a result, many of their functions, like flood control, have been diminished.

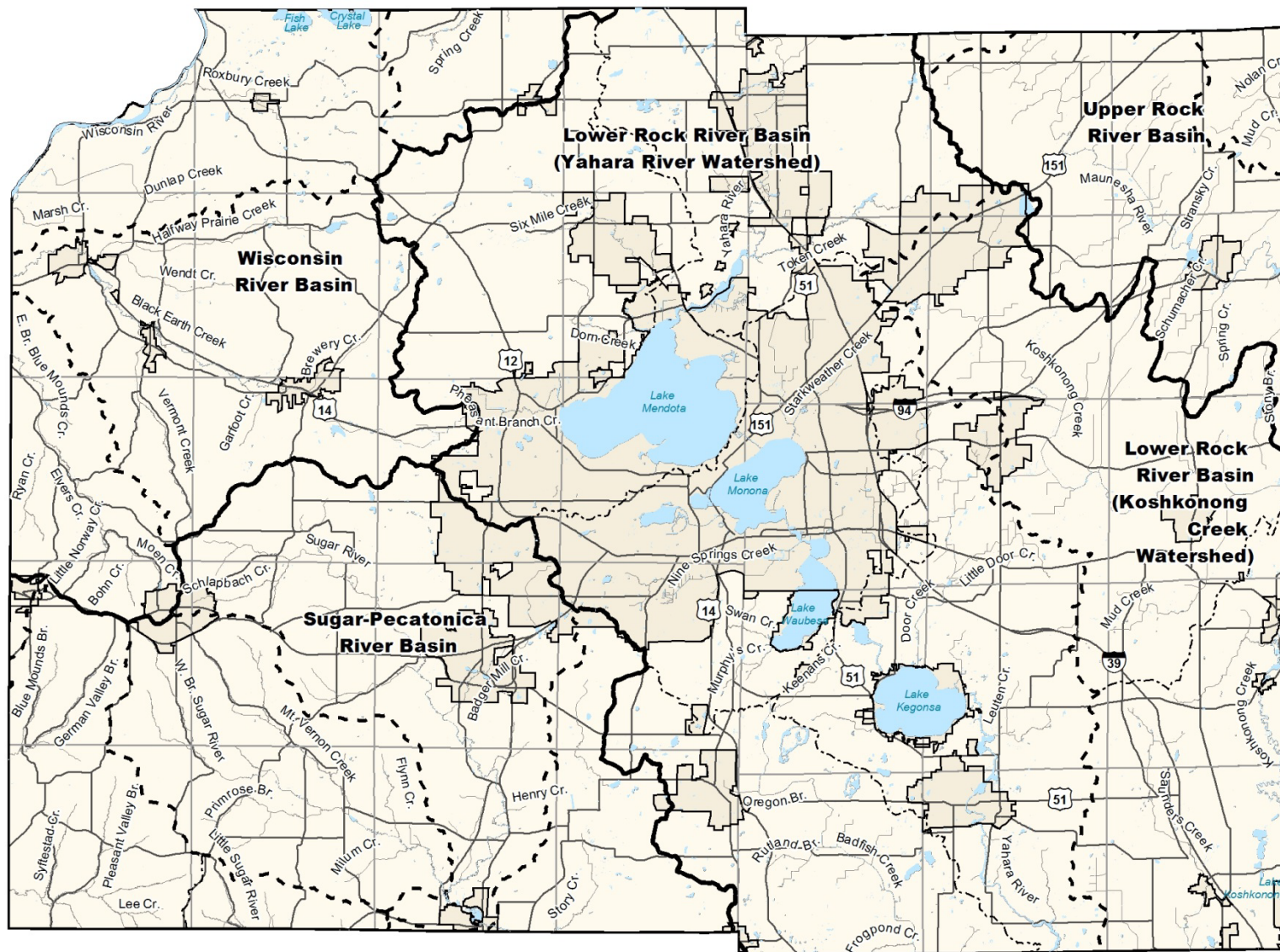
Avoiding construction and development in wetlands is an important means of protecting public safety and property. Wetlands are not good places for development. High water tables, the potential for flooding, and soils that shrink and swell seasonally can pose severe problems for development.

3. Water Quality Protection



Wetlands are particularly important for pollution control and improving water quality. Wetlands act as large biological filters that intercept nutrients and trap other pollutants through deposition and uptake by plants and animals. This function can be diminished if the wetland's assimilative capacity is overwhelmed by outside inputs.

Wetland plants and soils have the capacity to store and filter pollutants ranging from pesticides to animal wastes. Calm wetland waters, with their flat surface and low flow characteristics, allow toxins and nutrients to settle out of the water. Plants take up certain nutrients and pollutants from the water. Other substances can be stored or transformed to a less toxic state. As a result, our lakes, rivers

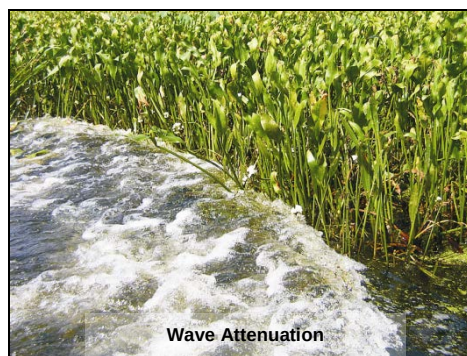


and streams are cleaner and safer. Larger wetlands and those which contain dense vegetation are the most effective in protecting water quality. Especially if surrounding lands contribute runoff, sediment, manure, or other pollutants to its surface waters, the value of this function may be particularly high.

However, wetlands which filter or store sediments or nutrients for extended periods may be overwhelmed and undergo fundamental changes themselves. Sediments will eventually fill wetlands, and nutrients will eventually change the vegetation to more tolerant species. Such changes can result in the loss of diversity, habitat degradation, and the ability of wetlands to trap nutrients and sediments over time.

4. Shoreline Protection

Shoreland wetlands act as buffers between land and water. They protect against erosion by absorbing the force of waves and currents and by anchoring sediments. Roots of wetland plants bind lakeshores and streambanks, providing further protection. Trout streams and other high quality waterways often depend on shoreland wetlands. Without this wetland buffer, the shoreline becomes undercut and collapses. When this happens, streams often become wider, shallower and more turbid. Water temperatures rise and habitat quality deteriorates. Overall benefits include the protection of stream habitat and man-made structures, as well as land which might otherwise be lost to erosion. This function is particularly important in waterways where boat traffic, water current or wind cause substantial water movement which would otherwise damage the shore. In the past, elimination of these shallow zones – and thus wetland vegetation – has led to increased erosion problems.



5. Groundwater Discharge and Recharge



Groundwater discharge is the process by which groundwater bubbles to the ground surface. In some cases, groundwater discharge sites are obvious, through visible springs or by the presence of certain plant species. Groundwater discharge is important for creating permanently moist conditions that give rise to unique wetland plants and animals. Groundwater discharge is also important for stabilizing stream flows, especially during dry summer months, as well as maintaining streamflow and areas of open water in shallow streams and ponds

during winter freeze. Groundwater discharge through wetlands can enhance aquatic communities in downstream areas. It also can contribute to high water quality in our lakes, rivers and streams. Groundwater discharge wetlands areas are often the places where streams are born.

Groundwater recharge is the process by which surface water moves into the groundwater system. Although recharge usually occurs on upland areas, some wetlands play an important role in

replenishing groundwater supplies. For example, vernal pools are a type of wetland often found in agricultural areas that usually flood during the spring melt and dry up as the water percolates into the ground. The filtering capacity of wetland plants and underlying soils help protect groundwater quality. In other cases, wetland areas that were once groundwater discharge areas may become recharge areas with the lowering of the water table due to human impacts (e.g., municipal well water withdrawals and impervious surfaces). Groundwater discharge wetlands on organic soils are degraded when they are drained. This is due to oxidation of the soil and the subsequent wind erosion or subsidence can lead to soil loss or destruction of soil structure.

6. Recreation, Education, and Scenic Beauty

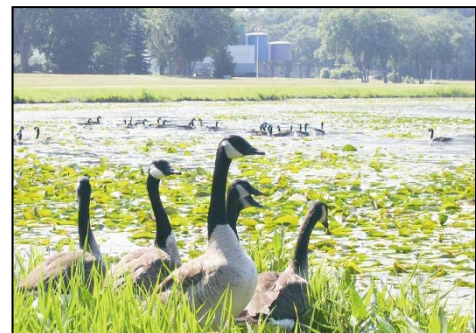
Wetlands are some of our favorite places to canoe, cross country ski, hike, bird watch, photograph, or simply drive by. They provide peaceful open spaces and present rich opportunities for hunters, anglers, scientists and students alike. Wetlands located within or near urban settings and those frequently visited by the public are especially valuable for the social and educational opportunities they offer. Open water, diverse vegetation, and lack of pollution also contribute to the value of wetlands for recreational and educational purposes.



Wetlands provide exceptional educational and scientific research opportunities because of their unique combination of terrestrial and aquatic life and physical / chemical processes. They are great places for teaching these concepts and it is particularly easy to give young people a feel for the biological world through the study of wetlands. Many species of endangered and threatened plants and animals may be found in wetlands. These areas may also be associated with nearby archaeological sites of early Native Americans who relied on these areas for food and

fiber. While wetlands are extremely important resources for nature study, interpretation and education, these areas are also fragile and generally not well suited to intensive recreational use.

Wetlands are also important in enhancing scenic beauty and shaping urban form. They often provide logical barriers or boundaries to urban development, as well as buffers between communities and incompatible land uses.



7. Open Space Corridors

Wetlands are an important source of open space for both humans and wildlife. They are also commonly associated with other important resource features such as lakes, ponds and streams, floodplains, shoreland areas, woodlands, parks, etc. – presented in **Table 3** and also displayed on

The Regional Development Plan Map, **Attachment A-1**. Open spaces are important elements of urban form and function. Urban areas and development projects that work well as living places invariably include open, green spaces in their design. For wildlife, open-space corridors are important for cover and travel between natural areas. Open space corridors that incorporate large wetland areas can help maintain and improve conditions for both wildlife and humans. Roads and development projects which do not respect the continuity of open space corridors tend to separate formerly contiguous areas, reducing the proper functioning of these corridors.

Table 3
Open Space Functions Associated With
Environmental Resource Features

Function	Resource Features							
	Lakes, Ponds, & Streams	Wetlands	Floodplains	Shoreland Buffer Strips	Steep Slopes	Woodlands	Parks	Unique Vegetation or Geology/Problem Soils
Protect Water Resources, Drainage & Hydrologic Functions	▲	▲	▲	▲		△		△
Provide Pollution Control		▲	△	▲	▲	△	△	
Protect Public Health, Safety, and Property	▲	△	▲		▲			▲
Provide Outdoor Recreation and Education Opportunities	▲	△	△	△		△	▲	△
Provide Wildlife Habitat	▲	▲	△	△		▲	△	△
Enhance Scenic Beauty and Shape Urban Form	▲	▲	△	▲	▲	▲	▲	

▲ Primary Function △ Secondary or Supplemental Function

Source: Dane County Water Quality Summary Plan, 2004

F. Wetland Impacts

Water is the driving force in wetlands. Wetlands have adapted to natural cycles of wet and drought. A naturally fluctuating hydrologic cycle over hundreds or thousands of years has helped shape the plant and animal communities that live there. Many of the organisms and plants have become adapted to fluctuating water levels, saturated soils, and anaerobic (low oxygen) conditions. These are important factors in natural wetland hydrology that maintain the functions and values that wetlands provide and that we enjoy. During pre-settlement conditions entire watersheds were in vegetative cover (e.g., prairie, oak savanna) with maximum infiltration and minimum runoff. With the massive conversion of this landscape to agricultural and urban uses came substantial changes in runoff to wetlands as well as lakes and streams.

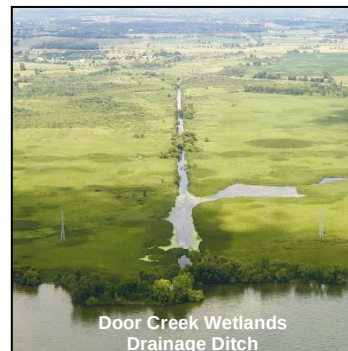
The most critical wetland impacts have been due to the direct loss of wetland acreage from ditching, draining, filling, dredging and impoundment. Degradation has also resulted from adverse changes in water quality and quantity from urban and agricultural runoff. This can open the door for invasion by aggressive plant species, which push out beneficial wetland plants and animals. Overall, the decrease in the quality and areal extent of wetlands and their proximity to urban land uses has decreased the effectiveness of many wetland functions.

These disturbances tend to reduce or change the quality of a wetland and its functional values, not to mention its aesthetic appeal. The biological diversity or richness of plant and animal species in an area can be seriously impaired through disturbance. A good wetland restoration

project attempts to restore the original hydrology, plants, and animals to the site along with the associated values and benefits.

1. Ditching, Draining, and Filling

The major human impact on wetlands is the result of trying to convert them to either dry land or open water. During drought, wetlands fed primarily by overland runoff tend to dry up. Many shallow wetlands of this type can be cultivated in dryer years. Since the topography of the surrounding region is generally not altered, the natural flow patterns remain. Whether or not cultivation is successful is dependent on the amount and timing of seasonal rainfall.



Partial drainage, very common in Dane County as elsewhere in southern Wisconsin, results from attempts to drain and farm either low, wet areas adjacent to wetlands, or the wetlands themselves. Farming in such wet areas is often hampered by spring flooding and short growing seasons due to frequent frosts. In many cases, farming was started during the droughts of the 1930s and despite drainage attempts has not been successful. In shallow wetland areas where effective drainage can be achieved, farming has been successful.

The effects of partial drainage of wetlands include nuisance invasions of nettle, ragweed, and trees or shrubs, and reduced water quality. Unfortunately, it is often considered necessary to drain sedge meadows and fens heavily to get the water away from adjacent farm fields. The wetland is degraded even though it is not directly cultivated.

When a wetland is partially filled, it is usually done from the edge toward the center. Thus, the slow transition from upland through shallow water to deep marsh is removed, along with the characteristic plant communities. Often this effect is increased by dredging the center to make a lagoon, such as at Vilas Park in Madison. Fill material such as soil, rocks, cement and gravel brought into a wetland can have direct and indirect adverse impacts. Filling is usually quite obvious. A wetland that has been completely filled, however, may not even be recognized as a former wetland. The fill material may contain seeds of undesirable species that can invade wetland areas. Filling one portion of a wetland may result in a shift in hydrology, increasing or decreasing water into other areas of the wetland. For example, water pooling behind a dike or road will cause a shift in wetland vegetation to adapt to the changed water depth.

The natural shallow edge is the link between land and water, and as such serves many functions. Turtles go ashore and frogs enter to lay eggs. The breeding of certain frogs requires very shallow water. Many types of birds feed in shallow water or on exposed mud. Relatively shallow areas support the emergent growth such as cattail used by most marsh birds to support and conceal their nests. For example, the least bittern prefers narrow strips of cattail parallel to the shore. For proposed urban development projects, current Environmental Corridors require a minimum 75 foot naturally vegetated buffer be maintained from the wetland edge. While this may provide some water quality benefits, it is largely inadequate from a more expanded biological perspective (see Section G. *Biodiversity and Core Habitat*).

2. Dredging

Wetlands are often deepened by dredging. Cherokee Lake is an example of this on the north side of Madison west of the Cherokee Neighborhood – the spoils of which were placed in Cherokee Marsh east of the golf course (doubling the impact). In many cases in southern Wisconsin, cottage or housing development along a shoreline has meant dredging of a deep marsh or even removal of peat from a bog or sedge meadow. The purpose of dredging is usually to provide access for boats along the shore or to remove undesirable sediment. The results of such channelization include: formation of berms or spoilbanks with associated bank erosion; shrub and tree invasion; decline in water quality from nutrient leaching; destruction of habitat; interference with movement of animals to and from the shore; and disturbance due to passing boats.



It has also been common practice to dig holes in wetland soil to make ponds. However, the spoil is often dumped nearby and becomes a source for disturbance vegetation to gain a foothold. The sides of the holes are usually too steep to support much emergent vegetation. An alternative to dredging holes has been blasting. But the resulting ponds were found to be too small and predator-prone. The digging out of springs has also been common practice.

3. Impoundment



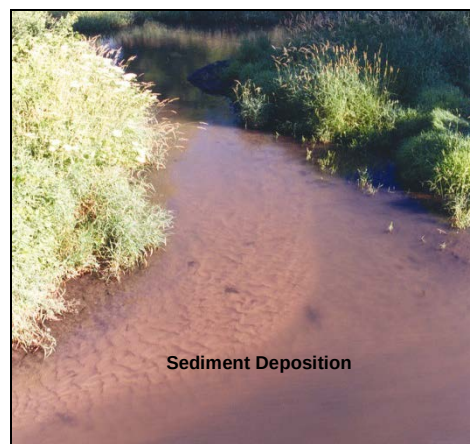
Another way to make a wetland deeper is to impound water. This may be desirable where there are many wetlands and few lakes, but this is not the case in Dane County. Impounding water to make an open lake or pond destroys the emergent vegetation and disrupts the wetland ecosystem entirely. For example, even though the Tenney Locks were constructed at Lake Mendota's outlet in 1912, there has been a dam at the site since around 1850. Current lake levels are estimated to be approximately 7 to 8 feet above natural conditions. Each succeeding dam was built higher, backing up more water and flooding the wetlands of Cherokee Marsh. Wetland plants along the Yahara River have broken away from the underlying peat to form floating mats. Using air photos and original public land survey records, the City of Madison has documented a loss of over 640 acres of wetlands along the Upper Yahara River in the past 160 years.⁹ A project is currently underway to protect these floating plant mats by establishing emergent and submergent plants along the river's edge. Several innovative techniques have been developed using various kinds of wire fencing to facilitate the establishment of native wetland plants in a difficult environment. Plantings are protected from the destructive forces of wave action, carp uprooting, and muskrat predation.

⁹ Russ Hefty, Conservation Supervisor for the City of Madison Parks Division, personal communication 2006.

In other cases, flooding can be quite beneficial, especially in restoring a previously drained wetland. Horicon Marsh is a classic example of this. Lately, it has become more usual to consider the entire ecosystem when planning management practices, which benefit not only the target species but the rest of the wetland as well. For example, a common problem with impoundments is the excessive growth of algae and nuisance aquatic plants due to high nutrient levels in the water, usually caused by poor land management in the watershed. By retarding flow, an impoundment can intensify this problem. This needs to be taken into account in any wetland restoration project that depends on impoundment.

4. Sedimentation and Pollution

Indirect impacts originate from both agricultural and urban lands that drain into wetlands (**Table 4**). These impacts result from alterations to vegetative cover, topography, and hydrologic conditions and may also include sediment deposition and pollutant accumulation, along with changes in the wetland communities themselves to monocultures of more tolerant invasive species. These indirect impacts, although originating outside the wetland itself, can drastically reduce many beneficial wetland functions such as flood control, habitat, and water quality protection. Furthermore, control of these indirect impacts lies squarely within the purview of local governments through better land management.



Predicting the magnitude of adverse impacts to wetlands when natural watersheds are converted to agricultural land and urban development is a complex task. An assumption can be made that any change directing more or less water into wetlands beyond what would naturally occur as a result of any given rainfall event is not necessarily good. Alternatively, we cannot automatically assume that when agricultural land and urban development surrounds a wetland basin, but do not actually encroach upon it, that the wetland will be preserved. If the supply of water is increased or reduced beyond the limits that the wetland's sensitivity allows, or if it carries excess pollutants, the wetland may not persist. Maintaining the pre-existing hydrologic conditions should be stressed in all cases, especially in those wetlands that are highly or moderately

Table 4. Indirect Impacts of Human Activities on the Land

- Increased ponding and water level fluctuation
- Constriction of downstream flow
- Decreased groundwater recharge
- Hydrologic drought in riparian wetlands
- Sediment deposition
- Pollutant accumulation in wetland sediments
- Nutrient enrichment
- Chloride inputs
- Increased abundance of invasive and tolerant plant species
- Decline in the diversity of wetland plant and animal communities

susceptible to stormwater impacts. The relationship between any storm event, no matter how small or large, and runoff volumes must be thoroughly understood. Both agricultural and urban Best Management Practices (BMPs) which address the full range of hydrologic conditions should be employed in order to minimize impacts.

5. Invasive Plants

If a wetland is extensively disturbed, an opportunity exists for aggressive plants to establish themselves and displace the more sensitive species. Disturbance of wetlands can be the result of cultivation; erosion and accumulation of sediment from agricultural and urban activities; soil compaction due to cattle grazing or driving heavy machinery over a wetland; ditching for pipelines, sewer lines, or underground cables; as well as wetland draining or filling. Once the wetland soil or water has been disturbed invasive species can gain a foothold and may eventually out-compete the less aggressive native plants. Invasive species are problematic because they often form high density monotypic stands within the ecosystem which causes decreased species diversity, impairing food web interactions, and removing habitat. Invasive species also affect ecosystem and watershed processes by altering erosion, runoff, and depositional processes.

Exotic species brought in from other countries can out-compete native species due to the absence of natural enemies (predators, parasites, and diseases). They are planted in gardens as ornamentals and escape into the wild by birds carrying berries or by other means. The exotic species can force out the native species and change the character of a wetland community. The most common invasive wetland plants are reed canary grass, purple loosestrife, common reed grass, and buckthorn. They move into disturbed areas and are typically quite aggressive. Getting rid of them is usually difficult. The two most prolific invasive species of major concern are Reed Canary Grass and Hybrid Cattails. Purple Loosestrife, Common Reed and Buckthorn can also be problematic.

Invasive species are problematic because they often form high density monotypic stands within the ecosystem which causes decreased species diversity.

These plant species occur frequently in disturbed wetlands. Becoming familiar with them helps in determining the extent of disturbance. For example, many sedge meadows have become shrub dominated because of the lowered water levels and the introduction of exotic buckthorn. Sedimentation associated with stormwater runoff has smothered sedges and allowed the invasion of reed canary grass, a Eurasian species more tolerant of drier conditions. In wetter areas, eutrophication from nutrient-carrying sediment favors the cattail, which, although native, behaves as an aggressive weed and outcompetes other, more desirable plants when fertilized. Typically, reed canary grass dominates wet meadows while hybrid cattail dominates marshes. Totipotency – the ability of a plant to reproduce from any part – enhances dispersal and is a problem with many exotics. This is especially so with purple loosestrife, an invasive exotic spread through cultivation as a garden ornamental.

There are multiple means of controlling these invasive species with different strategies based upon degree of spread. Where there are smaller patches of invasive species, herbicide application and manual removal are known to be effective. However, when the invasive species tend to form large, monotypic stands that blanket an area, heavy machinery, and controlled fires will be needed. Invasive species control as part of a restoration plan must also be performed on adjacent

sites, otherwise the invasive species will settle and colonize the site again. If urban development includes construction in areas with restorable wetland sites, it may be beneficial to use heavy equipment to remove extensive patches of invasive species (after receiving permission from WDNR).

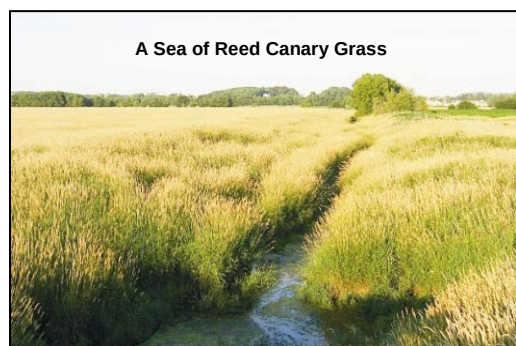
Reed Canary Grass (*Phalaris arundinacea*)

Beginning in the 1800s, people intentionally planted European strains of reed canary grass throughout the United States for forage, especially on lands subject to periodic flooding. Most agencies have discontinued planting reed canary grass and actively discourage its use. Today, many disturbed wetlands in Wisconsin support large stands of reed canary grass, where the grass may dominate vast areas to the exclusion of other plant species. Once established, the invading grass spreads aggressively via underground rhizomes or stems. The grass also produces enormous quantities of seed that germinate in disturbed soil and crowd out other vegetation or float downstream to colonize stream banks. A recently completed DNR project, using satellite imagery and extensive ground-truthing, has mapped wetland areas dominated by reed canary grass across the entire state. Over a half million acres of Wisconsin's 5.2 million acres of wetland are dominated by this plant, nearly ten percent. In Dane County, approximately 27 percent of the wetland acreage is dominated by reed canary grass (**Map 4**).¹⁰

“...[My observation with [reed canary grass] is that it is wise not to plant it if one wishes to ever get rid of it.” – C.C. Deam, 1940.

“Of all the invasives in Wisconsin, reed canary grass is the worst.” – Joy Zedler, UW-Wisconsin Restoration Ecologist.

Source Thompson and Luthin.



Reed Canary grass is a major problem in wetlands. Areas invaded by reed canary grass may be of little use to wildlife. It forms dense, nearly pure stands that displace all other species from large areas of the wetland, especially sedge meadows. Human disturbance such as nutrients from stormwater runoff and alteration of water levels, such as ditching, encourage reed canary grass invasion. While a number of control techniques have been attempted, no simple solution has been found for eliminating reed canary grass to date.

Purple Loosestrife (*Lythrum salicaria*)

Purple loosestrife arrived from Europe in the early 1800s, imported as a garden perennial and viaseeds carried in the ballast water of ships. The species has spread across the country, replacing native wetland vegetation. Purple loosestrife is a nuisance exotic weed that is extremely invasive in Wisconsin's wetlands. Although colorful, this plant is extremely undesirable because it prevents many desirable native wetland plants from becoming established. A purple loosestrife produces 100,000 to 2.5 million tiny seeds annually. Once established in a wetland, loosestrife displaces native vegetation. Although attractive, it is virtually useless to

¹⁰ Tom Bernthal, DNR Wetland Specialist, personal communication 2007 in reference to Hatch B. and T. Bernthal. 2008. *Mapping Wisconsin Wetlands Dominated by Reed Canary Grass: a Landscape Level Assessment*. WDNR Publ. WT-900-2008.

wildlife. A DNR survey conducted in the 1980s found various sites in Dane County invaded by purple loosestrife (**Map 5**)

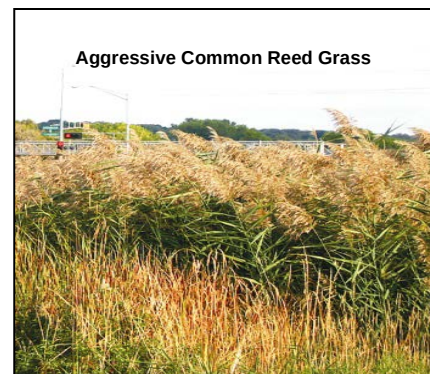


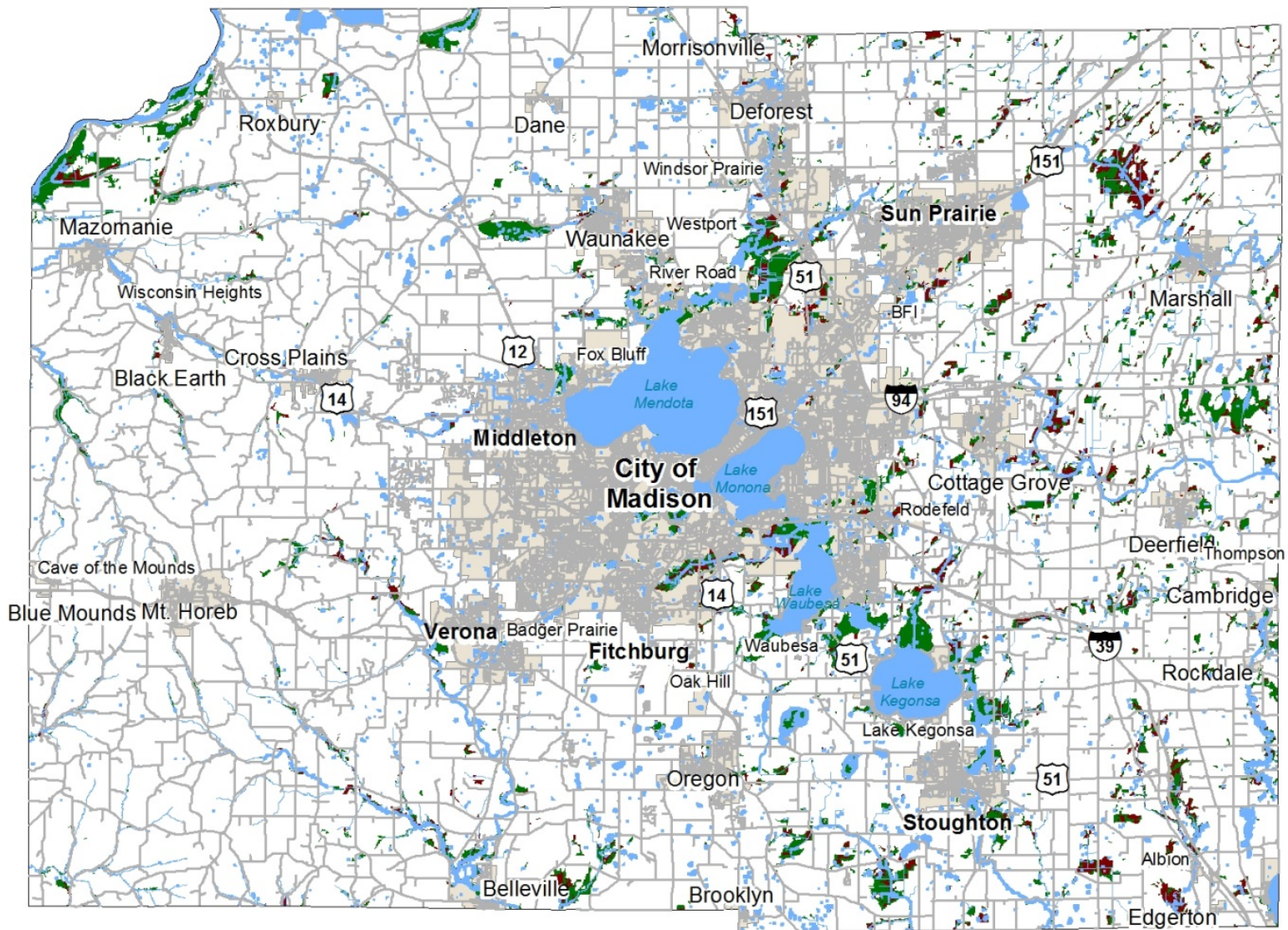
If a site has large stands of purple loosestrife that can't be controlled by hand pulling or selective chemical control, biological control might be an option. Several species of insects native to Europe are being released statewide that eat and control purple loosestrife. If a site is larger than four acres and is heavily infested, beetles may be received to help control the plants. Contact the UW-Extension or your local DNR aquatic plant manager about the availability of beetles and request a brochure on loosestrife. Currently the Dane County Conservation League has two mass rearing cages set up in Dunlap

Hollow to raise large numbers of beetles there. Additional releases have been conducted in other parts of the county as well.

Common Reed Grass (*Phragmites australis*)

Common reed grass is found throughout the world. In Europe, this tall grass has a long history of being used as thatch for roofs. In North America it is found in marshes, wet shores, ditches and swales, tamarack bogs, and open water up to 6 feet deep. The grass is tolerant of salt and thrives in roadside ditches. Because it produces few fertile seeds, reed grass spreads most commonly by its rhizomes. Although a native species, this plant is invading the coastal wetlands of Lake Superior, Lake Michigan, and the Mississippi River floodplains, forming dense stands and crowding out native plant communities. It is possible that these aggressive strains are of Eurasian stock.





Reed Canary Grass Invasion Sites

Dane County, Wisconsin

RCG Dominated (>50% Cover)

Other Vegetation (<50% RCG Cover)

Upland

Service Area

Map 4

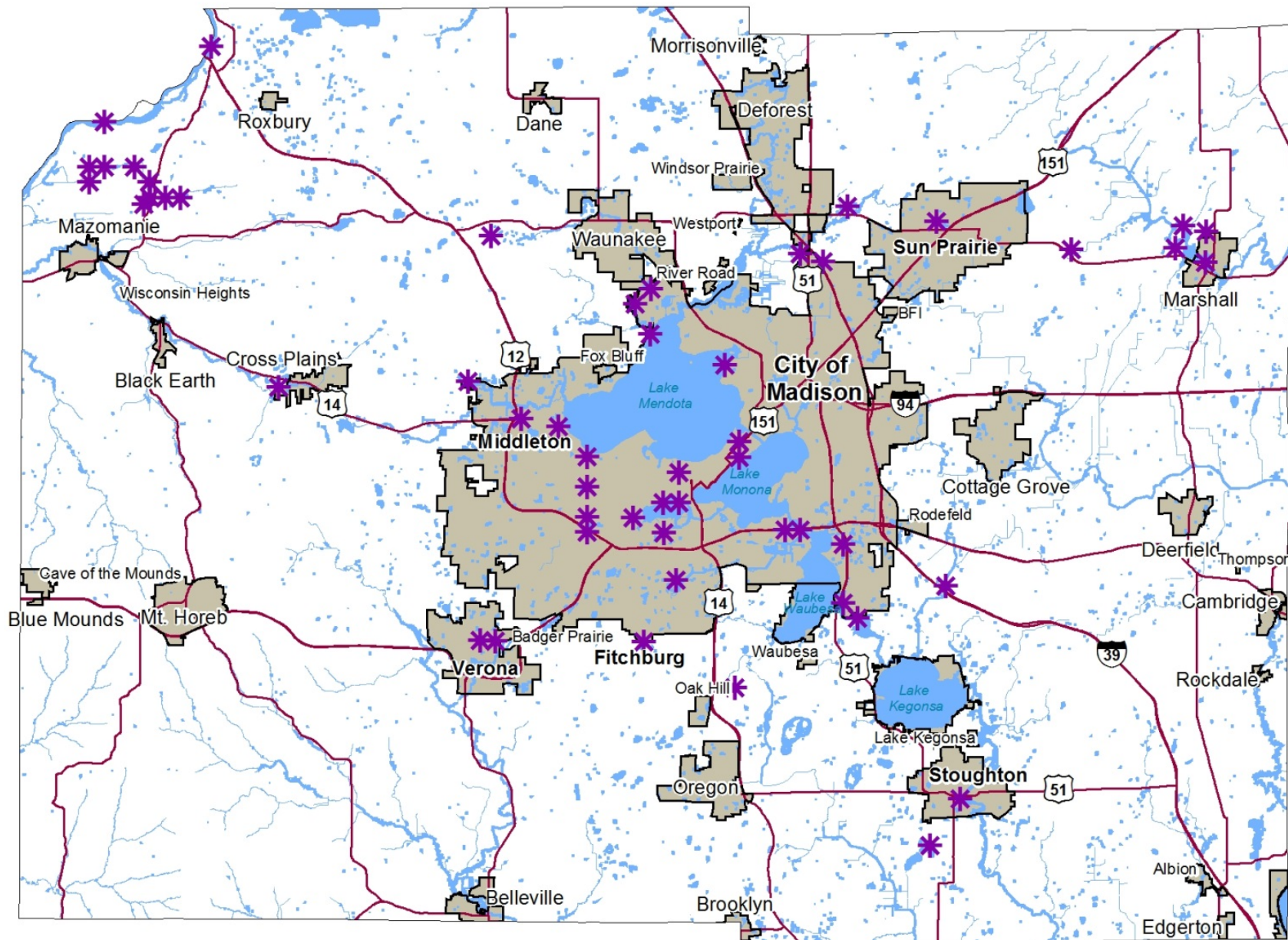


Prepared by: The Dane County
Capital Area Regional Planning Commission

Jan 2008
Reed Canary Grass: Hatch, B.
and Bernthal T. in preparation.
2007. WIDNR
Service Area: CARPC 2015

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Miles





Purple Loosestrife Invasion Sites



Known Locations of Purple Loosestrife



Service Area

Dane County, Wisconsin

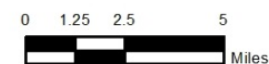
39

Purple Loosestrife Locations: Great Lakes Indian Fish and Wildlife Commission www.gliwc-maps.org 2007
Service Area: CARPC 2015

Map 5



Prepared by: The Dane County
Capital Area Regional Planning Commission



Reed grass can gain a foothold when a small segment of plant washes up on the shore of a lake or river. Once established, it invades the adjoining marsh, bog, or fen driving out native plants and reducing diversity. In southern Wisconsin, areas of disturbed soil and ditches close to highways where road salt concentrates are susceptible to such invasion. Several methods of control are being studied. Cutting and treating cut stems with herbicide shows some promise.

**Glossy Buckthorn (*Rhamnus frangula*) and
Common Buckthorn (*Rhamnus cathartica*)**



Glossy buckthorn is a small tree or tall shrub native to European wetlands. Due to its hardiness and ability to survive a variety of soil types and conditions, it was an ideal plant to use as hedges during the second half of the last century. Its initial introduction was in the eastern part of the U.S. and soon spread westward and into Canada. In Wisconsin, it is invading wetlands and shading out native vegetation. Common buckthorn is a related upland species that can invade meadow wetlands, particularly along the drier borders. While common buckthorn has long thorns on the ends of the twigs, glossy buckthorn has no thorns.

Both species are spread when birds eat the berries and disperse seeds in their droppings. Wetlands are susceptible to invasion by glossy buckthorn. Ironically, the only wetlands that glossy buckthorn apparently cannot invade wetlands dominated by the more aggressive reed canary grass.

The best method of control is to pull out young buckthorn seedlings. Once the seedling has become a larger sapling and is too big to pull, cut the stem close to the ground and paint the cut surface with herbicide. Chemical control is ineffective if not done within a few hours of cutting, and the tree will resprout vigorously if cut and left untreated.

A good time to detect trees and treat them is in the fall, since the species holds leaves longer than most native wetland trees and shrubs, or in the spring since it leafs out earlier. With large infestations, priority should be given to treating the largest fruit-producing trees, then focus on then mid-sized trees, and finally seedlings. Cut and remove the fruit-bearing trees to an offsite location, if possible. Once an invasion occurs, only routine ongoing removal will keep the species in check.

G. Biodiversity and Core Habitat

Criteria for maintaining biologic diversity (biodiversity) are different from criteria for maintaining water resources. For example, water resource protection criteria are primarily based on water temperature, siltation rates, contaminant levels, etc. Buffers surrounding water bodies are more important than just protecting our water resources; they are essential to the conservation and management of wildlife species as well. Numerous studies over the past few decades document the use of terrestrial habitat adjacent to lakes, streams, and wetlands by a broad range of taxonomic groups including mammals, birds, reptiles, and amphibians.¹¹ Wildlife protection criteria are based on use by target species for life history functions such as feeding, mating, nesting, and over-wintering.

While the protection of water resources from human activities such as agriculture and urban development is obvious, it is often less apparent that the terrestrial areas surrounding our surface waters also serve as “core habitats” for many semi-aquatic species that depend on both aquatic and terrestrial environments to fulfill their life-cycle requirements. These in turn serve as food for higher level organisms, and so on up the food chain.

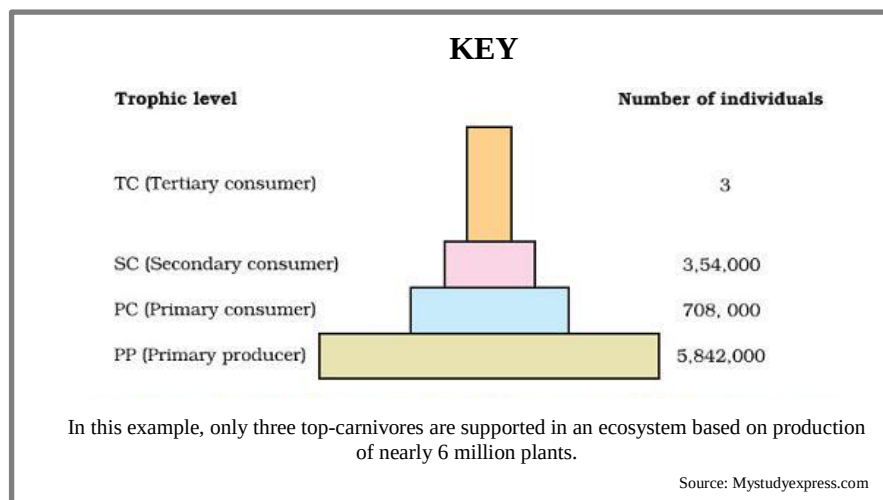
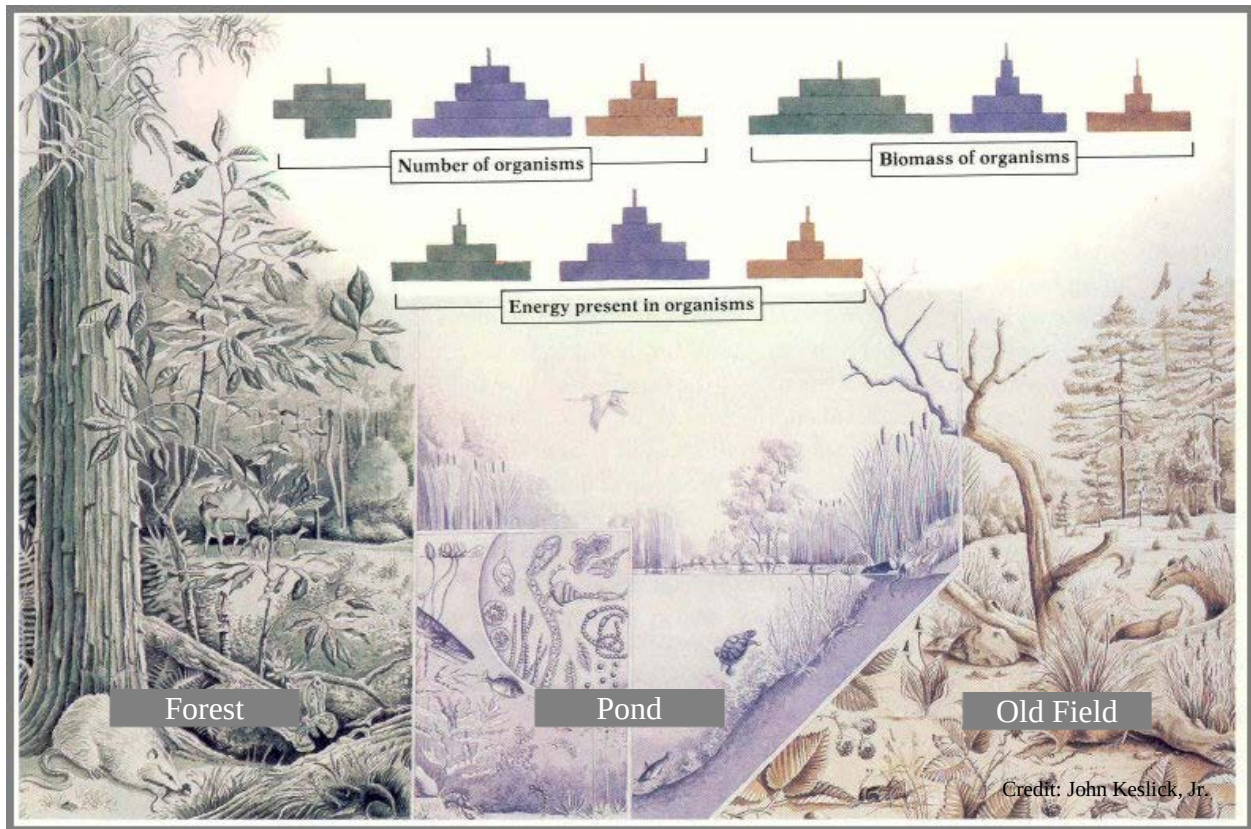
A serious gap is created in wildlife protection when regulations or ordinances have been set based on criteria to protect water resources alone, without considering upland habitats critical to aquatic wildlife.

It is not surprising that the terrestrial ecology of semi-aquatic species is often underappreciated or overlooked. Many pond-breeding amphibians spend the vast majority of their lives in uplands, but live mostly underground and are therefore infrequently seen in here. Semi-aquatic reptiles make only brief visits to terrestrial habitats when nesting, and hibernation sites are very rarely seen by the untrained observer. Observations and studies of these animals are consequently concentrated in streams and wetlands, where they are found more easily (in the right season), rather than in terrestrial habitats where they elude detection yet where important parts of their lives play out. Semi-aquatic organisms therefore depend on both aquatic and associated upland habitats during their entire life cycle. This aggregation of breeding adults constitutes a local population centered on, for example, a single wetland or wetland complex. Local populations are connected by dispersal and are part of a larger metapopulation, which extends across the landscape.

¹¹ Environmental Law Institute. 2003. *Conservation Thresholds for Land Use Planners*. Washington, D.C.

Semi-aquatic amphibians and reptiles (collectively known as herptiles) represent a crucial link between aquatic and terrestrial environments, especially biologic diversity and ecosystem health. Herptiles play particularly important roles in food webs because they occupy a middle position as both predator and prey, and also because they constitute an enormous amount of the biomass in some aquatic and riparian ecosystems (Figure 3).

Figure 3. Ecological Pyramids of numbers, biomass, and energy for a forest, shallow pond, and an “old field.”



The importance of amphibians and reptiles as prey in the diets of raptors, including several that are endangered or threatened, has been well documented.¹² Because of their large biomass and their movement between terrestrial and aquatic systems, amphibian populations can influence important ecosystem functions. Most of the amphibian species and many of the reptile species in Wisconsin rely on riparian habitat in some way. Preservation of riparian habitat is therefore essential for supporting biodiversity in the region.

For example, marsh, sedge meadow, and other riparian wetland habitats, being damp to wet and typically dominated by dense vegetation, are productive foraging areas and are particularly important in reducing dehydration of amphibians, while also providing good overhead cover for both amphibians and reptiles.

Development activities that cut too deeply into the base of these ecological pyramids can destabilize these systems, leading to diminished productivity and other negative effects that can cascade

Semi-aquatic amphibians and reptiles represent a crucial link between both the aquatic and terrestrial environments, especially biologic diversity and ecosystem health.

upward to higher predators leading to potential ecosystem collapse. Resource managers and policymakers need to recognize the special needs of semi-aquatic organisms during their entire life cycle and not just during the most obvious portion, the breeding season. So in order to maintain viable populations and communities of wildlife, attention must be directed to the terrestrial areas peripheral to our waters.

While the biological importance of these habitats in maintaining wildlife may be obvious, the criteria by which to define habitats and regulations to protect them are usually ambiguous or lacking. More importantly, a serious gap is created in wildlife protection when regulations or ordinances have been set based on criteria to protect water resources alone, without considering upland habitats critical to aquatic wildlife. Whereas protection for most species that inhabit wetlands stops at the waters edge or immediate shoreline, in fact both the aquatic and terrestrial habitats are essential for carrying out life-history functions – defined here as “core habitat.”

Core Habitat

Although wetlands vary in many characteristics related to type, region, topography, climate, and land-use surrounding them, the data suggest that a single all-encompassing value for the size of core habitats can be used effectively.¹³ Maximum values generated from a species with the greatest need for terrestrial habitat (i.e., largest core area) would likely encompass all other species and could be used more broadly. Scientist sometimes identify certain species as “umbrella species” in the hopes of saving a whole range of animals and plants in a given area. The idea is that by protecting an important umbrella species and preserving its habitat, various other species that depend on the same habit would also be protected.

Semlitsch and Bodie summarized data from the literature on the use of terrestrial habitats by amphibians and reptiles essential for carrying out their life-history functions. Using these values,

¹² Ross, D. 1989. *Amphibians and Reptiles in the Diets of North American Raptors*. Wisconsin Endangered Resources Report 59. Wisconsin DNR. Madison, WI.

¹³ Semlitsch, R. and J. Bodie. 2003. *Biological Criteria for Buffer Zones Around Wetlands and Riparian Habitats for Amphibians and Reptiles*. Conservation Biology. Vol. 17, No. 5 (1219-1228).

a grand mean for major taxa was calculated (**Table 5**), including a mean minimum and maximum. These minimum and maximum values likely encompass a large portion of the populations and adequately represent the majority of species.

Table 5. Mean Minimum and Optimum Core Habitat for Wisconsin Wildlife Species

Wisconsin Species	Minimum Core Habitat (feet)	Optimum Core Habitat (feet)	Number of Studies
Frogs	571	1,043	9
Salamanders	394	705	14
Snakes	551	997	5
Turtles	446	889	27
Birds	394	787	45
Mammals	263	No data	11
Fishes and Aquatic Insects	100	No data	11
Mean	388	885	

Source: SEWRPC *Managing the Waters Edge*, and Semlitsch and Bodie, 2003,

Data indicate that typical buffers of 100 feet used to protect water quality are clearly inadequate for most wildlife requirements. Data from these studies highlight the importance of terrestrial habitats for feeding, mating, nesting, and over-wintering and, thus, the biological interdependence between aquatic and terrestrial habitats that is essential for the persistence of wildlife populations. Depending on the level of protection needed, the minimum and maximum values for core habitats can be used to set biologically meaningful buffers for wetland and riparian habitats. These results indicate that large areas of terrestrial habitat surrounding wetlands are critical for maintaining wildlife.

Taking the minimum mean group (e.g., salamanders) provides a good reference point for establishing a minimum wildlife protection program. If we assume that the distances salamanders move from wetlands are normally distributed then, by definition, the mean for adults of all salamander species combined represents a distance encompassing 50 percent of the population. Therefore, a core habitat buffer zone encompassing the majority of the population

(95 percent confidence limits) would have to encompass the terrestrial habitat 550 ft from a wetland's edge.¹⁴

Although there is variation in the size of terrestrial habitats used by salamander species related to life-history requirements, geographic variation in climate and habitat, or even among particular ponds because of topography, vegetation, and wetland size, etc., a core habitat cannot realistically be determined for each wetland species. By combining all available data, Semlitsch suggests a general core habitat that could be used for conservation purposes for most wetlands and species of pond-breeding salamanders.

Both aquatic and terrestrial habitats are essential for carrying out life-history functions of semi-aquatic species – defined here as “Core Habitat.”

The 550 ft. core habitat calculated for 95 percent of the population is robust to most sources of variation mentioned above. It would also provide the minimum necessary for most reptiles and other amphibians. Since some of the literature values used in the analysis were minimum estimates of mean distances traveled, the measured values probably underestimate the actual buffer zone needed to encompass 95 percent of the population of some species of salamanders, so the recommended core habitat of 550 ft. should itself be considered an underestimate.

These analyses indicate that large terrestrial areas adjacent to wetlands are used by adult pond-breeding salamanders and newly metamorphosed juveniles throughout the majority of the year. The exclusion of these terrestrial areas from protection would most likely reduce recruitment of juveniles into the breeding adult population, reduce adult survival, and therefore reduce the potential of the population to persist. Combined with the life requirements of other aquatic creatures, this has significant implications for population, food-web pyramid, and other ecological interactions/dynamics.

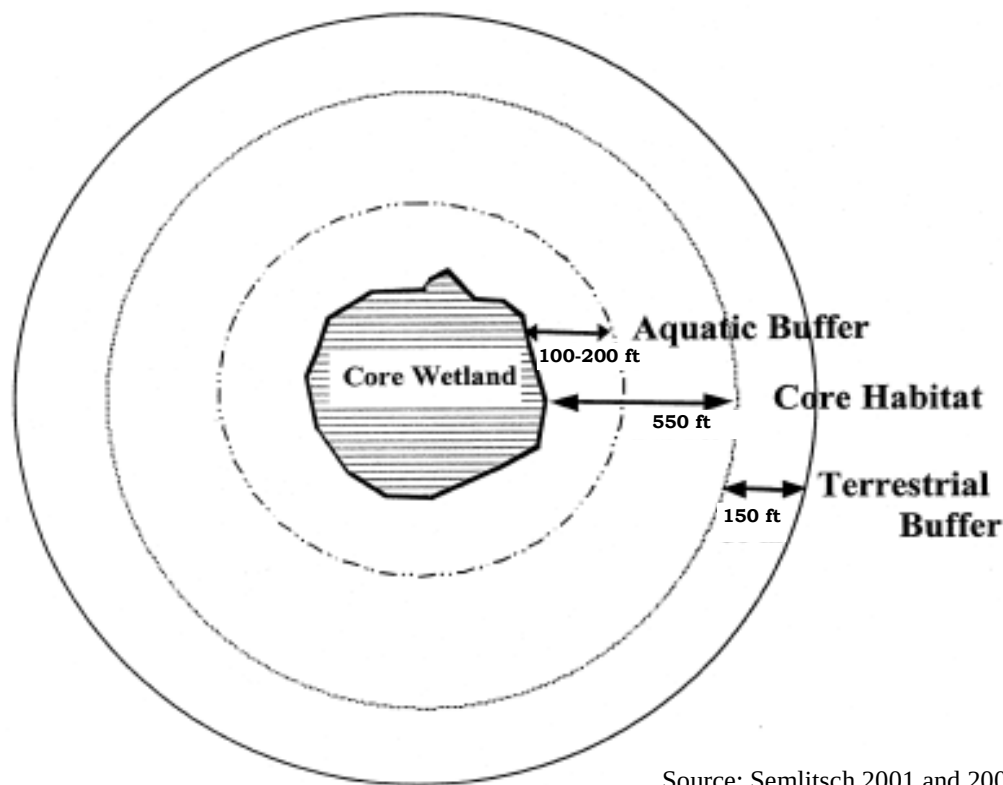
Semlitsch¹⁵ proposes use of stratified criteria that would include at least three terrestrial zones adjacent to core aquatic wetland habitats (**Figure 4**):

1. **Aquatic Buffer** – starting from the wetland edge, a first terrestrial zone would be restricted from use and designed to buffer the core aquatic habitat and protect water resources (100-200 ft.);
2. **Core Habitat** – a second terrestrial zone, overlapping the first, would encompass the core terrestrial habitat defined by the semi-aquatic focal-group (e.g., salamanders 550 ft., as above)
3. **Terrestrial Buffer** – a third zone, starting from the outward edge of the second zone, would buffer the core terrestrial habitat from edge effects and surrounding land use practices (e.g. 50 m¹⁶ or 150 ft).

¹⁴ Semlitsch, R. 1997. *Biological Delineation of Terrestrial Buffer Zones for Pond-Breeding Salamanders*. Conservation Biology Vol. 12, No. 5 (1113-1119).

¹⁵ Semlitsch, R. 2001. *Core Habitat, Not Buffer Zone*. National Wetlands Newsletter. Vol. 23, No. 4. Environmental Law Institute. Washington, D.C.

Figure 4. Zones of Protection for Semi-Aquatic Species



Source: Semlitsch 2001 and 2003

Greater emphasis has recently been placed on providing buffer areas between agricultural and urban land uses and adjacent surface waters. Under most circumstances, buffers necessary to protect streams, lakes, and wetlands should be a minimum 100 feet in width.^{17,18} Generally, buffer widths toward the lower end of the range help maintain the physical and chemical (water quality) characteristics of aquatic resources (**Figure 5**). For example, pollutant removal increases with increasing buffer width up to about 100 feet where a point of diminishing returns is reached. In other words, after about 70-80 percent removal is obtained, much greater widths are needed to gain the next increment of removal.^{19,20} Additional stormwater structures and practices may be necessary to avoid channelized flow, which negates buffer effectiveness. The type of vegetation

¹⁶ Murcia, C. 1995. *Edge Effects in Fragmented Forests: Implications for Conservation*. Trends in Ecology & Evolution. 10:58-62.

¹⁷ The Environmental Law Institute. 2003. *Conservation Thresholds for Land Use Planners*. Washington, D.C.

¹⁸ Wenger, S. 1999. *A Review of the Scientific Literature on Riparian Buffer Width, Extent, and Vegetation*. Institute of Ecology, University of Georgia. Athens, GA.

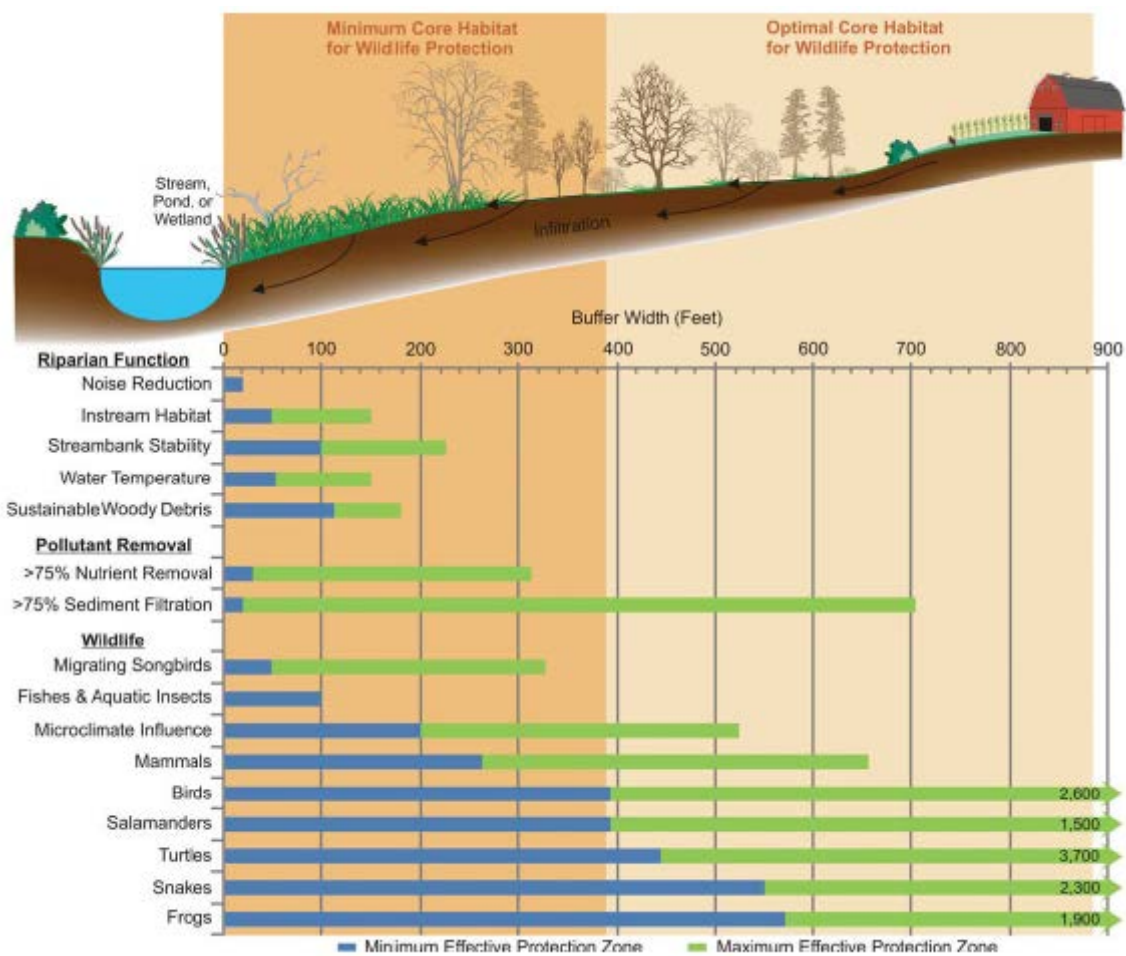
¹⁹ Desbonnet, A. et. al. 1994. *Vegetated Buffers in the Coastal Zone: A summary Review and Bibliography*. Coastal Resource Center, Rhode Island Sea Grant, University of Rhode Island.

²⁰ Bernthal, T. et al. 1997. *Effectiveness of Shoreland Zoning Standards to Meet Statutory Objectives: A Literature Review with Policy Implications*. WI Department of Natural Resources PUBL-WT-505-97. Madison, WI.

used in a buffer strip influences its effectiveness. In general, buffer strips with deep-rooted native prairie grasses are more effective than wooded buffer strips, because of the superior erosion protection and filtration provided by dense grass ground cover.

Buffer widths toward the upper end of the range appear to be the minimum necessary for maintaining the *biological* qualities of many streams, lakes, and wetlands. Most resource management objectives can be accomplished using a buffer width of 400 feet. Some researchers propose a multiple zone approach that allows more intense land uses farther away from a core undisturbed zone.^{21,22} Generally larger buffers are required for more sensitive semi-aquatic species (e.g., amphibians and reptiles).

Figure 5. Minimum and Optimum Core Habitat for Wildlife Protection



Source: SEWRPC *Managing the Water's Edge*

²¹ Wenger, S. 1999. *A Review of the Scientific Literature on Riparian Buffer Width, Extent, and Vegetation*. Institute of Ecology, University of Georgia. Athens, GA.

²² Semlitsch, R. et al. 2003. *Biological Criteria for Buffer Zones Around Wetlands and Riparian Habitats for Amphibians and Reptiles*. *Conservation Biology* Vol. 17, No. 5 (1219-1228).

Alternatively, riparian areas which are heavily infested with reed canary grass do not provide the same degree of ecological function or habitat support when compared to more naturally vegetated areas. Reed canary grass does not provide adequate woody debris or leaf litter inputs, nor provide adequate shade or cover for aquatic organisms. These disturbed areas are less likely to support diverse terrestrial insects, which are an important food resource for aquatic vertebrates.

It is also important to point out that in promoting core habitat and terrestrial buffer zones for wetlands, the focus has been on the conservation of local populations. It avoids the more complex issue of meta-population dynamics and landscape-level processes. It is therefore critical for resource managers to realize that the application of a core habitat and terrestrial buffer zone protects only that specific population for as long as it remains viable (i.e., births > deaths). Considering that many vernal pools and ponds used by salamanders are temporary over geological time, or possibly even over shorter periods due to succession, inevitable extinction of local populations must be counterbalanced by colonization of new sites. Thus it is clear that a successful management plan must also protect terrestrial habitats as corridors of movement from source ponds to new sites, as well as re-colonization or rescue of extinct populations at old sites. More specifically, because of their critical nature and position in the landscape, these areas offer both unique constraints and opportunities that need to be considered early on in a community's overall economic development and environmental resource protection plans and activities.

H. Habitat Loss and Landscape Connectivity

Habitat loss or fragmentation is the process whereby contiguous natural areas are reduced in size and separated due to land conversion for other uses, such as urban development or agricultural production. Because of the prime soils located here, agriculture has had a significant impact on wildlife habitat in Dane County. Due to draining and cropping practices over the last century, most remnant habitats can usually only be found in areas that are either too wet, steep, or stony to be effectively farmed. Also, as is too often the case in Dane County, where farmland has gained a toehold, development is often apt to follow. That leaves relatively few areas in the county that have not already been farmed or developed.

When habitat is destroyed, a patchwork of habitat fragments remains. These habitats are often isolated from one another, which impairs the flow of organisms and energy among them resulting in species losses, reduced biodiversity and habitat complexity, as well as increased competition and susceptibility to invasive species and higher local extinction rates. These remnant areas require protection, network re-connection, and enhancement where possible.

For example, **Figure 6** shows the probability of a local species population being extirpated increases as habitat patch size decreases (right side of the diagram). Conversely, a larger patch generally supports a larger population size for a given species, making it less likely that the species will go locally extinct (right side of the diagram). Species viability and diversity are also enhanced by well-connected habitats. This is because small, isolated reserves are unlikely to maintain viable populations over the long-term. Wildlife corridors are therefore recommended as a conservation measure to help counter the negative effects of habitat, loss, fragmentation, and

patch isolation (**Figure 7**). According to Diamond and Noss (**Figure 8**), landscape designs for maintaining habitat preserves should be based on the following principles:

- Larger habitat patches with large populations are better than smaller patches with small populations
- Contiguous patches are better than fragmented patches
- Closer patches are better than distant patches
- Patches that are mutually equidistant are better than patches which are distributed linearly
- Connectivity of patches is better than isolated patches
- Patches with higher area to perimeter ratios are better than long, thin patches

In addition:

- Species that are well distributed across a landscape have lower extinction risk
- Stable populations fare better than fluctuating populations
- Peripheral populations perform poorly relative to core populations.

Figure 6
Patch Size and Local Extinction

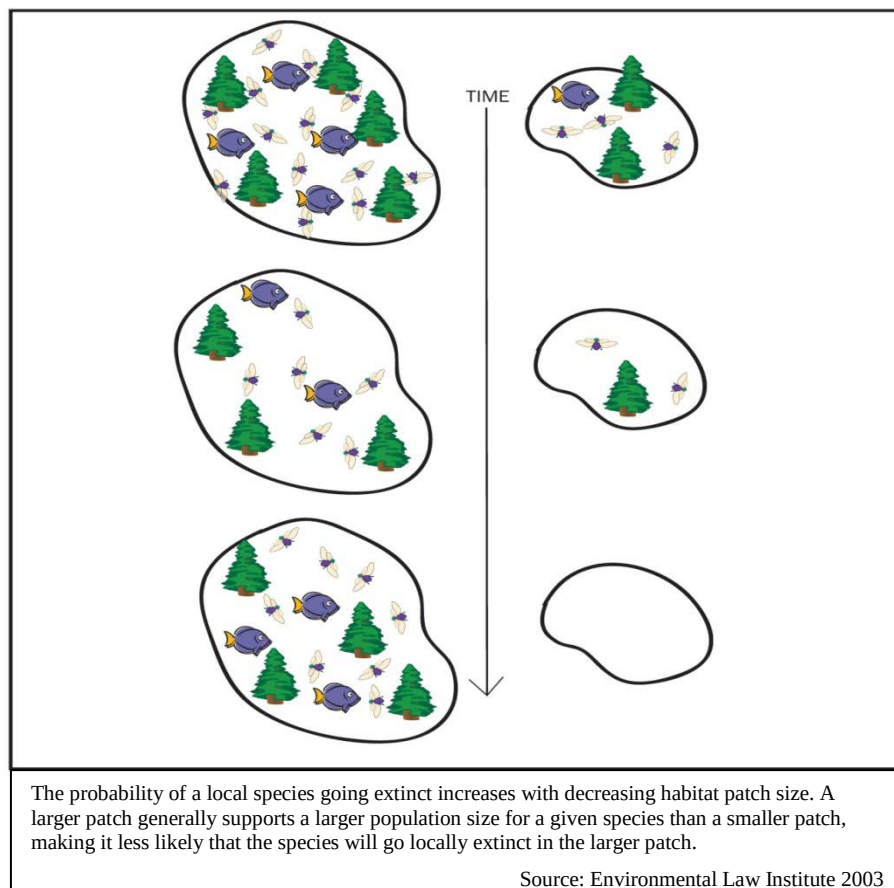


Figure 7
Habitat Connectivity

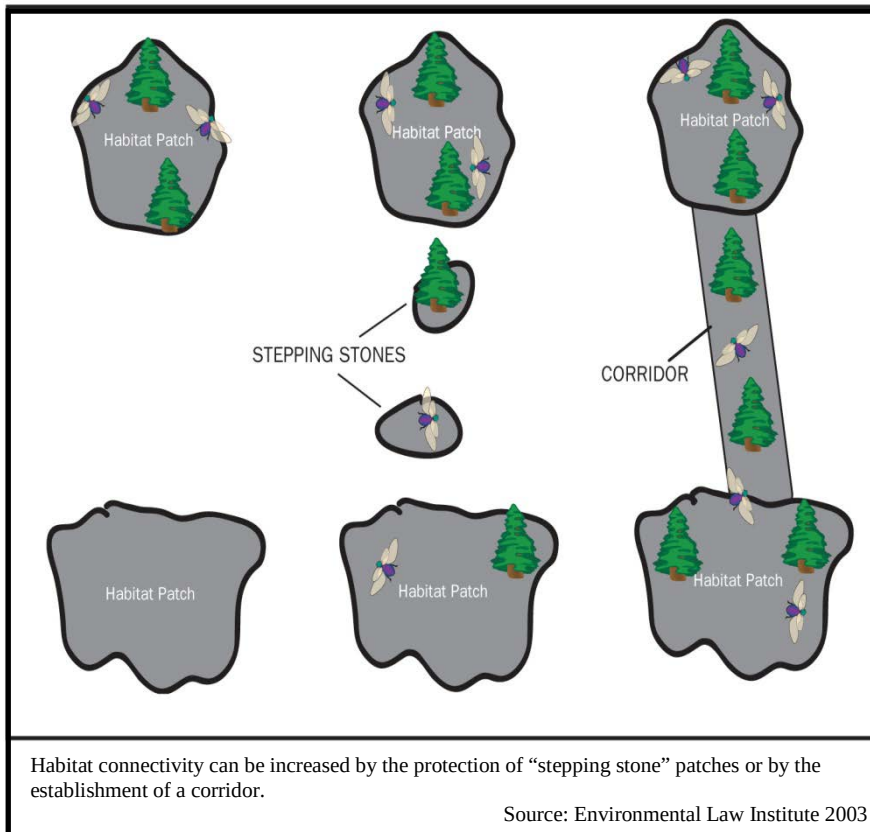


Figure 8
Preservation System Designs

A. Size		D. Linearity	
Better	Worse	Better	Worse
B. Subdivision		E. Connection	
Better	Worse	Better	Worse
C. Separation		F. Edge / Interior Ratio	
Better	Worse	Better	Worse

Some "better-worse" comparisons of preservation system designs as derived from island biogeographic theory.

Modified from Diamond 1975 and Noss 1997

As the landscape is being considered for habitat, it is important to note that not all patches are always occupied by regional species. Also, patches within the landscape vary in species content, with higher quality habitat likely containing sensitive species. Due to ecological activities and natural changes in population demography a species may become locally extinct. Therefore, maintaining a series of patches within a landscape is necessary for prey species to elude predators, providing refuge from contagious diseases and parasites, and re-colonization opportunities.

Another important consideration when maintaining or establishing habitat corridors is width. Corridor width is positively correlated with the abundance and species richness for birds, mammals, and invertebrates. As is true

for other conservation thresholds, in general, the wider a buffer is the better it will be. However, data limitations on the relationship between corridor width and

species response prevent the development of recommendations on optimal corridor sizes – especially at a regional scale. For any given set width, corridor effectiveness will vary with other attributes such as length, habitat continuity, habitat quality, topographic position in the landscape, among other factors.

We should strive to protect existing resources where they occur, and restore others where opportunities and circumstances permit .

In general, most natural resource objectives can be accomplished within 400 feet from the edge of a good quality wetland and 700 feet from the edge of an exceptional wetland. Where there are groups of small wetlands, they should also be combined. These are the areas where wetland stewardship activities will have the greatest beneficial effect. For example, these are the areas suggested by leading ecologists for providing core habitat and a protective buffer for semi-aquatic amphibians and reptiles which serve as umbrella species, described earlier. By protecting the needs of umbrella species, other associated species are likewise protected. Semi-aquatic species require both aquatic and terrestrial environments to fulfill their full life-cycle needs (e.g., breeding, hibernation, food, cover, etc.). Since amphibians and reptiles reside solidly in the middle of the ecological pyramid as both predators and prey, protecting core habitat for these umbrella species protects food, cover, and habitat for other associated species as well (i.e., other birds, mammals, fish, insects, and plants).

Researchers have also reported positive correlations between forest cover and amphibian and reptile populations in wetlands. These studies suggest the need to link terrestrial forest habitats adjacent to wetlands to sustain

amphibian and reptile species. In many cases these areas could be improved by management activities that allow the land to revert back to a more natural condition (passive restoration), or by

more active management projects such as restoration of farmed wetlands, prairie restoration projects, riparian re-vegetation, etc. Considerable property value and natural resource amenities are also realized by people living in developments near these natural features, thus promoting the overall notion of sustainable development in harmony with the natural environment.

In general, most natural resource objectives can be accomplished within 400 feet from the edge of a good quality wetland and 700 feet from the edge of an exceptional wetland.

Ideally, these zones of protection should extend outward from the edge of wetlands, streams, and ponds far enough to encompass all species populations. Realistically, however, the habitats used by specific species or at different life-history stages are probably not evenly distributed or necessarily coincident. To protect those habitats essential for these species, more information is needed about their specific requirements at each life-history stage and season of the year. For example, we know that special habitats are required by some species (e.g., threatened and endangered species), and these need to be taken into account.

Overall, the areas surrounding surface water features in the region are particularly rich habitat areas. The wildlife corridors proposed here would provide extremely valuable habitat as well as critical connecting corridors for a wide variety of wildlife species. For more detailed design considerations, please see *Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways*.²³

While this might provide the basic framework for promoting biological health in the region overall, it does not adequately reflect the permanent losses that have resulted from agricultural and urban development activities over the last century. While providing a useful vision over the long-term, a more focused approach is needed for more immediate, short-term actions. At a minimum – all in support of a larger vision or goal for the region, taking into consideration all the opportunities and constraints at any given site.

Wetland Brief

Wetlands are complex systems, which include many moving parts! In order to successfully protect and improve them it is critical to understand and assess the full range of internal and external elements and linkages outlined and discussed in this section. A key element in managing these critical resources involves conducting an inventory and assessment of individual wetlands where this information can be documented and analyzed. Then, based on this information, a management strategy, available tools, and specific actions can be tailored and directed to a particular site – thereby bringing it more into natural harmony with its surrounding environment based the available opportunities, constraints, and future prospects. This process is outlined in the following sections.

²³ US Department of Agriculture. 2008. http://nac.unl.edu/buffers/docs/conservation_buffers.pdf

III WETLAND RESOURCE MANAGEMENT OPPORTUNITIES AND IMPLEMENTATION

Wetland resource management opportunities exist throughout the region. It is largely an issue of priority and finding the necessary resources to tackle a project. As part of the natural resource inventory for the *Dane County Water Quality Plan*, the first qualitative evaluation of wetlands in Dane County was conducted by Bedford and Zimmerman in 1974 and modified more recently. The wetlands covered in the study included all of those known or suspected at the time to be of particular value. The most valuable of these were studied in detail. The 1974 report contains narrative descriptions, plant lists, and detailed maps of the most significant wetlands. This is a particularly useful reference for those individuals in the early stages of designing their own wetland project. Although the study was conducted in the early 1970s and needs to be updated, much of the information is still useful today.

This study provided information for planning and decision-making, as well as proposing strategies for managing wetland resources in the county. The study was conducted on the premise that the information necessary to determine the type of wetland, its condition, and its value can be read from indicators seen in the field. More recent updates were conducted in selected areas between 2011 and 2014. These Future

Wetland resource management opportunities exist throughout the region. It is largely an issue of priority and finding the necessary resources to tackle a project.

Urban Development Areas represent a collaborative planning effort between neighboring jurisdictions and the CARPC to protect vital natural resources in anticipation of future growth and development. Wetlands that have not been assessed are included in the areas labeled in the map below as being “Not Inventoried.” More investigation is needed to evaluate and classify these wetlands as well as update earlier assessments, if these have changed significantly. Ephemeral or temporary ponds have also not been listed, even though they may provide critical life cycle habitat for some species, especially amphibians.

A. Wetland Groups

The information collected during the 1974 study was used to group wetlands into five categories (**Map 6**). Wetlands are grouped based on their present or potential biological condition, scientific value, public use, extent of degradation, and immediate or long-range threats. While all wetlands have value, decisions must sometimes be made as to where specific approaches and efforts are best tailored or targeted such as:

- preventing wetland destruction;
- planning wetland acquisition;
- understanding the general effects of existing as well as future wetland loss;
- establishing guidelines for use, management, and preservation of wetlands;
- designating wetlands of outstanding scientific and educational value and those most suited for recreation and public use;
- identifying wetlands in need of further studies.

It should be pointed out that a missing or low grouping should not be interpreted that an area may be further degraded or destroyed. Instead, it provides insight into the management strategy most appropriately targeted to a particular site. Since the competition for land is intense, any remaining remnant of the natural soils or plant and animal communities is worth preserving. Even though a wetland may be degraded or aesthetically unappealing, it still serves an important purpose and function in the hydrologic regime of the watershed. As long as anything natural remains, there is the possibility of improvement to the point where the area can be restored to a functioning wetland one way or the other.

Wetlands have been placed in different groups based primarily on their biological condition (i.e., excellent, good, fair, poor, or non-existent). Biological condition was based on the intensive fieldwork of Bedford and Zimmerman in 1974 taking into account:

- Water quality and natural water level cycles
- Plant and animal species and structural diversity
- Edge gradation
- Wildlife production or use
- Lack of invasive species

Additional ecological and cultural factors have also been taken into account, such as its role in watershed protection, scarcity of type, recreation and educational value, size, proximity to other wetlands, buffer zones, and scenic value. The concurrent presence of two of these features moved a wetland up from its initial position to the next higher group. Four or more features moved a wetland up two groups.

The wetland groups derived from that study are shown in **Map 6** and described below.

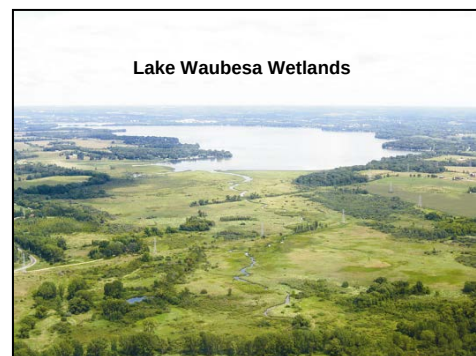
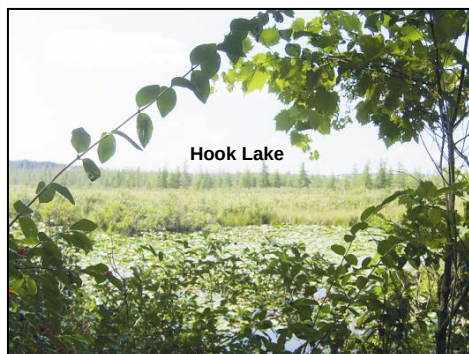
Group I Wetlands

Wetlands in this group are the best in the county and, in some cases, among the most valuable in southern Wisconsin. A few function substantially as they did at the time of early settlement, as far as can be told. Examples include Cherokee Marsh, Lake Waubesa and Lower Mud

Lake Wetlands.

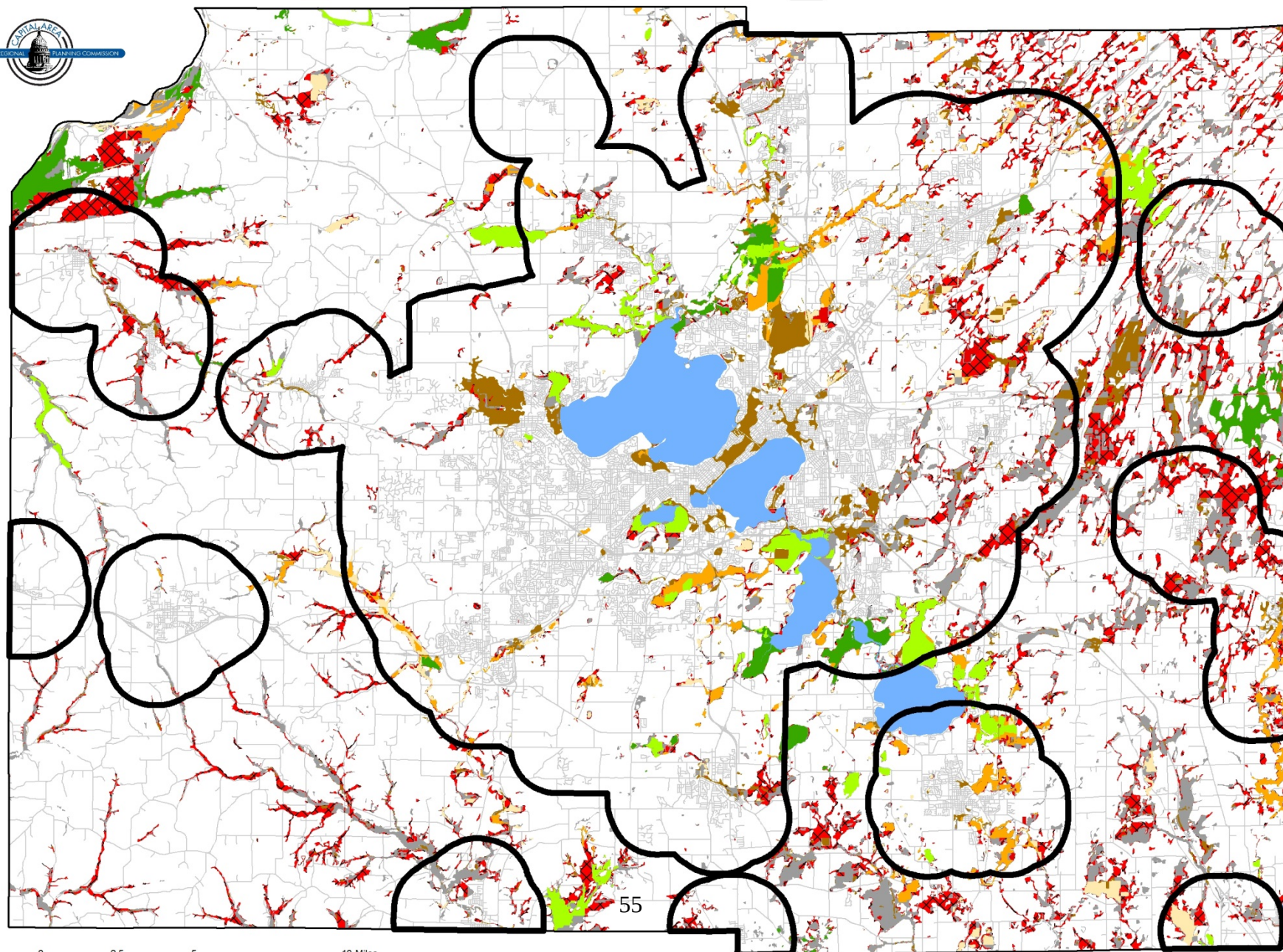
Although showing signs of disturbance they remain virtually intact. In

addition to their wildlife value, water quality, and flood protection benefits, these sites also provide important reference sites for designing restoration projects in other areas. Because of the scarcity of wetlands which approximate natural ecosystems in today's landscape, every effort should be taken to protect and preserve them.



Map 6. Wetland Groups in Dane County and Estimated Management Classification

- Group I (Preserve) Group III (Manage I) Group V (Prior-converted wetland) Potentially Restorable Wetlands
Group II (Preserve) Group IV (Manage II) Not Inventoried Extra Territorial Jurisdiction



0 2.5 5 10 Miles June 2015

Group II Wetlands

This group contains the rest of the large peat deposits not in Group I, which are particularly valuable for protecting the Yahara River and its chain of lakes. Examples include Pheasant Branch Marsh, Sixmile Creek, and Door Creek Wetlands. While these wetlands may be affected by agricultural or urban development activities, they still



remain in very good condition. Most of the wetlands in this group fall into the so-called “undrainable” category and, therefore, are large or deep enough to have resilience. Alterations have not had a profound effect. These wetlands should receive the same protection as those in Group I, and it is certainly possible to improve or enhance their condition.



Group III Wetlands

While the wetlands in this group do not currently have outstanding values, they serve as support systems for those which do. Furthermore, they enhance the environment as a whole. Although substantially altered, these wetlands support wildlife and provide open space. While all reasonable efforts should be made to ensure their protection, enhancement may be especially important to improve one or more degraded functions such as flood protection, water quality, and wildlife habitat. Examples include Nine Springs Creek Wetlands and the Stoughton Millpond.



Group IV Wetlands



These wetlands maintain some function or exist for temporary periods of time (such as protection from flooding or for migratory waterfowl use). Usually they have been altered and degraded by unsuccessful drainage attempts and are often dominated by invasive species, such as reed canary grass. The Upper Sugar River Wetlands are a good example. Many wetlands in this group can be looked upon as either wildlife areas or as agricultural lands. The fact that they can still be

considered wetlands after many decades of drainage indicates that they are not well suited for agriculture. Some of them have value for watershed protection, wildlife use, or open space. Their best use appears, then, to be enhanced or restored for one or more wetland values or functions – rather than continued attempts at drainage. An outstanding example of a wetland that has been restored is Patrick Marsh, moving it from a Group IV to a Group I Wetland. Further degradation

of these wetlands should be discouraged.

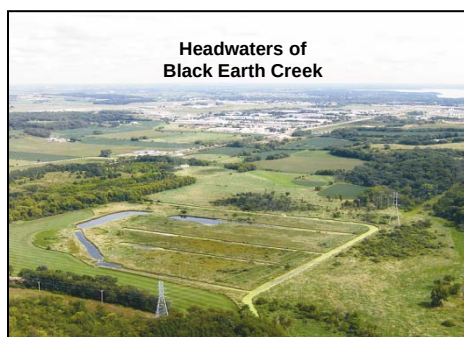
It should be noted that relatively few wetlands are listed as being in Group IV as compared to the actual number that exist in Dane County. Many wetlands which would have been placed in Group IV could not be visited during the 1974 study because of project limitations. More investigation is needed in these areas.

Ephemeral or temporary ponds have also not been listed. Since they fill with water almost every spring or after heavy rains, they are not as endangered as most other types of wetlands. While they can be emptied permanently by extensive ditching, this is usually not practical if the area is only a few acres. Cultivation and grazing do not appear to destroy their value for waterfowl; however, they do provide critical life cycle habitat for some species (e.g., tree frogs when such ponds are located next to woodlands). In such cases they need to be identified and protected.

Group V Wetlands

These areas no longer exist or function as wetland ecosystems. This is particularly apparent in the eastern Drumlin Marsh area of the county, as well as stream valleys in the Driftless Area. Ditching, draining, or filling have destroyed all functions and values. It may be possible, however, to restore them by reversing the action(s) that destroyed them in the first place.

Potentially restorable wetlands are indicated on **Map 6** based on WDNR modeled data accounting for land use and cover constraints. These areas present significant opportunities to restore wetland acreage that has been lost over the last century. The former Pheasant Branch wetlands are a good example of this; with the Pheasant Branch Confluence Pond project serving as an excellent example of how these wetlands can be restored to serve important functions and values (e.g., flood control, water quality improvement, wildlife habitat, outdoor recreation, and scenic beauty). Another good example is a Dane County wetland restoration project planned in the headwaters of Black Earth Creek immediately downstream of the Middleton business park. The former wetlands downstream from the Cities of Middleton, Stoughton, and Sun Prairie, as well as the Villages of Cottage Grove and Oregon, among other sites, offer significant additional opportunities and prospects for restoring many historic functions in the region in anticipation of future development.



Potential restoration sites should also be considered for improving or expanding existing wetlands. The MMSD lagoon restoration project is a good example of this along Nine Springs Creek. Other potential sites include Deansville Marsh near Marshall, Goose Lake near Deerfield, Story Creek near Belleville, the West Branch and Mainstem of the Uppers Sugar River, Black Earth Creek, Halfway Prairie, Wendt, and Dunlap Creeks, among many other opportunities. **Map 6** can help in determining where the best opportunities exist in relation

to these other features.

Wetlands should be protected regardless of their quality, not only because they are scarce in the landscape but also because of the values and functions they do and *can* provide – no matter how small or degraded. Many degraded wetlands provide important flood protection benefits and open space corridors. Many sites, particularly those where native species remnants exist, have a high potential for restoration or enhancement. So too do those that have been ditched or drained, since it is often possible to restore their natural hydrology by plugging ditches or breaking tile lines. In the end, the management strategy for each wetland will be as unique as the wetland itself, based on the site characteristics and available resources, opportunities, and constraints. Also, because of the scarcity of remnant aquatic habitat, both aquatic and terrestrial endangered species are often associated with wetland areas. Therefore, enhancing the quality and extent of wetland habitat in an area helps support and promote ecological food webs, species diversity, and overall biotic health, discussed earlier.

Alternatively, wetlands and former converted wetlands pose significant constraints to development such as high water table levels, potential flooding, and poor soils. County and municipal zoning prohibits development in wetland areas of 2 acres or greater. Wetlands, regardless of size, are also regulated by other state and federal laws. Existing laws and regulations, however, do not always provide adequate protection, especially against indirect impacts. The best strategy is to avoid these areas completely and direct future development to areas better suited for it.

In addition, existing laws and regulations largely ignore opportunities to restore some of the large wetland acreages that have been lost over the last century, including associated functions and benefits. These remnant wetland acres should be included in the basic framework for carrying out an effective wetland resources protection and restoration program throughout the region.

The Bedford et al. (1974) study is a particularly useful reference for those in the early stage of designing their own wetland restoration or enhancement projects. It is important to realize that, as with all ecosystems, each wetland is unique. In the end the management strategy will be as unique as the wetland itself. Wetland protection and restoration plans are routinely developed by consulting firms on behalf of their clients. There is also federal, state, and local funding available to promote these projects. This report outlines a framework and process for developing successful wetland restoration and protection plans and projects in collaboration with public and private partners.

Each wetland is unique. A systematic process should be followed promoting its highest and best use in collaboration with both public and private partners and in harmony with its surrounding environment.

Due to limited data, however, **Map 6** can only provide a “10,000 foot view” of what a wetlands resources management program or framework might look like. For example, full protection may not be warranted in many cases due, for example, to irreversible impacts from both historic and existing land uses or invasion by exotic species that would be too expensive or difficult to eradicate or restore. In other cases, wetland restoration projects may be advantageous to future development designs. Each case is site specific, while also being part of a larger region or

ecosystem. In each case a systematic process should be followed promoting the highest and best potential for each site in context with the surrounding area. With this objective firmly in mind, the following wetland resources management process and recommendations provide the basis for promoting and fostering more resource-sensitive projects and designs overall.

B. Wetland Classification Process and Management Recommendations

Impacts to wetlands include not only direct impacts such as filling, draining, and excavating, but also indirect impacts from stormwater inputs, changes to local ground and surface water hydrology, and pollutant loading. This section describes a recommended process developed in support of a wetland management strategy, the objective of which is to achieve no net loss and possibly even a *gain* in wetland functions, while also providing flexibility for economic development. This process is based on research and guidance provided by the Minnesota Board of Water and Soil Resources.¹

The wetland protection process begins with an inventory and field assessment of the wetlands in the area of interest using the Minnesota Rapid Assessment Method for Evaluating Wetland Functions (MnRAM).² The wetland inventory should identify wetlands by type,

Following completion of the assessment, each wetland can be classified, including a recommended level of wetland protection and prescribed management measures.

size, location, landscape setting, and wetland functions. The wetland assessment evaluates both existing and potential functional capacity based on inventory information as well as vegetative community, soils, hydrology, ecologic characteristics, and cultural uses. Following completion of the assessment, each wetland can be classified according to a recommended level of wetland protection (**Figures 9a or b**) and recommended management measures prescribed in **Table 7**, detailed below.

A wetland function and value assessment should be required for all waters proposed to receive new stormwater discharges from private development or municipal projects. The earlier this is done in the design of the project the less difficult it will be to incorporate needed protections and realize potential opportunities. The assessment should include not only the water body receiving the discharge directly, but also affected downstream water bodies as well. The assessment should be completed by qualified wetland personnel who specialize in such work. Developers should be responsible for submitting the assessment for private projects (along with supporting stormwater plans), with sponsoring municipalities conducting watershed-wide assessments as opportunities and resources permit. A municipality may want to designate management classifications for all the wetlands in their jurisdiction greater than one-quarter acre in size. Ideally these should be included in stormwater management plans developed for individual watersheds in cooperation with neighboring communities. The assessments and watershed plans should also be developed in cooperation with CARPC's water resource staff.

¹ <http://www.bwsr.state.mn.us/wetlands/mnram/>

² Minnesota Board of Water and Soil Resources (BWSR). 2010. *Minnesota Routine Assessment Method (MnRAM) Evaluating Wetland Function, Version 3.4* Comprehensive General Guidance. St. Paul, MN..

1. Wetland Susceptibility to Stormwater Input

Stormwater runoff carries soil particles, nutrients, and contaminants that can change the ecological balance of the receiving water body. Changes in the volume, rate, frequency, or duration of stormwater entering or discharging from the water body can also change the ecological integrity. Alterations to the ecological integrity of a wetland often result in changes in the functional capacity, fish and wildlife habitat, replacement of native vegetation with invasive and disturbance-tolerant plant species, and/or other impacts to the wetland's functions and values.

The various types of wetlands are determined by their hydrology, vegetation, and soils. Eggers and Reed 1997 provides detailed descriptions of the types of wetlands found in Wisconsin and Minnesota.³ Given the diversity of wetland types, it's not surprising that wetlands have a broad range of tolerance to urban stormwater input. Some wetlands (e.g., bogs and fens) are sensitive to any disturbance and will show signs of degradation with even low-level inputs of urban stormwater. On the other hand, some wetlands (e.g., floodplain forests) are better adapted to handle the fluctuating water levels and influx of sediment often associated with urban stormwater. Each wetland should be carefully evaluated to determine potential impacts from a proposed development project. The state of Minnesota has developed guidance for determining the susceptibility of wetlands to degradation by stormwater input. This guidance relates wetland type to a level of susceptibility as shown in **Table 6**.

Note that wetlands such as bogs and fens can easily be degraded by changes in the stormwater inflows and are designated as exceptionally susceptible. On the other hand, floodplain forests are more tolerant of changes in the frequency, magnitude and duration of flooding without degradation and are therefore classified as moderately susceptible. Shallow marshes and wet meadows dominated by hybrid cattail, reed canary grass, or other invasive/non-native species have a moderate susceptibility to stormwater fluctuations and inputs.

2. Wetland Classification and Management

MnRAM provides an organized and consistent procedure for documenting observations and conclusions about wetland processes. Accompanying computer software, training materials, and technical guidance is available from the Minnesota Board of Water and Soil Resources <http://www.bwsr.state.mn.us/wetlands/mnram/>. It is considered an EPA Tier 2 rapid assessment methodology. MnRAM is intended for routine planning and inventory applications as well as for project-specific evaluations. Since professional judgment is incorporated in several questions, using it requires experience and training in wetland science.

Note, MnRAM is a qualitative approach to identifying wetland functions. Because the input is qualitative the output is qualitative. Therefore, MnRAM ratings should not be used to quantify impacts. Averaging is also not appropriate because a high-rated plant community may prompt important regulatory considerations such as avoidance or special consideration for compensatory

³ Eggers, S.D. and D.M. Reed. 1997. *Wetland Plants and Plant Communities of Minnesota and Wisconsin*. (2nd Edition). U.S. Army Corps of Engineers, St. Paul, MN.

mitigation. Averaging high and low ratings, for example, would yield a medium rating that obscures the presence of the high-rated plant community.

Wetland functions/value characteristics evaluated include:

1. Maintenance of Characteristic Vegetative Diversity/Integrity
2. Maintenance of Hydrologic Regime
3. Flood/Stormwater Attenuation
4. Downstream Water Quality
5. Maintenance of Wetland Water Quality
6. Shoreline Protection
7. Maintenance of Characteristic Wildlife Habitat Structure
8. Maintenance of Characteristic Fish Habitat
9. Maintenance of Characteristic Amphibian Habitat
10. Aesthetics/Recreation/Education/Cultural
11. Commercial Uses
12. Ground Water Interaction

Additional evaluation information includes:

1. Restoration Potential
2. Sensitivity to Stormwater & Urban Development
3. Additional Stormwater Treatment Needs

In Dane County, existing information such as the Wisconsin Wetland Inventory, NRCS Wetland Inventory, *Wetlands of Dane County* (Bedford and Zimmerman 1974), and other inventories/studies can be used as a starting point. Since the information may be dated, it should be used as a preliminary guide to field identification and assessments. Since field visits will be necessary to carry out parts of the inventory, verification of the published information can be done at that time. Wetlands should be identified in the inventory and classified according to their appropriate wetland sensitivity group. The size should be estimated and the surface hydrologic connections should be recorded for each wetland identified on the inventory.

With data for each wetland in the assessment area complete, the functional indices can then be used to classify the wetlands. This plan presents two classification systems based on expert wetland recommendations and concepts.⁴ Local authorities can choose the management classification level based on local resource needs and preferences.

The **Basic Protection Flowchart (Figure 9a)** is the minimum recommended level that will satisfy no-net-loss goals, protect critical resources, and allow for use of some wetlands in development zones. The **Increased Protection Flowchart (Figure 9b)** includes more wetlands in the Preserve category that might otherwise fall into Manage 1, thereby protecting less-than-pristine wetlands in areas that are at an increased risk for wetland impact – whether direct (i.e., outright loss by development pressures) or indirect (i.e., ecological impact from increased use or hydrologic changes).

⁴ State of Minnesota Storm Water Advisory Group, 1997. *Storm-Water and Wetlands: Planning and Evaluation Guidelines for Addressing Potential Impacts of Urban Storm-Water and Snow-Melt Runoff on Wetlands*.

Table 6
Susceptibility of Wetlands to Degradation by Stormwater Impacts

Exceptionally Susceptible Wetland Types:¹	Highly Susceptible Wetland Types:²	Moderately Susceptible Wetland Types:³	Least Susceptible Wetland Types:⁴
Sedge Meadows	Shrub-carrs ^a	Floodplain Forests ^a	Gravel Pits
Open Bogs	Alder Thickets ^b	Fresh (Wet) Meadows ^b	Cultivated Hydric Soils
Coniferous Bogs	Fresh (Wet) Meadows ^{c,e}	Shallow Marshes ^c	Dredged Material/Fill Material Disposal Sites
Calcareous Fens	Shallow Marshes ^{d,e}	Deep Marshes ^c	
Low Prairies	Deep Marshes ^{d,e}		
Lowland Hardwood Swamps			
Seasonally Flooded Wetlands			

¹ Special consideration must be given to avoid altering these wetland types. Inundation must be avoided. Water chemistry changes due to alteration by stormwater impacts can also cause adverse impacts. Note: All scientific and natural areas and pristine wetland should be considered in this category regardless of wetland type.

² a., b., c. Can tolerate inundation from 6 inches to 12 inches for short periods of time. May be completely dry in drought or late summer conditions. d. Can tolerate +12 inches inundation, but adversely impacted by sediment and/or nutrient loading and prolonged high water levels. e. Some exceptions.

³ a. Can tolerate annual inundation of 1 to 6 feet or more, possibly more than once/year. b. Fresh meadows that are dominated by reed canary grass. c. Shallow marshes dominated by reed canary grass, cattail, giant reed, or purple loosestrife.

⁴ These wetlands are usually so degraded that input of urban storm water may not have adverse impacts.

Notes: There will always be exceptions to the general categories listed above. Use best professional judgment. A more complete description of wetland characteristics under each category is contained in Attachment A of the source (see footnote). Pristine wetlands are those that show little disturbance from human activity.

Source: : Storm-Water and Wetlands: Planning and Evaluation Guidelines for Addressing Potential Impacts of Urban Storm-Water and Snow-Melt Runoff on Wetlands, State of Minnesota Storm-Water Advisory Group, June 1997. Modified in Recommended Wetland Management Classification System to Accompany the Minnesota Routine Assessment Method for Evaluating Wetland Functions, (MnRAM) Version 3.4. Draft January 2015

Preserve

The Preserve category is for exceptional and highest-functioning wetlands or those sensitive wetlands receiving conveyed storm water runoff that have yet retained a medium level of vegetative diversity/integrity. These wetlands are those that should be preserved in (or improved to) their most pristine or highest functional capacity with wide, natural buffers, in perpetuity.

Manage 1

The Manage 1 category includes high-quality wetlands that should be protected from development and other pressures of increased use, including indirect effects. Maintaining natural buffers will help to retain the significant function these wetlands provide. In the event that impacts to these wetlands cannot be avoided, replacement ratios for mitigation should exceed the state-required minimums.

Manage 2

Manage 2 wetlands provide medium functional levels and the wetland extent should be maintained. These wetlands often provide optimal enhancement opportunity.

Manage 3

Manage 3 wetlands have been substantially disturbed. They should be considered for rehabilitating one or more functions.

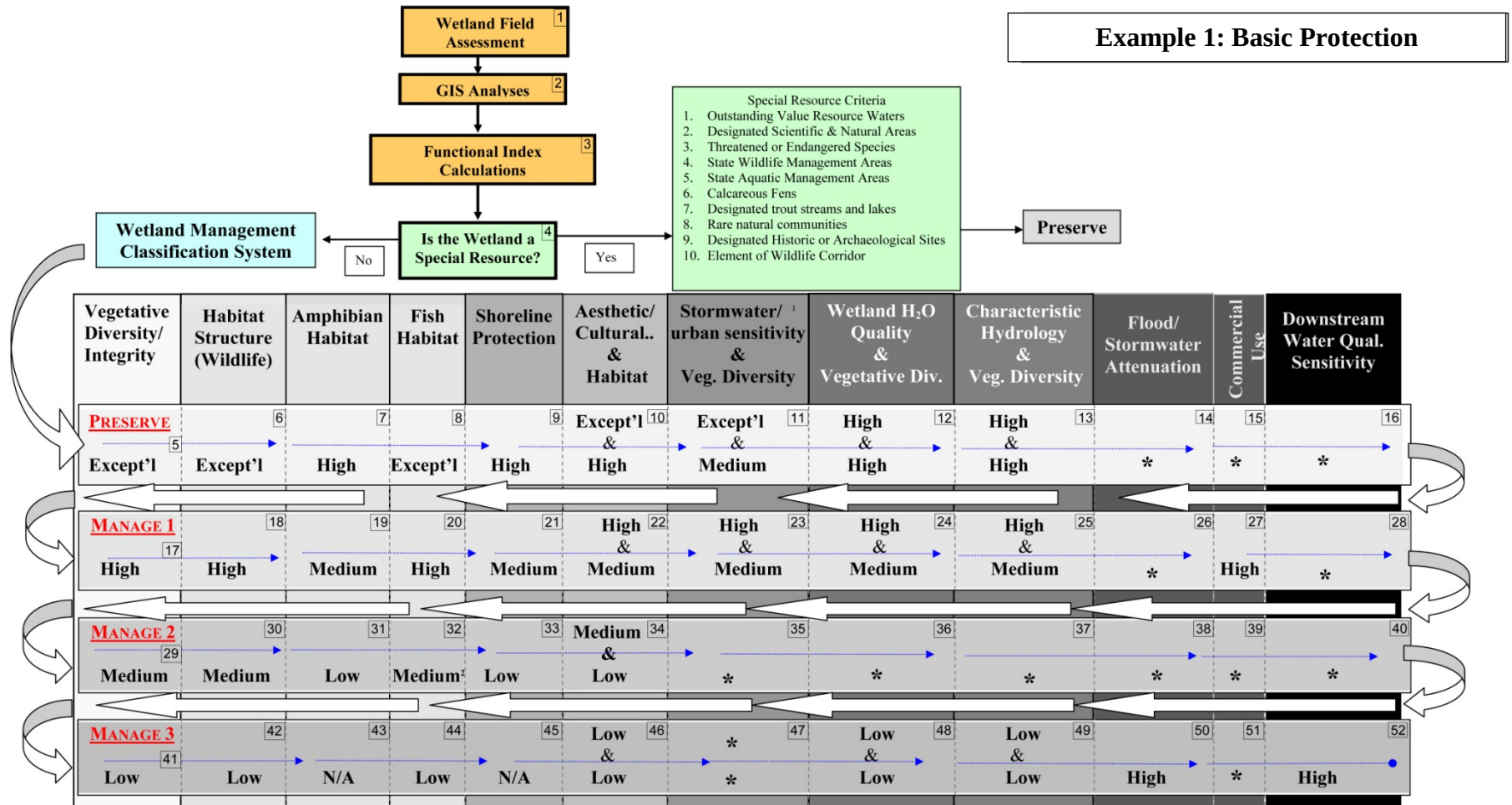
3. Using the Flowchart

The process can be followed in **Figure 9a** (Basic Protection) or **Figure 9b** (Increased Protection). The classification begins at the top and follows the arrows and numbered boxes through the diagram until the wetland has been placed in a management category. All wetlands that are classified as Critical Resources are classified in the Preserve category. Wetlands that do not fit any of the Critical Resources categories are then classified into one of the four management class groups. Each wetland is sorted or classified by its highest wetland functions (columns) and values (Exceptional, High, Medium, Low). The suggested wetland management strategies that could be applied to wetlands within each management class are provided in **Table 7**.

The classification process can be a little confusing at first. Basically, a wetland is dropped into the top of the sorting machine like a marble. By the time it rolls down to the end it will have settled into one of the management categories based on its highest functional value. For example in **Figure 9c**, assuming the wetland is not a Special Resource (which would receive an automatic Preserve classification), it will roll down through the various functional columns (left to right, top to bottom) until it settles into the Management 1 classification, as indicated. Notice that up until that point, each result for this wetland for each of the functions through the sequencing is less than the indicated minimum threshold value – that is, until it reaches Vegetative Diversity/Integrity. It is here the value (High) first meets the minimum threshold for that function, resulting in a Manage I classification.

Figure 9a
Wetland Management Classification Process Flowchart for Basic Wetland Protection

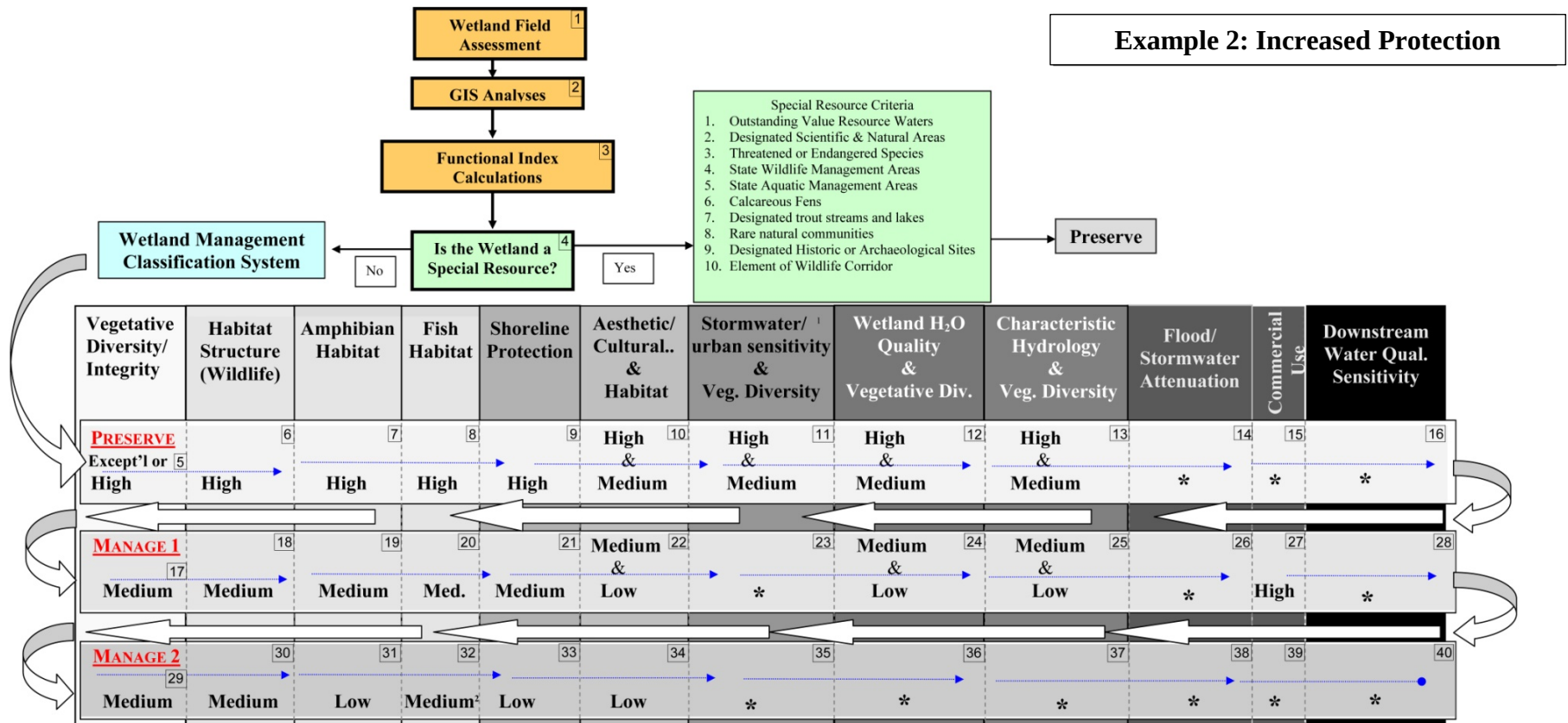
Each wetland will be ranked into a Wetland Management group by the highest rated function for the wetland.
 Follow the arrows through numbered boxes in progression through the tables; classify wetlands into the first group that applies.



* This rating does not apply here.

Figure 9b
Wetland Management Classification Process Flowchart for Increased Wetland Protection

Each wetland will be ranked into a Wetland Management group by the highest rated function for the wetland.
 Follow the arrows through numbered boxes in progression through the tables; classify wetlands into the first group that applies.



* This rating does not apply here.

Figure 9c
Wetland Management Classification Flowchart
-Example-

Wetland X Assessment Results

with these settings Wetland X classifies as **Manage 1**

Vegetative Diversity/ Integrity	Habitat Structure (Wildlife)	Amphibian Habitat	Fish Habitat	Shoreline Protection	Aesthetic/ Cultural & Habitat	Aesthetic/ Urban Sensitivity & Veg. Diversity	Flood/ Stormwater Attenuation	Commercial Use	Downstream Water Quality Sensitivity
High	High	Med	High	NA	High	High	High	High	High
Preserve					Except'l & High	Except'l & Medium	*	*	*
Except'l	Except'l	High	Except'l	High					
Manage 1 High	High	Medium	High	Medium	High & Medium	High & Medium	*	High	*
Manage 2					Medium & Low				
Med	Medium	Low	Medium	Low		*	*	*	*
Manage 3					Low & Low				
Low	Low	N/A	Low	N/A		*	High	*	High

Critical Wetland Resources

Wetlands in the assessment area should be evaluated as critical resources based on several features identified in Wisconsin. These critical wetland resources should be classified into the Preserve management class due to their special functions and values. Criteria for designating wetlands as critical resources are as follows:

- Outstanding and Exceptional Resource Waters
- Designated Scientific and State Natural Areas
- Wetlands with known occurrences of Threatened or Endangered Species
- State Wildlife Management Areas
- Designated trout streams
- Calcareous fens
- High priority areas for wetland preservation, enhancement, restoration and establishment

Preserve

Wetlands classified as Preserve have at least one of the following characteristics:

- Wetlands rated with exceptional vegetative diversity/integrity, which may include wetlands with natural communities not significantly impacted by invasive species or other human-induced alterations, wetlands harboring endangered or threatened plant species, or rare wetland habitats classified as imperiled (S1) or critically imperiled (S2) by the state rankings.
- Wetlands rated as exceptional for wildlife habitat. These include wetlands known to harbor endangered or threatened animal species, rare communities, or wildlife refuges and fish and wildlife management areas whose purpose is maintaining suitable habitats for wildlife.
- Wetlands rated as high for amphibian habitat.
- Wetlands rated as exceptional for fish habitat. These wetlands include those specifically managed for fish management; designated trout streams, lakes or adjacent wetlands; and known spawning habitat for game fish.
- Wetlands rated high for shoreline protection. Wide wetlands bordering lakes and feeder streams that have persistent, emergent, submergent, or floating-leaved vegetation are critical to protecting the water quality of the lakes from bank erosion and sedimentation from upstream.
- Wetlands rated exceptional for aesthetics/education/recreation/cultural and rated high for wildlife habitat, include those located on public lands that provide a unique or rare recreational, educational, or cultural opportunity, and have high functional level for wildlife since that is typically a primary focus for users.
- Wetlands that are exceptionally sensitive to stormwater impacts and have a vegetative diversity/integrity rating of medium or higher were also placed in this category. These wetlands may have suffered some degradation from human influences due to their heightened sensitivity. The vegetative quality of the wetland is such that improved management may allow for restoration of the community.

- Wetlands with a high vegetative diversity/integrity rating *and* a high rating for wetland water quality. The vegetative community in these wetlands typically has been only slightly affected by humans and still maintains high functioning to maintain water quality, which is critical to wetland sustainability.
- Wetlands with a high vegetative diversity/integrity rating *and* a high rating for hydrologic regime. The vegetative community in these wetlands typically has been only slightly affected by humans and still maintains high functioning levels for hydrologic regime, which is critical to wetland sustainability.

Manage 1

Wetlands classified as Manage 1 have at least one of the following characteristics:

- Wetlands rated with high vegetative diversity/integrity, which typically include diverse wetland plant communities with less than 20 percent cover of non-native or invasive species.
- Wetlands rated as high for wildlife habitat. These generally include wetlands located within large tracts of undeveloped land or in parks, which allow for wide high quality upland buffers. In addition, this includes seasonal wetlands that are well buffered.
- Wetlands rated as medium for amphibian habitat. This includes seasonal wetlands that are well buffered.
- Wetlands rated as high for fish habitat. These wetlands are lacustrine/riverine or are contiguous with a permanent waterbody or watercourse and provide spawning/nursery habitat, or refuge for native fish species in adjacent lakes, rivers or streams.
- Wetlands rated medium for shoreline protection. These wetlands include those that are moderately wide and support persistent emergent, submergent, or floating-leaved vegetative cover bordering lakes and feeder streams.
- Wetlands rated high for aesthetics/education/recreation/cultural *and* medium for wildlife habitat, include those that provide a number of benefits that may include: spatial buffering, accessibility, public ownership, multiple recreational opportunities, and medium-quality wildlife habitat.
- Wetlands that are highly sensitive to stormwater impacts *and* have a vegetative diversity/integrity rating of medium or high were also placed in this category. The vegetative quality of the wetland is such that improved management may allow for restoration of the community.
- Wetlands with a medium vegetative diversity/integrity rating *and* a high rating for wetland water quality. The vegetative community in these wetlands has only been moderately affected by humans and still maintains high functioning levels for water quality, which is critical to wetland sustainability. These wetlands would likely benefit from active management.
- Wetlands with a medium vegetative diversity/integrity rating *and* a high rating for hydrologic regime were placed in the Manage 1 category. The vegetative community in these wetlands has only been moderately affected by humans and still maintains high functioning levels for

hydrologic regime, which is critical to wetland sustainability. These wetlands would likely benefit from active management.

- Wetlands rated high for commercial use. These wetlands provide important social value without having an altered hydrology.

Manage 2

Wetlands classified as Manage 2 have at least one of the following characteristics:

- Wetlands rated with medium vegetative diversity/integrity, which typically include wetlands with less diversity and up to 50 percent cover of non-native or invasive species.
- Wetlands rated as medium for wildlife habitat. These often include wetlands that are increasingly separated from natural communities and wildlife corridors; they often lack significant upland buffers and are increasingly altered.
- Wetlands rated as low for amphibian habitat. These wetlands are increasingly altered, but they still have some opportunity to provide either breeding, over wintering, or resting habitat for amphibians.
- Wetlands rated as medium for fish habitat. These wetlands include those which are intermittently connected to waterbodies supporting native fish populations
- Wetlands rated low for shoreline protection. While these wetlands are not providing the highest level of protection to the lake or river systems, their mere presence provides some level of protection that should not be dismissed. These wetlands are typically narrow, with little emergent, submergent, or floating-leaved vegetation.
- Wetlands rated Medium for aesthetics/education/recreation/cultural and Low for wildlife habitat.

Manage 3

Wetlands classified as Manage 3 include all of the remaining wetlands that did not fit into any of the above-described conditions. All of these wetlands would rate low for vegetative diversity/integrity. Many of these wetlands rate medium or high for downstream water quality protection and for flood storage/attenuation. This correlation is expected since wetlands that provide higher levels of water quality treatment and runoff/rate control often suffer from ecological degradation.

4. Wetland Management Recommendations

Wetland management recommendations are proposed to help maintain tolerable hydrologic and water quality changes in wetlands based on the management strategy stated for the wetland classification (**Table 7**). The recommended wetland management program presents a framework for managing stormwater in and around wetlands as well as reducing the impacts to wetlands and wetland mitigation. The proposed methodology is meant to be used as a screening and decision-making tool and is not meant to replace the need for more specific and technical wetland area designs. Replacement plans must also consider other laws that may apply, including local regulations, state rules, and U.S. Army Corps of Engineers 404 or other permit requirements.

Additional investigations or evaluations, including detailed hydrologic modeling and modeling of nutrient loadings and removals, will also need to be performed to determine final pipe sizes, configuration, elevations, location, and site grading.

Hydrology Recommendations

The wetland hydrology management recommendations shown in **Table 7** were developed to protect wetlands from hydrologic impacts. These recommendations present tolerable hydrologic changes in terms of bounce (difference between the peak flood elevation and the normal wetland elevation), inundation period (time that flood waters temporarily stored in the wetland exceed the normal wetland elevation), and runout control (elevation of the outlet). These recommendations provide guidance for managing stormwater to minimize wetland impacts. It is assumed that wetland impacts will be minimized and existing wetland functions and values will be maintained if the proposed management program and recommendations presented here are adopted and implemented.⁵

These recommendations are provided unless site-specific guidelines can be developed. The hydrologic analysis must be conducted on an annualized basis or a broad range of storm events from very small (1/4-inch) to large, i.e. 10- or 25-year storms. The storm bounce and inundation should be the maximum that occurs for each event over the ambient conditions for similar events. In some cases these guidelines can allow for changes in hydraulics. Stormwater input to wetland basins supporting monotypes such as purple loosestrife or reed canary grass could flood out this vegetation, creating open water areas that may eventually re-vegetate with greater diversity. However, wetland alteration for any reason, even for improvements, should only be conducted after careful analysis to insure that the desired outcome will result.

The baseline condition of some wetland types may be so degraded that urban stormwater input may not cause appreciable adverse impacts. Some gravel pits, dredge/fill disposal sites, and cultivated hydric soil areas are good examples. An analysis of other potential impacts such as groundwater contamination, or opportunities for enhancement should determine the stormwater discharge tolerances in these cases. However, for most wetlands, especially the sensitive and highly sensitive wetlands, changes in the hydroperiod may have detrimental impacts.

A number of considerations factor into how stormwater should be routed through a natural wetland. The best approach is for local governments to set criteria based upon a truly comprehensive watershed management plan that considers local goals for water quality and quantity in conjunction with assessments of wetland functions and values, existing and future land uses, available finances, existing problems, and the management tools available (e.g., regulatory, acquisition, resource conservation, and restoration management), as well as public/private cooperation and assistance. Until that has been done, however, some framework or guidance needs to be followed to limit the negative impacts of stormwater discharges on a community's wetland resources, as outlined here.

⁵ State of Minnesota Storm-Water Advisory Group, June 1997. *Storm-Water and Wetlands: Planning and Evaluation Guidelines for Addressing Potential Impacts of Urban Storm-Water and Snow-Melt Runoff on Wetlands*. Modified in *Recommended Wetland Management Classification System to Accompany the Minnesota Routine Assessment Method for Evaluating Wetland Functions, (MnRAM) Version 3.4*. Draft January 2015.

Table 7
Wetland Management Recommendations According to Management Class

<u>Measure</u>	<u>Management Class</u>			
	Preserve	Manage 1	Manage 2	Manage 3
Management Strategy	Maintain wetland and existing functions, values and wildlife habitat. Possible need for active management of wetland to protect unique features. Apply strict avoidance standards.	Maintain wetland without degrading existing functions, values and wildlife habitat.	Maintain wetland footprint. Improve wetland biological and plant community diversity/integrity or enhance other functions if possible. ⁵	Consider rehabilitating one or more functions. ⁶
Bounce (10-year)	Existing	Existing plus 0.5 feet	Existing plus 1 feet	No limit
Inundation Period (1&2 year) ¹	Existing	Existing plus 1 day	Existing plus 2 days	Existing plus 7 days
Inundation Period (10-year) ¹	Existing	Existing plus 7 days	Existing plus 14 days	Existing plus 21 days
Runout Control ²	No change, maintain existing hydrology	No change, maintain existing hydrology	0 to 1 feet above existing outlet	0 to 4 feet above existing runout
Stormwater Treatment	Upstream sediment and nutrient pretreatment required to maintain (and, if possible, exceed) background loading rates	Upstream sediment and nutrient pretreatment required to maintain (and, if possible, exceed) background loading rates	Remove sediment from new inflows	Remove sediment from new inflows
Buffer Width ^{3,4}	700 ft	700 ft.	400 ft.	100 ft.

¹ Inundation period is defined as the proposed peak storage divided by the average discharge (S/Q).

² If currently landlocked, new outlet should be above delineated wetland elevation.

³ Buffers are unmowed, naturalized strips of vegetation around the perimeter of the wetland. While a general default number for a wildlife buffer is of limited value in and of itself, it is a reasonable starting point for general consideration/planning purposes pending more detailed site investigation.

⁴ Includes wetlands where vegetative diversity and wildlife habitat are a priority, identified by the Preserve row in Figures 10a and b (excluding Fish Habitat and Shoreline Protection); otherwise 100 ft. minimum for water quality protection. Based on Semlitsch and Bodie 2003, and SEWRPC *Managing the Water's Edge – Making Natural Connections*.

⁵ Enhancement involves heightening, intensifying, or improving a single, specific function of an existing wetland, potentially to the detriment of other functions.

⁶ Rehabilitation involves repairing or increasing the functionality of an existing degraded wetland.

Source: State of Minnesota Storm-Water Advisory Group. 1997. *Storm-Water and Wetlands: Planning and Evaluation Guidelines for Addressing Potential Impacts of Urban Storm-Water and Snow-Melt Runoff on Wetland*, as modified in Minnesota Board of Soil and Water Resources. 2015. *Recommended Wetland Management Classification System to Accompany the Minnesota Routine Assessment Method for Evaluating Wetland Functions, (MnRAM) Version 3.4, Draft*.

Buffer Recommendations

Wetland buffer recommendations were developed with the focus on the buffer widths necessary for protecting water quality and also providing suitable wildlife habitat. Wetland buffer recommendations in **Table 7** were developed based on a review of the scientific literature. The literature shows that the effectiveness of wetland buffers in removing sediments and nutrients from surface runoff varies widely due to many factors which include but are not limited to: slope, vegetative cover density, vegetation types, and width. Typically, buffers are established for their water quality improvement potential with diminishing returns beyond about 100 feet. High quality wildlife habitat requires significantly wider buffers and higher vegetative diversity/integrity. In general, wider buffers provide greater wildlife benefits. This is balanced against necessary economic development in the region in an effort to foster both economic development and environmental protection in the areas best suited for these pursuits.

Overall, wetlands provide very significant and valuable wildlife habitat, recreational opportunities, and water resource functions and benefits. Group I and Group II wetlands are larger, higher quality wetlands, or contain rare or irreplaceable ecological communities and should be granted wider buffers to protect their intrinsic resource qualities and to protect habitat. These wetlands should have at least a 700 foot buffer. Group III wetlands tend to be large wetlands that are moderately disturbed, provide protection to Group I or Group II wetlands or serve as refuge, stepping stones, or parts of ecological corridors connecting higher quality ecological communities. These should have at least a 400 foot buffer. Group IV wetlands are the most disturbed wetlands and provide few ecological services or are insufficient to provide adequate habitat for higher vertebrates. Existing wetlands should include a minimum buffer of 100 feet for water quality protection. Areas with hydric soils (Group V Wetlands) are strong indicators of historic and potentially restorable wetlands. Overall, it is recommended that prior converted wetlands be restored whenever possible, and degraded wetlands be enhanced where opportunities permit.

Other key considerations in promoting better buffers/corridors include:

- Continuous corridors are better than fragmented corridors for wildlife
- Natural linkages should be maintained or restored
- Linkages should not stop at political boundaries
- Two or more corridor linkages are better than one
- Structurally diverse corridors (e.g., diverse plant structure or community types, upland and wetland complexes, soil types, topography, and surficial geology) are better than corridors with simple structures
- Both local and regional spatial and temporal scales should be considered in establishing buffers
- Corridors should be located along dispersal and migration routes
- Corridors should be located and expanded around rare, threatened, or endangered species
- Quality habitat should be provided in a buffer whenever possible
- Disturbance (e.g. excavation or clear cutting vegetation) of corridors should be minimized during adjacent land use development
- Native species diversity should be promoted through plantings and active management

- Non-native species invasions should be actively managed by applying practices to preserve native species
- Fragmentation of corridors should be reduced by limiting the number of crossings of a creek or river where appropriate
- Restoration or rehabilitation of hydrological function, streambank stability, instream habitat, and/ or floodplain connectivity should be considered within corridors.
- Restoration or retrofitting of road and railway crossings promotes passage of both aquatic and semi-aquatic organisms

Protecting the integrity of native species in the region is an objective shared by many communities. The natural environment is an essential component of our existence and contributes to the quality of life we experience in our communities and neighborhoods. Conservation design and open space development patterns in urbanizing areas and farm conservation programs in rural areas have begun to address the importance of maintaining and restoring riparian buffers and connectivity among corridors. Just as there are core development centers in the region, many citizens believe there should be analogous environmental counterparts or complements.

C. Resource Based Approach to Ecosystem Management

One of the principal tenets of bioethics and a fundamental principle here as throughout the world is *Primum non nocere* (Latin: “First, do no harm”). Likewise, the overall conservation objective here should be to direct development **away** from sensitive and critical resource areas to areas better suited for it. If that is not possible, it should be incumbent on planners to design developments that provide equal or greater protection. This can be accomplished through advanced conservation design techniques, restoration of other areas, or other means based on the type of development, site characteristics, opportunities, and options available.

A resource-based approach to ecosystem management has proven to be a successful and comprehensive approach to resource conservation. A resource-based approach focuses on landscape patterns, managing these natural resource elements in such a way as to influence species in a positive

A resource-based approach focuses on landscape patterns, managing these natural resource elements in such a way as to influence species in a positive direction.

direction. Considering the significant habitat loss and fragmentation that has occurred historically due to human occupation, we should strive to limit the degree of isolation between existing habitat patches and optimize natural connectivity, where we can, to allow for the dispersal and re-colonization of sensitive native species among patches, thus promoting biodiversity in the region. This goal can be attained by establishing habitat corridors, maintaining landscape attributes (e.g., patch size, shape, edge, etc.), and connecting “stepping stone patches” where possible.

1. Avoid

The first and best alternative is to avoid adverse impacts. The recommendation here is to use a screening approach initially to help direct development away from sensitive resource areas. If

that is not possible, then a more rigorous assessment should be conducted to study the situation in more detail and thus tailor a prescriptive strategy to that particular development scenario, as below.

2. *Minimize*

Where the impacts due to development are unavoidable, there is a need to develop policies that reproduce predevelopment hydrologic conditions. This establishes the performance criteria (i.e., minimal impact) that developers can meet using their own combinations of cost-effective strategies built into their development designs. This means maintaining or reproducing the full spectrum of hydrologic conditions, including peak discharge, runoff volume, infiltration capacity, baseflow levels, groundwater recharge, and maintenance of water quality.

A comprehensive approach to hydrologic management can be difficult and often involves the entire context of site planning. The issues of runoff volume, infiltration recharge, and water quality revolve around the amount of impervious surface required by development and its configuration in terms of its relationship to drainage paths and vegetative cover. The goal is to mimic pre-development conditions through Best Management Practices.

A comprehensive approach to hydrologic management can be difficult and often involves the entire context of site planning.

One strategy should be to preserve and utilize the natural drainage system.⁶ Keep pavement and other impervious surfaces out of low areas, swales and valleys. For example, a site plan should keep roads and parking areas high in the landscape and along ridges wherever possible (**Figure 10**). Try to avoid connecting streets, roof tops and parking areas with pipes or other structures. Utilize natural topography and vegetated waterways to convey acceptable levels of runoff. Fit development to the terrain by choosing road patterns that provide access schemes that match the land form (**Figure 11**). For example, in rolling or dissected terrain (typical in this area), use strict street hierarchies with local streets branching from collectors in short loops and cul-de-sacs along ridge lines. This approach results in a road pattern that resembles the branched patterns of ridge lines and drainage ways in the natural landscape. Road patterns like these facilitate the development of plans, which work *with* the land form and minimize disruption of existing grades and natural drainage.⁷ These measures are often more difficult to achieve than they appear because they go against long-established policies that have historically tended to increase flows and destroy the waterways used.

⁶ State of Minnesota Storm-Water Advisory Group (MNSWAG). 1997. Storm-Water and Wetlands: Planning and Evaluation Guidelines for Addressing Potential Impacts of Urban Storm-Water and Snow-Melt Runoff on Wetlands. State of Minnesota Storm-Water Advisory Group.

⁷ For more information see Minnesota's Stormwater Best Management Practices Manual <http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/stormwater-management/stormwater-best-management-practices-manual.html>