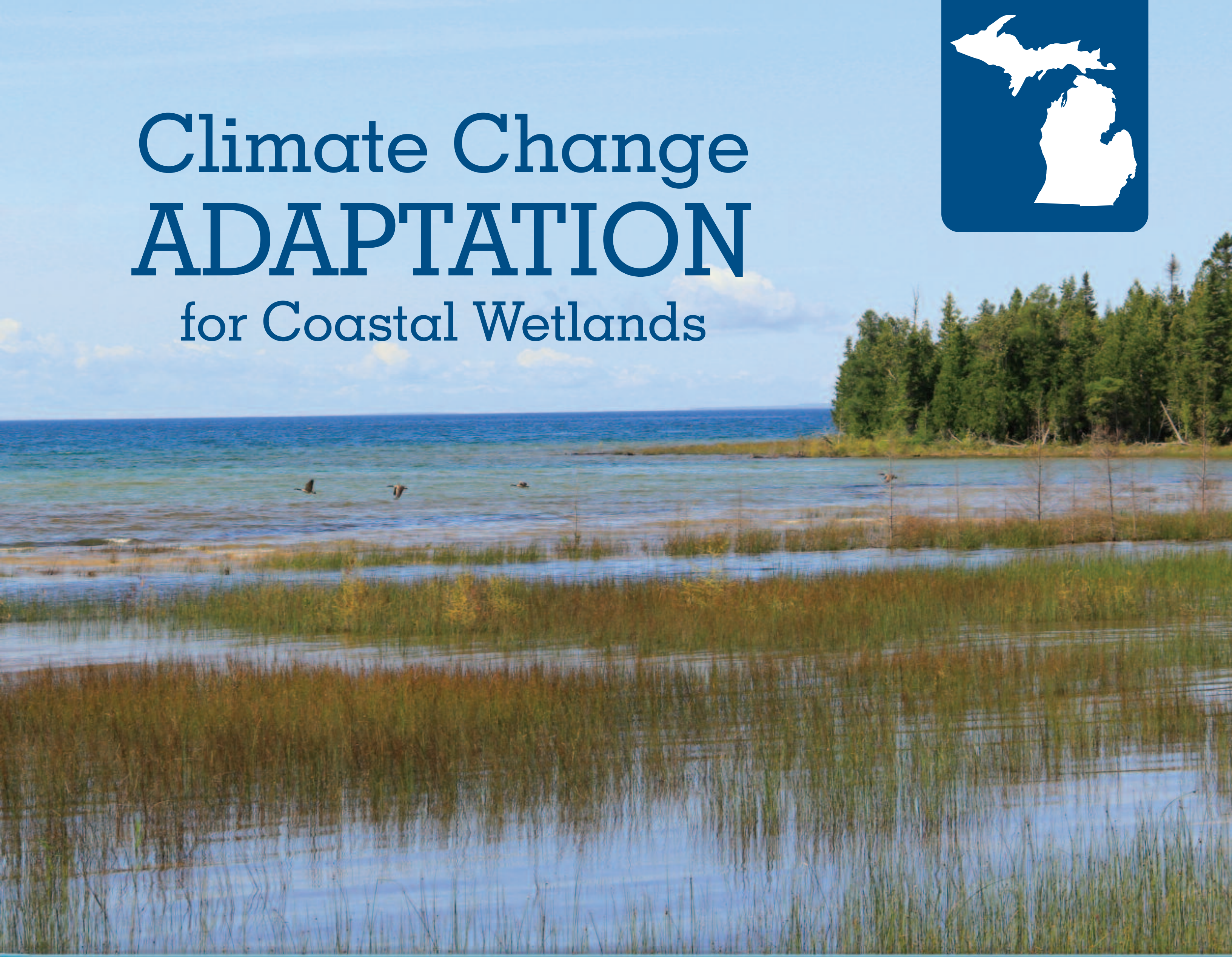


# Climate Change ADAPTATION for Coastal Wetlands

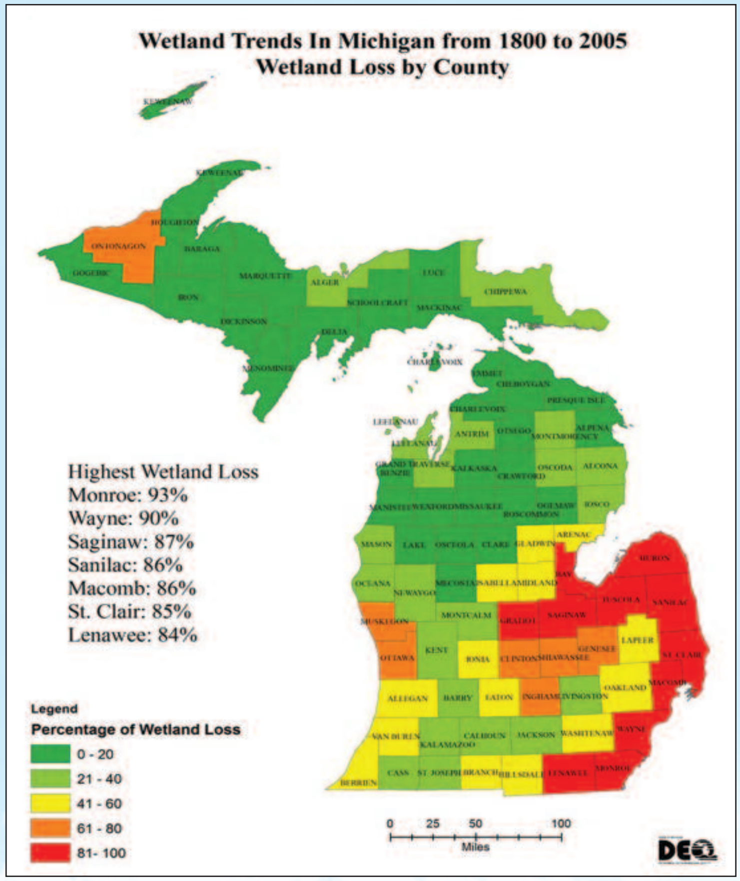
*A Toolkit of Best Management Practices for Coastal Wetlands in Michigan*

Produced by Tip of the Mitt Watershed Council

Financial assistance for this project was provided, in part, by the Michigan Coastal Zone Management Program, Office of the Great Lakes, Department of Environmental Quality, under the National Coastal Zone Management Program, through a grant from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

# Michigan's Wetlands

Wetlands are some of our most valuable resources – they are places of beauty that contribute greatly to the overall health of our environment and our quality of life. Approximately 17 percent of Michigan (6.5 million acres) is wetlands. Michigan originally contained approximately 10.7 million acres of wetland prior to European settlement, but by 1978, that number had dropped to approximately 6,506,044 million acres. The total decline of wetland since 1978 is estimated at 41,000 acres, with the rate of decline slowing between the periods 1978 to 1998 (loss of approximately 1,642 acres per year) and 1998 to 2005 (loss of approximately 1,157 acres per year).




Coastal wetlands are considered to be some of the most valuable ecological areas in the Great Lakes. They are critical to the Great Lakes ecosystem as a whole. In particular, coastal wetland systems support diverse assemblages of invertebrates, fish, reptiles, amphibians, birds, and mammals. Over 90% of the roughly 200 fish species that occur in the Great Lakes are dependent upon coastal wetlands for some part of their life cycle.

Based on the Great Lakes Coastal Wetland Consortium inventory of coastal wetlands, Michigan has approximately 275,748 acres of Great Lakes coastal wetlands. Coastal wetlands are distributed throughout Michigan's Great Lakes shoreline with 37% along Lake Huron, 28% along Lake Michigan, 16 % along the St. Clair River, 13% along Lake Superior, and 6% along Lake Erie.

Michigan has approximately 275,748 acres of Great Lakes coastal wetlands.*

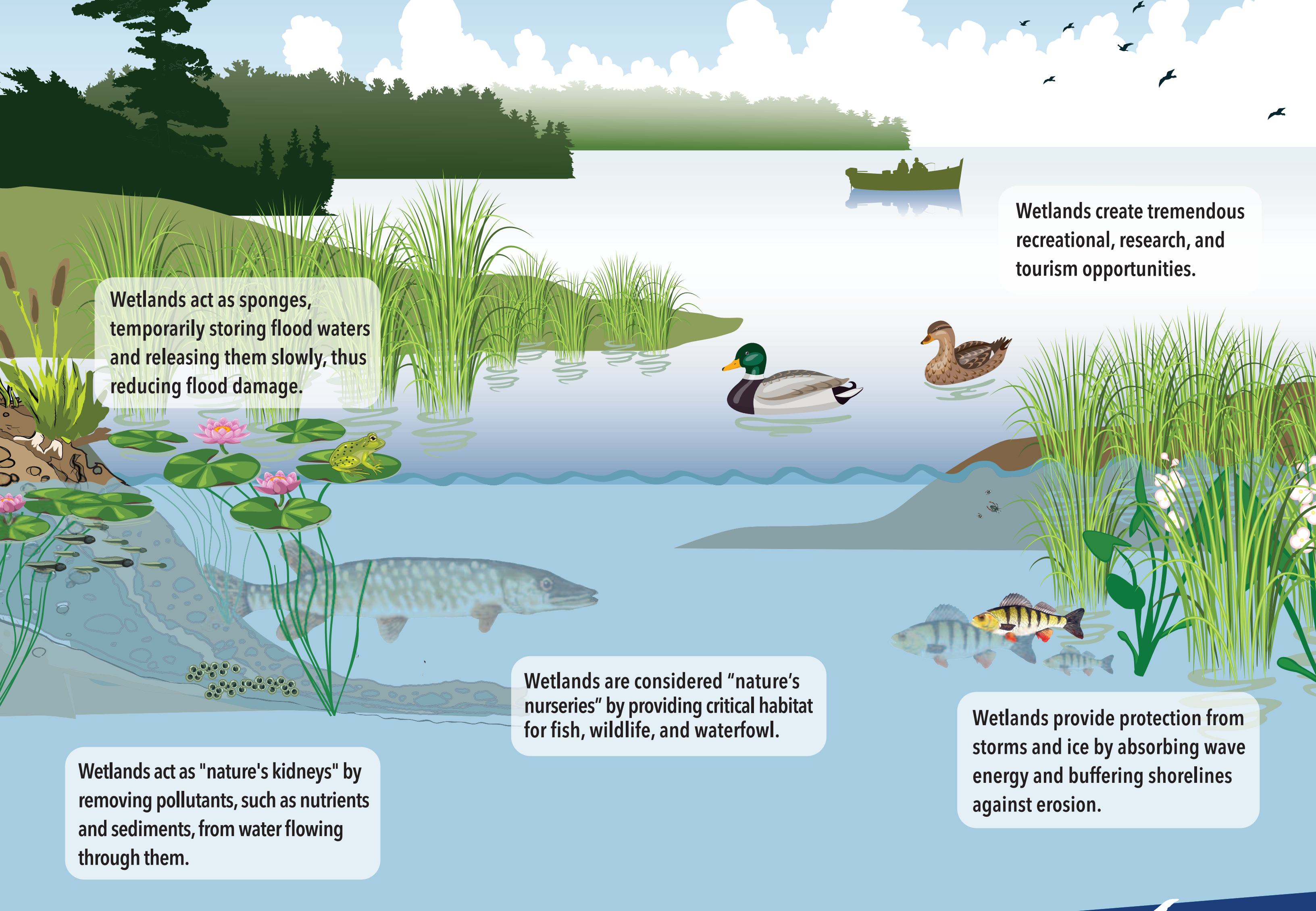
*Based on the Great Lakes Coastal Wetland Consortium inventory.

*The statements, findings, conclusions, and recommendations in this document are those of the authors and do not necessarily reflect the views of the Department of Environmental Quality and the National Oceanic and Atmospheric Administration.*

# Benefits of Wetlands

Wetlands are complex ecosystems that provide numerous benefits to society. Great Lakes coastal wetlands are different than inland wetlands due to the influence of large lake processes, including powerful waves, wind-driven tides (seiches), and especially the seasonal and long-term fluctuations of Great Lakes water levels. The dynamic nature of the Great Lakes contributes to the ecological functions of these vegetated bottomlands. During low water periods, nearshore areas of the Great Lakes typically under water are exposed. Vegetation growth naturally increases on exposed wetlands during low water years.

Throughout the cycle, if left unhampered, coastal wetlands provide a range of important functions. Wetlands provide critical wildlife habitat, prevent shoreline erosion, and protect water quality. They are the most biologically productive ecosystems in the Great Lakes watershed. These benefits become increasingly significant as we continue to lose wetlands throughout Michigan.



### Weather

- Highly variable
- Short time frame

### Climate

- Average weather over a long period of time

# Climate Change

The Intergovernmental Panel on Climate Change (IPCC) defines climate change as:

> *Any change in climate over time, whether due to natural variability or as a result of human activity.*

When we are talking about climate change, we are talking about changes in *long-term* averages of daily weather. The difference between weather and climate is a measure of time. Weather is a specific event or condition that happens over a short period of time, such as hours or days. Climate is the average weather for a particular region and time period, usually over 30 years. For example, a thunderstorm, a snowstorm, and today's temperature all describe the weather. On the other hand, Michigan's climate in winter is cold and snowy while Miami's climate is hot and humid.

**According to the IPCC, scientific evidence for warming of the climate system is unequivocal**. Significant changes in the earth's climate have been observed and thoroughly documented. Changes include average air and ocean temperatures, rising sea levels, the melting of ice and retreating glaciers, and increases in extreme weather events resulting in more floods, severe storms, and heat waves.

**Before and after photos of a flooding event in Grand Rapids, Michigan in 2013.**

*Photo Credit: Imgur*

# Climate Change in the Great Lakes Region

The effects of climate change are already apparent in the Great Lakes region, with observable changes in temperature, precipitation, and extreme weather events over the last century.

Between 1968 and 2002, average temperatures in the Great Lakes region increased 2.3 degrees Fahrenheit.

Average annual ice coverage on the Great Lakes declined 72% between 1973 and 2010.

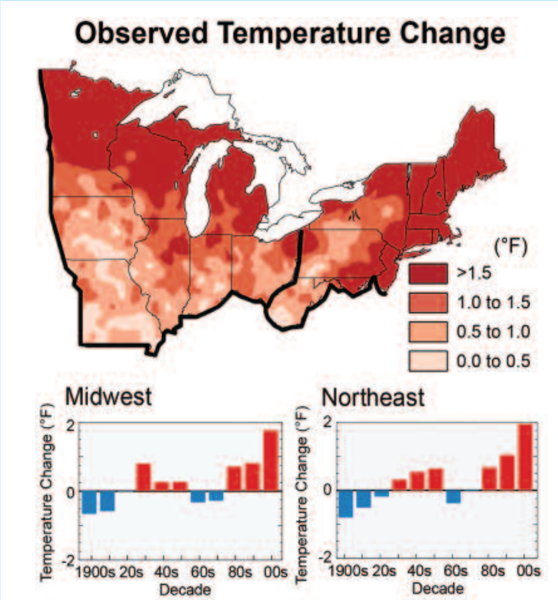
Total precipitation has increased 11% since 1900 in the eight Great Lakes States.

The amount of precipitation falling in the heaviest 1% of storms increased by 37% in the Midwest from 1958 through 2012.

From 1975 to 2004, the annual number of days with land snow cover decreased by 15 and the average snow depth decreased by 2 inches.

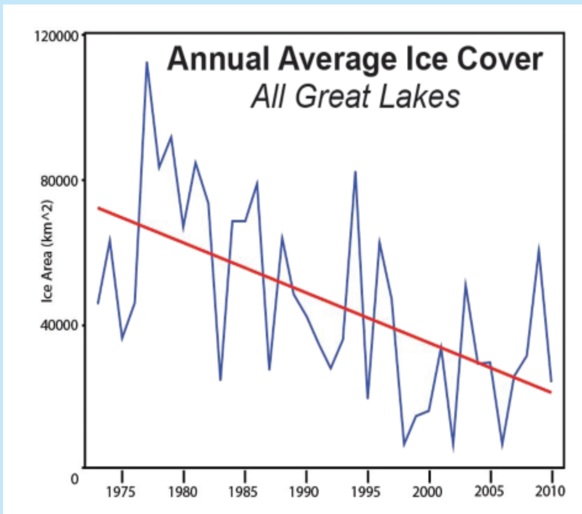
The frost-free season lengthened by 9 days in the Midwestern U.S. between 1958 and 2012.

These trends are expected to continue along with changes in the frequency of intense storms, extended droughts, and heat waves. To lessen these and future impacts, and to protect the State's vast natural resources and the people that depend on them, we must take action now.




Credit: GLISA

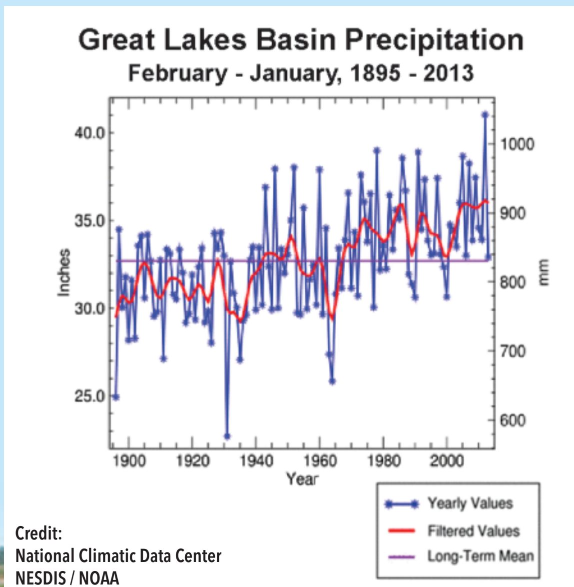
Changes in temperature vary by geography within the Great Lakes region, with northern areas experiencing the most warming.




Credit: From Wang et al. (2012)

Observed Decline in Great Lakes Ice Cover 1973-2010.

Observed increases in precipitation in the Great Lakes Basin.




Credit:
National Climatic Data Center
NESDIS / NOAA

Photo Credit: Michigan SeaGrant

# Climate Change Impacts to Wetlands

The changes in climate will have a significant impact on water resources, including the Great Lakes, rivers, streams, lakes, groundwater, and inland and coastal wetlands. Climate change is resulting in the decline in both the quantity and quality of Michigan's waters. The most recent National Climate Assessment highlights the expected effects of climate change on the Great Lakes, including changes in the range and distribution of certain fish species, increased invasive species and harmful algal blooms, declining beach health, and more.

Wetland ecosystems are fundamentally linked to hydrology and thus, are likely to be more adversely affected. While the full extent of how climate change will impact Michigan's coastal wetlands is still unknown, there are many anticipated climate impacts on our wetlands. More frequent and severe precipitation will lead to increased erosion of fields, ravines, streambanks, and bluffs resulting in increased sedimentation. Large storms and flooding can stress aquatic systems by causing water level fluctuations that favor invasive plant species and interrupt the life cycles of aquatic organisms. Increased evaporation during hot, dry summers and droughts can reduce many wetlands in size, convert some wetlands to dry land, or shift one wetland type to another.

In order to ensure Michigan's coastal wetlands and waters can continue to provide recreational, commercial, and ecological benefits and services, actions need to be taken to prepare for climate impacts.

## Great Lakes Climate Variability Trends

**There is a high level of scientific certainty that the climate has changed in significant ways in recent decades and that it will continue to change in the future.**

**This table summarizes what computer models indicate may be the trends and impacts of climate change in the Great Lakes.**

*Note: There will be variability in climate trends across the region, and that overall year-to-year variability is likely to increase.*

| CLIMATE FACTOR | TREND | CERTAINTY | FAST FACTS |
|---|---|---|---|
| **Air temperature** | Increasing | Very high | Summer warming faster than winters |
| **Rainfall** | Increasing | High | Up overall, but variable by season: Fall and winter much rainer,summers drier |
| **Snowfall** | Unclear | Medium | Increase in lake effect snow, likely decrease in snowfall otherwise |
| **Wind** | Unclear | Low | Average wind speeds declining, but may have more high intensity wind events |
| **Heat waves** | Increasing | High | Heat waves are likely to be more frequent, longer-lasting, and more severe |
| **Growing season length** | Increasing | High | Likely to increase by 3-6 weeks by the end of the century |
| **Extreme rains** | Increasing | High | Frequency of heavy rainfall events increasing year-round |
| **Evaporation/drought** | Increasing | Medium | Increase larger in summer; loss of winter lake ice will increase evaporation off lakes |
| **Lake level** | Unclear | Medium | Decrease likely, but increase also plausible; lake level variablity to continue regardless |
| **Runoff** | Increasing | High | Up overall, but variable by season |
| **Lake temperature** | Increasing | High | Lake Superior warming fastest; warmer water hold less oxygen for fish and other animals |
| **Lake ice cover** | Decreasing | High | Variable by lake; Lake Michigan likely to become ice-free soonest |

Source: Freshwater Future, http://ecoadapt.org/data/documents/Climate101FactSheet.pdf

# Climate Change Adaptation

Actions to better manage impacts arising from changes in the climate are known as climate change adaptations. Adaptations seek to lower the risks posed by the consequences of climatic changes. They can be technologies, procedures, practices, and behaviors taken in anticipation of impacts or in response to impacts. They are practical steps to help avoid or reduce climate change consequences and protect communities from the likely disruption and damage that will result from effects of climate change. Individuals, communities, organizations, and institutions have opportunities now to protect their most important assets from the impacts of climate change.

Specifically, adaptations include: planning, communication, and preparedness for extreme weather events; incorporating expected changes into land-use decision-making processes; guiding development out of flood-prone areas; improving the resiliency of shorelines, natural systems, and critical infrastructure; and applying cost-effective green technologies and using natural systems to reduce vulnerabilities. Conserving habitat, erosion control, protecting water quality, encouraging biodiversity, and providing buffers against natural hazards such as storms and floods are also actions that will assist in adapting to changing patterns of temperature and precipitation.

**The Fountain View Recreation Center in Carol Stream, Illinois, features many techniques for controlling stormwater runoff.**

Photo Credit: Center for Neighborhood Technology, www.cnt.org

# Climate Change Adaptation Tools

This Toolkit provides information about climate change adaptation best management practices that can be used by various sectors. It is not an exhaustive listing of adaptation strategies, but it does provide examples of actions that can be implemented on an individual, local, or regional level to address many of the potential impacts of climate change. It can be used by almost anyone in Michigan, including homeowners, developers, municipalities, organizations, and water and wetland resource managers.

The best management practices identified are designed to protect, manage, and restore natural ecosystems so as to increase their resistance and resiliency to climate change. From maintaining hydrology and reducing pollution to controlling invasive species and protecting wetland biological diversity and integrity, all of these are important activities to maintain and improve the resiliency of Michigan's coastal wetlands and water resources so that they continue to provide important services and functions under changed climatic conditions.

## Preservation and Protection

- Wetland and Floodplain Ordinances
- Conservation Easements
- Setbacks
- Site Plan Review
- Cluster Development/Conservation Design

## Stormwater Management and Green Infrastructure

- Rain Barrels
- Rain Gardens
- Native Landscaping
- Greenbelts/Riparian Buffers
- Natural Shorelines
- Permeable Paving
- Green Roofs
- Bioswales

## Wetland Management, Creation, and Restoration

- Invasive Species Management
- Stormwater Wetlands
- Wetland Restoration
- Landscape Level Assessment

# Wetland and Floodplain Ordinances

Local governments in Michigan have the authority to implement local regulations that foster the health and well-being of their communities, including conserving natural resources. Zoning can be used to regulate parcel use, density of development, setbacks, impervious surfaces, type of construction, shore protection structures, landscaping, and more. It can also be used to regulate where development can and cannot take place, making it an invaluable tool in efforts to protect natural resources and environmentally sensitive areas, as well as guide development away from hazard-prone areas. While many types of zoning can be useful as a climate adaptation strategy for all of Michigan's waterways, wetland and floodplain ordinances are particularly beneficial climate adaptation practices for coastal wetlands.

Michigan's Wetland Protection Act, Part 303 of the Natural Resources and Environmental Protection Act (Act 451 of 1994 as amended), authorizes local units of government to adopt and administer their own wetland regulations, provided they are consistent with state regulations.

Floodplain zoning ordinances regulate the types of land uses that are permitted in the floodplain, only allowing uses that are not susceptible to flood damage. Floodplains are the natural low areas adjacent to surface water bodies that hold floodwaters.

When wetlands and floodplains are altered by development including filling, dredging, and vegetation removal, their ability to handle floodwaters is greatly reduced, aggravating flooding and subsequent flood damages. Local ordinances can help prevent this from happening. Benefits of zoning can include resource conservation, open space preservation, public access, and water quality protection, all of which serve to make Michigan's wetlands more resilient to impacts from climate change.

Photo Credit: CNT / Army Corps of Engineers

**Limitations:**

- Michigan's wetland protection statute authorizes municipalities to regulate wetlands as long as they use the same wetland definition, regulatory standards (local governments can regulate wetlands smaller than five acres), and application process as the state.
- Care must be given to integrating new standards in a way that minimizes legal risks associated with any challenge to the regulations. It is important to ensure that the municipal attorney is involved throughout the ordinance development process.
- Zoning regulations will need to be adaptive to accommodate climate changes.

# Conservation Easements

Protection and preservation of sensitive natural resources is a key climate change adaptation strategy. Conservation easements have emerged as a popular conservation tool for helping protect private land from development and overuse. A conservation easement is a legal agreement between a landowner and a land trust or government agency that can be used to protect sensitive land before it is developed and restrict activities that may impair natural processes. Easements typically apply in perpetuity and are passed on from owner to owner. Landowners who donate their easement may be eligible for federal or state tax breaks.

Lizzadro Lakeshore Preserve

Photo Credit: Keweenaw Landtrust

Drafting conservation easements for long-term success requires consideration of many factors, including potential climate change impacts. Conservation easements should be designed to be adaptable, allowing managers to respond in a timely manner to changing conditions and conservation values.

As the landscape changes with climate change, an easement with more specific purposes, such as protecting a particular species or ecological community, may no longer be able to meet some or all of its objectives. For example, a site originally protected to provide habitat for brook trout may no longer meet this purpose if stream temperatures warm and can no longer support this species. Incorporating a range of multiple purposes into a conservation easement ensures that at least some of the purposes are likely to remain, even if some are diminished or absent in the future due to climate change. Another strategy for protecting land as the climate changes may be to include purposes related to ecosystem services, such as watershed or farmland protection or groundwater recharge, rather than specific species or ecological communities.

**Limitations:**

- Conservation easements are voluntary, which can make them less effective than regulatory approaches such as setbacks and zoning.
- Acquiring lands that are highly susceptible to climate-induced changes could undermine the land's future value under a conservation easement.

# Setbacks

One way to protect important natural features in your community is to require "setbacks," which are intended to provide a buffer between natural features and development. This can be accomplished by including a natural features setback as part of the zoning ordinance to ensure that buildings or various activities, such as grading or cutting vegetation, are located a safe distance from a wetland or other natural feature. Natural feature setbacks are typically 25 to 40 feet in width, but larger setbacks (up to 200 feet) are desirable for best protection of the adjacent resource.

Natural feature setbacks can protect local rivers and streams, lake shorelines, and inland and coastal wetlands. They also provide additional benefits including:

- Protection of surface water runoff and water quality.
- Beneficial water recharge for drinking, irrigation, and other purposes.
- Water storage areas during storm events.
- Preservation of aesthetic views and enjoyment of natural resources.
- Stabilization of soil and prevention of erosion.
- Protection of wildlife habitat, including preservation of threatened and endangered species habitat.
- Allowing wetlands and waterbodies to change and adapt.

**Limitations:**

- Setbacks may need to be reassessed with changing conditions of climate change. A periodic review of setback distances will ensure that buffer zones continue to provide sufficient protection.
- Minimum setbacks may not adequately protect the natural vegetated boundary, nearshore habitat, and water quality.
- Development may already exist within setback distance, limiting its effectiveness.

# Site Plan Review

Photo Credit: Shutterstock

Site planning is an invaluable tool local governments can use when attempting to control the amount, quality, and timing of runoff to prevent its damaging effects on natural resources, private property, and public infrastructure. Site plans are the documents and drawings that present information showing what an applicant for zoning approval wants to achieve on a parcel of land. Because good site plans usually include information on stormwater, topography, soils, and wetland locations, they can help local decision makers better assess what might be necessary to protect water resources before construction begins. Communities can require landscaping information, use of native plant species, on-site stormwater treatment, percentage of allowable impervious coverage, and a host of other environmental design considerations through the use of site plan review. This will help improve the ability of natural systems, such as coastal wetlands, to withstand or adapt to impacts associated with climate change.

The following are a few elements that should be considered when reviewing site plans:

- Protect streambanks, shorelines, and other natural vegetation and provide setbacks.
- Prohibit direct discharge of stormwater into wetlands.
- Limit fill in wetlands, floodplains, and other natural stormwater collection areas.
- Limit the percentage of impervious surfaces in a development.
- Reduce design demands for curbs and gutters, allowing replacement with bioswales where appropriate.
- Require a stormwater management plan that ensures proper design, installation, and maintenance of stormwater management structures.
- Preserve, to the greatest extent possible, the site's pre-development drainage.
- Maintain habitat connectivity, migration corridors, and hydrologic connectivity and corridors.
- Ensure stream crossings are sized properly to accommodate flashier storm events while maintaining stable banks and streams.

**Limitations:**

- While site plan review is an effective zoning tool, it is generally only applied to large development projects and, therefore, may not account for wetland impacts from smaller-scale project sites.
- Site plan review typically requires professional assistance and trained decision makers if it is to be used most effectively. This may require hiring outside consultants, but the cost can be borne by fees paid by applicants.

# Cluster Development/Conservation Design

Cluster development, also called open space development or conservation design, attempts to achieve balance between growth and preservation of open space in rural and suburban settings. It is done by clustering homes on a smaller proportion of land. The additional land, which would normally be allocated to individual lots across the entire subdivision, becomes protected as common space.

**Benefits of conservation design include:**

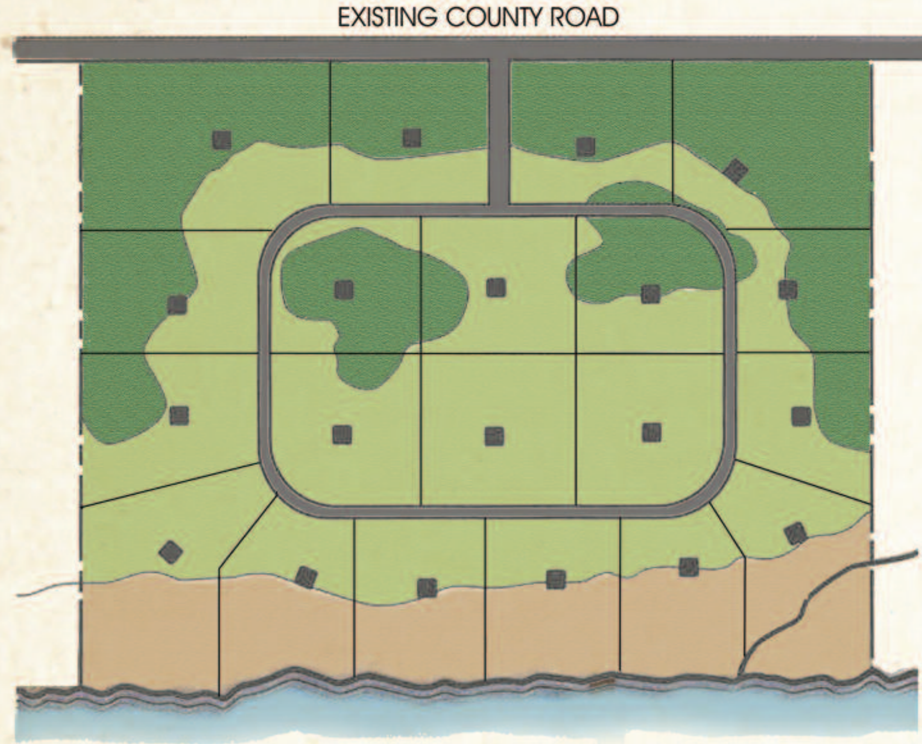
- Protection of sensitive landscapes.
- Providing community members with larger recreation areas and creating a sense of openness that many people desire.
- Providing habitat for wildlife, naturally filtering stormwater, reducing stormwater runoff from impervious surfaces, and protecting the natural features of a site.
- Linking the open space of several conservation design subdivisions can help develop larger and more effective "environmental corridors" within and between communities.
- Reduced site development costs and increased market prices of individual plots in comparison with traditional subdivisions.

**Limitations:**

- In many cases, local regulations must be updated to facilitate building cluster development subdivisions.
- The open space preserved may require maintenance by the homeowners or homeowners' association.
- Stormwater and septic management often requires additional planning because it must be carefully designed for smaller lots.

***Prairie Crossing is an acclaimed conservation community in Grayslake, Illinois.***

*Photo Credit: Prairie Crossing Homeowners Association*




### Traditional Development

Grid layout with little regard for natural and special features.

### Cluster Development

**(AKA Open Space Development or Conservation Design)**

Trees, wetlands, scenic views, and natural features are retained. All homes have lake views. Single-loaded roads provide more privacy and better views. Trails make a pedestrian and recreation-friendly development.

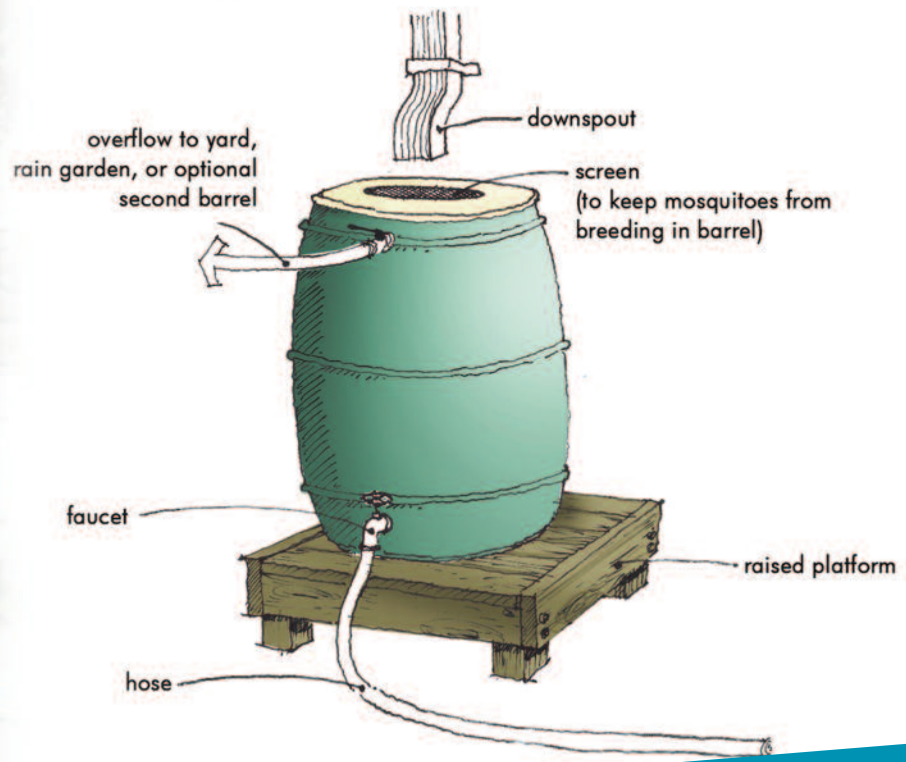
# Rain Barrels

Rain barrels are most commonly used in a residential setting to capture rain from rooftops that would otherwise be directed to a storm drain. Using a rain barrel or a series of rain barrels will help reduce runoff volume, promote infiltration, and slow and filter runoff from the roof. They also help reduce runoff and erosion during large storm events, and maintain plants and gardens during extreme hot and dry conditions or in a drought. Rooftop runoff collected can be stored and used later for non-potable applications such as watering a lawn or flower garden.

Rain barrels take up very little space, are inexpensive, and easy to install. There are many styles of rain barrels that can be found online or at your local home goods or landscaping store.

**MAINTENANCE: LOW**
Rain barrels require regular draining after rainstorms and removal of leaves and debris collected on screens. Always check that the overflow is clear and directed to an appropriate location.

**INVESTMENT: LOW**
Rain barrels range from $20 for a do-it-yourself kit to upwards of $200.



# Rain Gardens

A rain garden is a specialized landscape design that captures runoff from roofs, driveways, or other impervious surfaces. It uses plants to remove pollutants and improve infiltration, allowing water to soak back into the ground. Rain gardens increase aesthetic value, absorb water, reduce runoff, protect water quality, and prevent flooding.

The average cost of a rain garden is about $8-$10 per square foot depending on several factors including area, site preparation, plants (types, sizes, and quantity), and any additional accents or features.

Similarly, bioretention cells are shallow, landscaped depressions that can handle large volumes of water. They are well-suited for commercial, institutional, industrial, or residential settings.

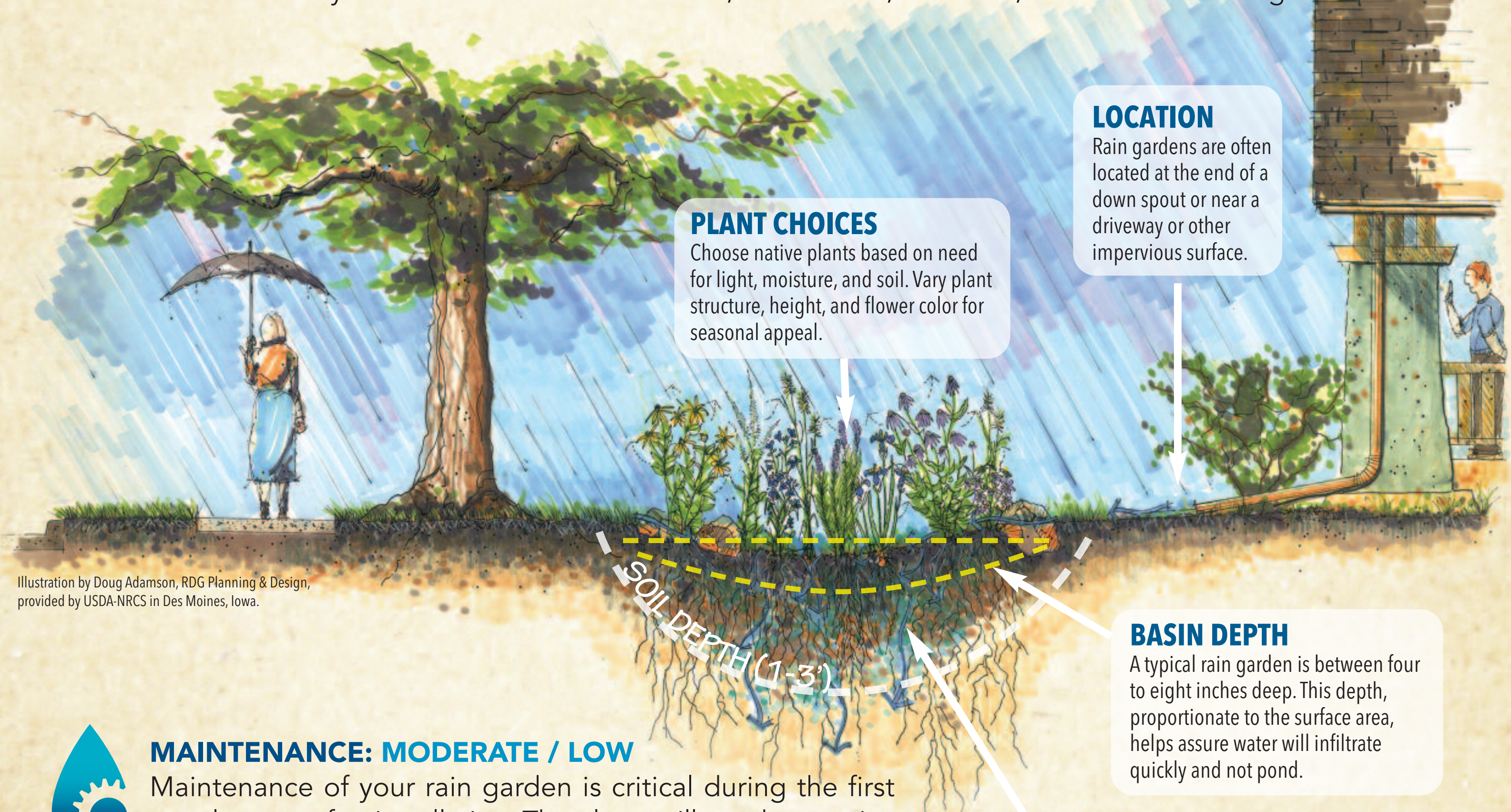



Illustration by Doug Adamson, RDG Planning & Design, provided by USDA-NRCS in Des Moines, Iowa.

**LOCATION**
Rain gardens are often located at the end of a down spout or near a driveway or other impervious surface.

**PLANT CHOICES**
Choose native plants based on need for light, moisture, and soil. Vary plant structure, height, and flower color for seasonal appeal.

**BASIN DEPTH**
A typical rain garden is between four to eight inches deep. This depth, proportionate to the surface area, helps assure water will infiltrate quickly and not pond.

**SOIL AMENDMENTS**
Soil amendment recommendations vary based on site conditions. In general, a good soil mix for rain gardens is 60% sand, 15% topsoil, and 25% compost.

**SIZE**
A rain garden is typically 10-30% the size of the impervious surface that generates runoff.

### MAINTENANCE: MODERATE / LOW

Maintenance of your rain garden is critical during the first couple years after installation. The plants will need to receive plenty of water until they are well established. Mulching, weeding, and replacing plants that fail to thrive in the rain garden are all important maintenance tasks necessary for both the maximum success of the rain garden and to control invasive species that might infest the garden from nearby sources. The use of native, site-appropriate vegetation reduces the need for fertilizers, pesticides, excessive water, and overall maintenance.

### INVESTMENT: MODERATE

Approximately $8-$10 per square foot depending on several factors including area, site preparation, plants, and accent features.

# Native Landscaping

Native plants are plants that naturally occur in a particular region or ecosystem and co-exist with local fauna, birds, insects, and other animals. These plants have adapted over thousands of years to the diverse weather conditions, soils, and topography of the area and often thrive with less human intervention like watering, fertilizing, and mulching. They provide a key component to a balanced ecological system.

Native shrubs, groundcover, and tree roots provide a fibrous web that stabilizes and anchors the soil. The roots function much like reinforcing steel in concrete structures, adding strength. Native plants are beneficial for maintaining shorelines because they decrease erosion from waves and ice while anchoring shoreline soils. They also provide a natural habitat for bees, butterflies, birds, and other wildlife. One of the most important benefits is that native plants help catch and slow rainfall, allowing moisture to evaporate from the leaf surfaces rather than run across the ground picking up contaminants before it enters our lakes and streams. It is best to use native plants with a variety of hydrologic regimes. This way, during wetter periods there are native plants that will thrive, as well as native plants that will endure during drier periods This adaptation technique also helps reduce the likelihood of invasive species taking over and ensures consistent healthy plants and aesthetic value.

Native plants also require less fertilizer and pesticides, thus protecting our waters from runoff of these chemicals. This improves the quality of the water in our lakes, streams, and wetlands, as well as the aquatic life in them.

**MAINTENANCE: LOW**

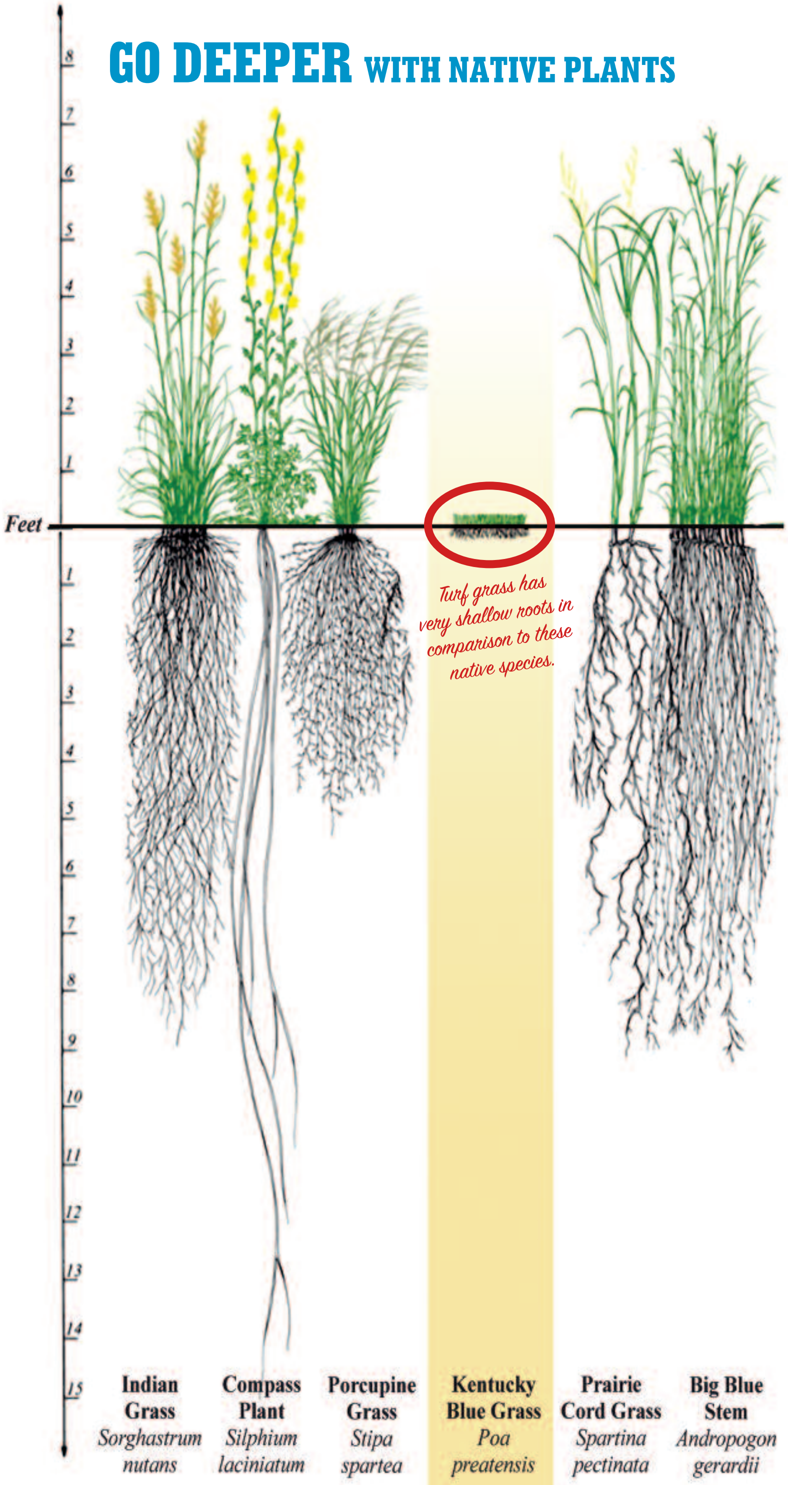
Once established, native plants need less care than their nonnative counterparts.

**INVESTMENT: MODERATE / LOW**

The cost of using native plants for landscaping is often lower than the cost of using nonnative plants when factored over a period of time.

Photo Credit: Larry Tracy

# GO DEEPER WITH NATIVE PLANTS




***Native plants have deeper root systems** that substantially increase the ability of soil to absorb and retain water. When native plants are used, more stormwater is absorbed into the ground, leading to less stormwater runoff and water pollution.*

## Best for Average to Wet Conditions

**Blue Flag Iris**
*Iris versicolor*

**Swamp Milkweed**
*Asclepias incarnata*

**False Sunflower**
*Heliopsis helianthoides*

**Cardinal Flower**
*Lobelia cardinalis*

## Best for Average to Dry Conditions

**Little Blue Stem**
*Schizachyrium scoparium*

**Wild Lupine**
*Lupinus perennis*

**Beardtongue**
*Penstemon digitalis*

**Black-Eyed Susan**
*Rudbeckia hirta*

### CHOOSE WISELY!

*Choosing native over nonnative plants also means you are helping prevent the spread of invasive species, such as Japanese Knotweed, Common Privet, and Common and Glossy Buckthorns. Many invasive species are still available for sale at nurseries, so be sure to learn what to avoid when purchasing plants for your rain garden.*

*The Northwest Michigan Invasive Species Network website has a listing of invasive plants to watch for at **www.habitatmatters.org***

# Greenbelts/Riparian Buffers

A greenbelt or riparian buffer zone is defined as an undeveloped area directly adjacent to a body of water. A healthy greenbelt consists of a mix of native trees, shrubs, and herbaceous plants.

Greenbelts serve many purposes, including:

- Reduction in runoff by increasing stormwater infiltration into soil. Reduced runoff means less nutrients and other pollutants are entering the water body.
- Stabilization of soils with plant roots.
- Reduction in shoreline erosion.
- Improvement of wildlife and fish habitat by providing food, shelter, and cooling water temperatures.

It is important to note that turf grass does not provide the same benefits that a mix of native vegetation does, and therefore, is not considered an adequate greenbelt.

**MAINTENANCE: MODERATE / LOW**
Riparian buffers using native plants often require little to no maintenance once established, leaving more time to enjoy lakefront living. At most, maintenance is common landscaping procedures such as mowing and trimming.

**INVESTMENT: MODERATE / LOW**
Greenbelts are relatively inexpensive to plant. Many federal, state, and local governments, and even community organizations such as lake associations offer financial incentives to install riparian buffers.

## Shoreland Properties

Each section of your shoreland property serves a function in protecting our water resources.

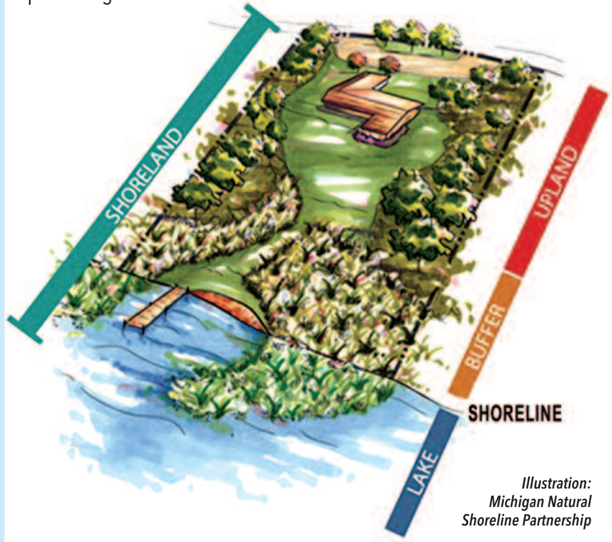



*Illustration: Michigan Natural Shoreline Partnership*

**Upland Zone:** This zone sets back from the lake and typically includes the house, driveway, and garage. This is also where the majority of stormwater runoff will be generated due to the amount of hard surfaces.

**Buffer Zone:** This zone is immediately next to the lake and is typically the first 35 feet of the lake front property. This part of the shoreland property is very important in protecting the lake ecosystem and maintaining a stable shoreline.

**Shoreline Zone:** This is the transition zone from water to land. There is not an exact line between the land and aquatic zones. It begins at the top of the bank and extends to the land-water interface. The shape and size will vary greatly. It is important to maintain as natural of a shoreline zone as possible.

**Lake Zone:** This is the nearshore area or "littoral zone" of the lake. It is the shallow part of the lake where there is enough light reaching the bottom to allow aquatic plants to grow. A healthy littoral zone provides food, shelter, shade, and areas to raise young for fish and wildlife.

MI SHORELAND STEWARDS

The **MI Shoreland Stewards program** is a statewide program developed to recognize lakeshore property owners who protect their lake through good shoreland management practices.

MICHIGAN NATURAL SHORELINE PARTNERSHIP

For more information, visit **www.mishorelandstewards.org**

Photo Credit: Larry Tracy

# Natural Shorelines

Natural shorelines are a green infrastructure technique using native plants, biodegradable products, and other natural materials to provide a stable shoreline. Natural shorelines provide a better alternative to hardened shorelines like seawalls or bulkheads. They provide numerous benefits including nutrient pollution remediation, habitat for fish, waterfowl, aquatic insects and other shoreline-dependent species, and protection of the shoreline from waves and storms. Plants, shrubs, and trees can also provide an attractive privacy screen for property owners while maintaining views of the lake.

On shorelines where native vegetation has been removed it is possible to restore the shoreline with a combination of methods known collectively as bioengineering techniques. Bioengineering is usually less expensive than structural methods like concrete seawalls. Some applications can be done by the homeowner while other applications will require a contractor.

Natural shorelines can increase resiliency to large storm events and reduce the risk of property flooding. Natural shorelines are also known to store carbon, which keeps carbon out of the atmosphere. Protection and restoration of natural shorelines will result in increased carbon sequestration and storage, potentially mitigating the effects of climate change. Additionally, the preservation of good water quality can increase property value and/or recreational opportunities.

**MAINTENANCE: MODERATE / LOW**
Newly planted areas will require some initial maintenance. Once established, there is little to no maintenance required.

**INVESTMENT: VARIES**
Bioengineering is usually less expensive than structural methods like concrete seawalls. The estimated cost of installing a natural shoreline, including bioengineering materials, averages from $10-20 per linear foot. The financial cost of hard armoring the shore (using seawalls and bulkheads) can range from $45-200 and up per linear foot.

# Permeable Paving

Porous or permeable surfaces allow stormwater to infiltrate into underlying soils, thereby promoting pollutant treatment and groundwater recharge. Depending on design, paving material, soil type, and rainfall, permeable pavements can infiltrate as much as 70% to 80% of annual rainfall.

Permeable paving options include block pavers, porous asphalt and concrete, and vegetated grid systems.

Photo Credit: JJ Harrison, Creative Commons

**Permeable pavers** are comprised of interlocking concrete bricks, separated by joints or gaps, filled with small stones or sand, which are laid over a bed of aggregate stones. Water is able to infiltrate through the joints in the paver and is stored in void space in the stone bed underneath the paver surface, where it is then filtered back into the soil.

**Porous asphalt** is the same as regular asphalt except it is manufactured with the fine materials omitted, leaving open spaces that allow water to filter through to a "recharge" or drainage bed.

**Porous concrete** is composed of materials that result in voids when it is dry, allowing water to drain through a bed of stone

**Vegetated grid** systems are plastic or concrete grids over a bed of drainage material and soil. The voids are then seeded with low maintenance grass varieties.

Permeable pavers and porous asphalt and concrete are generally used in higher traffic parking and roadway applications while vegetated grid systems are more commonly used in auxiliary parking areas and roadways.

Photo Credit: WikiMedia Commons

Photo Credit: EcoTec Permeable Pavers

**Limitations of Permeable Paving:**

- Porous or permeable pavement surfaces are best suited for parking lots, low traffic residential streets, driveways, and sidewalks.
- Porous pavement projects need to be designed and constructed by an experienced professional.
- It is critical that all types of porous pavement projects are maintained according to manufacturer specifications.
- Initial costs for porous pavements are typically higher than costs for conventional pavements. However, these initial costs are often said to be offset by eliminating the need for other stormwater infrastructure.

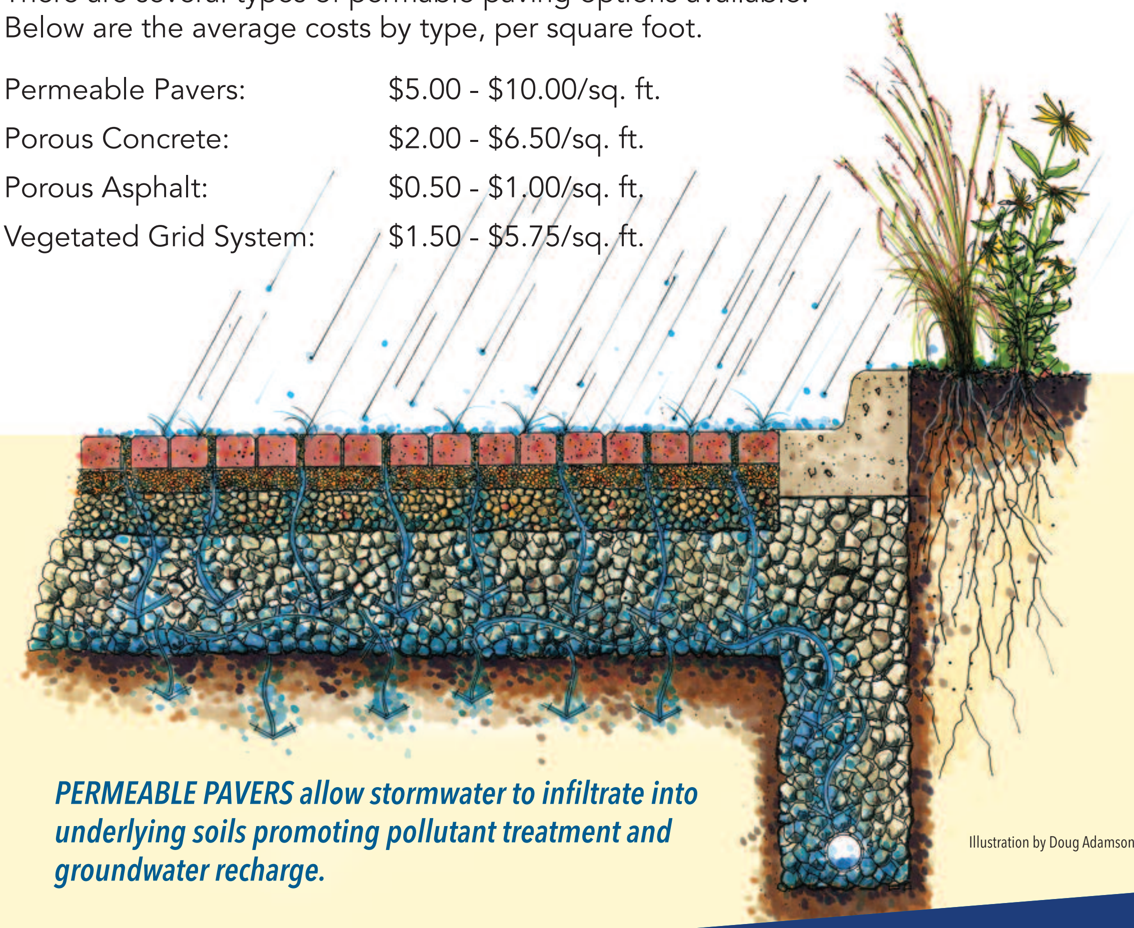
## MAINTENANCE: MODERATE / LOW

Keep the area clear of sediment to prevent clogging. Annual sweeping or vacuuming of sediments helps maintain permeability. The gaps between pavers may require occasional weeding and sand or gravel replenishment. Because pervious pavers are easily lifted and reset, they are easy to repair or replace.

## INVESTMENT: MODERATE / HIGH

There are several types of permable paving options available.
Below are the average costs by type, per square foot.

| | |
|---|---|
| Permeable Pavers: | \$5.00 - \$10.00/sq. ft. |
| Porous Concrete: | \$2.00 - \$6.50/sq. ft. |
| Porous Asphalt: | \$0.50 - \$1.00/sq. ft. |
| Vegetated Grid System: | \$1.50 - \$5.75/sq. ft. |



*PERMEABLE PAVERS allow stormwater to infiltrate into underlying soils promoting pollutant treatment and groundwater recharge.*

Illustration by Doug Adamson

# Green Roofs

A green roof is a low maintenance vegetated roof system that reduces stormwater runoff by absorbing and retaining the water in the soil medium for plant growth. Green roofs are constructed on top of existing roofs and include four basic components: a waterproofing layer, a drainage layer, a growing medium, and vegetation. In addition to reducing the amount of roof runoff, the plants filter pollutants and carbon dioxide from the air and rain water.

They are easy to incorporate into new construction, and can be used on many existing buildings as well. Another added benefit of green roofs include reduced heating and cooling needs and associated costs. Green roofs are likely to last much longer than conventional roofs, since the roofing material itself is shielded from ultraviolet light and thermal stress. Green roofs can also reduce noise pollution and serve as living habitats for birds and other wildlife.

*Photo Credit: LiveRoof Hybrid Green Roofs*

*Photo Credit: Greenroofs.com*

**MAINTENANCE:**
**MODERATE / LOW**
The vegetation needs watering during establishment and will require weeding usually once or twice a year.

**INVESTMENT:**
**MODERATE / HIGH**
Costs for green roofs vary, depending on many factors such as growing medium, depth, and green roof size. Costs for green roofs in the United States are estimated to average between $15 to $20 per square foot. The highest costs associated with green roof creation are the soil substrate/growth medium and the plant components. However, a properly designed and maintained green roof can save money in the long term from reduced utility costs and roof maintenance.

***Example of a Green Roof***

*Photo Credit: Virgina Living Museum, Newport News, Virginia*

# Bioswales

Bioswales are shallow channels designed to slowly convey water to storm sewer inlets or surface waters and filter the 'first flush' of runoff. The first flush occurs during the first few moments of a rain event when pollutants are most concentrated. The vegetation in swales help trap pollutants (suspended solids and trace metals), reduce the velocity of stormwater runoff, and encourage infiltration. In some cases, street-side bioswales can replace curb and gutter systems, as well as storm sewers.

Filter strips and grassed swales are easily located and constructed. The vegetation is highly effective in preventing erosion and thus controlling sediment in stormwater runoff.

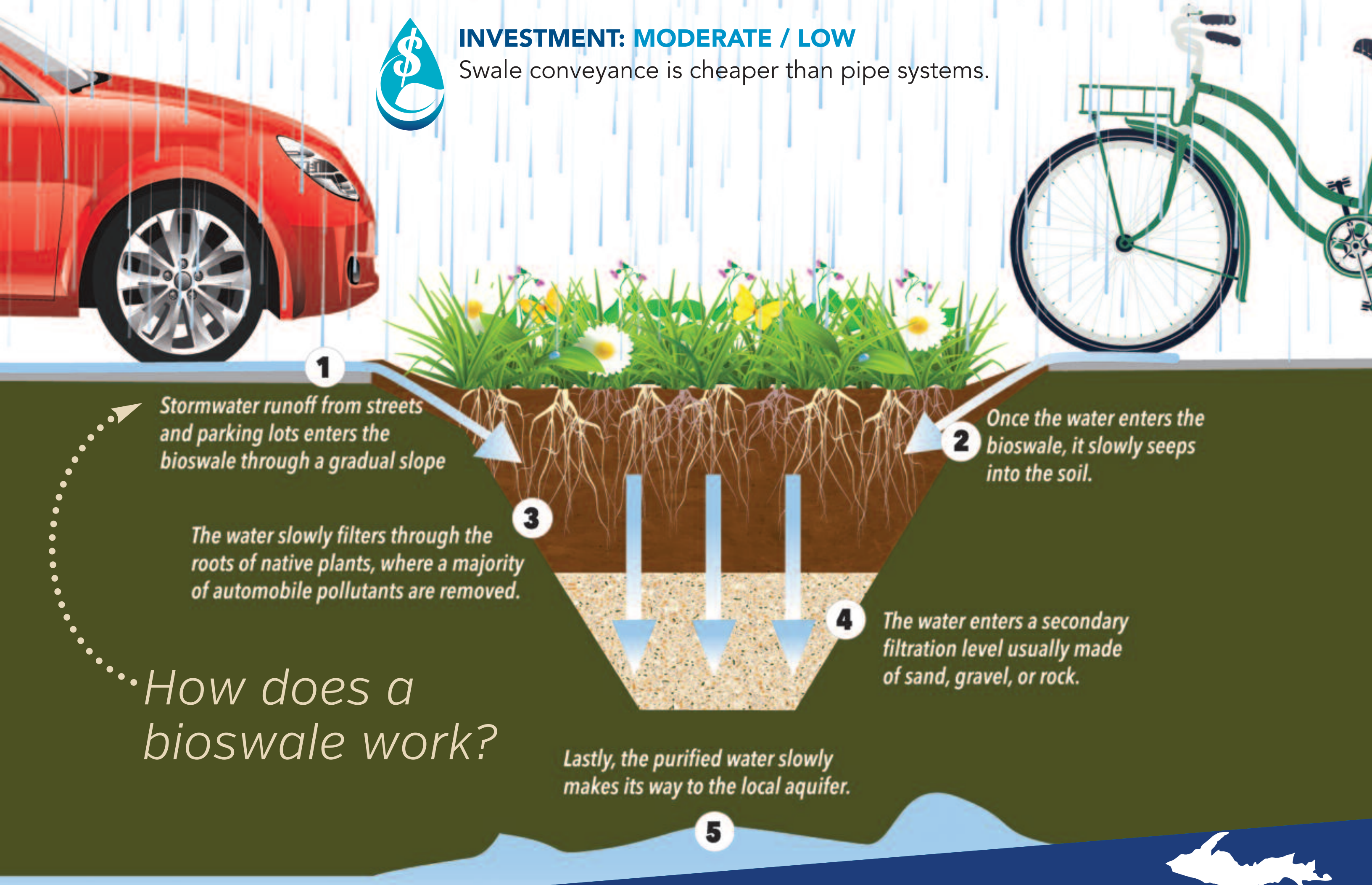
*Example of a bioswale in action.*

**MAINTENANCE: MODERATE / HIGH**

Routine maintenance is required for bioswales. Before a planted swale is densely vegetated, it is extremely vulnerable to erosion and must be protected with straw matting and other erosion control materials. Maintenance of a dense, healthy vegetated cover consists of periodic mowing (keep grass 2-4 inches high), weed control, reseeding of bare areas, and clearing of debris and accumulated sediment.

**INVESTMENT: MODERATE / LOW**

Swale conveyance is cheaper than pipe systems.



Invasive *Phragmites (Phragmites australis)* can become the sole dominant plant in many wetlands at the expense of native flora and animals dependent on these native habitats.

Photo Credit: Michigan Tech University

# Invasive Species Management

An invasive species is one that is nonnative to the ecosystem and whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health.

Climate change and its impacts are expected to facilitate the establishment and spread of invasive species. The U.S. Environmental Protection Agency warns that in response to temperature increases, "the habitat ranges of many North American species are moving northward in latitude and upward in elevation." These range shifts may threaten critical habitat or may stress certain native species, in turn creating a welcoming environment for invasive species. In aquatic environments, increasing water temperatures may enable invasions of new species. As well, severe weather events involving flooding, high winds, and habitat disturbance may damage native systems, opening the door to invasive species.

Adaptation to climate change requires increased efforts to prevent new invasions and to eradicate or control existing invasives. Invasive plant management can protect ecological function and support resilience to climate change. Removing or preventing the establishment of invasive species will support the integrity and function of an ecosystem and help buffer future impacts associated with climate change. It is critically important to develop practices that strengthen environmental monitoring and management of invasive species to minimize impacts on ecosystem resources as climatic conditions change.

## Learn more about invasive species at the following websites:

### IDENTIFICATION & REPORTING

**Michigan Invasive Species Information Network**
www.misin.msu.edu

**Michigan Invasive Species Program**
www.michigan.gov/invasives

### CONTROL & PERMITTING

**Michigan Department of Environmental Quality - Aquatic Nuisance Control**
www.michigan.gov/anc

## Be on the lookout for these serious shoreline invaders...

### Eurasian *Phragmites*

*Phragmites australis*

**DESCRIPTION:** The "Common Reed" is a stout, warm-season perennial grass ranging in height from 6-15 feet. Forms dense, impenetrable stands, in contrast with the native subspecies, which typically occurs in a colony of scattered stems.

**HABITAT:** Wetlands, ditches, streambanks, lake shorelines, and other wet areas. Tolerates road salt.

**MODE OF SPREAD:** Most commonly, *Phragmites* spreads by horizontal above-ground stolons and underground rhizomes. The use of maintenance equipment in wetland areas (particularly ditches) and shoreline erosion caused by waves and ice can move live rhizome fragments that establish new stands. It can also be spread by wind or animal-born seeds. Once established, *Phragmites* is difficult to control or eradicate.

Photo Credit: WikiMedia Commons

### Purple Loosestrife

*Lythrum salicaria*

**DESCRIPTION:** Herbaceous perennial 1.5-6 ft. tall with showy magenta-colored flowers on spikes in mid to late summer. Strongly developed taproot, stem becomes woody with age. Spreads vigorously in moist soil conditions. Very persistent.

**HABITAT:** Wetlands, lake shorelines, streambanks, and disturbed wet areas (e.g. ditches), tolerates up to 50% shade.

**MODE OF SPREAD:** Reproduces by seed, by resprouting from cut stems, and regenerates from pieces of root stock.

### Japanese Knotweed

*Polygonum cuspidatum (Fallopia japonica)*

### Giant Knotweed

*Polygonum sachalinense*

**DESCRIPTION:** Herbaceous perennial shrub growing from 3-10 ft. (Japanese knotweed) or up to 12 ft. (Giant knotweed). Broad leaves, hollow stems that resemble bamboo. Deep taproot with surface roots that extend laterally from 23-65 ft. Can cause structural damage to buildings, roads, etc.

**HABITAT:** Roadsides, river banks, wetlands, wet depressions, and woodland edges.

**MODE OF SPREAD:** Spreads primarily through rhizomes or fragments or by seeds in fertile locations. Extremely difficult to control once established.

# Stormwater Wetlands

Constructed stormwater wetlands are wetland systems designed to maximize the removal of pollutants from stormwater runoff through settling and uptake and filtering by vegetation. Constructed stormwater wetlands temporarily store runoff in relatively shallow pools that support conditions suitable for the growth of wetland plants. Stormwater wetlands are designed specifically for the purpose of treating stormwater runoff and typically have less biodiversity than natural wetlands, both in terms of plant and animal life.

**SPREAD PHOTO: The thriving stormwater wetland at North Central Michigan College in Petoskey, Michigan. Stormwater runoff from the parking area (shown above) drains to the stormwater wetland.**

**INSET RIGHT: A heavy rain shows the stormwater wetland in action.**

Although less biodiverse than natural wetlands, they can provide adaptation functions by providing habitat, corridors, shade, microclimate benefits during hot spells, and greater aesthetic values than traditional stormwater ponds. They can provide nutrient uptake and groundwater recharge. Stormwater wetlands are much less likely to become full of algae and stagnant water, and are designed to function more like natural systems than traditional stormwater basins.

**MAINTENANCE:**
**MODERATE**

All constructed stormwater wetland components receive and/or trap debris and sediment. They should be inspected for clogging and excessive debris and sediment accumulation at least twice annually.

**INVESTMENT:**
**MODERATE / HIGH**

The cost of establishing a constructed wetland varies depending on size and site conditions. In general, larger stormwater wetlands involve high construction, installation, and maintenance costs. Stormwater wetlands are considered relatively inexpensive compared to traditional stormwater management techniques. However, since constructed wetlands typically require more land area to be effective, land acquisition costs could result in wetlands being more expensive than other stormwater practices that require less area.

# Wetland Restoration

Wetland restoration is at the heart of many climate change adaptation and mitigation plans. Wetland restoration reestablishes or repairs the hydrology, plants, and soils of a former or degraded wetland that has been drained, filled, or otherwise modified. The purpose of wetland restoration is to restore the functions and values of wetland ecosystems that have been altered.

Climate change concerns are leading many efforts to focus wetland restoration designs to meet program goals such as flood-peak attenuation or nonpoint source runoff reduction. Wetland restoration is a key adaptation method for agricultural areas, as well. In future climate scenarios with larger storm events and longer drought periods, wetland restoration can provide essential groundwater recharge in areas where it has been lost, a significant benefit to farmers. In addition, the shade and microclimate in restored wetlands can help alleviate the harsh, hotter conditions.  Restored wetlands in and around farms can be placed in areas where wetlands historically were in order to restore the lost groundwater recharge functions.

In addition, wetland restoration projects should be designed to adapt to, and withstand, the impacts of climate change. Restoring wetland hydrology typically involves breaking drainage tile lines, building a dike or embankment to retain water, or installing adjustable outlets to regulate water levels. Water level management infrastructure, such as dikes, water control structures, and pumps, need to be designed in a manner that facilitates adaptation to emulate natural wetland conditions in changing climatic conditions. This could include strategies such as development of habitat structures at multiple elevations or habitat zones to provide more adaptive capacity. Diversification of planting and seeding is also important to include plant species that are adapted to future climate conditions.

Although infrastructure that facilitates adaptation may be more expensive to develop, the long-term success of the restoration efforts will be better if it recognizes and prepares for water level and climate uncertainty.

### MAINTENANCE: HIGH

Management of restored wetlands requires a long-term commitment to achieve successful, sustainable ecosystems. Vegetation often requires active management in the years following initial establishment to either limit the spread of invasive species or promote a certain successional level of plant communities. Water levels may need to be actively managed and modified depending on conditions that may alter with climate change. Monitoring the restored wetland is key in evaluating future management strategies.

### INVESTMENT: MODERATE / HIGH

The cost of wetland restoration varies greatly depending on wetland type, site conditions, and construction activities needed. State and federal agencies and conservation groups often have programs that may provide technical assistance and cost-share expenses for wetland restoration.


After Installation

Wetland restoration project at Elizabeth Park in Trenton, Michigan.

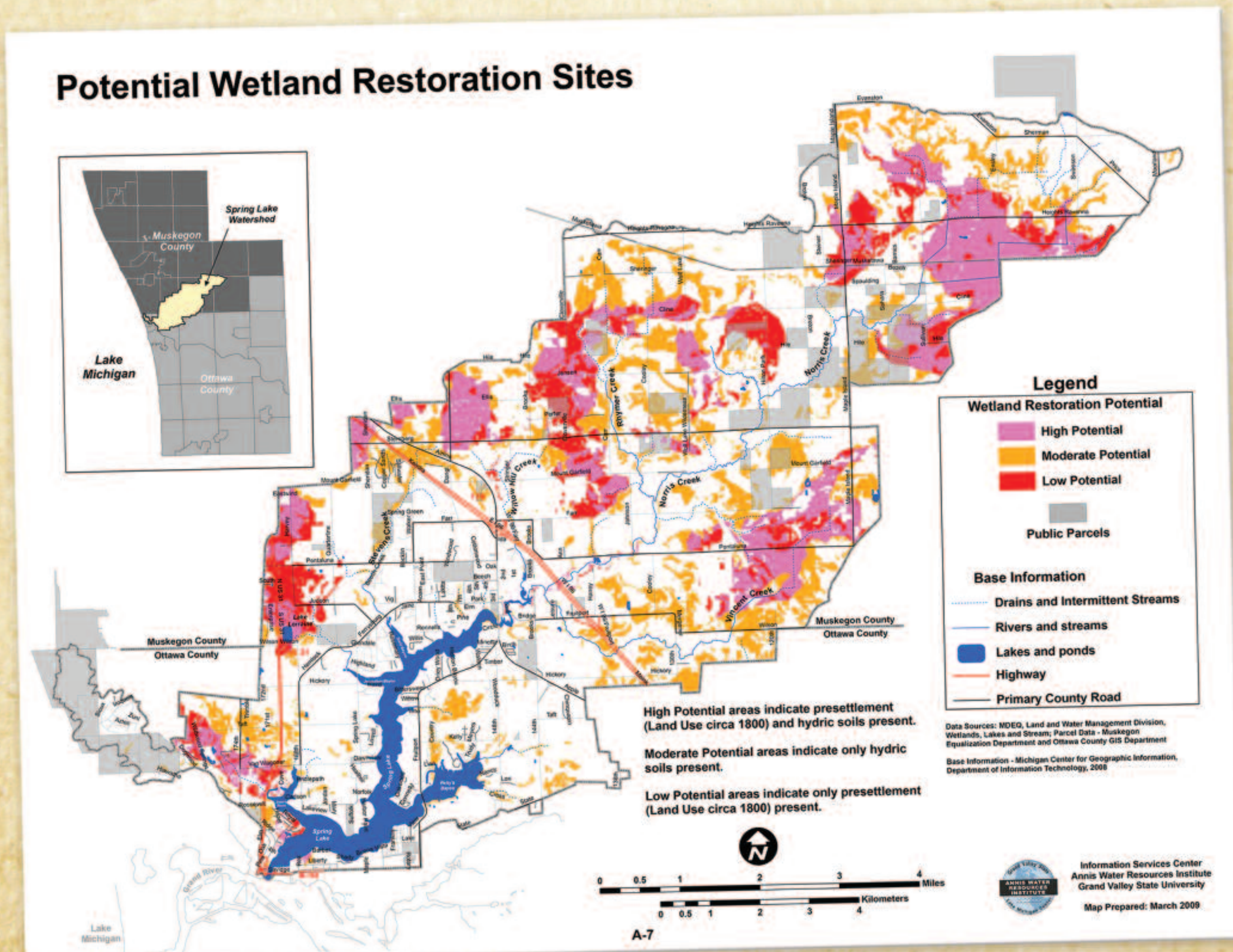
Photo Credit: Todd Marsee Michigan SeaGrant


Restored wetland

# Landscape Level Wetland Assessments

The Landscape Level Wetland Functional Assessment (LLWFA) is a tool to identify areas to target wetland protection and restoration efforts. The LLWFA is a process using spatial data to prioritize wetland protection and restoration based on functions the wetland provides. Functions could include floodwater storage, stream flow maintenance, sediment retention, nutrient transformation, and shoreline stabilization. The resulting analysis can be used to provide a generalized map of current wetland functions within a watershed as well as the loss of wetland function associated with past land use changes. The information can be used to identify potential wetland restoration areas, but more importantly, to target wetland restoration by selecting and pursuing optimal locations for cumulative functional value. As a result, you can help prioritize wetlands for protection or restoration based on how well those wetlands serve specific functions. This tool is especially useful for farmers to identify priority locations for wetland restoration for groundwater recharge in heavy agricultural areas.

The Landscape Level Wetland Functional Assessment (LLWFA) has been completed for several watersheds in Michigan and can be accessed through the Michigan Department of Environmental Quality.




Produced by Tip of the Mitt Watershed Council
October 2016

Financial assistance for this project was provided, in part, by the Michigan Coastal Zone Management Program, Office of the Great Lakes, Department of Environmental Quality, under the National Coastal Zone Management Program, through a grant from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.