Monroe County Climate Readiness and Rural Economic Opportunity Assessment – Final Report

April 4, 2022

WISCONSIN'S greenfire
VOICES FOR CONSERVATION

Monroe County Climate Change Task Force

Acknowledgements

The Monroe County Climate Readiness and Rural Economic Opportunity Assessment (CRREOA) has been a collaborative effort supported by the following partner organizations:

Monroe County Climate Change Task Force
The Nature Conservancy in Wisconsin
Northern Institute of Applied Climate Science
U.S. Army, Fort McCoy
University of Wisconsin-Madison, Division of Extension
Wisconsin Dept. of Agriculture, Trade and Consumer Protection
Wisconsin Dept. of Natural Resources
Wisconsin Initiative on Climate Change Impacts
Wisconsin Land and Water
Wisconsin's Green Fire

Report Contributors

This report and its conclusions include contributions from the more than 40 members of technical teams that supported the CRREOA project. For a complete list of technical team members see Appendix II.

Primary Contributors

Christina Anderson
Fred Clark
Joanne Kline
Bob Micheel
Nick Miller
Rob Montgomery
Heather Stricker

Monroe County lies within the ancestral homelands of the Ho-Chunk peoples, and we gratefully acknowledge that history, as well as the diverse and vibrant Native communities who make their home here today.

Funding for this project came in part from The Nature Conservancy in Wisconsin, and the Wisconsin Department of Agriculture Trade and Consumer Protection, Soil and Water Resource Management grant program. A shorter Summary Version of this report is also available.

Recommended Citation

Monroe County Climate Readiness and Rural Economic Opportunity Assessment - Final Report

Wisconsin's Green Fire, 2022

Photos provided by Monroe County Land Conservation Department, Wisconsin DNR, Federal Emergency Management Agency, and Wisconsin's Green Fire.

For a Summary Report, Recommendations, Appendices, and related project materials, see https://wigreenfire.org/community-climate-resiliency/

Table of Contents

1 INTRODUCTION

Project Purpose

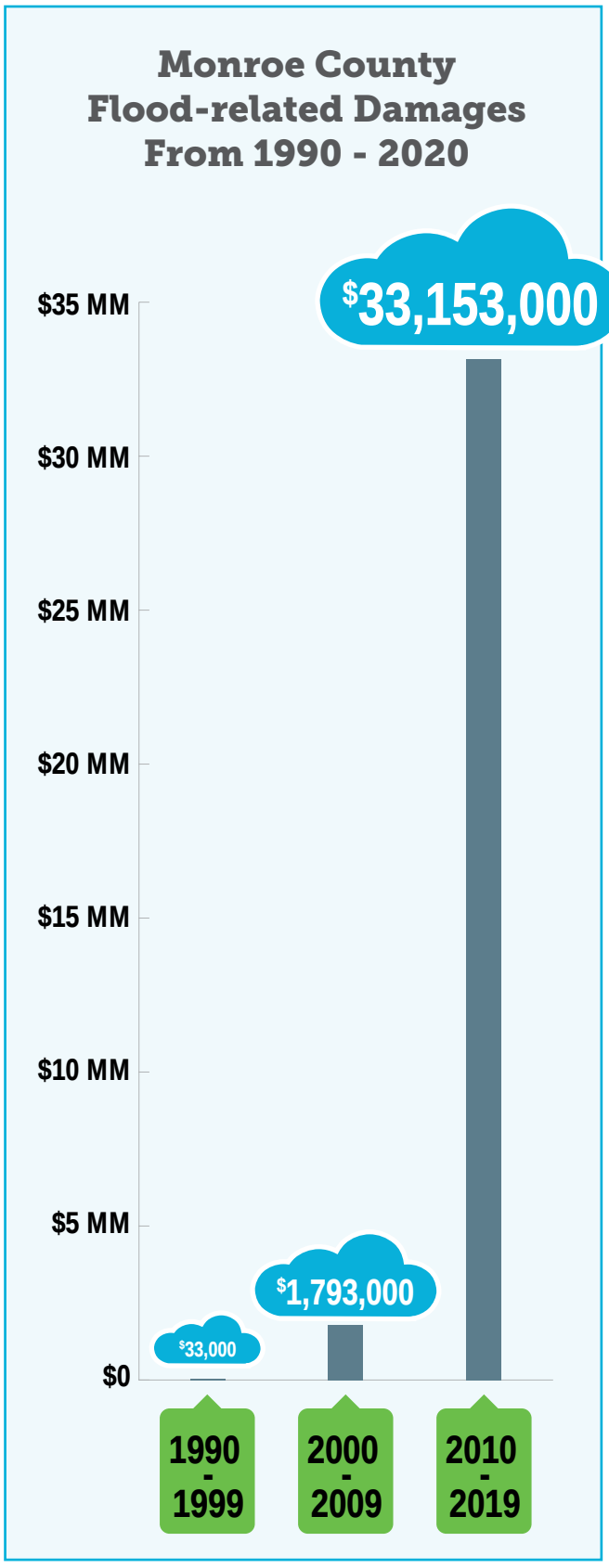
The Monroe County Climate Readiness and Rural Economic Opportunity Assessment (CRREOA) is a first of its kind effort to conduct a rapid, comprehensive assessment that brings together climate readiness and conservation-based economic opportunities at a county level. This collaborative effort was initiated as a pilot project in Monroe County, Wisconsin using an approach that can be rapidly replicated at a similar scale in other locations.

The CRREOA project utilized a team of specialists working with county leaders to conduct a multi-faceted assessment with emphasis on community climate resiliency, built and natural infrastructure, and rural economic development through conservation. This work is intended to be a foundation for Monroe County to take the most effective actions and make the best investments to improve climate resiliency, while identifying productive land uses that protect soil, water, and ecosystem services, and address the needs of vulnerable populations and communities.

The CRREOA addresses many of the primary climate risks and vulnerabilities experienced by rural communities throughout the Midwestern United States. While state and federal governments play an essential role in developing climate policy, leading climate research, and delivering resources, the on-the-ground actions most needed to address climate change impacts will occur primarily at the community level.

Limitations of Assessment

The scope of this project is a broad assessment intended to highlight climate vulnerabilities and identify potential solutions and recommendations that Monroe County can choose to implement to become more climate resilient and economically



Between 2007 and 2020 more than 20 flash flood events have occurred in Monroe County, which destroyed homes and infrastructure, caused the failure of multiple dams, and resulted in significant economic losses to agricultural producers.

viable for future generations. The findings and recommendations in this report are supported by spatial assessments, existing data sets, and opinions from subject matter experts within and outside Monroe County all support the findings and recommendations in this report. This report makes no findings or conclusions about specific land use and specific land ownerships.

Recent Climate Events

Similar to other areas in the Upper Midwest, Monroe County has experienced severe flash flood events in recent decades. Some of these events have included unprecedented rainfall intensities. On August 28, 2018, during one of the most damaging flash flooding events, rain amounts approached 20 inches in a 24-hour period causing extensive damage and devastation.

Reported flood damages reflect the increasing frequency and severity of flood events, as seen in chart at left. The Monroe County Emergency Management Department lists the following reported levels of flood-related damages for each decade in the 30 years from 1990 until 2020.

Severe flooding is now a regular fact of life for many Monroe County residents that puts public and private property, lives, and livelihoods at risk.

The impact of flash flooding goes beyond damage to property and infrastructure. Soil losses in some places in the area have been estimated based on transect surveys at 649,057 tons/year (Monroe County Land and Resource Management Plan) causing excessive sediment delivery to local rivers and streams, extensive topsoil loss, and infrastructure damage. Extensive flood damage within watersheds can damage future flood resilience by de-stabilizing bank structure and creating long lasting effects to the quality of fisheries and the biotic systems fish depend on.

Following the August 2018 flooding event, county leaders began discussing ways to be better prepared for climate change and its impacts. In August 2019 the Monroe County Board of Supervisors voted unanimously to address climate change impacts and proactively plan for a climate-resilient future by creating the Monroe County Climate Change Task Force (CCTF), a standing committee of county government. The Climate Change Task Force represents key interests in the county, including farming, forestry, infrastructure, natural resources, the Fort McCoy military base, and underrepresented communities.

The CRREOA Project

Following several months of planning, the Monroe County Climate Readiness and Rural Economic Opportunity Assessment was launched in May 2021. The project is the result of the combined efforts of a coalition of conservation agencies and Non-Governmental Organizations working together with Monroe County leaders, with coordination provided by Wisconsin's Green Fire and the Monroe County Land Conservation Department.

Objectives

1) Conduct a comprehensive climate change vulnerability assessment based on current conditions.

2) Project future climate-related risks.

3) Provide expert recommendations for increasing resilience and mitigating current and projected climate impacts.

4) Identify conservation practices and land uses that increase resiliency and help conserve soil and water.

5) Help grow economic opportunities in rural communities through conservation action.

Scope of Work and Project Structure

The CRREOA project team is led by a team of specialists together with local resource experts conducting a multi-faceted assessment with emphasis on community climate resiliency, built and natural infrastructure, nature-based solutions, and rural economic development through conservation.

The assessment was led by a **Core Team** that provided overall project guidance, and a **Host Team** whose members reflected local leaders and representatives of the Monroe County Climate Change Task Force. **Four technical sub-teams (Climate and Hydrology, Floodplains and Infrastructure, Agriculture, and Forestry)** each assessed defined aspects of climate change in the county or surrounding areas. The sub-teams compiled local and statewide data sets, reports, and historical records on lands within the county and within surrounding watersheds. They also interpreted existing models or created new analyses to identify the climate-related threats within the county. The sub-teams collectively identified risks and vulnerabilities and developed recommendations that form the heart of this report.

Project Co-Leads

Fred Clark, Executive Director, Wisconsin's Green Fire

Bob Micheel, Director, Monroe County Land Conservation Department

Core Team Members

Christina Anderson, Climate Specialist, Wisconsin Land and Water

Ann Calhoun, The Nature Conservancy in Wisconsin

Joanne Kline, Wetland Ecologist, Conservation Strategies Group

Nick Miller, Director of Conservation Science, The Nature Conservancy

Rob Montgomery, PE, Consulting Engineer

Sarah Peterson, Science Director, Wisconsin's Green Fire

Pam Porter, Policy Advisor, Wisconsin Department of Natural Resources

Heather Stricker, Climate Science Fellow and GIS Support, Wisconsin's Green Fire

Nancy Turyk, UW-Extension Emeritus, Wisconsin's Green Fire

Project Host Team

Tina Osterberg, Monroe County Administrator

Cedric Schnitzler, Monroe County Board Chair, County Supervisor, District 4

Ron Luethe, Monroe County Supervisor, District 9, Town Supervisor Town of Ridgeville

Jack Herricks, MC Farm Bureau President, Chair Town of Jefferson, dairy farmer

Bill Halfman, Agricultural Agent, UW-Madison Division of Extension

John Noble, Fisheries Biologist, US Army Fort McCoy

Mark Van Wormer, Public Works Director, City of Sparta

Project Advisors

Prof. Anna Haines, Director, Center for Land Use Education, UW-Stevens Point,

Dr. Steve Vavrus, Senior Scientist, Nelson Institute Center for Climatic Research, UW-Madison

See **Appendix II** for a listing of all CRREOA partners and team members.

Community Engagement

This project is intended to address the needs and concerns of residents of Monroe County. Concerted community engagement and input has been an important component of the CRREOA project. Throughout the project our team has had the opportunity to build and deepen relationships with local citizens, landowners, local elected officials, and Ho-Chunk Natural Resource managers who have helped inform our team's work and conclusions of this project.

Community engagement in 2021 included the following events:

- May 5th - Public project kick-off meeting in Sparta
- August 4th - Project public briefing and field tour in Cashton area
- September 29th – Project open house in Sparta
- October 21st – Public listening sessions in Wilton and Tomah
- November 18th – Briefing with Monroe County government leaders
- November 18th – Presentation to Wisconsin Towns Association, Monroe County Unit
- December 1st – Public listening sessions in Cashton and Sparta
- Ongoing – Monthly updates to the Monroe County Climate Change Task Force
- Communication through the Monroe County Climate Change Task Force Webpage

Understanding this Report

This assessment report is intended for community leaders, professionals, decision-makers, and anyone interested in a resilient climate future in Monroe County, or in similar places. Although readers can absorb the report and its subject areas (such as forests, agriculture, etc.) independently, reviewing the entire report will help with understanding the many interrelated aspects of climate risk and resiliency that this report addresses.

Effective climate actions require an understanding of the interrelated resources affected by climate change. It will also require coordinated action that brings together leaders and actors from all sectors. This report reflects that understanding, and the recommendations in this report address both public and private solutions.

While we strive to make the content here accessible to all readers, we cannot avoid all use of technical terms. Whenever possible we've defined technical terms and important climate concepts in context, or in glossaries accompanying the main text.

This report captures the following key elements from the CRREOA project:

- Climate terms and concepts necessary for understanding climate resilience
- A snapshot of key characteristics of Monroe County
- Recent climate trends and current climate projections through the year 2030
- Study of landforms, soils and geology, land uses, and their relationship to water movement and flooding
- Assessments of climate resilience and vulnerability and detailed findings from our technical teams
- Opportunities for improving climate resilience through investments in natural capital
- Watershed-based assessments for targeted investment in climate resiliency
- Specific strategies and recommendations for increasing climate resilience

Throughout this project, we have strived to maintain a focus on increasing climate resilience and managing climate risk through investments in "natural capital" such as farms, forests, and functioning watersheds that will bring multiple benefits for people and communities.

Putting Climate Resilience in Context

Climate science is a complex field and climate scientists will be the first to acknowledge that it is impossible to predict in detail all the ways climate-related and non-climate stressors will affect people, property, and natural resources. There is no question that Monroe County residents are already experiencing climate-driven stressors. All the information we have suggests these effects are likely to increase in magnitude in the future. In some cases, these changes could be profound, however our ability to precisely predict those changes is limited.

For example, while climate change may bring greater amounts of precipitation, the impact of that increased precipitation on flooding is also dependent on local topography, land use, and other non-climate variables. In turn, the responses to climate change can include activities that have the potential for simultaneous positive impacts not just on flood response, but also on the local economy, wildlife habitat, and more.

With those uncertainties and risks in mind, we used the most up-to-date and available scientific data, methods, and expert knowledge to anticipate climate impacts and recommend ways to reduce risks from climate impacts. The strategies and recommendations in this report are well documented in on-the-ground application and research and are intended to have co-benefits across sectors.

For more information on climate change and its expected impacts in the Midwest, see the Fourth National Climate Assessment's Chapter 21: Midwest.

For more information on interrelated climate impacts, see also the Fourth National Climate Assessment's chapter on Sector Interactions, Multiple Stressors, and Complex Systems.

2 BACKGROUND

Key Concepts and Terminology

Climate vulnerability is the tendency or susceptibility of an area or a resource to be negatively impacted by long-term stresses or short-term hazards related to a changing climate.

Climate stressors are directly related to changes in weather patterns and long-term climate change. Climate stressors include increased frequency and severity of such as large-scale wind events, precipitation events, heat events, or prolonged drought.

Baseline stressors (or, **non-climate stressors**) are conditions that are not specifically tied to climate or weather events but can increase a system's vulnerability/risk. Examples of baseline stressors include changes in land cover (e.g. when a natural area is cleared and paved with concrete), unnatural changes in water flow (e.g. straightening of a waterway that increases the velocity of water), or pollutants in the soil or streams. The combination of exposure to climate-related hazards and existing non-climate hazards ultimately determines future vulnerability or risk.

Assets may include built infrastructure such as buildings/ structures, roadways, and bridges, or may include natural resources and semi-natural systems such as agricultural systems, forests, waterways/ wetlands, and wildlife habitat. After assets have been identified, the next step is to look at **stressors** on those systems – in other words, conditions that make hazards more frequent or severe.

Exposure is generally considered the degree to which a system or landscape is harmed from weather and climate-related hazards. Part of assessing exposure is to identify the systems, places,

ECOSYSTEM SERVICES

Regulating and Supporting Services:

Functional processes provided by the ecosystem, such as oxygen production, flood control, water storage and filtration.

Provisioning Services

"Products" derived from ecosystems, such as lumber, nuts and fruits, wild fish and game.

Cultural Services

Non-material benefits used by local peoples such as recreation (hiking, hunting, etc), educational purposes, and health and wellness activities.

and services (also known as "resources" or "assets") that a community depends upon as well as the specific landscape features that may make those assets exposed to weather events.

Sensitivity determines the potential impacts of exposure on local assets. An asset is considered "sensitive" if it is likely to sustain damage from a hazard. If an asset is not likely to sustain damage, it is considered "not sensitive". For example, while a farm field likely would experience a negative outcome from an extreme flood (sensitive), a parking lot generally would withstand a flood and be minimally impacted (not sensitive).

Adaptive capacity considers an asset's ability to be resilient to or recover from exposure to a hazard. Adaptive capacity—the ability to adjust to new situations—reduces the potential impact of a sensitive asset. Adaptive capacity in a built environment such as a city might be the use of "permeable concrete" which allows the absorption of flood water; on farmland it may be the ability to switch to drought or flood-tolerant crops; in a forest, it may be the ability for certain tree species to withstand a fire or flood.

Resilience is related to adaptive capacity, and is the ability for an area, whether an urban area or a natural ecosystem, to "bounce back" from a disturbance. Resilience does not necessarily mean a return to pre-disturbance conditions; rather, it refers to a return to a more stable state after a disturbance, disaster, or change in conditions. Many experts in social and ecological systems agree that **resilience is about *thriving in the context of change.*[1]**

It is equally important for both social and ecological systems to obtain a level of resiliency in the face of climate change, as both protect human health and wellness. Fully functioning ecosystems provide ecosystem services that humans and wildlife depend on.

Ecosystem services are the various benefits humans derive from healthy ecosystems in the natural environment. These services include the natural pollination of crops, clean air, and extreme weather mitigation (such as flood water abatement and erosion control). Ecosystem service benefits can also include improved mental and physical health.

Biodiversity - the variety and variation of animals, plants and micro-organisms - is necessary to sustain key functions of the ecosystem and maintain ecosystem services. Biodiversity for food and agriculture can be managed to maintain or enhance ecosystem functions and contribute to the resilience of ecosystems for risk mitigation. See the Millennium Assessment synthesis on Ecosystems and Human Wellbeing for a detailed look at climate change and ecosystem services.

A **watershed** is an area of land that drains all the streams, snowmelt, and rainfall to a common outlet such as a lake, reservoir, or larger river channel. The watershed contains of surface water--lakes, streams, reservoirs, and wetlands--and all the underlying groundwater. This assessment is primarily organized around watersheds.

Monroe County Context and Setting

Monroe County, Wisconsin is located in the picturesque Driftless Area of southwestern Wisconsin, USA. The population in 2017 was an estimated 46,109 people. The cities of Tomah and Sparta, tribal land holdings of the Ho Chunk Nation, as well as the Fort McCoy military base are located within the county.

Farms, forests and stream valleys are interspersed throughout the County.

The county straddles two ecoregions, with southern and western portions comprised of steep ridges and valleys known as the **Western Coulee and Ridges (also known as the Driftless Area)**, and northeast portions characterized by sandy plains known as the **Central Sands**.

The Driftless Area portions of the county escaped the flattening effects of glaciation during the last ice age and are characterized by steep valleys (coulees), forested ridges, spring-fed waterways, and cold-water trout streams. The sandstone and fractured bedrock with rich loess soils on ridgetops and in valley bottoms make the county ideal for family farms with widespread row crop, dairy cattle rotations, and other agricultural uses.

The northeastern portion of the county descends into the glaciated terrain of Wisconsin's Central Sands region. This area generally has flatter terrain and more areas of wetlands and slow-moving streams (Figure 1).

The total area of the county is approximately 581,300 acres, or 908 square miles. Nearly 50% of the landscape is in forest, while another nearly 35% is in some form of agricultural production (crops, pasture, cranberries, etc.), making agriculture a very important economic resource in the county. See Table 1 for a summary of Monroe County Land Cover.

The Fort McCoy Military Reservation is located in parts of six townships and encompasses 60,000 acres. The Central Wisconsin Conservation Area, owned primarily by the U.S. Fish and Wildlife Service (USFWS) and managed cooperatively with the Wisconsin Department of Natural Resources (WDNR), is approximately 16,000 acres in size and located in the northeastern portion of the county, which is primarily forest, wet meadow, and forested wetland.

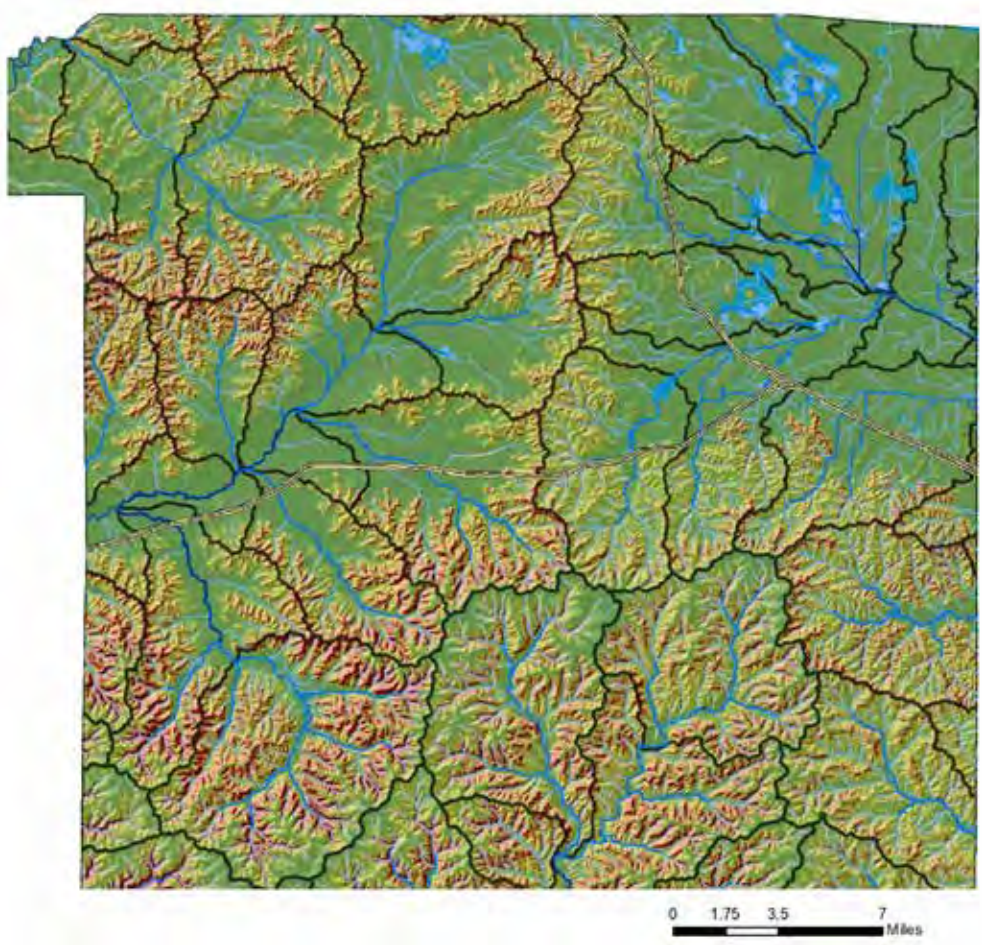


Figure 1. *Topography, waterways, and watersheds of Monroe County.*

Monroe County is part of a long history of conservation leadership. Prior to the 1930s, land use and agricultural practices in the Driftless Region caused extensive flooding and severe soil erosion. In 1933 under the fledgling U.S. Soil Conservation Service, the nation's first watershed project was launched at Coon Creek. The Coon Creek Watershed project engaged over 400 farms in developing soil conservation practices in Vernon, Monroe, and La Crosse Counties. The partnerships with area farmers led to widespread and widely adopted soil and water conservation practices throughout the Driftless Area.

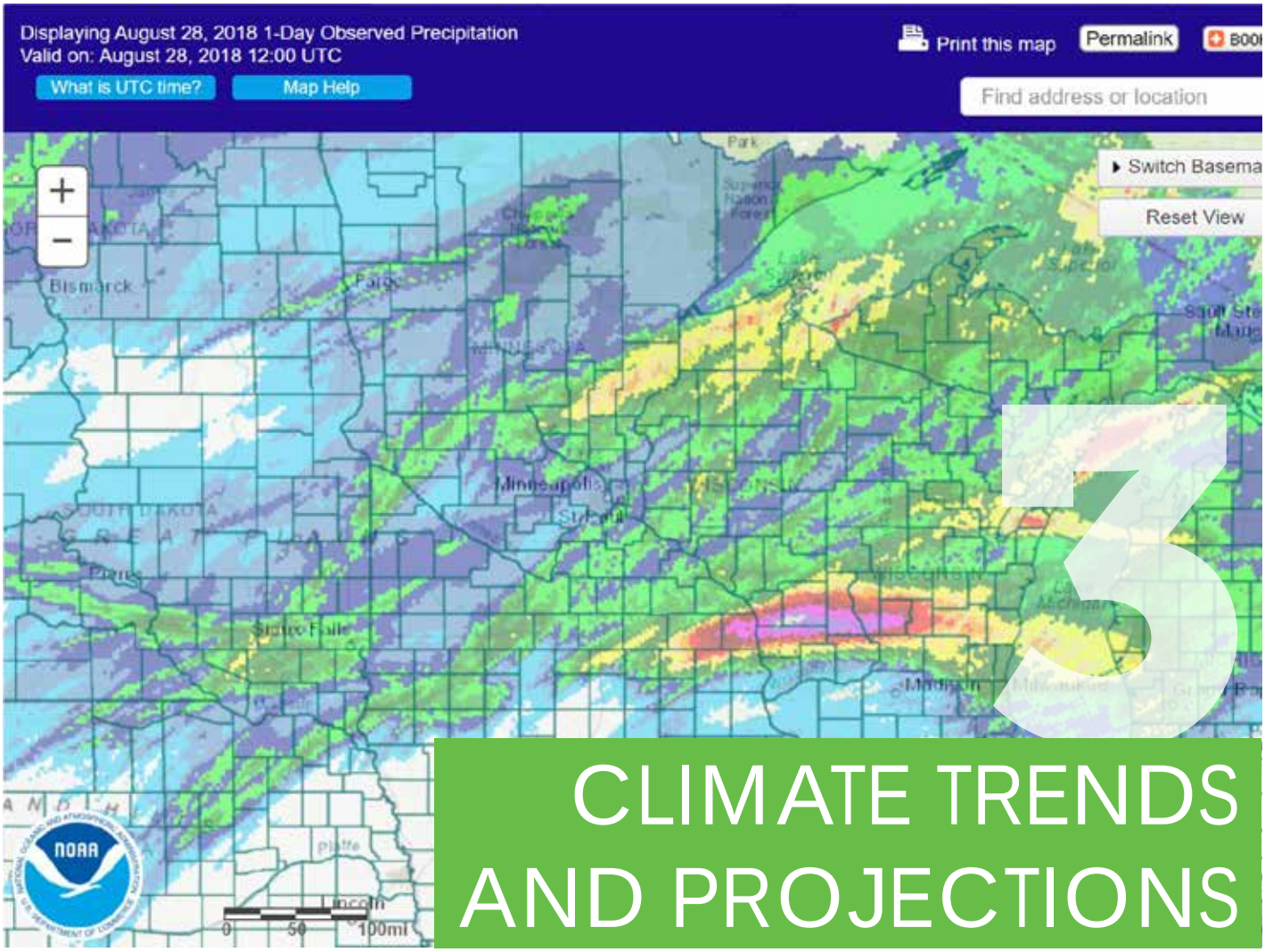
Coon Valley Historic Marker

With improvements in water quality due to improved agricultural practices, the WDNR began a concerted effort to improve in-stream habitat for trout in the 1960s. Efforts to improve fish habitat in the Coon Creek Watershed have been a great success, and trout fishing in the county's 200+ miles of Class I trout streams is an important contributor to tourism in the county.

Tourism in the form of hiking and biking is an important activity in the county as well, with the nation's first "rail-to-trail" biking/hiking trail stretching between Sparta and Elroy. Agritourism in the county's apple orchards occurs throughout the summer and fall. There are several conservation and recreation areas in the county, including Mill Bluff State Park, Eureka Maple Woods State Natural Area, and the Big Creek State Fishery Area.

Land Cover/Use	Acreage	Percent of Landscape
Broad-leaved Deciduous Forest	227,150	39.1%
Crop Rotation	113,516	19.5%
Forage Grasses	76,710	13.2%
Conifer Forest	50,272	8.7%
Forested Wetland	27,830	4.8%
Idle Grass	22,151	3.8%
Low Intensity Urban/Developed	21,044	3.6%
Emergent/Wet Meadow	17,873	3.1%
Cranberries	6,794	1.2%
Open Water	4,318	0.7%
High Intensity Urban/Developed	4,003	0.7%
Barren	3,448	0.6%
Mixed Deciduous/Coniferous Forest	2,584	0.4%
Scrub/ Shrub Wetland	2,255	0.4%
Aquatic Bed (Floating Herbaceous)	904	0.2%
Shrubland	95	0.02%

Table 1. *Proportion of Monroe County landscape by cover type using Wiscland 2 data (WDNR 2016).*



3 CLIMATE TRENDS AND PROJECTIONS

Overview

The damage produced by the storm of August 2018, as well as other large storms between 2007-2019, made understanding the changing climate of Monroe County a priority for the Climate Readiness and Rural Economic Opportunity Assessment Project. Our analysis focused on climate conditions that will affect agriculture, forestry, water resources, and biodiversity in Monroe County. This work included collecting historic as well as future climate model data, review, and analysis, and summarizing county-specific climate data. Results are summarized in this section.

A wide range of data and analyses were evaluated in this work, starting with data, reports, and researcher input from the UW-Madison Nelson Institute Center for Climatic Research and analyses available through the Wisconsin Initiative on Climate Change Impacts (WICCI). Additional data sources included the National Oceanographic and Atmospheric Administration (NOAA), National Weather Service and the Advanced Hydrologic Prediction, the Wisconsin and Minnesota state climatology offices, rainfall analyses conducted by Daniel Wright and others at the University of Wisconsin-Madison Department of Civil and Environmental Engineering, and climate analyses prepared by the University of Maryland and other research groups [see full reference list in Appendix I]. Additional data are included in Appendix III.

For projecting future climate effects, we selected a 30-year planning horizon.

Projections of future climate conditions based on modeling vary depending on the model used, the target timeframe for the projection, and important assumptions about the magnitude of future greenhouse gas emissions to the atmosphere

(referred to as emissions scenarios). Despite these differences, most climate model outputs have relatively small differences in projected temperature and precipitation up to around year 2050, even when using different emissions scenarios. However, the difference in model projections becomes much greater in the timeframe between 2050 and 2100.

Because the 30-year outputs of climate model projections are relatively consistent, and because the findings and recommendations in our assessment are based on a similar time horizon, **we focused our projections of future climate conditions on the year 2050**.

Methods

Our team used historical data and models of future temperature for anticipating changes in annual as well as seasonal characteristics, duration of the growing season, and extreme high and low temperatures. Historical data and model projections for precipitation were analyzed for the trend in annual, seasonal, and large storm rainfall depths. In our assessment we selected 1950 as a baseline date for which historic trends were calculated.

Extreme storm rainfall depths were estimated using statistical analysis of a series of annual maximum rainfall depth data. Until recently, the best available source for extreme storm precipitation data was prepared by the NOAA National Weather Service and referred to as Atlas 14. The source data used in this analysis were individual rainfall stations with the data records that typically began in the early 1900s up to 2010.

Data on the many extreme storms that have been experienced since 2010 throughout the Midwest are not included in the Atlas 14 analysis. Professor Daniel Wright at UW-Madison has developed a methodology using storm radar data that includes the most recent heavy storms to develop extreme storm rainfall statistics. This approach has been developed and tested, and recently issued for public use as part of the Wisconsin Rainfall Project.

The resulting new extreme storm rainfall depths, such as the 100-year, 24-hour storm, are typically slightly larger than the rainfall depths predicted using the generally accepted Atlas 14 model. Because the Wisconsin Rainfall Project data uses the most recent data, we selected it for use in this project for description of extreme storm events under current conditions.

The Wisconsin Rainfall Project has also created projections for future extreme rainfall statistics by using downscaled global climate model output to create daily maximum storm depths which are then evaluated using extreme value statistics. We used these future extreme storm projections in our evaluation of future rainfall.

The statistical descriptions of extreme storms described above were compared with the rainfall depth and distributions of the August 2018 storm that created extensive damage in the southern portions of Monroe County. The August 2018 storm was evaluated using radar rainfall depth tracking data obtained from the National Oceanic and Atmospheric Administration (NOAA).

The 100-year Flood

The "100-year storm" or "100-year flood" is a shorthand way of describing an event that has a 1% (1/100) chance of occurring in any particular year. The 100-year event is often used to describe a large and rare occurrence. A 10-year storm is more common and has a 10% (1/10) chance of occurring in any particular year.

Just like any event driven by probability, the occurrence of a 100-year flood in any year does not reduce the probability that such an event will occur again. There is no reason why two 100-year storms could not occur in two consecutive years, or even in the same year.

As severe storms become more frequent, it's important to understand that storm event probabilities are based on available data records, with **the underlying assumption that conditions are not changing over time**. But with relatively rapid advent of climate driven events, the climate statistics that inform calculations of flood probability need to be very carefully evaluated and updated.

Changing Temperature

One of the clearest signs of climate change is the increase in temperature being experienced worldwide. Since 1880, average global temperatures have increased by about 1.8°F. This global warming trend has also been apparent in Monroe County. Some of the earliest temperature and precipitation data in Wisconsin was reported in the 1882 Wisconsin Geological Survey Atlas, and detailed data have been collected in and near Monroe County since the 1890s. Climate model projections available from the Wisconsin Initiative for Climate Change Impacts (WICCI), the WICCI Report to the Wisconsin Governor's Task Force on Climate Change, and other sources were used to understand continued warming for Monroe County. For more detail on our climate assessment and available data, see Appendix III.

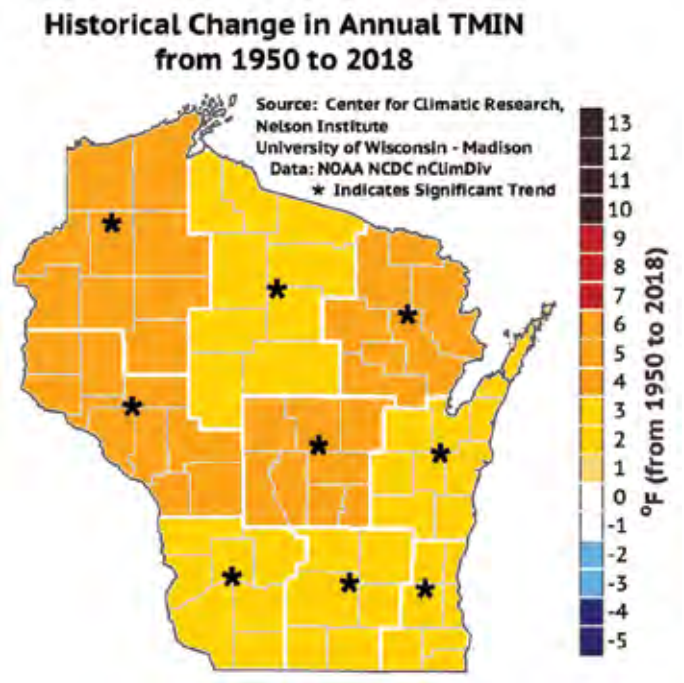


Figure 2. *Historical change in annual minimum temperature (TMIN) in Wisconsin 1950-2018.*

Findings

Historic Temperature Trends

- Annual average temperatures and minimum temperatures (TMIN; Figure 2) have increased by approximately 2.5°F since 1950. The largest monthly temperature increases, approximately 4°F, have been in the winter months of December, January, and February.
- Due to warmer conditions, the growing season is more than two weeks longer than it was at the beginning of the 20th Century.

Future Temperature Projections

- Temperatures in 2050 will continue the warming trend seen in recent decades, but at an accelerated pace. Average annual temperatures are projected to increase above current conditions by approximately 4°F. Average winter and fall temperatures will likely increase by approximately 5°F.
- The number of days with summer low temperatures over 70 F will increase from approximately 5 days currently to 15 in 2050.
- No recent summer or autumn in Monroe County has been as warm as the future predicted temperature averages.
- By 2050, the typical number of heat wave days in Wisconsin is projected to increase from around 10 to nearly 60 days per year.
- The overall increase in winter temperatures will be most notable as a reduction in the number of very cold nights.

Selection of Timeframe for Historic Climate Summary

The maps and historical climate change summaries prepared by the UW Center for Climatic Research use the time period 1950 through 2018. Because the decade beginning in 1950 featured some relatively cold years, the resulting calculation of percentage temperature changes over that period is slightly greater than if we had selected a year 1940 or 1900 baseline. The difference between baseline periods is not substantial enough to alter our findings or recommendations – significant warming trends exist for any period since 1900 that can be measured with available weather data.

Changing Precipitation

Wisconsin has been getting wetter for decades. Since 1950, Wisconsin has experienced significantly increased annual precipitation in most areas, including Monroe County (Figure 3). As in most of the Upper Midwest, precipitation increases are believed to be driven in part by increasing temperatures that result in storm systems with greater potential energy and greater likelihood of causing extreme precipitation events.

Projections for future precipitation in 2050 show a continuation of the upward trends. Extreme storms with very heavy rainfall amounts, such as the August 2018 storm that struck Monroe County, have become increasingly common across the state in recent decades, a trend that is also expected to continue (see detailed analysis in Appendix III).

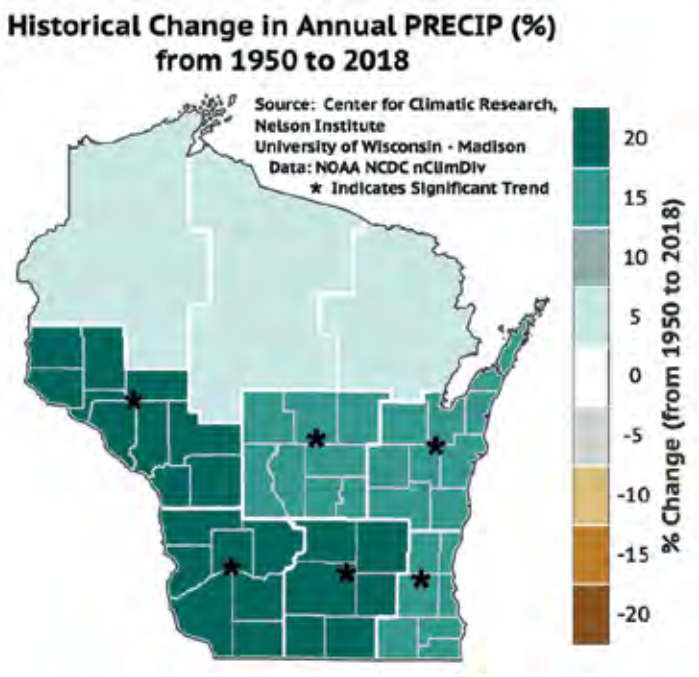


Figure 3. *Historical change in annual precipitation in Wisconsin 1950-2018.*

Precipitation Analysis for Monroe County

Historic Trends

- Annual precipitation in Monroe County is up approximately 20% (more than 7") from 1950. This increase has occurred mainly in fall, winter, and spring. Summer precipitation has increased approximately 10%.
- The August 28, 2018 storm rainfall depth of approximately 11.8 inches was between a 500-year and 1000-year storm using the latest Wisconsin Rainfall Project statistics. An August 8, 2021, storm which also caused significant damage in southwestern Monroe County had a total rainfall depth of between 4 and 5 inches, which if over 24 hours would fall between a 10-year and 25-year storm.
- As destructive as it was, the August 2018 storm was not as severe as several very large storms that have occurred elsewhere in Wisconsin in recent decades (see Appendix III).
- Both the 2018 and 2021 storms that struck Monroe County tracked east-west along the south line of the County. Analysis of severe storms and their tracks throughout Wisconsin suggests that extreme storms such as these, though rare, could occur anywhere in the county.

Future Projections

- Annual precipitation in 2050 will further increase above current amounts by about 5%, with a 10% increase projected for the winter. Current climate models do not provide a clear indication of changed summer precipitation.
- The 24-hour 100-year rainfall depth is projected to increase approximately 10%, with a similar increase in the maximum rainfall intensity.
- Extraordinarily large storms like August 2018, although still rare, will be more likely in the future.
- Peak rainfall intensities for future conditions of extremely large storms are expected to be similar to or slightly more intense than the record rainfall rates recently observed.
- More winter precipitation will occur as rain rather than as snow.

Climate Analogues

Depending on the climate scenario selected, locations in Iowa or Kansas currently have climates similar to what is projected for Monroe County in 2050.

We used the University of Maryland interactive future climate tool[2] (and see Appendix III) to identify areas where the current climate is similar to what is projected for Monroe County in 2050. The tool uses 12 different climate measures, including minimum and maximum temperature and total precipitation for each season, integrated with two greenhouse gas emission scenarios and 27 climate model outputs.

One scenario assumes high current emissions to continue (RCP 8.5), and one assumes emissions peak mid-century and then decline (RCP 4.5; Figure 4). These projections are not perfect analogues and will be subject to some variance and potential error.

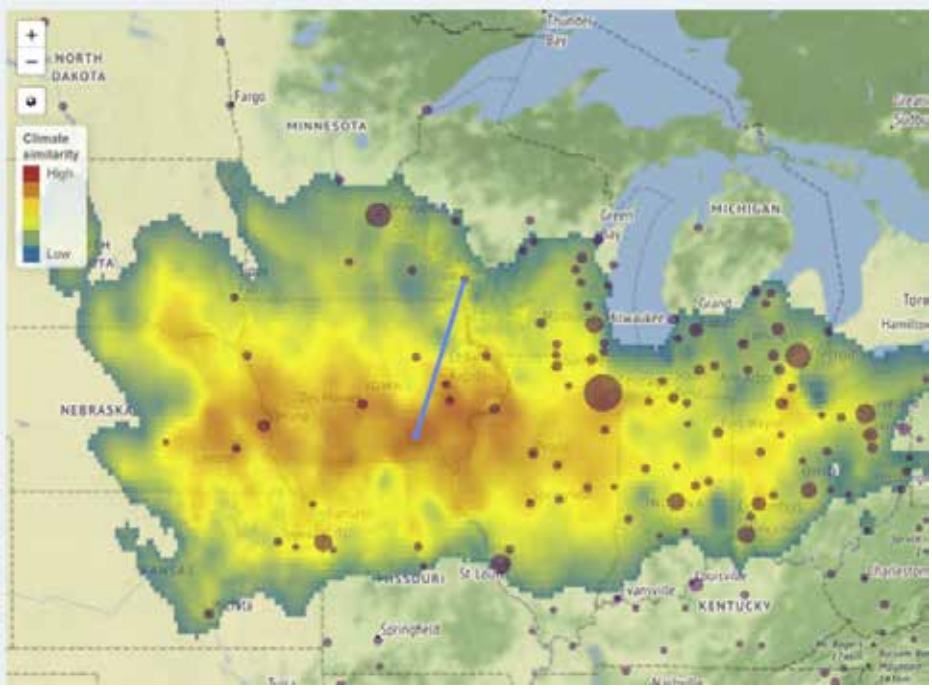


Figure 4. *Climate analogue map for emission scenario RCP 4.5.*

Findings

- The low emissions scenario analysis indicates that the climate in Monroe County in 2080 will be similar to currently exists in Ottumwa, Iowa, located 220 miles southwest of Sparta.
- For the high emissions scenario, the current analogue climate is in Lansing, Kansas, 390 miles southwest of Sparta.
- Although these analogue communities are comparable in terms of general climate trends, the comparison may not fully reflect the impact of increasingly frequent severe weather events.
- Temperatures are higher in the identified analogous locations, and precipitation is generally similar but may have less rainfall in summer. For additional detail see Appendix III.
- The climate characteristics of the analogue areas could be particularly valuable in evaluating conditions important to agriculture. For example, the **growing season** in Ottumwa, Iowa is more than a month longer than it is in Monroe County.

4 UNDERSTANDING RAINFALL, RUNOFF, AND FLOODING

Severe flooding is now a regular fact of life for Monroe County residents that puts public and private property as well as lives and livelihoods at risk.

As in much of the Upper Midwest, severe precipitation events and associated flash flooding have been the most profound and consistent impacts resulting from a changing climate. In southern Monroe County, flash flood events have repeated along similar storm tracks since at least 2007, including events with rainfall intensities of 2-6" per hour. **Given the extensive damage to property and the disruption to people and communities resulting from flooding, an assessment and modeling to understand the factors that affect flood events has been a particular focus of the CRREOA project.**

The hydrologic response (direction, speed, and volume of water runoff) in a watershed is dependent on soils and geology, land cover, and climate. The Driftless Area, which includes most of Monroe County, is well known for its vulnerability to floods due to the steep topography. Severe flooding occurred in response to the major storm of August 2018 in the Driftless Area in southwestern Monroe County. Watersheds in the northeastern portion of the county descend into the glaciated terrain of the central sand plains which has much less topographic relief and features slower-moving streams and wetlands with potential to convey and store excess water.

Runoff Modeling Methods

Understanding how different land uses affect water on the landscape during severe storms is critical to informing effective strategies that increase watershed resiliency.

The objectives of the hydrologic analysis were 1) to identify source areas of runoff across several representative watersheds under current land use and climate conditions, and 2) to identify the sensitivity of watershed runoff response to possible future conditions.

Monroe County Watersheds

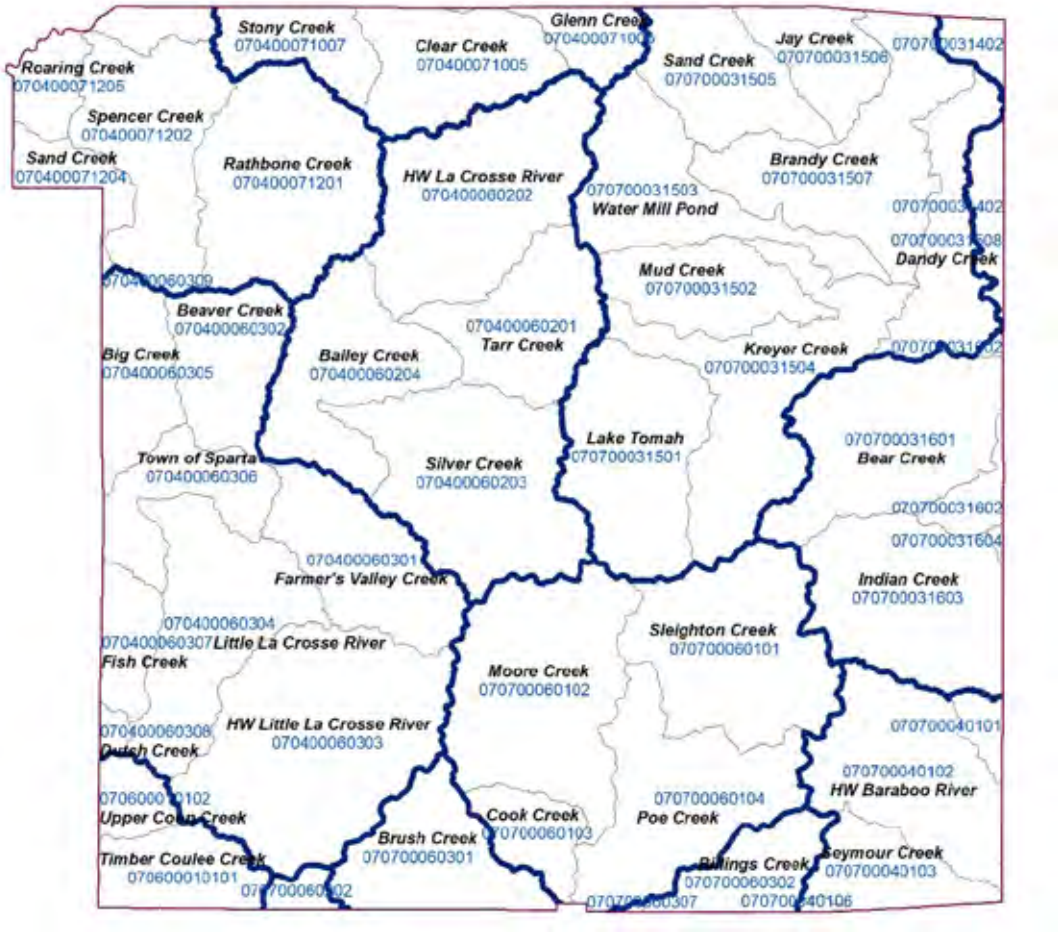


Figure 5. *Map of Monroe County HUC-10 (dark blue) and HUC-12 (gray) watersheds.*

Our analyses considered 29 watersheds (Figure 5) classified by the United States Geological Survey throughout the county, ranging in size from 10,000 to 40,000 acres. We selected five of these watersheds for initial evaluation in this project. Four are in the Driftless Area, draining into rivers that exit Monroe County to the north, west and south. The fifth watershed is in the eastern portion of the county, draining ultimately to the Wisconsin River.

We used a Geographic Information System (GIS) analysis to determine the areas of the watershed producing the greatest runoff during storm events of various sizes. Previous research has shown that runoff amounts (also called "runoff depths") vary according to the land uses on the soil (for example, impervious surfaces such as concrete, row crops, and forests would have different impacts on runoff amounts). Our analysis used the USDA Natural Resource Conservation Service "Curve Number" methodology for assessing storm events and runoff depths.For each of the five watersheds we selected for study, a baseline analysis was conducted to evaluate runoff generation under current land use/ land cover conditions from the 100-year rainfall depth defined by the Wisconsin Rainfall Project. Results are described in numerical tabulations and maps showing the areas generating runoff across the watershed, as shown in Appendix IV.

For Timber Creek, the southwestern-most watershed considered in the analyses, an additional runoff generation sensitivity analysis was conducted for existing and future 2-year, 10-year, and approximately 200-year storms, while also converting all current agricultural land cover from current conditions to pasture and to all row crop. A final sensitivity analysis considered the hydrologic effects of increasing the forest cover by approximately 10%. The purpose of the analysis was to test the sensitivity

of rain events to generate runoff in response to substantial land use changes.

It is important to note that we were not able to incorporate current within-field conservation practices such as no-till and cover crops employed by farms that are practicing conservation agriculture due to a lack of data and NRCS landowner privacy policies.

We modeled the following three scenarios:

- Shifting all agricultural lands from current conditions to 100% permanent cover.
- Shifting all agricultural lands to 100% annual cropping, assuming no use of conservation practices.
- Increasing forest cover on highly erodible and sensitive lands by approximately 10%.

Our selections were not recommended scenarios. They were selected to illustrate how runoff would change as a result of changing land use.

Runoff Modeling Results

For each of the five watersheds we studied, a baseline analysis was conducted to evaluate runoff generation under current conditions from the approximately 200-year rainfall depth defined by the Wisconsin Rainfall Project (Appendix III). This large storm was selected to be representative of the extreme storms that have affected the county, most recently in 2018. Results are described in numerical tabulations and maps showing runoff generation across the watershed (see Appendix III).

The most significant results of this analysis indicate that conservation practices and changes in land use have the potential to more than offset the expected increase in runoff produced by future larger storms. This potential is strongest for the more frequent 2-year and 10-year storms. These are the storms that collectively have the most important impacts to water quality.

Although the changes in rainfall depth that will occur in the future will create more runoff, changes in future land cover can have a significant impact in reducing flooding, erosion, and runoff during severe rain events.

Findings

Model Results

- In rural watersheds, most of the runoff for both current and future conditions is generated from agricultural lands in annual cropping. Wooded areas produced much less runoff, indicating the importance of woodland areas in promoting interception and infiltration while reducing runoff. (See Figure 6 for graphic representation of model results.)
- The runoff effects of future land use change were larger than those of increased future rainfall, especially for storms that occur relatively frequently such as the 2-year storm and were somewhat less significant for the larger 100-year storms.
- Changing all agricultural land use to row cropping without conservation practices increased runoff volume from existing conditions approximately 25%.
- Changing existing agricultural land cover to all permanent cover (e.g. meadow) reduced runoff by more than 20%.
- Increasing the woodland area by approximately 20% reduced runoff volume by approximately 13% for the 2-year storm and somewhat less than 10% for the 100-year storm.

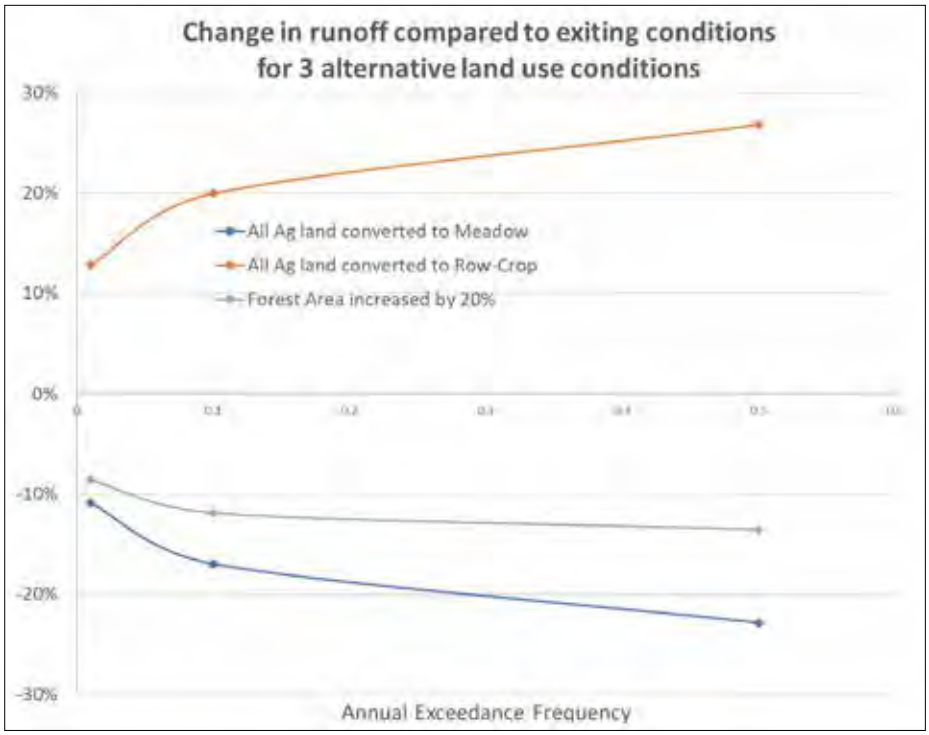


Figure 6: *Timber Coulee Creek Flood Modeling Results*

These results indicate that adopting agricultural practices that maximize perennial cover such as pasture or include seasonal cover crops will have beneficial effects in reducing small storm runoff, which has soil conservation and stream water quality benefits. The substantial reductions in runoff from forested areas suggests that restoring woodlands in select areas would also reduce runoff depth.

Findings

Key Conclusions

- **Changes in land use that may occur by the year 2050 could have more impact on watershed hydrologic response than changes in storm rainfall.**
- **The potential benefits on watershed hydrologic response from changes in land use could help substantially offset the impact of increased storm rainfall as a result of projected climate impacts.** The watershed hydrology study led by Professor Eric Booth at UW-Madison highlighted this finding and our study reinforced that conclusion.
- **The August 2018 storm was extraordinarily large - approximately a 1,000-year storm by National Weather Service definitions.** Storms of this size are anticipated to be more likely in 2050 than at present. The 2018 storm produced flooding similar in magnitude to the types of future storm conditions projected to occur in 2050.
- The runoff produced from an extreme storm such as the August 2018 storm is so large that significant flooding will occur regardless of changes in watershed land use, or other non-structural measures. **This suggests that although land use strategies are an important part of a resilience solution, land use cannot be the only strategy.**
- **Runoff generation is significantly influenced by the pre-storm soil moisture and water-holding capacity.** In recent years, calculated soil moisture levels have been high due to heavy precipitation, however drought conditions could become more frequent in the future given the substantial increases in temperature and evapotranspiration likely to occur by 2050. Quantifying this possibility will be a complex effort.

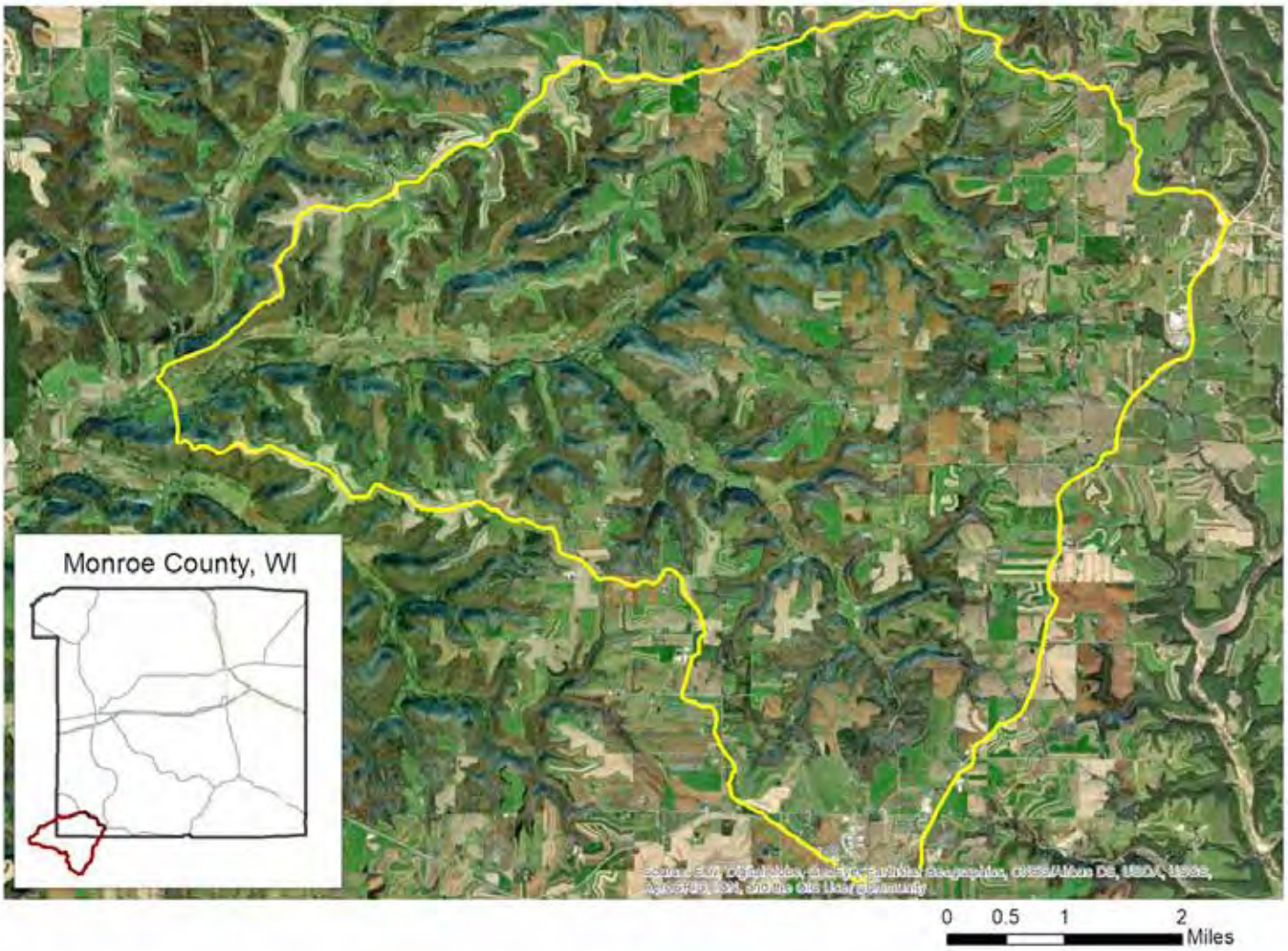


Figure 7. *Timber Coulee Creek Watershed*

For complete results from flood modeling see **Appendix IV.**

Managing for Resilient Watershed Conditions

Multiple strategies will be needed to manage and improve future conditions in watersheds in order to reduce runoff generation, which will have the added benefit of improving stream water quality. Extensive strategies around land use and infrastructure management are discussed in Sections 6 and we provide detailed recommendations in Section 7.

A risk reduction plan for runoff from large storms should address managing land use and managing development activities in the floodplain. It should include designing road crossings to be robust with respect to extreme runoff events. Subsequent work beyond the scope of this study would be to identify areas of high vulnerability to extreme flooding that were not impacted by recent storms and could be affected by future storms, using hydrologic analysis including storm transposition.

5 CLIMATE VULNERABILITY ASSESSMENTS

Climate change affects both the infrastructure that safeguards human communities, as well as the natural systems such as farms, forests, and watersheds that people rely on. A goal of the CRREOA project is to assess the vulnerability of critical resources in Monroe County and recommend adaptation actions to improve resilience over a range of future conditions.

Our climate vulnerability assessments consider the current conditions and vulnerabilities of Monroe County's built and natural assets, as well as how well the landscape may be able to respond to future climate conditions. We also consider the role of natural systems in supporting communities that are climate resilient, economically prosperous, and that enjoy the benefits of clean water and healthy soil.

The findings presented throughout this section are tied to detailed recommendations presented in Section 7.

Concepts and Methods

From May through November 2021, our technical teams independently conducted rapid climate vulnerability assessments on specific resources within the county. Our results are drawn from the review and analysis of data collected from available sources, and the consensus of our teams which included both statewide subject matter experts and Monroe County professionals and residents with extensive local knowledge. This work has formed the foundation of the CRREOA project.

Vulnerability Assessments evaluate how climate change is likely to affect local areas and communities and the critical resources or "assets" within the county. Vulnerability assessments are the foundation for identifying strategies to increase climate resiliency.

Assessments of each resource sector (Infrastructure, Agriculture, Forests, Waterways and Wetlands, and Biodiversity) are discussed in detail in this section, describing the resource and the specific vulnerabilities, sensitivities and risks related to each particular asset.

The final component of our vulnerability assessment is a data-driven assessment of watershed vulnerability that we applied throughout the county.

For details on methods used in our rapid vulnerability assessments see Appendix V.

Farm structures such as this stream crossing are some of the most frequently damaged assets during storm events.

Floodplain Infrastructure Vulnerability

Monroe County residents have seen first-hand how large storms and changes in land cover have affected private property, public infrastructure, and watershed health. Homes are damaged by floodwaters, public roads become impassable and are costly to repair, and culvert damage and failure can hamper fish and wildlife movement to the habitats they depend upon. As the climate continues to change, with increased rainfall, warming temperatures, and more frequent extreme events, the stress on the landscape increases. The Floodplain and Infrastructure Sub-Team assessed how these stress factors, combined with climate impacts, contribute to the vulnerability of the built environment, and ways that the community can minimize its vulnerability.

Flooding is common across southern Wisconsin, including Monroe County, causing risks to people and damage to land and property. Since 1953 more than half of the state's declared disasters have involved flooding, many of which have occurred in the southern part of the state (Figure 8). While damage from extreme storm events like those experienced between 2007-2019 can't be completely prevented, the extent of damage and risk to people can be reduced while also improving fish and wildlife habitat and supporting the ecosystem services provided by healthy watersheds.

Floodplains and Floodplain Zoning

A floodplain is any land area susceptible to being inundated by floodwaters from any source. Much of this area has regulated statewide floodplain zoning to protect people and property. These laws prevent or limit building and development in certain flood zones. **Current floodplain maps for Monroe County were developed before 2010 and consequently have lower accuracy than what is possible with today's technology and updated weather event data.** Even non-riparian areas can flood when drains are clogged or during intense storms when road-side drainage and storm-water management facilities are overwhelmed. **No land can completely avoid flooding; it's only the risk of flooding that varies.**

Floodplain zoning saves tax dollars. Every flood disaster affects a community's local budget. Federal disaster assistance is not available for all

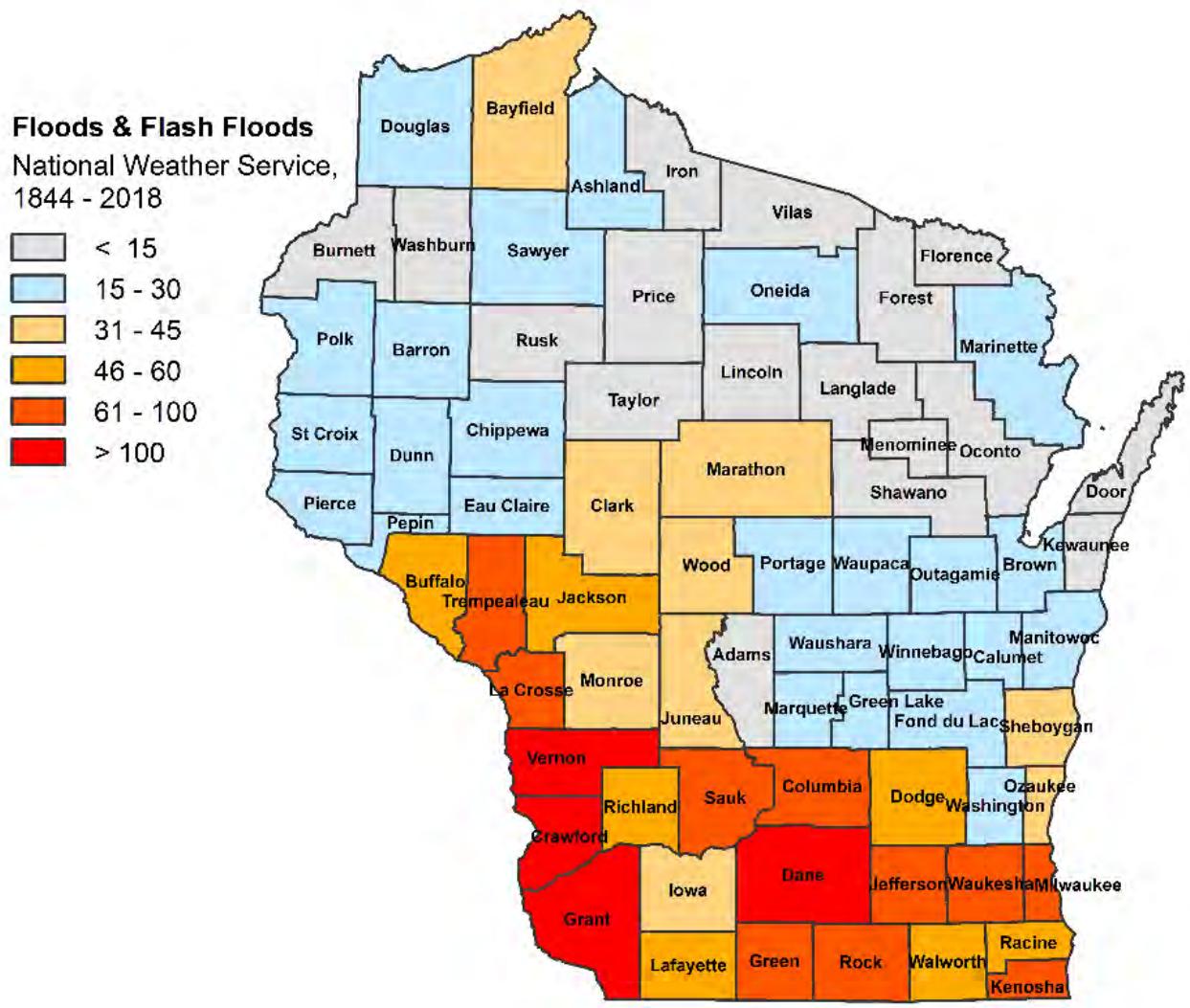


Figure 8. *Frequency of flood and flash flood events in Wisconsin.*

floods. Even after a federally declared disaster, communities still must pay a portion of repair and clean-up costs, temporary housing assistance, and evacuation expenses.

Communities that participate in the National Flood Insurance Program (NFIP) must comply with minimum standards in mapped floodplains. Wisconsin floodplain ordinances have somewhat higher standards for further protection, which result in lower cost flood insurance for Wisconsin landowners. The Federal and State requirements apply in those areas that have been mapped by the Federal Emergency Management Agency (FEMA) as being in a flood hazard zone. The various hazard zones, shown on Flood Insurance Rate Maps, indicate the degree of flood risk and the type of analysis that supports it. Floodplain terms and the hazard zones are explained in the sidebar on page 23.

Flooding can occur anywhere, not just within mapped floodplains of the 1% storm where floodplain zoning applies. All waterways have floodplains, but many are not mapped. Large storms and intense rainfall can cause flooding well beyond the 1% floodplain, particularly under future climate conditions that are anticipated to bring greater rainfall amounts.

FEMA Regulatory Floodplain Definitions

Base flood is the flood that has a 1% chance of equaling or exceeding that level in any given year. The base flood is commonly referred to as the 100-year flood.

Base flood elevation Is the elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year. Land lower than the base flood elevation is in the 100-year floodplain.

Floodway is the channel of the river or stream and the adjacent land associated with moving water in a 100-year flood. It's the area that must remain free from obstruction so that the 100-year flood can be conveyed downstream.

Flood Fringe is the remaining portion of the 100-year floodplain. FEMA and state regulations permit communities to allow the flood fringe to be obstructed and developed if standards (i.e., elevating and floodproofing structures) are met.

High Risk Areas (Special Flood Hazard Areas) represent the area subject to inundation by 1-percent-annual chance flood. Structures located within the SFHA have a 26% chance of flooding during the life of a standard 30-year mortgage. Federal floodplain management regulations and mandatory flood insurance purchase requirements apply in these zones.

- Zone A - Areas subject to inundation by the 1-percent-annual-chance flood event. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown.
- Zone AE - Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. BFEs are shown within these zones.

Moderate Risk Areas
Moderate risk areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by a levee. No BFEs or base flood depths are shown within these zones.

Minimal Risk Areas
Minimal risk areas outside the 1-percent and 0.2-percent-annual-chance floodplains. No BFEs or base flood depths are shown within these zones.

Flood Factor, a nationwide web-based flood risk assessment tool developed by First Street Foundation, provides one way to assess flood risk beyond the hazard zones identified on FEMA maps by incorporating geospatial data of past floods, current risks, and future projections. Flood Factor uses a national digital terrain model, hydrologic analysis of both riverine and upland area stormwater flooding, and future climate conditions under RCP 4.5 to identify areas subject to flood risk that extend beyond areas currently mapped by FEMA. Flood Factor is independent of FEMA floodplain mapping and it is not suitable as a stand-alone tool without field checking, however it may be a useful complement to other information sources in future land use planning and project reviews.

Flood Factor estimates that there are 6,895 properties in Monroe County that have greater than a 26% chance of being severely affected by flooding over the next 30 years. This represents 18% of all properties in the county. Overall, Flood Factor analysis considers Monroe County to have a **major risk** of flooding over the next 30 years, which means flooding is likely to impact day to day life within the community. Flood Factor data are publicly available by zip code. Data at the property level are available for a fee.

Example Floodplain Zoning Map

Village of LaFarge, Kickapoo River at STH 82, Vernon County, 8 July 2008

Structures in the Floodplain

Many existing structures in Monroe County are in flood-risk zones. Based on preliminary building footprint data, and current FEMA maps, over 200 structures occur in a floodway, over 500 in a flood fringe zone, and over 600 in an unstudied floodplain.

As mentioned above, however, FEMA floodplain likely underestimate the spatial extent and degree of flood risk, meaning that our estimate above is likely conservative. FEMA maps that assign flood risk do not include all streams with flood potential. The current FEMA maps are based on relatively coarse topographic data and rainfall statistics that don't reflect current climate conditions and, consequently, need an update.

Furthermore, flooding can occur outside the floodplain of the 1% flood event. Consequently, the number of structures identified with current methods underestimates the number at risk. Updated FEMA maps will help improve flood risk assessment, however improved maps won't be available until 2027 and won't take into account current rainfall statistics or anticipated future conditions.

Flood risk data available to the county includes much more than FEMA maps. They include document files, parcel, landowner, and structure information. Connecting this information to FEMA maps in a geospatial database would help assess

the level of flood risk, set assess the level of flood risk, set priorities to reduce risk, work with landowners to flood-proof structures or remove them from high-risk zones, and increase floodplain protection. Consolidating these records in a spatial database would help the County review proposed projects and zoning compliance, respond when flood damage does occur, and be available for current or prospective landowners.

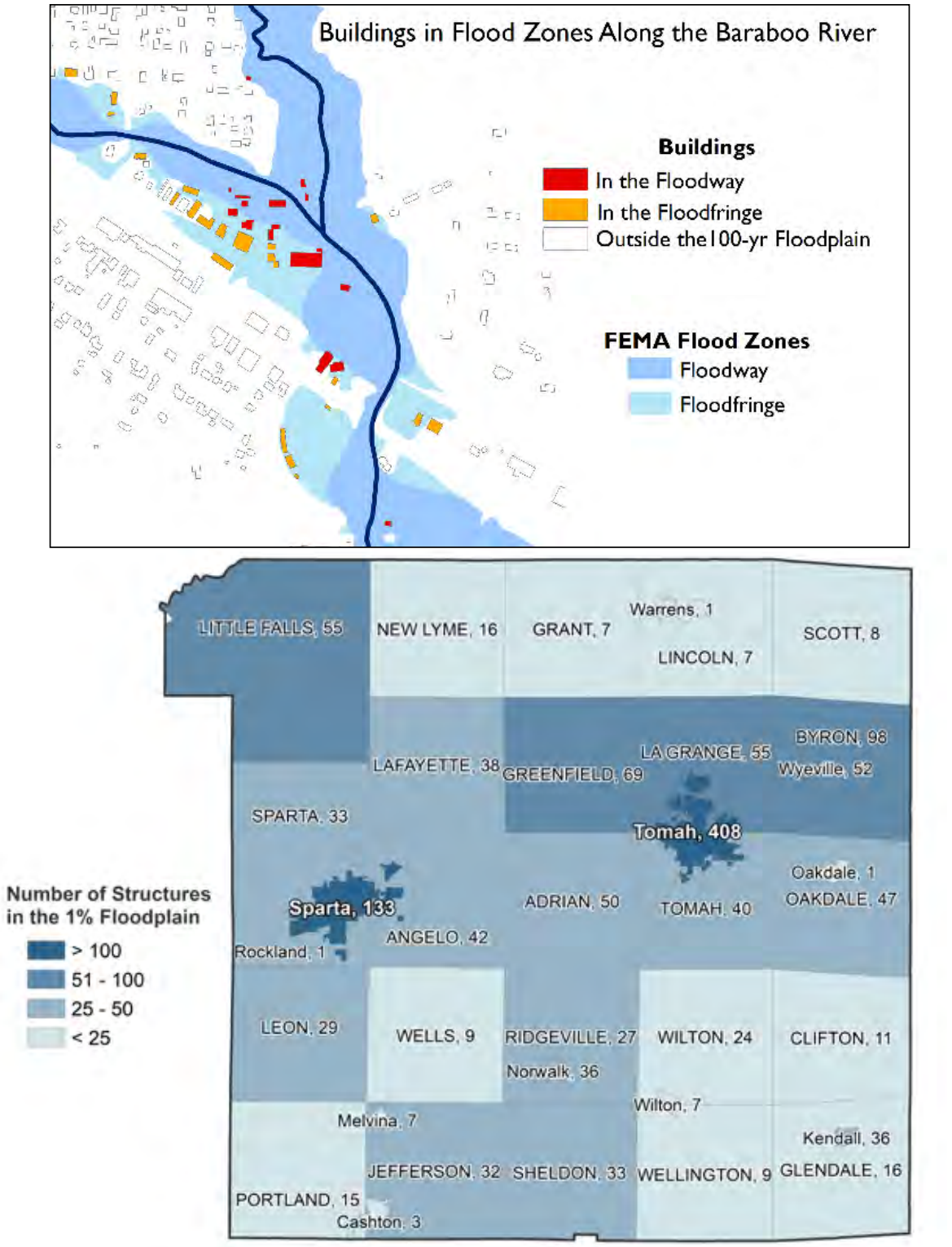


Figure 9. *Number of structures larger than 600 sq.ft. that lie within the 1% or 100-year floodplain in each township/ municipality (bottom). The top map is an example of structures in mapped flood hazard zones along the Baraboo River.*

Dams

Dams in the county provide flood storage and serve other purposes that benefit business, agriculture, and recreation. WDNR, collaboratively with county officials, is responsible for regulating dams. WDNR maintains a dam database with information on each of the 143 approved dams in the County, such as its size, hazard rating, and inspection reports. Dam requirements and inspection schedules vary by the size class of the dam and the degree of potential hazard to life or property should it fail. For more information see the sidebar on the following page, "Understanding Dam Size and Dam Hazard Ratings".

The inspection schedule for large dams varies from 2 to 10 years based on the dam's hazard rating. High-hazard dams must be inspected every 2 years. Significant hazard dams must be inspected every 3 to 4 years, and low hazard dams must be inspected once every 10 years. WDNR receives and completes inspection reports for large dams, and generally assigns a Sufficiency Rating based on the report. The Sufficiency Rating does not carry any regulatory significance and, even if "Unsatisfactory", does not trigger any follow-up maintenance or repair. Small dams do not have inspection schedule requirements. Dam owners have responsibility for dam inspection and maintenance, and WDNR receives no inspection reports.

Monroe County has 29 large, low hazard dams. Of these, five are under federal jurisdiction, fourteen are for cranberry operations in the northeast, and the remaining are owned by a municipality, the Land Conservation District, or a private landowner. The county has operation and maintenance responsibility on eight PL566 dams that are authorized and supported by the NRCS. These include seven dams in the Coon Creek watershed, three of which breached in the 2018 storm, and one in the Kickapoo River Watershed upstream from the village of Norwalk on Moore Creek. Figure 10 shows the dams listed in the database in 2021.

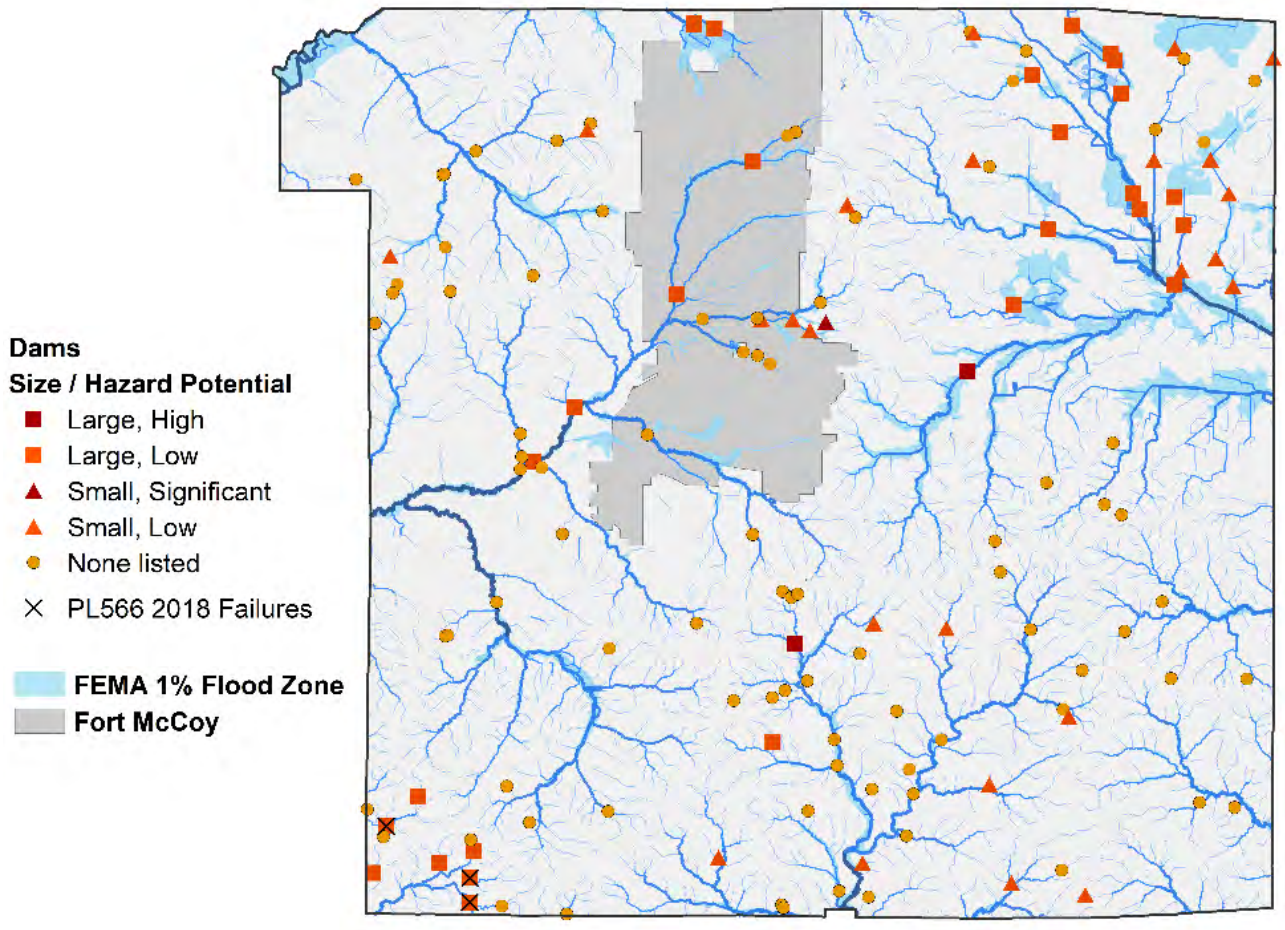


Figure 10. *Monroe County dam locations and hazard potential.*

The NRCS Plan-EIS for the Coon Creek and West Fork of the Kickapoo watersheds identifies two of the remaining four Land Conservation District dams (Coon Creek #25 and #31) as having a short life span and a high priority to address.

Some of the dams listed in WDNR's database have been removed or may have washed out. Recently constructed dams may not be listed, and some dam records lack size, condition, and storage information. The design of new dams generally considers fish passage, but existing dams in the county do not allow for fish passage upstream. Dams are also related to floodplain zoning which prohibits building in a dam's hydraulic shadow, where flooding would occur if a dam fails.

One strategy to reduce risk of dam failure is for WDNR to connect a dam's Sufficiency Rating with plans for corrective action when warranted. For example, WDNR assigned a Sufficiency Rating of Unsatisfactory to all three dams that failed on Coon Creek, for the Korn Dam as early as 2012. WDNR has no policy in place however to notify the dam owner or require action based on the Sufficiency Rating. It is also important that Emergency Action Plans, required by the state, be in place and updated with correct emergency response contact information.

Further risks related to dams can be addressed by continuing to update the WDNR's dam database with each dam's status and condition, better understanding the contribution of dams to flood abatement, and outreach to dam owners regarding dam maintenance and inspection. The barriers that dams pose to the migration of fish and other aquatic organisms also need assessment. This is discussed in more detail in the Stream Crossings section.

Understanding Dam Size and Dam Hazard Ratings

Large dams have a structural height of more than 6 feet and a maximum storage capacity of 50 acre-feet or more or have a structural height of 25 feet or more and a maximum storage capacity of more than 15 acre-feet.

A high hazard rating is assigned to dams that have existing development in the hydraulic shadow that will be inundated to a depth greater than 2 feet or do not have land use controls in place to restrict future development in the hydraulic shadow. This rating must be assigned if loss of human life during failure or mis-operation of the dam is probable.

A significant hazard rating is assigned to dams that have no existing development in the hydraulic shadow that would be inundated to a depth greater than 2 feet and have land use controls in place to restrict future development in the hydraulic shadow. Potential for loss of human life during failure must be unlikely. Failure or mis-operation of the dam would result in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities.

A low hazard rating is assigned to dams that have no development unrelated to allowable open space use in the hydraulic shadow where the failure or mis-operation of the dam would result in no probable loss of human life, low economic losses (losses are principally limited to the owner's property), low environmental damage, no significant disruption of lifeline facilities, and have land use controls in place to restrict future development in the hydraulic shadow.

Stream Crossings

An estimated 1,700 road-stream crossings occur in the county, each involving a culvert or bridge in the waterway. Road-stream crossings can also affect fish and other aquatic life that need to migrate to different habitats for feeding and reproduction. Where structures are barriers to aquatic connectivity, organisms are limited in the habitat they can reach as river and stream conditions change.

The Monroe County Land Conservation Department began conducting a stream crossing inventory and assessment project in 2021 with support from Trout Unlimited, Monroe County Highway Department, WDNR, and involved townships. The survey was designed to assess the condition of each culvert or bridge and whether it was in need of repair, and whether the culvert or bridge was a barrier to fish and other aquatic life moving up or downstream. The lower third of Monroe County was completed in this assessment with plans to move north. The project is estimated to require two years to finish.

One-third of the structures surveyed had at least moderate deterioration, and more than half of the structures were identified as barriers to migration under some flow conditions. These barriers will become increasingly limiting as the climate changes, making aquatic organisms more vulnerable.

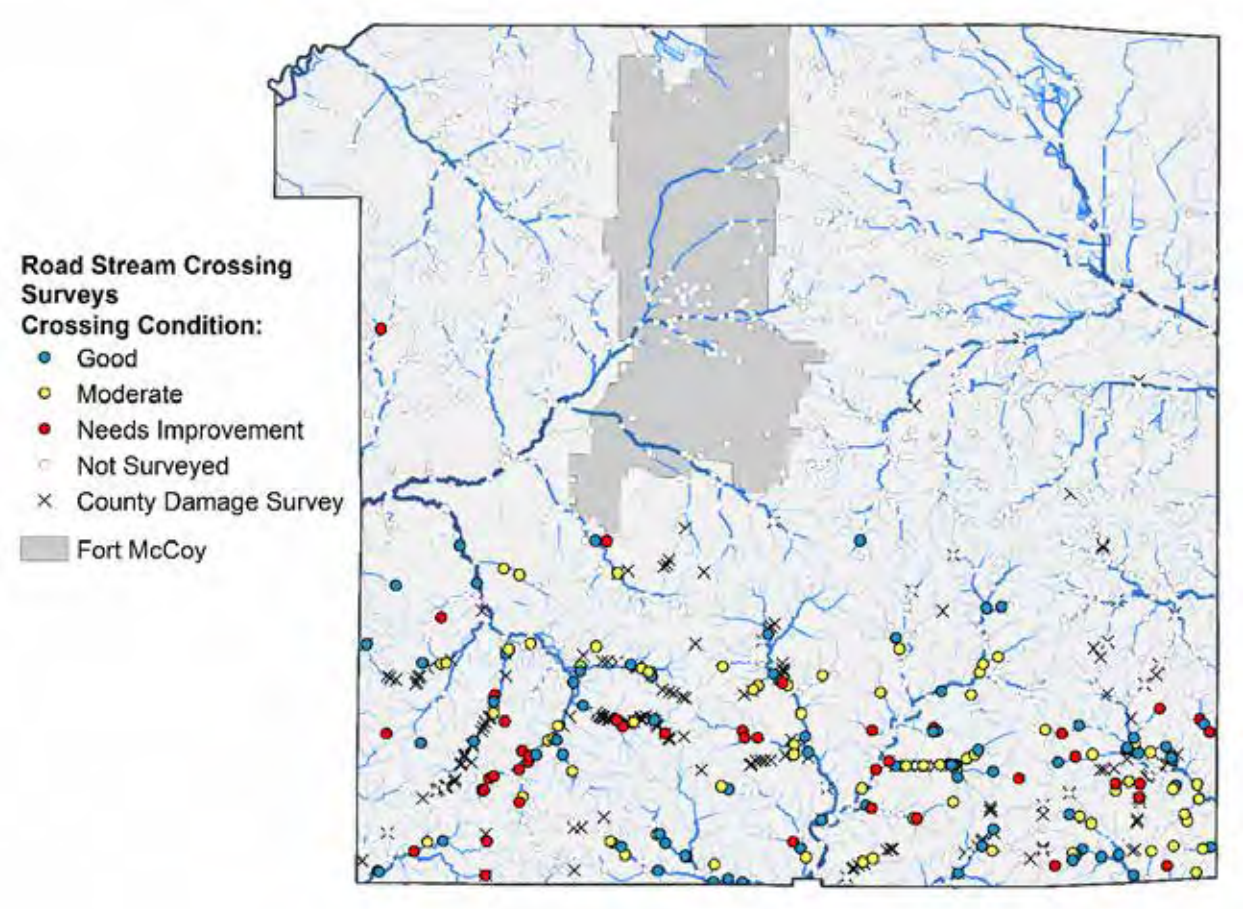


Figure 11: *Each dot on the map at right represents a culvert or bridge. White dots have not been assessed. Colored circles indicate the structure's condition based on the 2021 survey: green (good), yellow (moderate deterioration), red (needs repair). "X" indicates County damage assessments after the 2018 storms.*

Results for each road-stream crossing survey are available online: Great Lakes Stream Crossing Inventory (arcgis.com).

Background on the survey methods and the crossing assessment: Assessing Fish Passage | NAACC (streamcontinuity.org); Great Lakes Road Stream Crossing Inventory Instructions (michigan.gov)

Findings

Key Findings on Floodplain Infrastructure

- **Many existing structures are in flood-risk zones.** Based on preliminary building footprint data and current FEMA maps, over 200 structures occur in a floodway, over 500 in a flood fringe zone, and over 600 in an unstudied floodplain. Many of these occur in the cities of Sparta and Tomah.
- **Current FEMA maps likely underestimate the spatial extent and degree of flood risk**. FEMA maps are being updated using current technology, but they won't be available for several years. Even updated maps won't show where structures occur in the floodplain, whether a structure complies with floodplain zoning standards, or whether a structure is associated with other flood-related documents. When damage occurs after a flood event, the absence of geospatial data delays the response time needed to provide aid. This information is also not readily available for current or prospective landowners, or for the county to review future projects and zoning compliance.
- **An estimated 1,700 road-stream crossings occur in the county and some culverts and bridges at these crossings are in need of repair.** The 2021 survey of 204 crossings indicated 58 (32%) culverts or bridges with at least moderate deterioration and 5 (3%) with major to severe deterioration. Road crossings in need of repair, or improperly sized or placed, are at a higher risk of failure, pose a risk to public safety and downstream property, and can cause environmental damage. About half of the culverts impede fish migration up and downstream. Road crossings in need of repair, or that are improperly sized or placed, are at a higher risk of failure, pose a risk to public safety and downstream property, and can cause environmental damage.
- **WDNR dam information is incomplete and inspection reports are limited**. Absence of status and condition data on some dams impedes flood risk assessment and makes it difficult to evaluate the role dams play in flood abatement. Recognized safety issues can persist at some large dams because there is no automatic means to address them. Some dams limit fish and other aquatic organisms in the habitat they can reach as river and stream conditions change.
- **Land use conversion and land use practices have increased stormwater runoff rate and volume especially for smaller storms.** Some landowners have adopted practices that reduce runoff, but more of these practices are needed on farmed, forested, and developed lands**.** Runoff increases with conversion of wetlands to agricultural land, conversion of agricultural land to non-metallic mining, and development. Runoff also increases where land use practices compact the soil, reduce the amount of soil carbon, and allow seasonal bare soil, gully erosion, and unbuffered streams. Increased runoff results in greater water volumes, higher peak flows, transport of excess nutrients and sediment to waterways, and increased streambank erosion.

2018 flooding made many state trunk highways impassable, such as at this location on State Highway 131 at State Highway 33 outside Ontario.

Urban Floodplain Risks

Cities and other urban areas are among the most susceptible landscapes to the impacts of climate change[3]. Evaluating climate risks in Monroe County cities was outside the scope of this project, however as part of our assessment some general observations are warranted.

Cities concentrate both people and infrastructure, contributing to the development of "heat islands," and are often situated along rivers and other waterways, making homes, industry, and transportation highly vulnerable to floods and flood damage. Extreme weather in urban areas causes disruptions to critical infrastructure like water systems, sewer systems, roads, and power plants, particularly those already aging and in need of repair.[4]

Lower-income and underserved communities which are often located in cities, are at higher risk of impacts from climate change, in part because they are often near polluting industrial and flood-prone areas, and because they may lack the resources to escape or cope with disasters.

More information on urban vulnerability to climate change is found in Appendix IV.

Findings

- **Both Tomah and Sparta are vulnerable to future flooding impacts.** Tomah is situated alongside the South Fork of the Lemonweir River and Council Creek, while Sparta is intersected by the La Crosse River. Flood Factor data indicates that Tomah will generally have a moderate risk of flooding in coming decades, while Sparta's risk is much greater (major to severe risk).
- **Flood risk in urban areas should be evaluated more thoroughly using Flood Factor, FEMA maps, and other resources to evaluate risk and plan for adaptation.** Areas near industrial sites, contamination sites, housing (especially low-income and underserved areas) should receive special attention to ensure evacuation routes, resource availability (including access to emergency services), and contamination control.
- **Data obtained from the WDNR indicates that there are four Superfund sites and 26 Brownfield sites in Monroe County, located within urbanized areas** (Figure 12). These listed sites include one Superfund site and four Brownfield sites that are in or within 100 feet of a floodplain. The status of these sites should be reviewed to identify whether they present risk of downstream hazardous waste contamination during a flood.

Superfund and Brownfield Sites

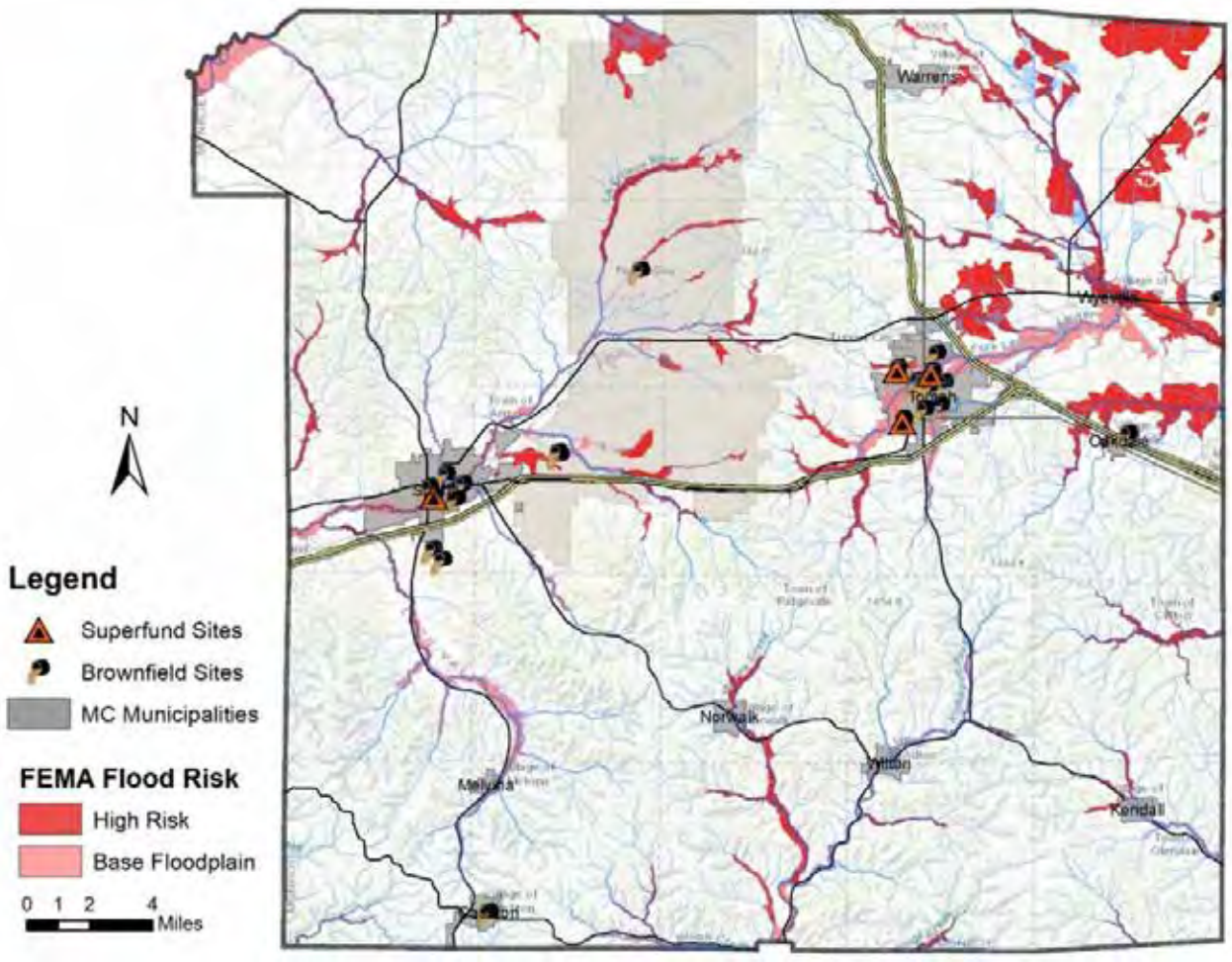


Figure 12. *Location of Superfund and Brownsfield sites in relation to municipal boundaries and FEMA flood risk in Monroe County. Superfund and Brownfield site data provided by WDNR.*

Another concern in urban and suburban areas is the presence of contaminated and toxic sites (often called Superfunds and Brownfields). **Superfund sites** are a formal Federal designation (CERCLA) through the US EPA and are considered severely polluted toxic locations requiring a long-term response to clean up hazardous material contaminations. A **Brownfield** is also a polluted site but differs from a Superfund in that it is less severely contaminated, and thus less likely to be cleaned up with federal funds. Oftentimes Brownfield sites are former Superfunds that have received some level of cleanup and remediation, lowering the level of contaminants, but still requiring additional action to reduce or eliminate toxicity. Contaminated sites pose a particular threat when they become flooded, dispersing potentially hazardous materials throughout floodwaters reaching homes, yards, and drinking water sources. Furthermore, the US EPA found that even those sites that have had remediation efforts may be at risk if remedies involve pump-and-treat systems that could become flooded.

Data obtained from the WDNR indicates that there are four Superfund sites and 26 Brownfield sites in Monroe County. Of these, one Superfund site and four Brownfields are in or within 100 feet of the floodplain, presenting risks of downstream hazardous waste contamination during a flood. One Superfund site and eight Brownfields are located within Sparta municipal boundaries, and three Superfunds and seven Brownfields are located within Tomah. The status of the sites (i.e. level of cleanup efforts and treatment technologies) should be made to evaluate the risk level of these sites.

Spring rains create increased risk for runoff and soil loss on lands without conservation cover.

Agricultural Vulnerability

Farming defines life for many Monroe County residents, and agriculture is a critical component of Monroe County's economy and culture. Maintaining a productive and prosperous farming sector is an essential outcome for any efforts aimed at climate resiliency. The agricultural producers who have been part of our project teams, and many of their neighbors, have contributed valuable insights to inform this part of our assessment.

The Agriculture and Climate Sub-team was tasked with assessing climate impacts, reviewing adaptation strategies from the Wisconsin Initiative for Climate Change Impacts (WICCI) and the Northern Institute for Applied Climate Science (NIACS), and providing recommendations to support Monroe County's farmland.

Farmers in the Midwest have been experiencing the impacts of extreme weather events, especially flooding, for the last 14 years. More extreme weather events and other climate-driven impacts are projected to increase and may affect farm operations in the future.

Background

Agriculture is a highly important activity in Monroe County. The USDA Agricultural Statistics Services reports that Monroe County has 1,555 farms and over 300,000 acres of land stewarded by farmers, with an estimated market value of $202,741,000 products sold.[5] More than 70,000 acres are dedicated to dairy rotation, 33,000 acres to cash grains, and nearly 10,000 acres are in continuous corn. The remaining acreage is largely dedicated to pasture and hay forage.

Monroe County has the second highest cranberry acreage in Wisconsin at approximately 3,740 acres in 2012 (Monroe County Land & Water Resource Management Plan). Cranberry operations are located primarily in the northeast portion of the county, while grazing, dairy, and crop lands are located primarily in the south.

Agriculture provides jobs for more than 4,500 Monroe County residents and contributes more than $279 million to the county's total income (UW-Ex 2014). The increased interest in local foods and agritourism has contributed to an increase in small farms, where some small acreage owners decided to enter specialty markets of apple orchards, pumpkin patches, and other specialty crops. The Amish communities have numerous outlets in the county selling produce, bakery goods, lumber, and other goods.

With over half of Monroe County's land managed by farmers, it is important to assist landowners in their efforts to be stewards of the land and support them in using practices that significantly reduce climate vulnerabilities and build a more resilient landscape across the county. Few industries depend on the ability to predict weather patterns as greatly as agriculture. As the climate changes, decision-making on the farm will become more challenging. To ensure a vibrant agricultural community remains, adjusting farm operations and building resilient soils will provide a more robust industry across the county.

Farming and Climate Change

Agriculture is extremely vulnerable to climate change. Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. Changes in precipitation and temperature patterns increase the likelihood of short-run crop failures and long-run production declines.

For example, since the 1990s, increased rainfall from April to June has been the most significant climate trend for agriculture in the Midwest. In less extreme scenarios, above average precipitation can provide favorable soil moisture that leads to increased yields. However, when precipitation comes in the form of intense rainfall events, increased precipitation can lead to undesirable impacts such as early season saturated soils that delay planting, post-planting losses due to heavy rains, increased soil erosion, and additional runoff of chemicals to waterways.[6,7]

Continued heavy rain events and associated flooding will continue to disrupt farm operations, and in some cases will affect yield for agricultural products.

Other tradeoffs for the agriculture sector will come with climate change as well. Projected 5-day maximum temperatures are expected to move above optimum conditions for many crops and closer to the reproductive failure temperature, particularly impacting corn in the Midwest. Impacts to pollinators may also contribute to periodic pollination failures.[7] For example, while plants may grow faster and mature more quickly under higher temperatures, elevated growing-season minimum daily temperatures have been found to reduce grain weight in corn due to increased nighttime plant respiration.[8] **Increased nighttime temperatures, coupled with humidity, causes stress to crops and livestock.**

Similarly, while higher levels of carbon dioxide concentrations in the air can stimulate plant growth (both crops and weeds), some crops like corn do not respond as readily to higher carbon dioxide levels (Iowa State University Extension). Elevated atmospheric CO^2 is expected to partially, but not completely, offset yield declines caused by climate extremes for soybeans, but less so for corn.[9]

Climate change can have impacts beyond yield and production. Agricultural producers in Monroe County interviewed for this project have expressed concern over increased stress levels and mental health issues exacerbated by extreme weather events. Concern was also expressed over possible impacts on generational transfer and financial risks associated with farming in a changing climate.

While preparing for extreme rain events has been a primary focus, warming temperatures and longer growing seasons may also affect farm production and could ultimately impact County goals and the wellness of farmers.

Farming and Carbon

Overall, agricultural activities are estimated to contribute approximately 19-20% of Wisconsin's annual greenhouse gas emissions. Those estimated emissions are the net of various farm activities including soil carbon changes, greenhouse gas emissions from nitrous oxide (from nitrogen fertilizer), methane emissions from livestock, and farm operations. Greenhouse gas emissions on any individual farm are highly variable and are affected by farm systems and application of conservation practices.

Agriculture has the potential to shift from a net source to a net sink of greenhouse gases.

A wide variety of farm conservation practices are known to generate measurable carbon storage and reduced greenhouse gas emissions. Increasing soil carbon also increases infiltration of precipitation and soil moisture holding capability.

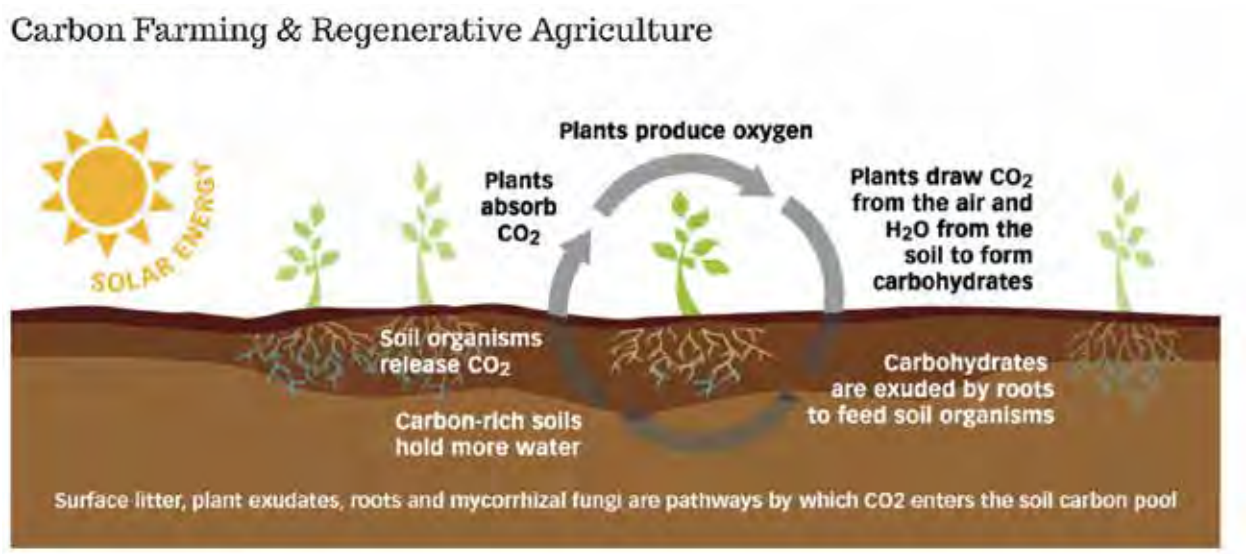
Limiting soil disturbance, keeping landscapes covered, and maintaining contour strips adds protection from extreme rain events by improving infiltration rates and slowing runoff across fields. While there is a growing acceptance of conservation practices, such as cover crops, implementation remains under 50%.[5] A recent study by the UW – Water Resource Management program identified a decrease in contour strips from 2004 – 2018 in the Rullands Coulee sub-watershed (report forthcoming; see project website).[10] **Understanding barriers in implementing and maintaining conservation practices is needed to protect agricultural lands from extreme weather.**

Managed grazing, cover crops, crop rotations, no-till farming, filter strips, prairie strips, windbreaks and shelterbelts, alley cropping, riparian buffers, and reforestation for forest products are all practices that can be carbon positive.

Application of any of these practices can contribute to a "triple win" of 1). generating income from farm products, 2). Protecting soil and reducing climate risks for producers, and 3). Contributing to watershed resilience.

Income opportunities for farm-based carbon are also a future potential benefit.

Spring soil runoff on fields without conservation practices can be excessive, even during moderate rain events.



Impacts of a Changing Climate

Findings

- **Continued heavy rain events and associated flooding will impact production and yield, as well as contribute to soil erosion and the creation of gullies through cropland.**
- **Increased nighttime temperatures, coupled with humidity, causes stress to crops and livestock.** Temperatures are expected to move above optimum conditions for many crops and closer to the reproductive failure temperature, particularly impacting corn in the Midwest. Elevated temperatures, humidity, and prolonged moisture can impact planting times, annual yields, and losses due to pests, pathogens, and rot.
- **Climate change impacts to pollinators is largely unknown, however some studies have suggested many pollinators will be negatively impacted by climactic changes.**
- **Climate change may have unpredictable results on crop yields**; while increased temperatures and growing season lengths may provide benefits to crops, yield weights may be reduced and pollination rates may be more unpredictable.
- **Severe precipitation will continue to contribute to higher rates of soil erosion** and effects such as the creation of gullies through croplands. Runoff from unprotected fields will increasingly lead to higher runoff and soil and nutrient deposition in waterbodies.
- **Dairy livestock are vulnerable to increased summer temperatures.** Higher temperatures during both day and night may bring added stress to livestock that may cause reduced feed intake, reduced milk production, more susceptibility to disease, and potentially shorter productive lifespans.
- **Erratic weather patterns have health and well-being impacts on growers.**
- **Agriculture has the potential to shift from a net source to a net sink of greenhouse gases.**
- **Since Monroe County's climate is predicted to be similar to Kansas, Missouri, and Iowa, producers here could prepare by learning more about concerns and practices in those areas.** The Monroe County Climate Change Task Force is one platform that could serve that role by connecting to conservationists and university researchers.
- **Understanding barriers in implementing and maintaining conservation practices is needed to protect agricultural lands from extreme weather.**

Forest Vulnerability

Overall, Monroe County forests are a significant resource facing significant threats. Assuring resilient and productive forests for the future will require increased investment in good forest management that addresses existing stressors such as invasive species and forest pests and reduces risks from future climate impacts.

Because forests are long-lived, they exhibit some natural resiliency and may respond more slowly to many climate or weather related changes. Other climate-driven impacts, such as high-severity fire events or large area "derecho" wind events can create devastating damage across thousands of acres in a matter of hours or days.

Overall, climate risks to forests are numerous and significant, and these risks are compounded by other long-term stressors that are not directly related to climate.

Regnerating jack pine on County Forest lands near Cataract

Background

Monroe County forests cover about 297,000 acres, which is approximately 50% of the county's land base. Private family forest owners own about 219,000 acres (73%), of which, 53,673 acres (24% of private forests) are enrolled in Wisconsin's Managed Forest Law. The remainder of forest lands are owned by the Department of Defense at Fort McCoy (14%), Monroe County (4%), U.S. Fish and Wildlife Service (4%), and the State of Wisconsin (2%).

The variable nature of climate impacts in our region makes it difficult to predict precisely which species may be most threatened by climate change. However, conditions such as sustained periods of saturated soils, or conversely, periods of sustained drought, could create conditions causing failure of species regeneration or outright loss of sensitive species on some sites. One resource for predicting response of tree species to climate change is the US Forest Service Climate Change Tree Atlas.

In general, tree species whose native ranges are near their southern extent in Monroe County such as eastern hemlock, yellow birch, or red pine may be most at risk of declines under warmer conditions, however there will be exceptions to this trend.

Other tree species that may see increased growth opportunities include those with southern distributions adapted to warmer conditions. They include oak and hickory species already present in the region. There is also potential for increase or establishment of species not yet broadly established in the region such as hackberry, honey locust, or sycamore.

Forest cover provides important infiltration for precipitation and runoff in watersheds, however in landscapes such as southern Monroe County where forests and agricultural lands intersect, heavy rains on ridgetop fields in row crops without conservation practices routinely create erosion and gullying on adjacent side-slope forests.

Forest health threats cause significant economic losses to forest owners and may be more pronounced under changing and variable climate conditions, especially conditions that put trees under stress.

Findings

Direct Climate Impacts to Forests

- **Forest logging operations, especially in the county's southern ridge and coulee region, are increasingly limited by shorter winters and less frozen/firm ground conditions, as well as by longer periods of wet conditions**. This trend is expected to continue, as some studies we have cited project that frost-free growing seasons across southern Wisconsin could increase by as much as 20 days by the middle of the century.
- **Forests will be increasingly vulnerable to severe precipitation events, potentially causing gully erosion and damage to forest roads and infrastructure**. Forest cover provides important infiltration for precipitation and runoff, however heavy rain on ridgetop fields in row crops without conservation practices creates erosion and gullying in side-slope forests.
- **Tree species loss due to climate change is a future risk**. The variable nature of climate impacts in our region makes it difficult to predict with accuracy which species may be most threatened. However, conditions such as sustained periods of saturated soils, or conversely, periods of sustained drought, could create conditions causing failure of species regeneration or outright loss of sensitive species on some sites.
- **Forest diseases and insects are an increasing threat to productive forests**. Forest health threats cause significant economic losses to forest owners and damage may be more pronounced under future climate conditions, especially conditions that put trees under stress. For example, the insect pest emerald ash borer has caused widespread mortality of both green and white ash trees in recent years. Oak wilt, a fungal disease of oaks, thrives especially after storms create damaged trees which invite disease.

Red pine plantations are particularly good habitats for invasive species such as common or glossy buckthorn, which are both common, especially in Northern Monroe County.

In addition to direct climate impacts, other stress factors that are made worse by climate change are already affecting productivity and creating vulnerabilities for forests in the county.

Findings

Indirect Climate Impacts to Forests

- **Invasive species are an increasing problem in Monroe County forests that reduces productivity, increases management costs, and threatens native forest ecosystems**. Invasive species are expected to benefit from climate change because of warmer temperatures and longer growing seasons. Invasive plants, including common buckthorn, Eurasian bush honeysuckle, and autumn olive, are common throughout Monroe County forests. In recent years, emerald ash borer, an invasive insect, has caused widespread mortality of both green and white ash trees.
- **Browsing by white-tailed deer is a significant factor limiting forest regeneration and reducing forest productivity**, particularly in the ridge and coulee regions in the southern portions of the county. Climate change is expected to favor white-tailed deer due to milder winters and reduced snow depth. Based on the Monroe County Forest Regeneration 2020 CDAC Report, forest regeneration monitoring from 2018-2020 indicates that 34% of the observed recently harvested stands in Monroe County are failing to meet regeneration guidelines and 85% of recently harvested stands are not meeting regeneration height expectations.[11]
- **Lack of fire in fire-dependent forests is a significant factor limiting forest regeneration and reducing forest productivity**. The health and regeneration of oak, jack pine, and red pine is historically tied to low to moderate intensity fire disturbance.
- **Threatened and endangered species, and rare natural communities are especially at risk from degradation or loss** due to a combination of factors described above, including invasive species, high deer densities, and lack of fire.
- **Markets for forest products are becoming less stable and predictable, making sound forest management practices more difficult to implement**. Weakening forest product markets are reducing income opportunities for forest owners, hurting profitability for loggers who play an essential role in forest management, and limiting the ability for foresters to manage forests effectively. Closure of the Wisconsin Rapids Verso paper mill in July 2020 had a major impact on Wisconsin's entire forest products supply chain, with an estimated total economic impact on Monroe County alone of nearly $5 million.
- **Splitting up ownership parcels into smaller pieces creates barriers to effective forest management**. Smaller parcels (together with habitat fragmentation from more homes and driveways) makes forest operations and logging access more difficult and makes forest management uneconomical for small ownerships. Fragmented forests are more susceptible to impacts from invasive species and reduce habitat for a variety of plant and animal species.

Waterways and Wetlands Vulnerabilities

Background

Monroe County's water resources are diverse. Extensive wetlands and slow, meandering streams are common in the glaciated northeast of Wisconsin's Central Sands. Waterways in the Driftless Area are typically fast-moving streams in narrow valleys with wetlands only along the stream corridor. Groundwater is a major source of stream flow and its stable supply of cooler water moderates stream temperatures year-round. The constant groundwater supply, steep topography, and the abundance of natural habitat in stream corridors lead to many miles of trout streams in the Driftless Area.

Flood runoff in valley bottoms damages infrastructure and degrades habitat quality for fish and aquatic organisms.

Fisheries

With increased temperatures and an increase in extreme weather, Wisconsin's cold-water fishery resource is at risk of decline. In the County's Driftless Area, a productive warm water fishery is not likely to replace the cold-water fishery because the conditions required for warm water sport fish – slower, larger streams -- aren't common. WDNR estimates a 75% decline in brook trout habitat in the Driftless Area by 2,050, from 9176 to 2,302 stream miles, and a 32% decline in brown trout habitat statewide.

Parts of Monroe County, however, have features that increase its potential to sustain a cold-water fishery even as climate changes. WDNR's Brook Trout Reserve Program has identified places in Wisconsin where brook trout have the best chance of enduring the effects of climate change and other environmental disturbances.

The designation of reserves enables the WDNR and its partners to focus their specific tools to ensure that Brook Trout remain viable in the state. Reserve #14, largely in Monroe County, is the highest ranking of the larger Reserves in the Driftless Area and in southern Wisconsin, due to the extent of thermally resilient streams and the presence of strong brook

Figure 13: *Brook Trout Reserve Map*

trout populations, both of which are favorable for future Brook Trout conservation even as the climate changes. The limiting factors to sustain Brook Trout within Reserve #14 are related to improving stream habitat, which can be addressed by readily available adaptation measures, for example by extending and widening natural land buffers along stream corridors, protecting them through easements, and enabling fish passage. These measures will support other trout populations as well.

Wetlands

Wetlands vary widely, and not all wetlands provide the same benefits or to the same degree, but together they contribute to watershed health by increasing water quality, providing habitat for aquatic and terrestrial wildlife, and moderating stream flow. Wetlands act as water reservoirs during dry periods, slow stormwater runoff, and store floodwater after storms. Their contribution to multiple aspects of watershed health increases landscape resilience to a changing climate and to temperature and precipitation extremes.

Wetlands in Monroe County are minor features in all but the northeastern watersheds, but they play an outsized role in the benefits they provide.

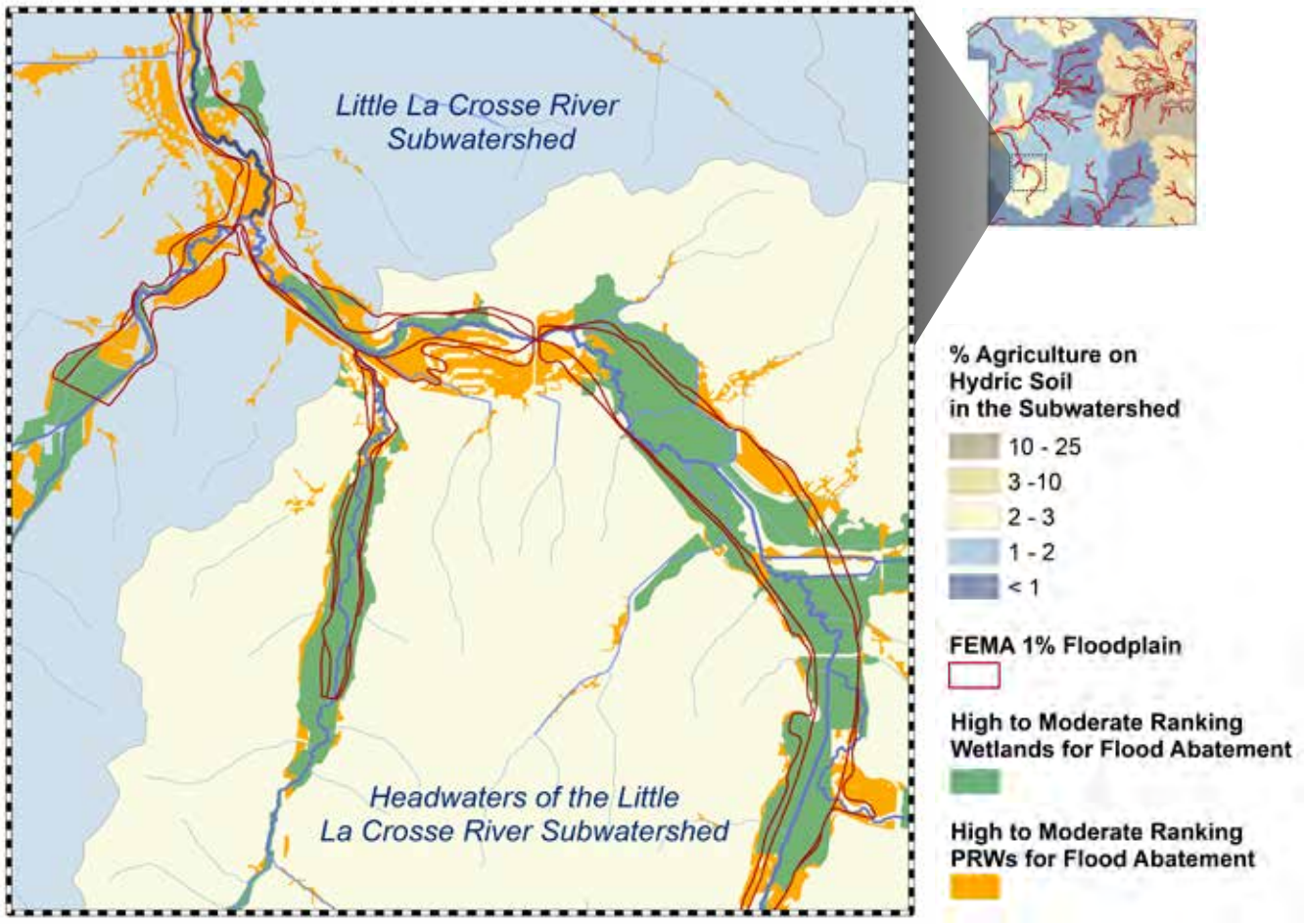
The high organic content of wetland soils makes them highly productive for agriculture in dry years. Many wetlands have been covered by eroded sediment and tiled or drained to expand farmland. These former wetlands are mapped as Potentially Restorable Wetlands (PRW), areas of hydric soil that no longer function as wetlands and that haven't been developed or forested. Often these PRWs can be restored along with some of the former wetland benefits. For example, watersheds with PRWs along stream corridors have opportunities for wetland restoration that will store flood water and moderate flooding downstream, improve water quality, and provide fish and wildlife habitat.

Often these PRWs can be restored along with some of the former wetland benefits. For example, watersheds with PRWs along stream corridors have opportunities for wetland restoration that will store flood water and moderate flooding downstream.

Figure 14 in the side bar shows an example along the Little La Crosse River. The wetlands and PRWs associated with flood storage were identified by *Wetlands by Design*, an online tool that guides prioritized choices for where to invest in protecting existing wetlands and restoring former wetlands to meet different watershed needs.

Link to Wetlands by Design: https://freshwaternetwork.org/projects/wetlands-by-design/

Agriculture & Hydric Soils with Flood Abatement Potential



Watersheds with many headwater streams, and with wetlands or former wetlands on hydric soils, have the potential to retain stormwater runoff and slow floodwaters in rivers and streams. This can help reduce flooding downstream.

The County map shows the floodplains and how the extent of agriculture on hydric soils varies among watersheds. Where these hydric soils are drained they have less capacity to store floodwater.

The focus area zooms into the Little La Crosse River area where the Headwaters of the Little La Crosse River Subwatershed drains into the Little La Crosse River Subwatershed.

The wetlands shown in the focus area have a high to moderate probability of abating floods based on their landscape position. The PRWs have similar probability should their flood storage capacity be restored. Well-planned restoration can be compatible with continued agricultural use.

Figure 14: *Agricultural and Hydric Soils*

Key Findings

- **Trout and other fish populations that depend on the County's cold-water streams are expected to decrease as the climate changes.** With increased temperatures and an increase in extreme weather, Wisconsin's cold water fishery resource overall is likely to decline. Waterways in Monroe County are mainly small, cold, fast-running streams that support trout. Lakes and slow, large rivers that support cool water sport fish, like walleye, or warm water sport fish, like bass and crappie are less common. The lack of habitat limits the opportunity for other climate-adapted species to increase as the trout fishery declines.
- **Parts of Monroe County have features that increase its potential to sustain a cold-water fishery even as climate changes.** WDNR's Brook Trout Reserve Program has identified places in Wisconsin where brook trout have the best chance of enduring the effects of climate change and other environmental perturbations if the stream habitat is improved. Monroe County contains much of the largest Reserve in southern Wisconsin
- **Dams and road-stream crossings are often barriers to aquatic connectivity.** The County's recent road-stream crossing inventory indicated 55% of the bridges and culverts surveyed are barriers to fish and aquatic life moving up and downstream. The ability to move to different habitats is essential to complete life cycles. The effects of these barriers will increase as climate changes and will make populations of aquatic organisms more vulnerable.
- **Wetlands may be minor features in the Driftless Area of Monroe County but protecting existing wetlands and restoring former wetlands increases resilience**. Wetlands along streams abate floods, feed streams in dry periods, improve water quality, and provide habitat for fish and wildlife.

Habitat restoration and recreational uses are both compatible activities that can contribute to climate resilience.

Biodiversity and Climate Vulnerability

Biodiversity, or the natural variation of plants, animals, fungi, and micro-organisms, forms the web of life which ultimately makes human life possible. **Loss of biodiversity contributes to the loss of ecosystem function and ultimately, the loss of ecosystem services on which all life forms, including humans, depend.**

Understanding Biodiversity and Climate

Species of the Midwest have already been responding to the landscape and environmental changes occurring over the last several decades, and climate change is expected to further amplify the stress these organisms are experiencing.[12,13,14] The impacts of climate change on biodiversity have been observed across a range of scales, including at the level of individuals (such as changes in behavior, physical characteristics, and physiology), populations (such as changes in the timing of life cycle events), and species (such as changes in geographic range). Organisms can adapt to climate change through shifts in behavior, geographic range, or physiological processes. The inability to adapt in one or more of these ways often means the species will decline or die out, either in entirety or throughout a portion of their original range.

It is anticipated that climate change will both directly and indirectly impact plants, wildlife, and fish. For most native animals, there is a common set of weather and climate conditions that will either support or negatively alter their behavior, distribution, development, reproduction, and/or survival; this includes such things as the timing of spring conditions, high temperature extremes, altered snow cover and cold exposure, drought, and heavy precipitation and flooding events. Changes to these conditions will result in a direct impact to these species. For example, frogs and other amphibians are particularly sensitive to drought because they have permeable skin and many require a range of aquatic habitat for reproduction.

Flooding and heavy rainfall events can destroy habitat, and flooding has been shown to cause complete nest loss in an entire colony of waterbirds. Indirect impacts of climate change can include changes in habitat quantity and quality, increases in pests and pathogens, and an "uncoupling" of interspecies relationships (for example, predator/prey relationships or plant/pollinator relationships). See the Preliminary Assessment of Climate Change Impacts on Wisconsin's Wildlife[15] for an in-depth look at climate impacts on wildlife.

Threatened, Endangered, and High-Conservation Value Species

Unlike more widespread generalist species, rare or uncommon species are usually characterized by some limitations on the range of habitats or environmental conditions they need to survive and reproduce. Rare species can become especially vulnerable when they exist in small, isolated habitat patches which can limit their ability to move to more favorable locations.

Pine and oak barrens provide important habitat for some plants and wildlife which is available in natural areas as well as some managed forests.

Climate changes can create unfavorable conditions which can easily cause local elimination (extirpation) of sensitive species due to their already-limited range of suitable habitat and conditions.

Wisconsin's Natural Heritage Inventory (NHI) maintains a location-specific database of rare, threatened, endangered, and otherwise sensitive species and ecosystems in Wisconsin. In Monroe County, NHI currently lists 26 insects and invertebrates (e.g. snails and mussels), 17 birds, 6 fish, 6 mammals, 36 plants, 9 species of amphibians and reptiles, and 32 habitats.

A detailed assessment of individual species was outside the scope of this project, however our team reviewed NHI occurrence records for Threatened and Endangered species and documented natural communities in Monroe County and recommend the protection of high-quality habitats described in the sidebar.

Key Findings

From this review, some habitats related to areas of high biodiversity in the county are as follows:

- Pine Barrens are a significant and well represented natural community throughout northcentral Monroe County, supporting a significant diversity of plant and animal species, including the federally listed Karner Blue Butterfly and numerous other insect and reptile species of concern. The U.S. Army base at Fort McCoy supports one of the best pine barrens complexes in the region due to their intensive and sustained management program.
- High-quality wetland complexes occur around lake complexes in the northeast corner of Monroe County, featuring Emergent Marshes, Open Bogs, Tamarack Swamps, and Poor Fens. Some of the county's highest densities of threatened, endangered, or high-conservation value species occur in this complex. Much of the land in this area is managed cooperatively with the U.S. Fish and Wildlife Service - Necedah Wildlife Refuge and the Wisconsin DNR Wildlife Management program.
- Natural communities associated with the Driftless Area occur in the southern tier of Monroe County, typically occurring on ridge tops, cliff sides, and valley bottoms where the topography is steepest. Representative communities include Dry Cliffs, Dry Prairies, Hemlock Relicts, Moist Cliffs, and Pine Relicts. Rare or endemic species of plants and insects are typically associated with these communities, as well as forest songbirds that may find favorable habitat with specific structural conditions and species.

Known areas of high ecological and species diversity such as those described here present opportunities to create climate refugia and should be a particular focus for habitat improvement and restoration.

Watershed Vulnerability Assessment

Maintenance of healthy, functioning natural ecosystems helps to ensure sustained, long-term provision of ecosystem services to local people. Functioning ecosystems help to buffer against the impacts of more frequent extreme weather events, and therefore help to create a more resilient landscape in the face of climate change, protecting both natural and built systems. As such, we used available data to assess both the current health of ecosystems in the county, as well as projected impacts in the face of climate change.

We organized this assessment around the HUC-12 watersheds of the county. A **watershed** is an area of land that drains all the streams, snowmelt, and rainfall to a common outlet such as a lake, reservoir, or larger river channel. Many different features in a watershed contribute to watershed health and watershed stress, including topography, geology, and land cover.

Watersheds are important because the amount and velocity of streamflow, as well as water quality, of a river or stream are affected by the things happening in the land area "above" the outflow point. Therefore, a watershed is an interconnected landscape, in which both ecological processes and flood water movement are driven by interacting land and water features. Given the variability in topography, land use, and health/stress indices, **watersheds in the county are expected to vary in terms of their resilience to climate change**. Watersheds, therefore, create an opportunity for focusing the management of flood waters, ecological systems, and land use practices.

Our Watershed Vulnerability Assessment used available data to rate watersheds throughout the county against measures of climate resilience and measures of stress (vulnerability).

Grass cover along waterways is among the most effective conservation practices for reducing and filtering runoff, and protecting soil and stream banks.

Watersheds that are more ecologically intact, with fewer stressors, are more resilient under extreme conditions, and enable plants and animals to move and adapt. Watersheds that are less intact and with more stressors are also more vulnerable.

First, we assessed baseline (current) conditions in each watershed by comparing U.S. EPA watershed stress indices and watershed ecological condition indices (Figure 15). The cross axes on the figure represent median values for the county, whereby green points represent watersheds that have above average ecological health (and typically lower stress), those in yellow and orange have approximately average health and stress, and those in red have the lowest ecological index and the highest stress.

Ultimately, a higher ecological condition index and a lower watershed stress index collectively creates a more resilient current-state watershed. Healthy watersheds (those with a high ecological condition index) provide stormwater storage, flood control, erosion and sedimentation control, nutrient cycling, carbon storage, biodiversity, wildlife movement corridors, and help reduce the effects of climate change and other natural disasters. Watershed stresses are factors that limit the ability of watersheds to respond to environmental impacts or to provide human and environmental benefits. Some of these stressors include high soil erodibility, low aquatic index scores (aquatic health), percentage of impervious surface in the watershed.

Using the baseline EPA data, as well as other "current condition" data (see Appendix V), we calculated an overall "baseline condition" score and mapped the watersheds accordingly (Figure 16a). Next, we measured and mapped each watersheds' predicted vulnerability (sensitivity and adaptive capacity) to climate change (Figure 16b) using data on landscape resistance to flood and fire, forest diversity and tree species adaptability to climate change (based on Northern Institute of Applied Climate Science Climate Change Field Guide), presence of invasive species (plants only), number of toxic sites in the floodplain (e.g. Brownsfield sites), and more. Finally, the two maps were combined (Figure 16c) to geographically compare health and vulnerability among the watersheds.

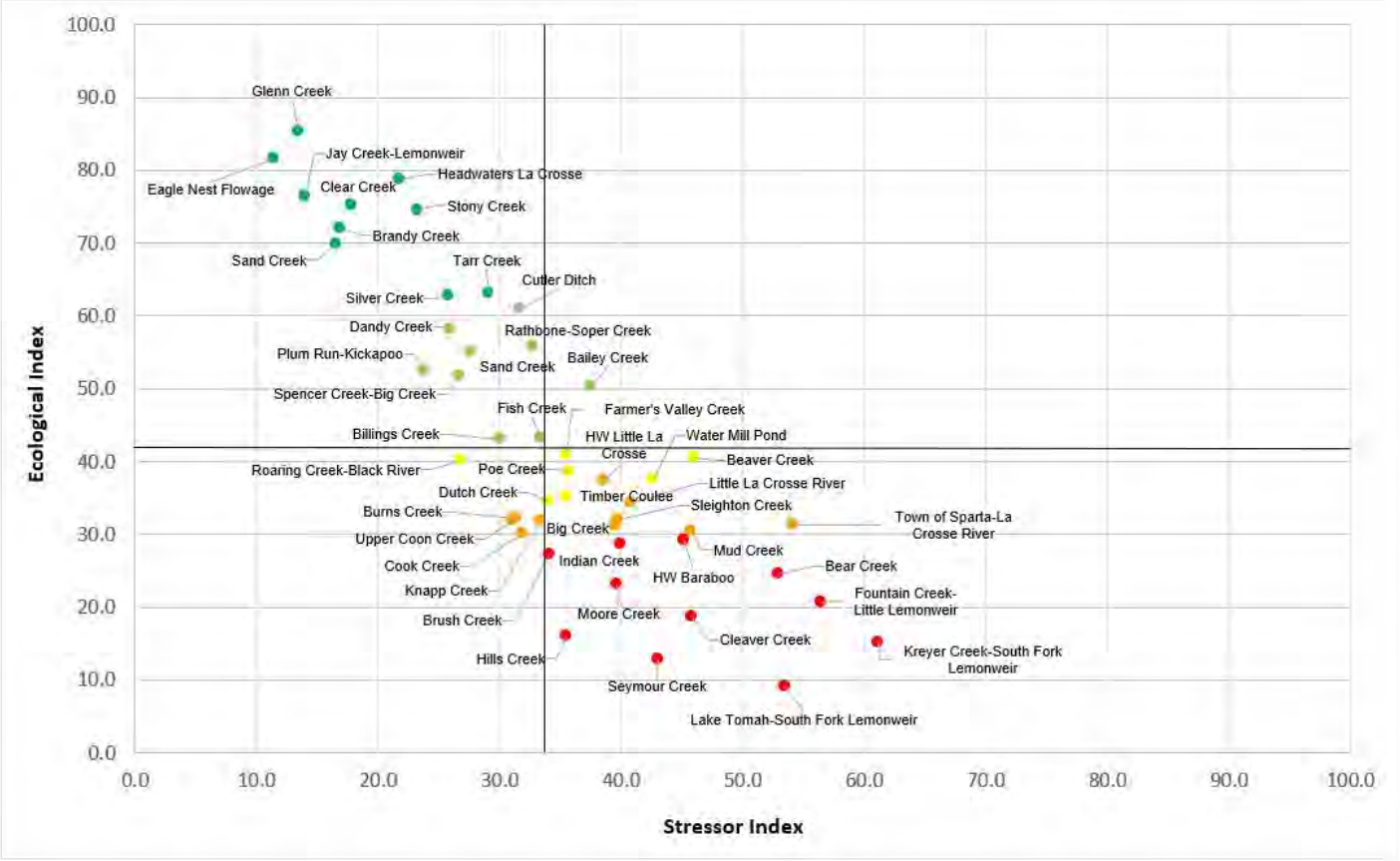


Figure 15: *Ecological index score plotted against stressor index data (index data via EPA).*

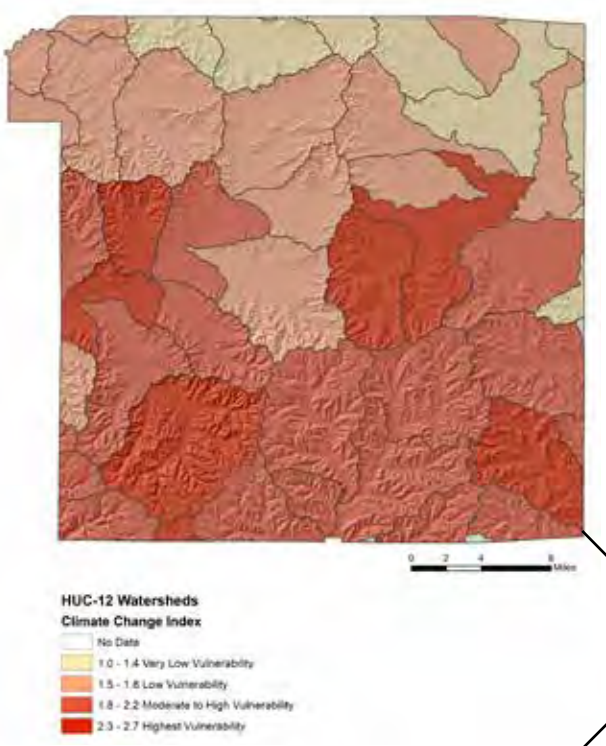


Figure 16b.

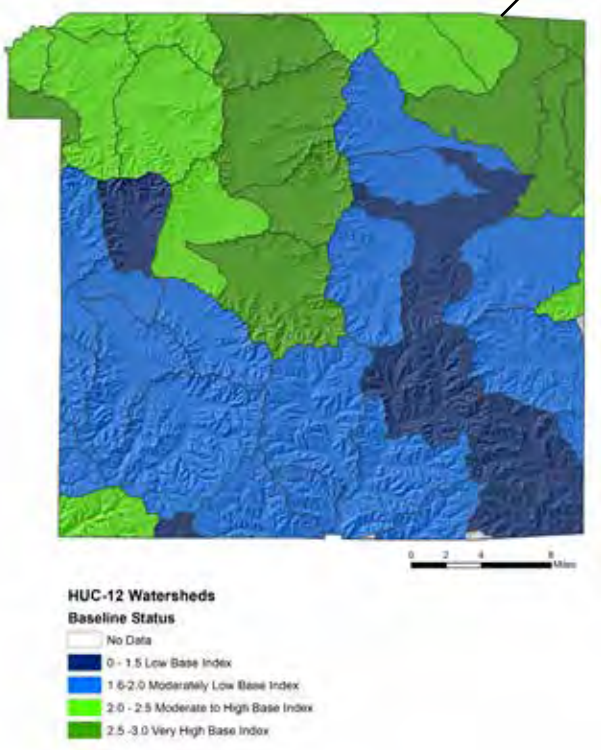
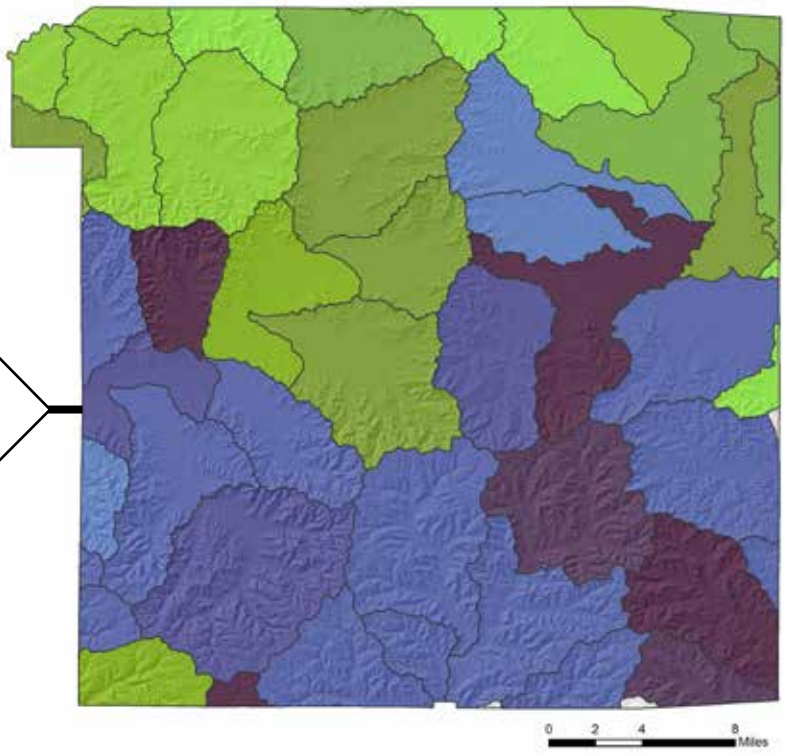


Figure 16a.



Combined Baseline Condition + Climate Change Vulnerability

= Lowest baseline condition, highest vulnerability
= Moderate baseline condition, high vulnerability
= Moderate baseline condition, moderate vulnerability
= High baseline condition, low vulnerability

Figure 16c.

Findings

- 19 of the 47 HUC-12 watersheds (40%) in the county are generally in good baseline condition and have conditions of relatively high resilience.
- 11 watersheds have relatively high stress and low ecological indices, indicating a need for improvement in land and water quality measures.
- The watersheds in the northern part of the county (generally north of I-90) had higher ecological indices and lower stress indices. This is likely primarily due to the protected status of lands located within the boundaries of Fort McCoy and the wildlife refuge areas of the northeast, where levels of industrialization, development, and agricultural practices are generally lower.
- Despite higher baseline conditions in the northern half of the county, some of these watersheds still have a moderately high vulnerability rating, due to low forest diversity, low levels of natural wetlands, and high numbers of stream/road crossings.
- Watersheds along the I-90 corridor (particularly those with larger urban centers) and watersheds in the southern half of the county are at the greatest climate change risk (relative to other watersheds in the county).

6 CREATING A RESILIENT FUTURE

Climate change resilience means the ability to recover from the impacts caused by a changing and more unpredictable climate. Creating climate resilient communities occurs through positive collective actions and strategies that help reduce climate risks and provide benefits for the most people.

Strategies to increase resiliency can include a wide variety of actions that help communities ***thrive in the context of change***.

Our recommendations throughout this report are intended to bring triple win benefits of increasing climate resiliency, protecting soil, water and air, and improving rural prosperity and economic opportunities.

Findings

- **There are ample opportunities to make investments in improved climate resiliency that will bring multiple benefits for people and the economy.**
- **Healthy, functioning forests, fields, soils, waters, and wetlands serve as "natural capital," ensuring that crucial ecological and economic activities—like agriculture, forestry, and recreational fishing—can continue to thrive, even in the face of change.**
- **The investments in conservation practices that increase climate resiliency and reduce future risks can also have economic benefits for landowners and communities.**

We describe concepts and strategies to achieve those benefits in this section, along with our analysis of where some of the best opportunities for targeted conservation investments to increase climate resiliency can occur.

In ***Section 7 – Recommendations***, we provide detailed, actionable recommendations to support the concepts and opportunities presented here.

Monroe County has installed monitoring stations at stream crossings with flood histories. Data generated is fed to the National Weather Service to support flood alerts, and also generates stream data for researchers.

Resilience Concepts

Climate Resilience

Climate resilience is the ability for an area, whether infrastructure, urban areas, working lands, or natural ecosystems, to recover from the impacts of a changing climate.

While there is no "one-size-fits-all" strategy, there are many strategies and actions that can improve climate-resilience. Many of these actions can simultaneously improve livelihoods, social and economic well-being, and environmental quality, and often encompass both adaptation and mitigation.

Resilience activities can range from purely technological solutions (also known as gray infrastructure) to "green infrastructure," which can include activities ranging from reforestation and restored wetlands or grasslands in rural areas, to green roofs and rain gardens in residential areas.

Natural Climate Solutions

Investments in green infrastructure are sometimes called *natural climate solutions*. Natural climate solutions can be less expensive to implement than hard infrastructure and can bring many additional benefits. For example, when culverts are re-designed to improve aquatic habitat, local trout populations can benefit, restoring ecological systems as well as improving the potential for increased tourism revenue through a robust trout fishery.

Investing in natural climate solutions safeguards the natural systems that help protect communities from floods, droughts, and other extreme weather events. Protection of these systems supports healthy soil, healthy fisheries, infrastructure, and human health and well-being.

Natural climate solutions provide other benefits such as floodwater absorption, removal of carbon dioxide (CO_2) from the atmosphere, and wildlife habitat. Conserving these ecosystems in their natural state is a cost-effective mechanism for preserving the services they provide.

The benefits of climate resilience investments go directly to taxpayers, landowners, and all citizens in cities and towns in climate affected areas.

Many paths to a resilient landscape

INFRASTRUCTURE

STRUCTURED EVALUATION

Review the condition of existing dams, culverts, and bridges and prioritize their repair or removal.

REDUCE RISK TO PEOPLE

such as

Remove homes in high flood risk area through the county buy-out program and anticipate for future conditions.

Consider early warning or automatic road closures where frequent flooding occurs.

CONSERVATION

INCREASED CARBON and WATER STORAGE

NO-TILL and COVER CROP PRACTICES

through

MANAGED GRAZING with silvopasture and composting

PRESERVATION of natural systems

RESTORATION

RESTORE WETLANDS in floodplains and on marginally productive land

RESTORE NATURAL or PERMANENT VEGETATION to stream banks and slopes

RESTORE FORESTS particularly to slopes and streambanks

together

These actions prevent erosion, absorb floodwaters, break down pollutants, provide habitat, and more.

Increasing Resilience in Infrastructure

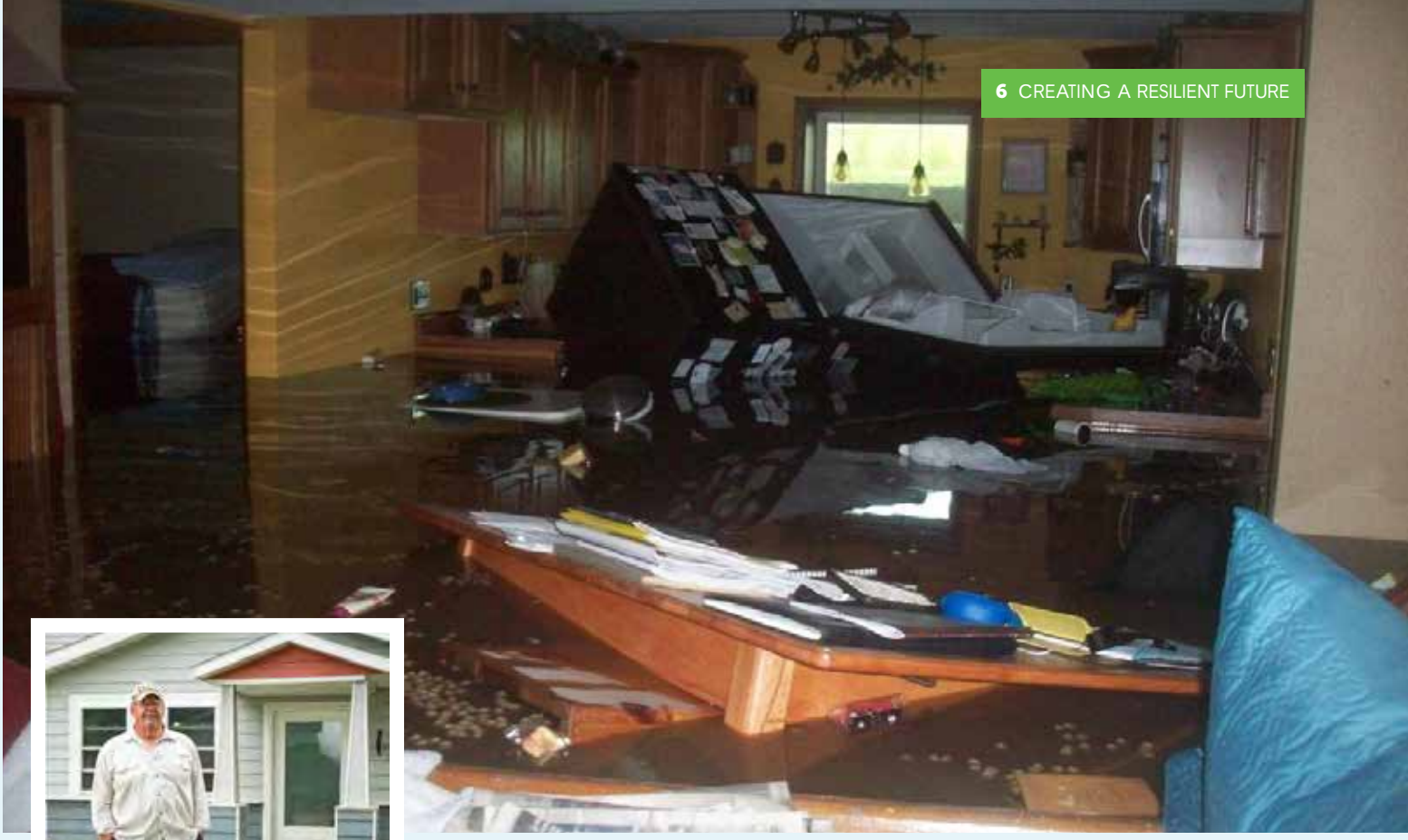
Climate change impacts, particularly flooding, have long been a concern in Monroe County, causing damage to homes, bridges, dams, and roadways. In many cases federal disaster recovery programs require rebuilding infrastructure in a manner identical to its pre-damage state. **Recent events have made it clear that replacements of infrastructure cannot simply be brought back to pre-disaster conditions, but instead will need to incorporate designs that provide multiple benefits and that include adaptation for a wetter future.**

Traditional infrastructure (also known as "gray infrastructure") such as dams and impoundments provide critical functions. However, gray infrastructure can be costly and require long-term maintenance, while typically providing only a single function. In contrast, "green infrastructure" meets infrastructure needs using design of natural systems and primarily natural resources. An example of green infrastructure would be restoring floodplain storage in previously drained wetlands as part of stormwater management. A green infrastructure design would reduce the size of culverts (gray infrastructure) needed at downstream road crossings.

Infrastructure designs that incorporate hybrid gray and green infrastructure are becoming more widely used in planning to accommodate climate change impacts.

With careful analysis, design, and consideration of operation and maintenance, the hybrid gray / green approach to infrastructure can improve system performance, increase resiliency to large events, and reduce long term operating costs. Green infrastructure can also provide substantially greater social and environmental benefits by contributing to improved wildlife and fish habitat, improved filtration of water and sediments, and complementing parks and other outdoor recreation spaces.

Future infrastructure can include updated standards reflecting the likely size of future events, and incorporating both "gray" and "green" design features.



Marty Severson - "If You Live By the Water"

Sparta resident Marty Severson has experienced the impacts of five flood events in the course of two years at his home on the Little La Crosse River. He had just completed clean up and rebuilding following the first flood in 2017, when the August 28th, 2018 flood hit, filling his house with 7.5 feet of floodwater and causing him to lose everything from family heirlooms to the brand new cabinets and appliances that had been installed just months before.

Severson was inside his home during the 2018 flood, while floodwaters rose high enough to float his refrigerator through the kitchen ceiling. Beyond the appliances, losses that can never be replaced included an extensive tool collection, a complete set of Japanese dinnerware, and pictures and collections of letters from family. As a long-time radio station DJ, it was especially painful for Marty to watch as an entire wall of shelves collapsed in the flood waters, destroying his career-long collection of classic and rare vinyl LPs.

One thing Marty has been vocal about is the value of FEMA sponsored flood insurance through the multiple flood events he has experienced. "Without that insurance I don't know where I would be today" he said. Marty even helped FEMA produce a video ad showcasing the value of FEMA Flood Insurance. https://www.youtube.com/watch?v=uBW0MLBKoqs

Following damage from the fifth and last flood event, it became clear that his home was no longer inhabitable. Beginning in 2019, staff from the Monroe County Planning and Zoning and Land Conservation Departments began managing a series of property buyouts for residents in hardest hit areas in the Little La Crosse and Coon Creek watersheds using combined funding from FEMA, WDNR, and Community Development Block Grants. For Marty, the buyouts helped cover his financial losses and allowed him to relocate and rebuild on a nearby home on high ground.

While nothing will replace some of what he has lost, Marty remains grateful for the help he has received from neighbors, from Monroe County staff, and from the FEMA Flood Insurance Program.

"If you live by water, you have to have flood insurance," Marty emphasized. "It's cheap – it only costs me a few hundred bucks per year, but if I hadn't had it then, I would have nothing today."

Increasing Resilience Through Conservation and Restoration

Creating resilient landscapes that can withstand extreme weather will take a multi-layered approach to conservation. In some cases, land and water restoration activities can ensure increased infiltration, controlled runoff, and restored hydrology throughout all landscapes and new development.

Much of the climate-related risk (both current and projected) to communities and landscapes lies in extreme water flow fluctuations (both flood and drought). Human-driven land-use changes, including development, agriculture, and vegetation loss directly along river, streams, and within floodplains, combined with increased climate risk, has increased flood vulnerability in many areas.

"Slowing the flow" of water on the landscape through nature-based solutions is one approach to reducing flood risk, while providing multiple co-benefits. It means slowing the rate that water (precipitation) runs across the landscape to larger order streams by increasing the storage of water in soil, vegetation, and groundwater. Wetlands, forests, and prairies are effective in slowing the flow by holding, storing, and filtering water, conserving soil, and protecting natural habitats. "Slowing the flow" of water on the landscape using nature-based solutions is an underlying strategy behind many of the actions we recommend in the sections that follow (and see Appendix VII for more details).

Restoring resilient watersheds can include re-shaping stream banks to accommodate more natural flow patterns.

Forests

Keeping forests in forest by keeping them productive is an essential strategy in protecting this critically valuable resource. Forest management that helps forests adapt to climate change is also highly important in order to maintain productivity.

Forests harbor unique and sensitive habitats such as ephemeral ponds, bird rookeries, springs, and seeps. Protection of unique habitats, both within and outside of forests, is crucial for maintaining hydrologic integrity, ecosystem services, biodiversity, and carbon sequestration functions.

Forest conservation can include measures such as invasive pest management, fire management (including controlled burns), and restocking degraded forests with more native, climate-adapted species (see the Climate Change Field Guide for Southern Wisconsin Forests).

Reforestation efforts can aim to restore natural "wild" habitats or be integrated into urban areas and working lands. By using the watershed vulnerability assessments in this report, new and restored forests can be strategically sited on marginal, highly erodible, and high-risk lands in highly vulnerable watersheds. Trees can be integrated into working lands through strategies such as agro-forestry efforts (see below), and trees in greenspaces in urban and other built areas can provide shade, flood control, and other benefits.

Findings

- **Protecting and conserving existing natural assets is always more cost-effective than restoring new ones.** Strategies that keep forest in forest, keep farmland productive, and keep wetlands wet should be priority strategies for land managers.
- **Restoring wetlands, forests, and grasslands is an especially important strategy** where it can be employed to reduce flood risk and increase resiliency. Given the extensive loss of natural habitats and concurrent trends of increased flooding in regions of the Upper Midwest, habitat restoration will have special benefits where it can be targeted to areas of highest priority.
- **Conservation lands can remain working lands.** While increasing conservation land uses is a critical strategy, in most cases there are many conservation options available that generate income and meet landowners' goals while increasing climate resiliency.

For more details on increasing resilience through conservation practices see Appendix VI.

Members of the CRREOA Forestry Sub-team at the Steve and Patty Harelson Tree Farm.

Steve and Patty Harelson Tree Farm

Steve and Patty Harelson's grandkids bound down a trail on their American Tree Farm property in rural Monroe County near the town of Little Falls. "Most importantly, I do this for my grandkids," Steve says. "I want the next generation to see these oaks the way we did."

The Harelson farm, also known as Whitetail Ridge, includes 155 certified tree farm acres, planted with oak and pine, primarily on former agricultural fields and steep hillsides. Steve and Patty have owned the property since 1988, and they first started planting trees on it in 1992. They have pine plantations they planted in 1995 and 1996 that have just been thinned for the first time. There are oak trees that were planted on the property that are now producing acorns. This afforestation has simultaneously decreased erosion as well as increase carbon sequestration on the property.

The trees also serve as an important crop on the Harelson farm, contributing to a diversity of products and income sources on the family's land. They completed an oak harvest on the property in 2020 and planted oak and spruce in 2021.

Steve and Patty were also nominated for the American Tree Farmers of the Year for Monroe County in 1998 and went on to be chosen as Area Tree Farmers of the Year for District 14 which included Monroe, Vernon, Crawford, and Juneau Counties. All of the Harelson's work on the property will produce quality trees and wildlife habitat well into the future.

Grasslands and Prairies

Grasslands of the Midwest hold great potential for increasing climate resiliency, with added benefits for biodiversity, wildlife habitat, and carbon storage. Grasslands include both managed pastures that may be dominated by cool season grasses and used for livestock, and native prairies (native grasslands) dominated by warm season grasses as well as native wildflowers. Grasslands may occur on a range of sites from extensive formerly cultivated agricultural lands, to riparian buffers, to small remnant prairies on hilltops.

Grass cover can serve multiple purposes - in pastures, with native grasses for wildlife habitat, and as a component of flood control structures.

Grasslands store most of their carbon underground, in their roots and deep into the soil. This deep root system makes grasslands reliable "carbon sinks" because their carbon is stored in the soil and is not released back into the atmosphere when grazed or burned. A landscape consisting of grasslands, along with forests, wetlands, and annual cropping, will contribute to a diverse "portfolio" of land uses that will contribute to a more resilient, adaptable landscape.

Existing remnant and restored prairies in Monroe County include portions of the La Crosse River Trail Prairie and areas of the Fort McCoy Military Reservation. The drier Monroe County portion of the La Crosse River Trail prairie remnant includes species such as white wild indigo, lead-plant, prairie bush-clover, plains larkspur, pasqueflower, prairie coreopsis, stiff cinquefoil, thimbleweed, and more (WDNR).

Grassland restoration can be conducted on a gradient of natural wildlands to integrated working lands and even urban backyards. Large-scale prairie restoration, while potentially costly and effort-intensive, can store carbon, provide wildlife habitat and recreation opportunities, and create essential habitats for pollinators. Grasslands can be part of a broad spectrum of working lands options that generate income from pasture, agro-forestry, or from grass-based biofuels. Native wet prairie plantings can also be used in bioswales, detention basins, and rain gardens in urban and suburban areas.

Waterways and Wetlands

Lakes, streams, and wetlands offer many ecosystem services, including water quality improvement, flood mitigation, and wildlife protection. However, because they continuously funnel precipitation from the surrounding landscape, they are sensitive even to distant land-use activities.

Protecting and restoring waterways and wetlands in targeted locations can be one of the most effective strategies for reducing flood risks and increasing resiliency.

Wetland restoration contributes multiple benefits in capturing and storing flood waters, filtering and capturing sediments, and providing habitat for fish and wildlife.

Monroe County has some of the best conditions in southern Wisconsin to become a trout fishing destination, even as the climate warms. Spring-fed streams help keep water temperatures cool despite rising ambient temperatures, and topographic features help to provide natural shade. Despite this, without good stewardship, even the highest quality coldwater fisheries will be at risk.

Restoring the functions of rivers and streams may require bank restoration, establishing riparian buffers beyond the banks, and restoring or reconnecting adjacent wetlands to improve the natural capacity for these systems to withstand a changing climate.

Reconnecting streams to their floodplains and restoring ditches to natural channels will help divert and disperse surface flows to reduce flood severity and associated impacts.

Wetlands (including marshes, swamps, fens, and bogs) act as sponges, absorbing water during times of excess (i.e. flooding) and serving as critical storage of water during drier times. The water management services of a functioning wetland are almost always more cost-effective to maintain than the cost of designing, building, and maintaining engineered solutions. Wetlands are also optimal natural environments for sequestering and storing carbon from the atmosphere.[16]

Restoring wetlands or other natural land cover along streams, especially on marginally productive land (see Appendix VII) and in watersheds with high restoration potential is one of the most effective strategies for increasing resiliency.

Agricultural Lands

The farm conservation toolbox is full of practices designed to limit soil erosion, reduce and redirect runoff, improve nutrient efficiency, and support more sustainable farming systems. While many farm practices and conservation programs were intended to meet soil and water quality goals, they may be equally robust and effective in adapting to a changing climate.

Cover crops increase soil protection and rainfall infiltration in spring and fall.

Climate-smart farming can help farms remain productive, maintain a strong agricultural economy, and create the potential to generate carbon credits that can be sold in carbon offset markets.

Practices that improve infiltration and create conservation cover also generally provide co-benefits of protecting water quality and storing carbon. Re-thinking farms through a carbon lens can help reduce the effects of climate change, create resilient landscapes, and meet water quality goals. Our recommendations (see Section 8) are focused on building resilient soils while supporting land use practices that keep water on the land, slow the flow of runoff to streams, and buffer waterways from excess nutrient runoff.

Climate-smart farming practices include most traditional conservation practices as well as newly developed concepts, and can include (but are not limited to):

- Cover crops for soil conservation
- Buffer strips at field edges
- Prairie strips within row crops
- Agro-forestry or silvopasture practices blending tree and grassland elements
- Producing bio-fuels from switchgrass

For greater detail on these practices, see Appendix VI.

Re-thinking the landscape through an integrated carbon lens will promote farms as the solution to complex conservation problems, much like the county did 90 years ago when the Soil Conservation Service started in the Coon Creek Watershed.

Organic farmer Tucker Gretebeck discusses conservation practices on his farm in Monroe County.

Tucker and Becky Gretebeck Farm: A "Rural Renaissance"

In the warm afternoon sun of August 4, 2021, with remnant smoke of Canadian wildfires still hanging in the valleys, organic farmer and dairy producer, Tucker Gretebeck, discussed the challenges and successes associated with transitioning to a sustainable farm, and the reasons behind his hard work. Gretebeck cited a trip to a spring-fed creek as a transformative moment in his operation. The creek, once cool and clear and a favorite place for his children, was now stagnant, green, and murky due to nutrient offloading and erosion.

Gretebeck, along with his wife Becky, owns and operates a dairy farm with 50 grass-fed cows in Monroe County. The couple have been implementing sustainable practices, including permanent cover crops and tree plantings to increase the resilience of their land, which has been passed down over generations.

Alongside the dairy operation, the Gretebecks also own 10 acres of land in the valley below the farm on which they have spent the last several years growing an agri-tourism business based on a pick-your-own pumpkin patch. The Gretebecks were growing this portion of their business, using a 150-year-old tobacco shed, which they had restored and commissioned area artists who painted the shed with murals of original artwork. Their annual pumpkin event was drawing in more than 4,000 people annually and a sense of community around the farm was growing.

Then, the August 28th, 2018 storm came through the valley.

During this historic storm, an NCRS dam, located above the pumpkin patch, gave way, destroying and washing away everything in its path, including the Gretebeck's tobacco shed and pumpkin patch. Despite all the work the Gretebecks have done to improve their land, the storm proved to be too much for the historic shed and other buildings in their valley. Despite setbacks, the community came together to help the Gretebeck's rebuild, and Tucker and Becky continue to look for more ways to improve the resiliency of their land.

Learn more about Tucker and Becky's story here: https://www.organicvalley.coop/blog/farm-art-cooperative-spirit/

Mapping Conservation Opportunities

As a concluding step in our assessment, we performed an analysis to identify priority sites for restoration to help guide management action and maximize effectiveness of limited financial and logistical resources.

Our analysis focused on identifying areas of the landscape with the best opportunities to "slow the flow" of flood waters and provide other co-benefits such as wildlife habitat, carbon sequestration, and water quality improvements. Conserving or restoring floodplain ecosystems through reforestation, riparian buffers, and wetlands/forested wetlands is a common example of a nature-based approach to slowing the flow.

Analysis and Results

Our analysis of conservation opportunities focused on three priorities for improving climate resiliency through targeted restoration of lands and waters in watersheds throughout Monroe County.

1). Establishing forest cover on marginal and highly erodible soils

We identified reforestation opportunities using The Nature Conservancy's Reforestation Hub mapping tool, that we modified and refined to improve accuracy. This resulted in identifying nearly **23,000 acres** of land amenable to reforestation in Monroe County.

2). Restoring potentially restorable wetlands (PRWs)

We identified potentially restorable wetlands as historic wetlands (open marsh, emergent wetland, forested wetland etc.), with hydric soils, not currently mapped as a wetland, and with a land use compatible with restoration techniques. A total of 78,652 acres of PRWs have been identified by the WDNR in Monroe County. By prioritizing PRWs with the greatest potential to slow and absorb floodwaters, we identified **2,470 acres of high-priority PRWs** in the county. Many of these are in the southern portion of the county where flood damage has been greatest.

3). Restoring riparian buffers

We identified areas amenable to restoration of riparian (streamside) buffers by first identifying non-buffered streams in crop rotation areas (within 100 feet of a stream). This 100-foot "general" buffer distance has been demonstrated in the research to provide streambank stability, stream shading (where applicable), some level of floodwater control, and sediment control, under "typical" storm events. We further prioritized areas needing streamside buffers as those being within 450 feet of a high slope (>30% grade). This resulted in **2,588 acres of high-priority streamside buffers** identified.

For detailed description of our methods and results for mapping conservation opportunities see Appendix VII.

Figure 17 provides a detailed look at the results of the restoration opportunities identified for the Moore Creek watershed, while Figure 18 provide county-wide results.

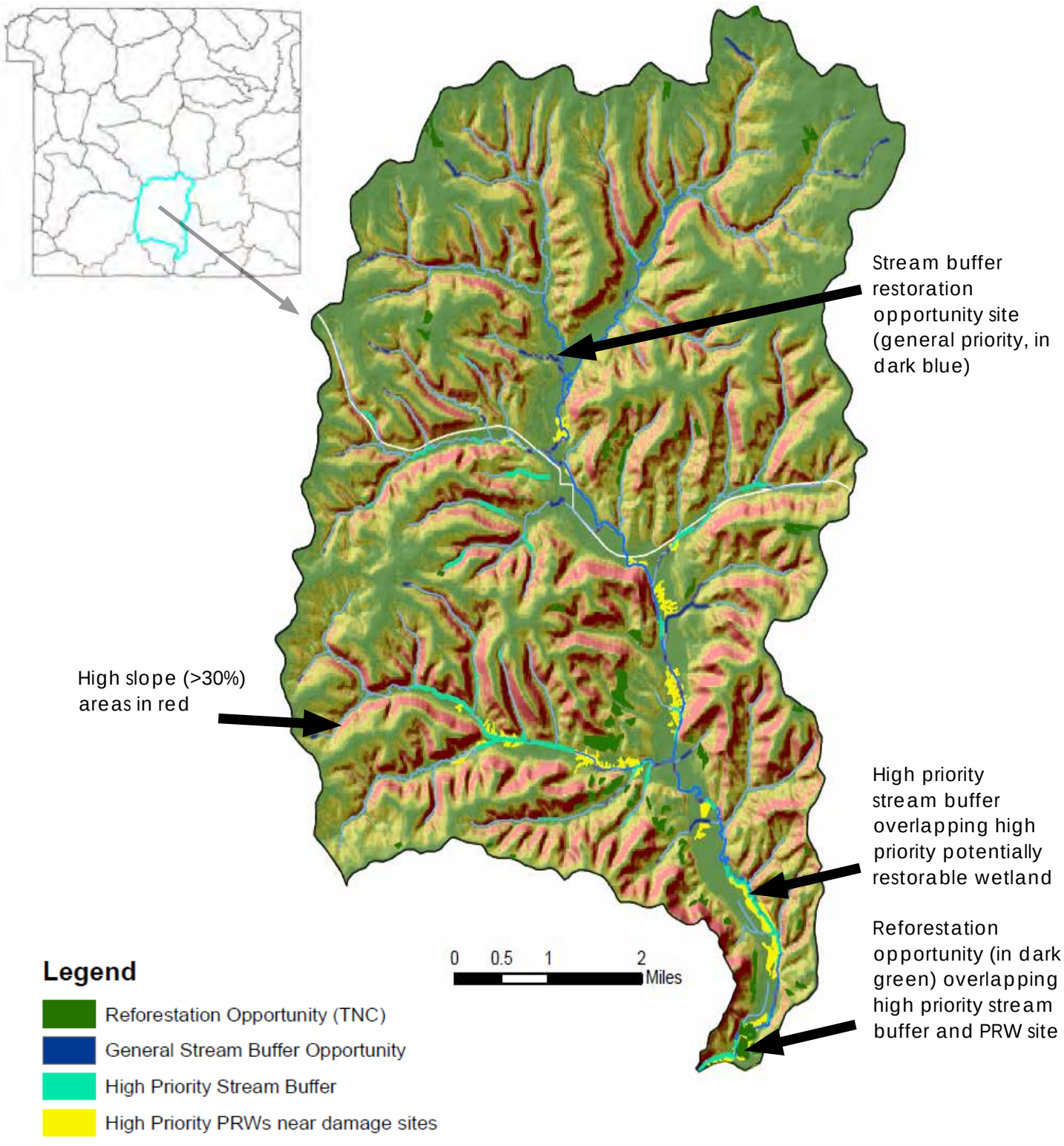


Figure 17. *Restoration opportunities identified in the Moore Creek watershed showing reforestation opportunity, general and high priority stream buffer needs, and high priority potentially restorable wetlands.*

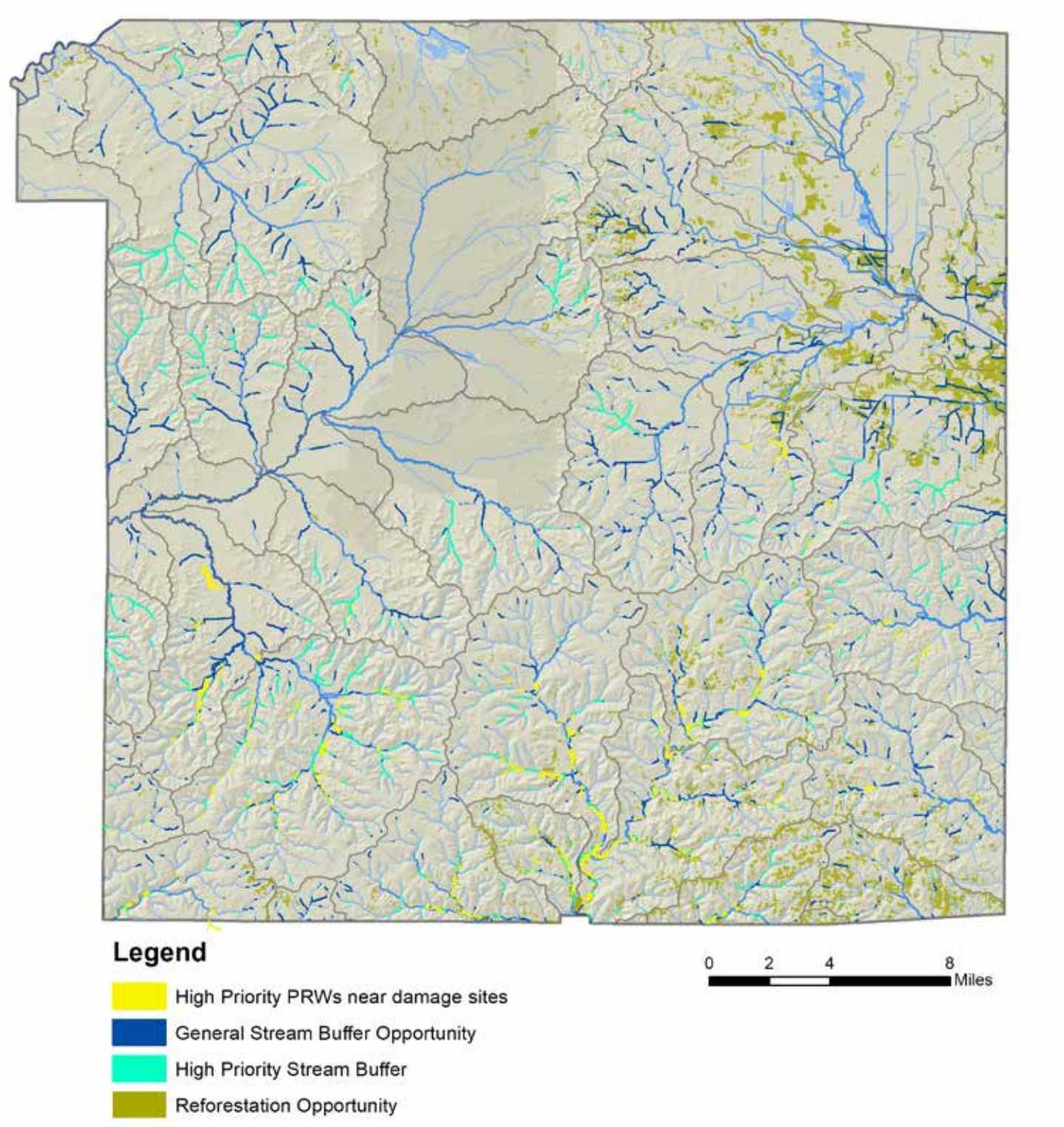


Figure 18. *County-wide results of restoration opportunity analysis.*

See Appendix VII for a breakdown of high-priority restoration acreages by watershed.

7 RECOMMENDATIONS

Based on our CRREOA assessment, our technical teams have developed 80 distinct recommendations. The recommendations provided here are a synthesis of several different activities and sources of input based on our team's best judgement and on all the input available to us.

These recommendations are grouped by subject area: **Resilient Infrastructure**; **Resilient Watersheds**; **Resilient Agriculture**; and **Resilient Forests,** and a final section on **State and Federal Policy**.

Our four technical sub-teams (Climate and Hydrology; Floodplains and Infrastructure; Agriculture; Forestry) each developed findings and recommendations based on team discussions. Additional suggestions for recommendations were provided by members of the Monroe County Climate Change Task Force, and from county residents during our public engagement sessions.

The final recommendations listing is the summary of all those inputs, with review from our advisors, and final review and approval from members of our Core Team. We have included the primary and secondary entities that can play a lead role in implementing each recommendation.

The following pages are organized around five subject areas:

- Resilient Infrastructure
- Resilient Watersheds
- Resilient Agriculture
- Resilient Forests
- State and Federal Policy

For complete recommendations with implementation notes see https://wigreenfire.org/community-climate-resiliency/

Recommended Strategies - Infrastructure

Sector	Strategy	Action	Responsible or Lead Party	Secondary Party	Public Safety	Resiliency	Soil, Air, Water	Carbon
Resilient Infrastructure	1. Invest in Enhanced Floodplain Risk Assessments	1.1 Review additional floodplain risk assessments to supplement FEMA maps and incorporate into future land use planning and project reviews.	Counties, Cities, and Villages		+	+		
		1.2 Complete a geospatial data set for buildings > 600 sq. ft. and their associated flood risk zone(s)	Counties, Cities, and Villages		+	+		
		1.3 Use the improved topography developed from the County's digital elevation model (DEM) to contribute to floodplain hydraulic modeling.	WI DNR	Monroe County	+	+		
		1.4 Review stormwater management standards across jurisdictions	Counties, Cities, and Villages	WI DNR	+	+		
		1.5 Inspect and evaluate stream corridors in flood risk areas	Monroe County	Farmers and Forest Owners	+	+	+	
		1.6 Use rainfall runoff analyses using transposition of the August 2018 storm to explore flooding vulnerability in selected watersheds	Monroe County	Non-government Entities	+	+		
		1.7 Evaluate the extent of cleanup and remaining toxicity of Superfunds and Brownfields sites in or near floodplains throughout the county, especially in urban areas.	Local Units of Government	Monroe County	+	+	+	
	2. Improve Assessments and Reduce Risks Associated with Dams	2.1 Work with WDNR's Dam Safety program to update WDNR's dam database and make sure emergency action plans are integrated with Monroe County Emergency Management.	WI DNR	Monroe County	+	+		
		2.2 Encourage small dam owners to maintain and inspect dams regularly, especially after large storms.	WI DNR	Private Citizens	+	+		
		2.3 Assess and implement recommendations of the NRCS PLAN-EIS for Coon Creek and the West Fork of the Kickapoo.	WI DNR	NRCS	+	+		
		2.4 Use existing zoning authority to prevent new construction in a dam's hydraulic shadow.	Monroe County	Local Units of Government	+	+		
		2.5 Work with WDNR to ensure consistent assessment of dams' effects on aquatic connectivity and fish migration.	WI DNR	Monroe County	+	+	+	

Recommended Strategies - Infrastructure (Continued)

Sector	Strategy	Action	Responsible or Lead Party	Secondary Party	Public Safety	Resiliency	Soil, Air, Water	Carbon
Resilient Infrastructure	3. Improve Assessments and Reduce Risks Associated with Roads / Stream Crossings	3.1 Continue and complete the County's 2021 stream crossing survey	Monroe County	Local Units of Government	+	+	+	
		3.2 Continue to expand installation of stream monitoring gauges in at-risk watersheds.	Monroe County	Non-government Entities	+	+		
		3.3 Inform new infrasturcture project design, such as road-stream crossings or stormwater conveyance, with rainfall statistics from the Wisconsin Rainfall Project	Monroe County	WI DOT	+	+		
		3.4 Request WDNR increase its technical assistance for improved aquatic connectivity.	WI DNR	Local Units of Government	+	+	+	
		3.5 Coordinate road repair needs across all jurisdictions.	Monroe County	WI DOT	+	+	+	
		3.6 Target and advocate for increased funding for road / stream crossing infrastructure needs.	Monroe County	Local Units of Government	+	+		
	4. Increase Capacity for Stormwater Storage to Reduce Flood Risks	4.1 Increase the extent and the width of permanent vegetative cover along streams	Monroe County	Farmers and Forest Owners		+	+	+
		4.2 Maintain and/or restore wetlands and other natural land cover along streams	Monroe County	Farmers and Forest Owners	+	+	+	+
		4.3 Reconnect surface waters to their floodplains	Monroe County	Farmers and Forest Owners		+	+	
		4.4 County coordination with municipalities in stormwater managemen across boundaries, and more robust project design for facilities, and enhancing greenspaces.	Monroe County	Local Units of Government	+	+		
		4.5 Utilize the HUC 12 watershed assessments from this assessment in project planning	Monroe County	Farmers and Forest Owners	+	+	+	

Recommended Strategies - Watersheds

Sector	Strategy	Action	Responsible or Lead Party	Secondary Party	Public Safety	Resiliency	Soil, Air, Water	Carbon
Resilient Watersheds	5. Improve Aquatic Connectivity to Reduce Barriers to Fish and Aquatic Organisms	5.1 Prioritize aquatic connectivity in road design	WI DOT	Monroe County		+	+	
		5.2 Ensure quality control in road crossing inventories.	Monroe County	WI DNR	+	+	+	
		5.3 Incorporate aquatic connectivity into highway project designs.	WI DOT	WI DNR		+	+	
		5.4 For non-WisDOT projects ensure that culvert replacements address aquatic connectivity.	WI DNR	Local Units of Government	+	+	+	
	6. Ensure Viable Fish Populations and a Robust County Fishery	6.1 Prioritize climate adaptation efforts in watersheds with high-quality trout fisheries.	WI DNR	Monroe County		+	+	
		6.2 Engage state, local and federal partners in fishery restoration and promotion.	WI DNR	Monroe County		+	+	+
		6.3 Build on the WDNR designation of Brook Trout Reserve #14 in north and west central watersheds.	WI DNR	Monroe County		+	+	
	7. Maintain and Improve Watershed Resiliency	7.1 Make the business and economic development case for watershed conservation and compatible uses.	Monroe County	Non-government Entities	+	+	+	
		7.2 For the highest risk watersheds, adopt tailored strategies to enhance resiliency.	Monroe County	Farmers and Forest Owners	+	+	+	+
		7.3 Ground truth and assess feasibilty of potential restoration and improvement projects	Monroe County	Farmers and Forest Owners	+	+	+	

Recommended Strategies - Agriculture

Sector	Strategy	Action	Responsible or Lead Party	Secondary Party	Public Safety	Resiliency	Soil, Air, Water	Carbon
Resilient Agriculture	8. Increase Conservation Practices and Reduce Flood Severity and Soil Disturbance	8.1 Expand adoption of climate-smart farm conservation practices with co-benefits that meet water quality goals.	Monroe County	NRCS		+	+	+
		8.2 Increase resiliency to flooding by increasing continuous living cover on agricultural land.	Monroe County	NRCS	+	+	+	+
		8.3 Reduce environmental risks from flooding by reducing vulnerabilities from liquid manure storage.	Monroe County	WI DNR	+	+	+	+
		8.4 Reduce greenhouse gas emissions and manage producer costs through improved nutrient and manure management.	Monroe County	WI DNR	+	+	+	+
		8.5 Significantly increase funding and staffing resources for the County Land Conservation program to aid adoption of climate-smart conservation practices (see 16.5).	Monroe County	Wisconsin Legislature	+	+	+	
		8.6 Increase cost-share incentive funding to producers in prioritized high risk landscapes.	Monroe County	NRCS	+	+	+	
		8.7 Promote the work of private partners promoting conservation in agriculture.	Monroe County	Non-government Entities		+	+	
		8.8 Build on relationships with state and federal agencies to leverage funding and pilot program opportunities.	Monroe County	Non-government Entities	+	+	+	

Recommended Strategies - Agriculture (Continued)

Sector	Strategy	Action	Responsible or Lead Party	Secondary Party	Public Safety	Resiliency	Soil, Air, Water	Carbon
Resilient Agriculture (Continued)	9. Manage Farm Carbon	9.1 Protect farm carbon stocks by avoiding conversion of agricultural lands to development	Monroe County	Farmers and Forest Owners	+	+	+	+
		9.2 Protect carbon stocks by maintaining grasslands and working lands in permanent cover	Monroe County	Farmers and Forest Owners		+	+	+
		9.3 Quantify the carbon benefit of conservation practices that promote climate resiliency and soil and water protection.	Monroe County	Non-government Entities		+	+	+
		9.4 Emphasize carbon accounting and whole farm carbon planning as a routine aspect of farm management.	Monroe County	Non-government Entities		+	+	+
		9.5 Assess county-wide opportunities for farm carbon management.	Non-government Entities	Farmers and Forest Owners		+	+	+
	10. Farm Producer Education and Outreach	10.1 Identify and support demonstration farms that highlight climate resilient landscapes.	Monroe County	Farmers and Forest Owners	+	+	+	
		10.2 Promote establishment of Producer Led Watershed group(s) in Monroe County.	Farmers and Forest Owners	WI DATCP		+	+	+
		10.3 Conduct demonstration trials for newer practices and those requiring more information for successful adoption.	Farmers and Forest Owners	WI DATCP		+	+	+
		10.4 Identify and promote crops and farm business models that align with conservation land uses.	Farmers and Forest Owners	Monroe County		+	+	+

Recommended Strategies - Resilient Forests

Sector	Strategy	Action	Responsible or Lead Party	Secondary Party	Public Safety	Resiliency	Soil, Air, Water	Carbon
								
Resilient Forests	11. Maintain Productive Forests Through Active Forest Stewardship	11.1 Manage invasive species to minimize impacts on forest productivity	WI DNR	Farmers and Forest Owners		+	+	
		11.2 Increase use of prescribed fire management, especially for oak forests.	WI DNR	Farmers and Forest Owners		+	+	
		11.3 Provide technical resources and labor to improve understocked or degraded forests.	Monroe County	Non-government Entities		+	+	+
		11.4 Increase the number of private forest landowners with forest stewardship plans	WI DNR	Farmers and Forest Owners		+	+	
	12. Identify and Apply Climate-smart and Carbon-focused Forest Management	12.1 Train forest managers to use Southern Wisconsin Climate Change Field Guide	WI DNR	Farmers and Forest Owners		+	+	+
		12.2 Train forest managers in carbon forest management principles and carbon offset market opportunities	WI DNR	Non-government Entities		+	+	+
		12.3 Select and promote use of climate-adapted species for planting	WI DNR	Non-government Entities		+	+	+
		12.4 Increase forest resiliency through more robust design standards for forest roads and infrastructure	WI DNR	Farmers and Forest Owners	+	+	+	

Recommended Strategies - Resilient Forests (continued)

Sector	Strategy	Action	Responsible or Lead Party	Secondary Party	Public Safety	Resiliency	Soil, Air, Water	Carbon
Resilient Forests	13. Protect Forest Cover and Maintain Forest Carbon Stocks	13.1 Emphasize protecting existing forest cover in local and county comprehensive planning	Monroe County	Local Units of Government	+	+	+	+
		13.2 Establish a state property tax incentive for lands and practices that store and protect carbon stocks	Wisconsin Legislature	WI DNR		+	+	+
		13.3 Encourage state and private partners to help forest owners access forest carbon offset markets	Non-government Entities			+	+	+
	14. Establish New Forests and Conservation Cover Through Reforestation and Restoration	14.1 Use watershed-level opportunity assessments to target forest restoration with climate adapted-species on marginal, highly erodible, and high-risk lands	WI DNR	Farmers and Forest Owners	+	+	+	+
		14.2 Use trees as part of agro-forestry restoration efforts with agricultural land uses.	Non-government Entities	Farmers and Forest Owners		+	+	+
		14.3 Promote conservation and restoration of rare forest natural communities, such as woodlands and barrens, as well as ephemeral ponds, springs and seeps, sand blows, and dry prairies.	WI DNR	Farmers and Forest Owners		+	+	+
		14.4 Increase programs and funding to increase tree cover and greenspaces in communities.	Local Units of Government	WI DNR	+	+	+	+

Recommended Strategies - State and Federal Policy

Sector	Strategy	Action	Responsible or Lead Party	Secondary Party	Public Safety	Resiliency	Soil, Air, Water	Carbon
State and Federal Policy	15. Increase Infrastructure Resiliency Investments	15.1 Assess and secure funding through federal Infrastructure Investment and Jobs Act of 2021 (IIJA).	WI DOT	Local Units of Government	+	+		
		15.2 Target funding for road stream crossing improvements through WDOT Local Roads Improvement Program (LRIP).	WI DOT	Local Units of Government	+	+		
		15.3 Reform FEMA policies to allow building back safer and stronger.	FEMA	U.S. Congress	+	+		
	16. Increase Support for Soil and Water Conservation and Climate Resiliency	16.1 Assess and secure conservation funding through federal Infrastructure Investment and Jobs Act of 2021 (IIJA).	WI DNR	Monroe County	+	+	+	+
		16.2 Increase funding for the WI Forest Landowner Grant Program (WFLGP)	Wisconsin Legislature	WI DNR		+	+	+
		16.3 Enhance / Increase funding for Landowner Incentive Program (LIP).	Wisconsin Legislature	WI DNR		+	+	+
		16.4 Increase funding for Urban Forestry Grant Program	Wisconsin Legislature	WI DNR	+	+	+	+
		16.5 Provide state funding resources for County Land Conservation program staff using the statutory 100% / 70% / 50% formula on a long-term basis.	Wisconsin Legislature	Monroe County	+	+	+	+

Recommended Strategies - State and Federal Policy (Continued)

Sector	Strategy	Action	Responsible or Lead Party	Secondary Party	Public Safety	Resiliency	Soil, Air, Water	Carbon
State and Federal Policy	17. Tax Policy to Support Soil and Water Conservation and Climate Resiliency	17.1 Broaden Use Value Criteria to Incentivize Land Conservation	Wisconsin Legislature	WI DATCP		+	+	+
		17.2 Reforestation / Conservation Income Tax Credit	Wisconsin Legislature	WI DATCP		+	+	+
		17.3 Broaden / Expand Managed Forest Law	Wisconsin Legislature	WI DNR		+	+	+
		17.4 Establish a farm carbon program at DATCP	Wisconsin Legislature	WI DATCP		+	+	+
		17.5 Eliminate or reduce federal incentives for annual cropping on Highly Erodible Soils (H.E.L.) and floodplains.	NRCS	U.S. Congress				
	18. Facilitate market-based and private sector opportunities for conservation funding.	18.1 Facilitate access to family forest carbon credit programs for small woodland owners.	Non-government Entities	Farmers and Forest Owners		+	+	+
		18.2 Support private sector investment in green infrastructure for small communities.	Non-government Entities	Local Units of Government		+	+	+
		18.3 Facilitate access to carbon offset markets and carbon insetting within supply chains for ag producers.	Non-government Entities	Farmers and Forest Owners		+	+	+

8 NEXT STEPS

The Monroe County Climate Resilience and Rural Economic Opportunity Assessment is intended to identify both the risks and opportunities associated with a changing climate. **This assessment is not a plan,** and any actions taken to implement any of the recommendations we have provided will be based on decisions made by county leaders and by interested citizens.

Monroe County must clearly play a lead role in implementing actions around these recommendations; many other state and federal agencies and private partners will also need to be involved. **Most importantly, private farm and forest owners and private citizens will need to be actively involved in all stages of implementation**.

Available Federal Funding Opportunities

The passage of federal legislation since 2021 offers some significant one-time opportunities to help address some of the needs identified in the CRREOA project, and long-standing needs the County Climate Change Task Force has previously identified.

American Rescue Plan Act of 2021

The American Rescue Plan Act (ARPA) provided funding for local units of government under a Coronavirus State and Local Fiscal Recovery Funds Rule (SLFRF) published in May 2021. Included within the SLFRF are funds to counties and local units of government that can be used for a broad array of purposes consistent with replacing lost public sector revenue. Monroe County may use ARPA funds to help with planning and implementation of plans developed from the CRREOA project.

Infrastructure Investment and Jobs Act of 2021

The $1.2 trillion Infrastructure Investment and Jobs Act (IIJA), representing $550 billion worth of increased infrastructure investment, was signed into law on November 15th. Its goal is to modernize and expand currently declining US infrastructure, from roads to internet coverage to wildfire resilience. Authorizations within the IIJA relevant to this report include: Healthy Streets Program; Rural Surface Transportation grants; National Culvert Removal; Replacement, and Restoration Grant Program; National Dam Safety Program; Superfund and Brownfields Grant Program; Clean Water Revolving Loan Fund; Gulf Hypoxia Fund; and Wildfire Risk Reduction Funding.

Additional Analysis

Several of the areas touched on in the CRREOA project will require additional assessment to support effective actions. Some areas of additional assessment called for in our recommendations include:

- Better understanding of the particular needs of underserved and at-risk communities and ways they may be especially affected by climate change.
- Detailed analysis of structures in floodplains and structures at risk of flooding.
- Analysis of Superfund and Brownfield sites to determine level of risks and need for remedial actions.
- Detailed estimates of carbon offset potential from individual forest and agricultural practices.
- More refined analysis of Opportunity Areas within Monroe County Watersheds to identify areas where conservation priorities can be achieved and where existing conservation programs can be prioritized.
- Continued development of information on agriculture, forestry, and watershed restoration activities that are both economically viable and climate resilient.
- Analysis of renewable energy opportunities and planning needs.

Planning and Implementation

The findings and recommendations provided in this report were developed to build on current and past work around climate and support effective actions by leaders in Monroe County. A series of steps to move toward implementation would include the following activities:

- Selection of priority recommendations by county leadership and the Monroe County Climate Change Task Force.
- Group selected strategies based on outcomes and development of action plans and sequences for each strategy group with lead roles and partners identified.
- Identify and work to secure funding for planning and implementation of recommendations.
- Continue to engage with members of the public and key stakeholders in building support for and expanding community support for climate resilience activities.

Mainstreaming Climate Resilience

Climate resilience efforts began in Monroe County long before this assessment started and they will continue long afterwards. Especially with the advent of targeted, and mostly one-time, federal funding, there is an opportunity to move decisively on actions now that will help prepare the county for future climate changes while maintaining a productive and prosperous rural economy.

If successful, climate resilience will become a routine aspect of day-to-day work throughout Monroe County in activities ranging from conservation to public health, bringing multiple benefits for quality of life.


WISCONSIN'S
greenfire
VOICES FOR CONSERVATION


Monroe
County
Climate
Change
Task
Force