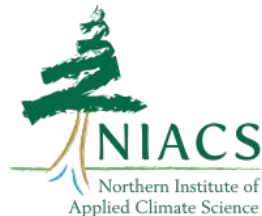


# Implementing Real-world Forestry Adaptation Solutions in Northeastern Wisconsin



Michigan  
Technological  
University

# Acknowledgements

## Partners:

- Florence County
- Sustainable Resources Institute
- Northern Institute of Applied Climate Science
- USDA Forest Service Northern Research Station
- Michigan Technological University
- Wisconsin Dept. of Natural Resources

## Funding:

- Climate Adaptation Fund, Wildlife Conservation Society

*The support to establish the Climate Adaptation Fund was provided by a grant to the Wildlife Conservation Society from the Doris Duke Charitable Foundation.*



# The Sustainable Resources Institute

A non profit corporation specializing in natural resource research, education, training and certification.

Interests include forestry projects ranging from certification of forest lands to harvesting urban wood to marketing.



## **Board of Directors**

President - Wendy Gehlhoff, Florence County Economic, Director

Treasurer - Thomas Steele, University of Wisconsin Kemp Natural Resources Station, Superintendent, retired

Board Member - Jane Severt, Wisconsin County Forest Association, Executive Director

# The Sustainable Resources Institute

## **Executive Director**

Donald Peterson, Renewable Resource Solutions, President

Sustainable Resources Institute contracts Renewable Resource Solutions for administration.

Renewable Resource Solutions staff:

- Donald Peterson, President
- Kari Divine, Office Manager
- Michelle Ross, Bookkeeper



# Presenters & Agenda

- **Stephen Handler, Northern Institute of Applied Climate Science**  
*Adaptation Workbook & climate change vulnerability assessment for northern WI*
- **Don Peterson, Sustainable Resources Institute**  
*Project overview*
- **Pat Smith, Florence County**  
*Project location, background, and implementation*
- **Robert Richard, Michigan Technological University**
- **Lynette Potvin, US Forest Service Northern Research Station**  
*Soil amendments: Experimental plot design and initial results*

# Northern Institute of Applied Climate Science



Climate

Carbon



ncasi



Michigan  
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University



College of Food, Agricultural  
and Natural Resource Sciences

UNIVERSITY OF MINNESOTA



The University of Vermont



[www.nrs.fs.fed.us/niacs/](http://www.nrs.fs.fed.us/niacs/)

# Working with forest managers

Invasive  
Species

Forest  
Ecology

Timber Sale  
Revenue

Wildlife  
Habitat

Forest  
Health

Past  
Management  
History

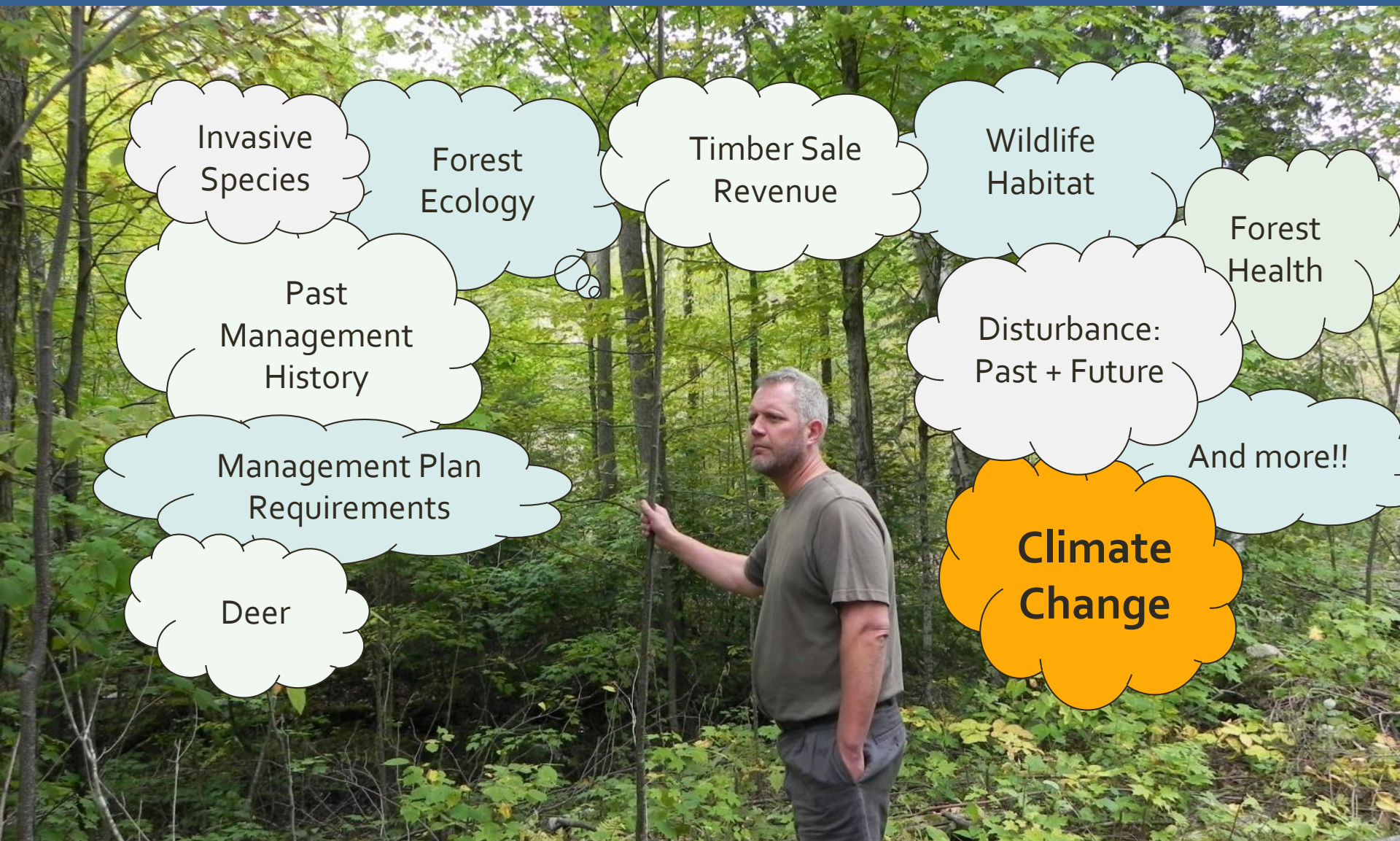
Disturbance:  
Past + Future

Management Plan  
Requirements

And more!!

Deer

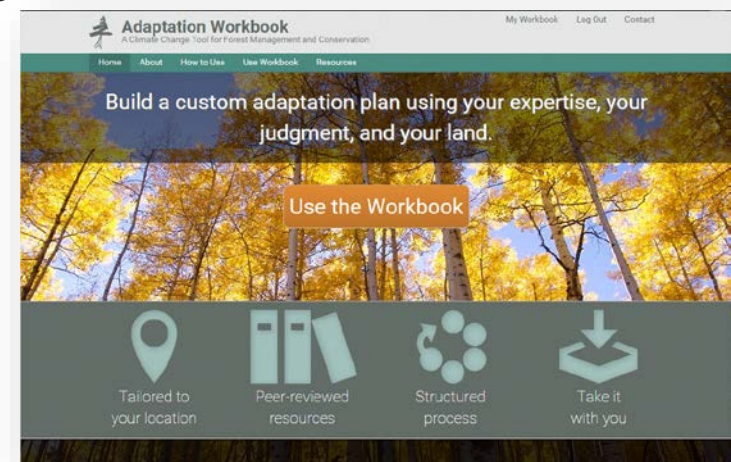
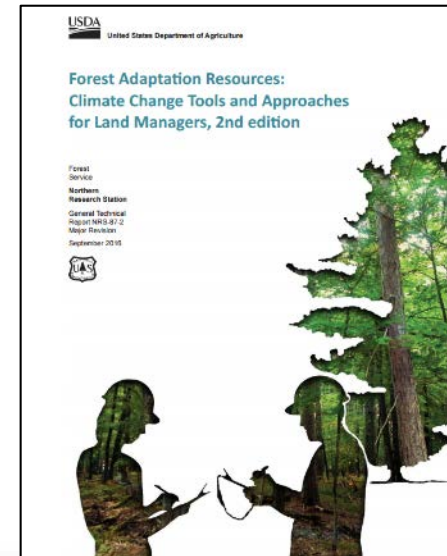
**Climate  
Change**



# A useful thought process

## *A flexible workbook and menu to address diverse needs*

- Designed for a variety of land owners with diverse goals
- Does not make recommendations
- Menu of adaptation strategies for forest management
- New versions – online and print!



# The Adaptation Workbook



# Real-world examples

*Case studies to help the whole community learn*



## Climate Change Response Framework

Home Our Approach Projects Demos Products Partners Resources Contact

● Start-Up ● Planning ● Action ● Complete

Central Appalachians

Central Hardwoods

Mid-Atlantic

New England

Northwoods

Urban

**Demonstration Projects**

Demonstration projects are real-world examples of how managers have integrated climate considerations into forest management planning and activities. These projects use the partnerships and resources developed through the Framework to test new ideas and actions for responding to changing conditions. Demonstrations come in all shapes and sizes, showing a variety of adaptation actions that also achieve forest management goals.

Project:  State:  Landowner Type:  Status:

**Stockbridge-Munsee Band of Mohican Indians**

The Stockbridge-Munsee Band of Mohican Indians, located in east-central Wisconsin, manages over 20,000 acres of forestland. Tribal forestry staff members recently attended a Forest Adaptation... [Read more](#)

News & Events

[Training Opportunities](#)

[Forest Adaptation Planning & Practices](#)

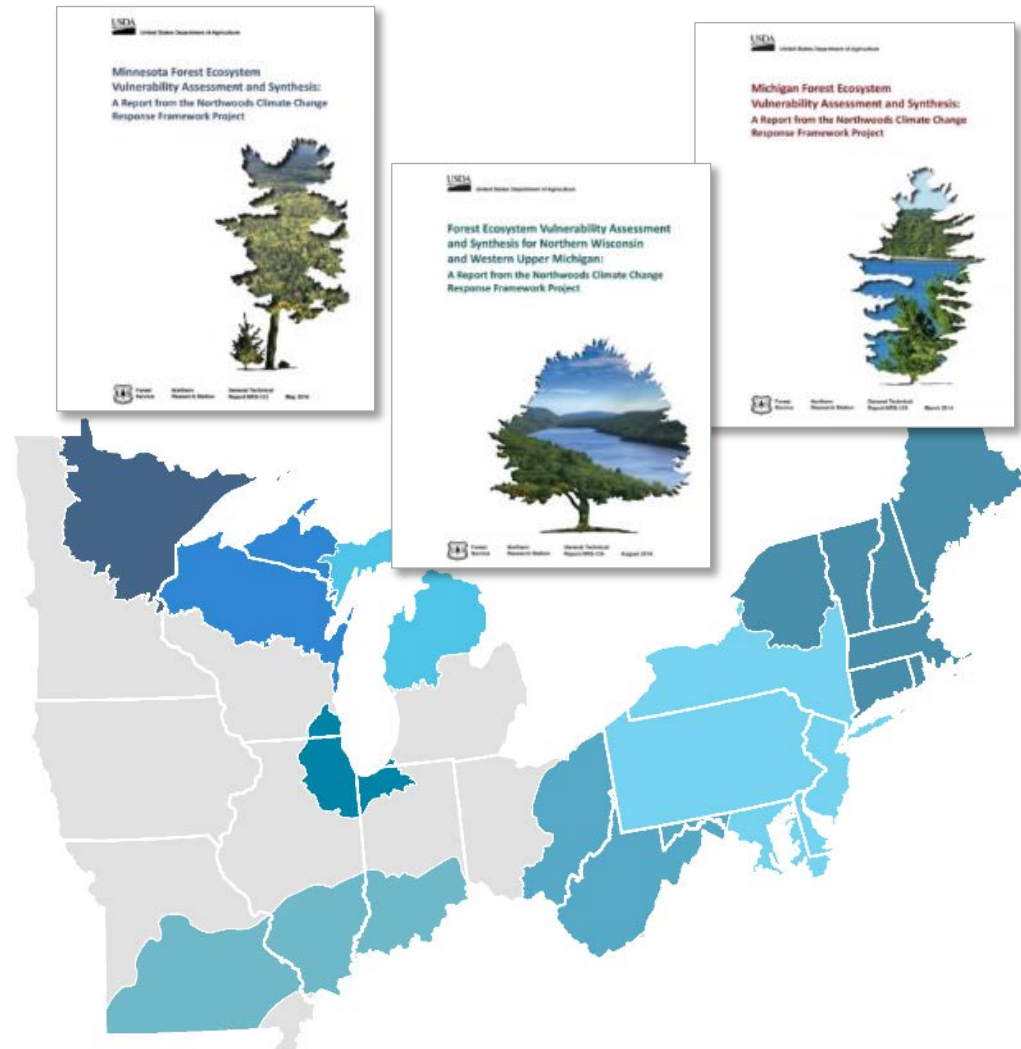
# The Adaptation Workbook



# Forest vulnerability assessments

## *Place-based, transparent, useful*

- Examine a **range** of future climates
- **Do not make recommendations**
- Sources of information:
  - Models
  - Published research
  - Local managers and experts



Download: <http://climateframework.org/vulnerability-assessment>

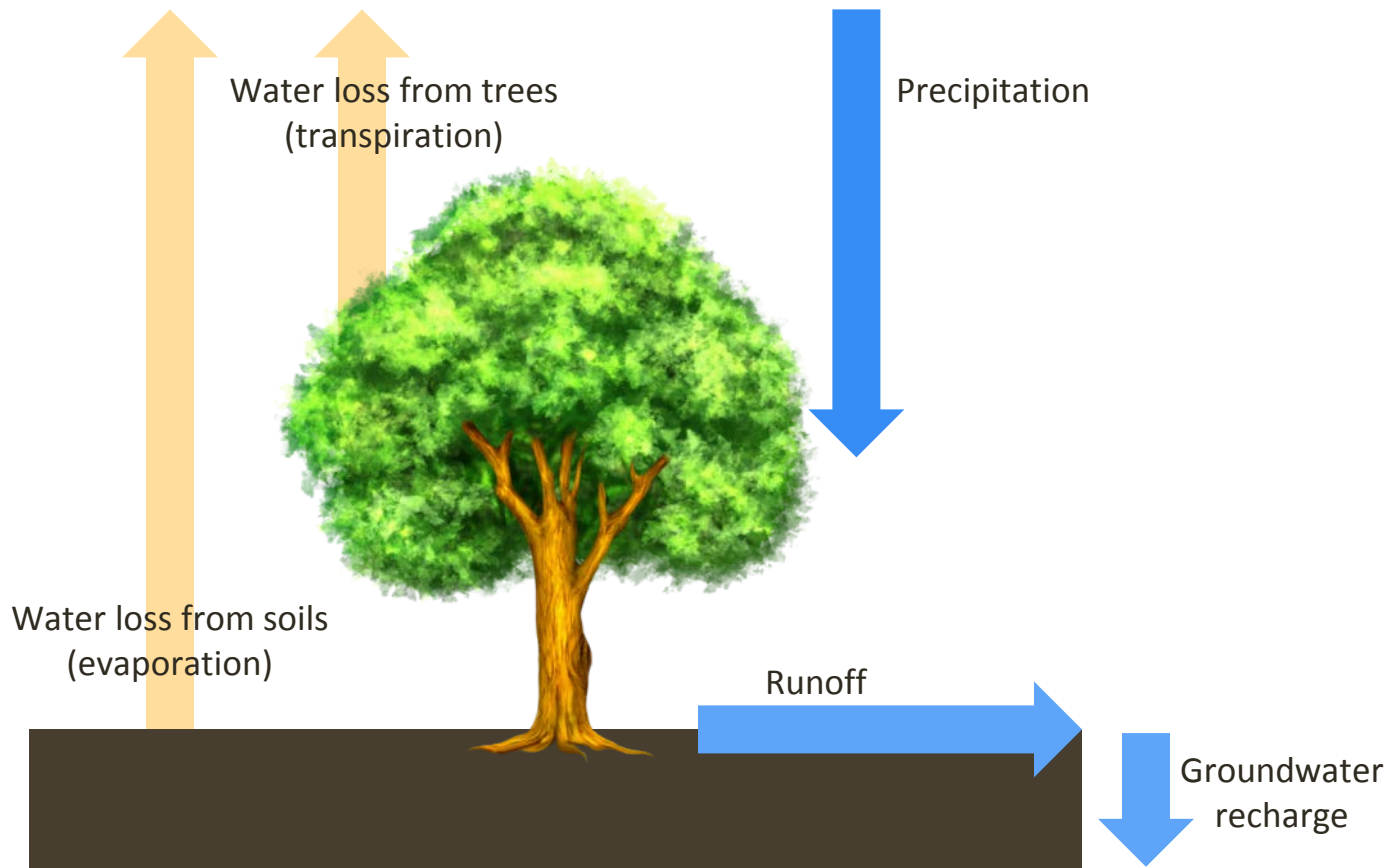
# Climate change impacts on forests

- Longer growing season
- CO<sub>2</sub> fertilization
- Altered soil moisture
- Extreme weather events
- Less frozen ground
- Increased fire risk
- Species range shifts
- Increased stressors



# Altered soil moisture

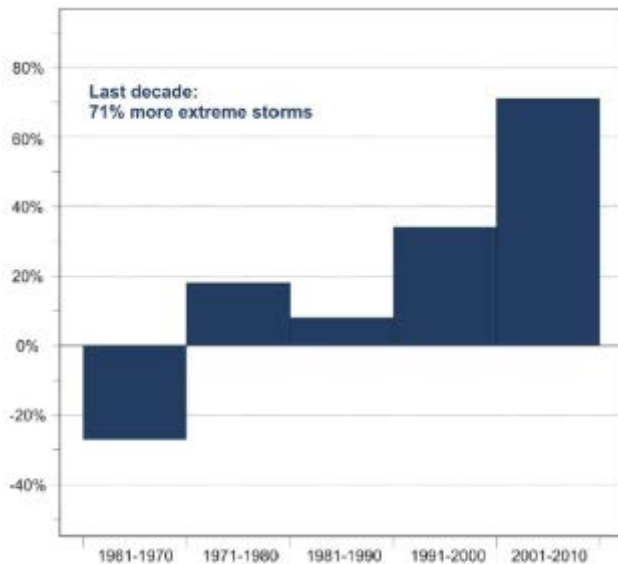
Greater uncertainty about future precipitation,  
but great risk of summer moisture stress



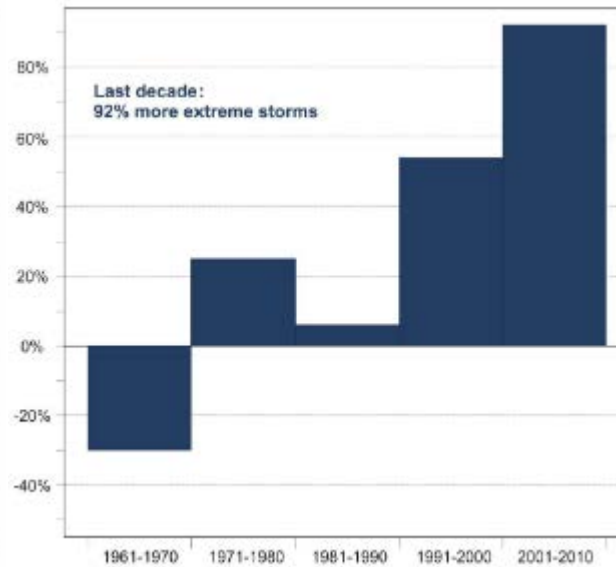
# Altered soil moisture

## *Frequency of 3"+ rainstorms*

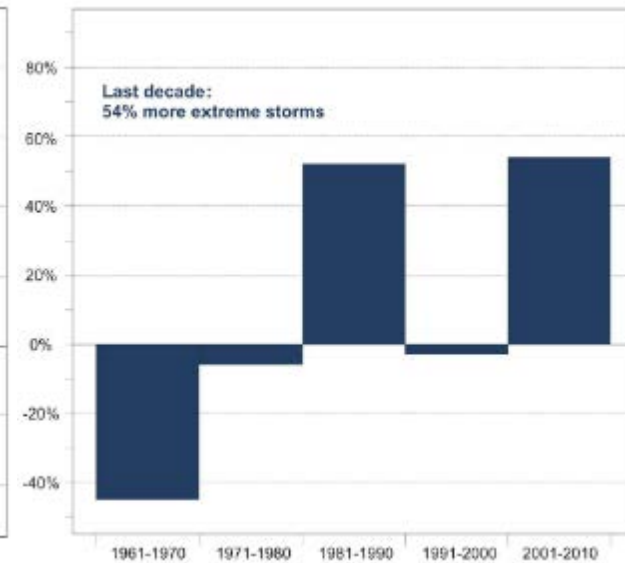
### Minnesota



### Wisconsin

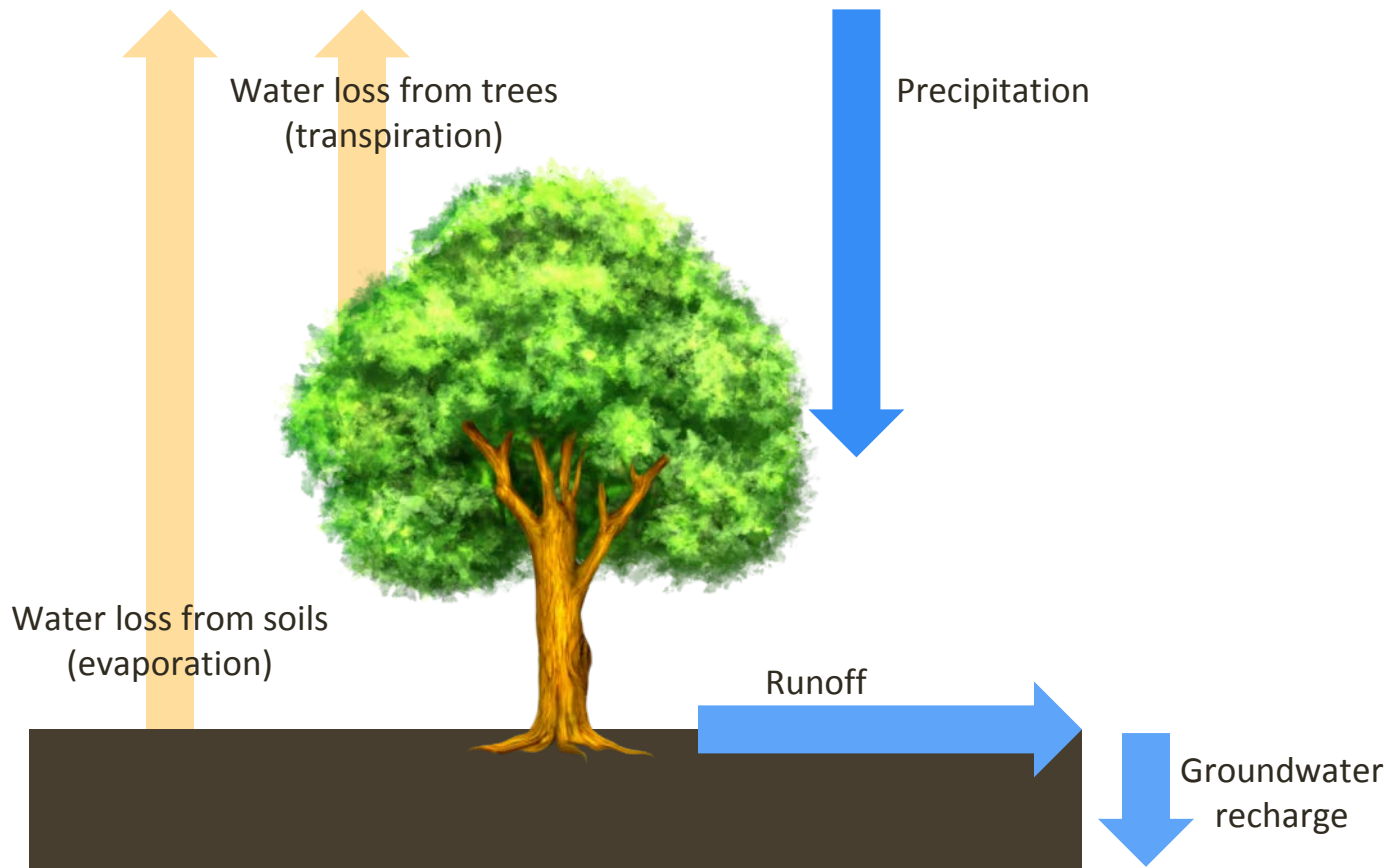


### Michigan



# Altered soil moisture

Greater uncertainty about future precipitation,  
but great risk of summer moisture stress

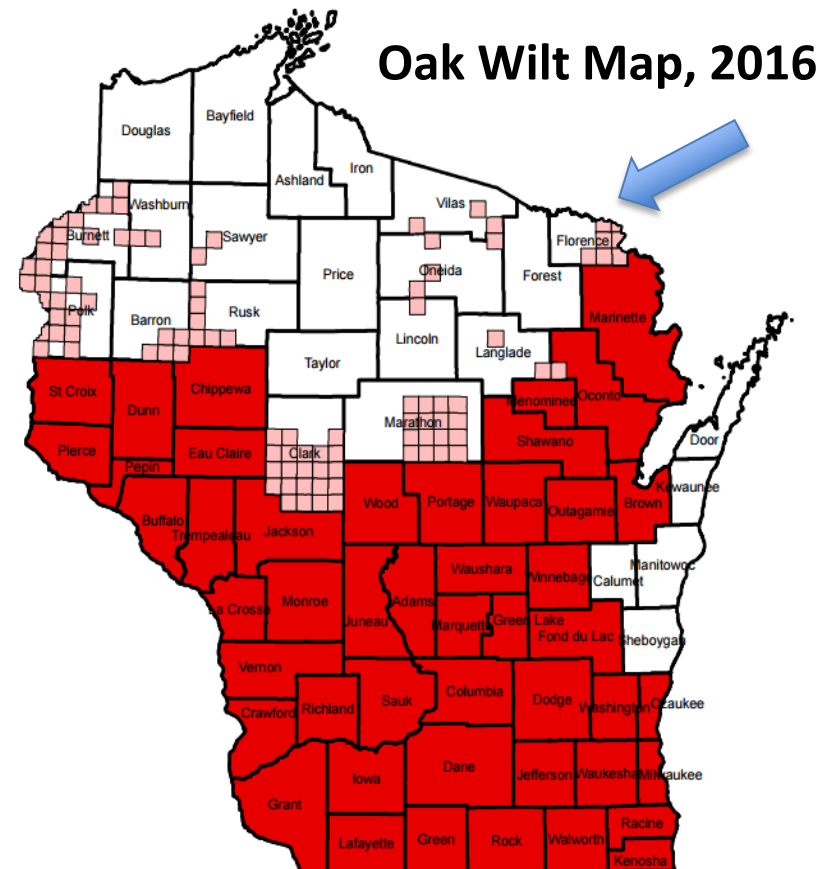


# Increased Stressors

*More drought leads to more damage from pests and diseases*



Two-lined chestnut borer, WI



# A menu of adaptation ideas



# A menu of adaptation ideas

## Menu of Adaptation Strategies and Approaches

### Strategy 1: Sustain fundamental ecological functions.

- 1a. Maintain or restore soil quality and nutrient cycling.
- 1b. Maintain or restore hydrology.
- 1c. Maintain or restore riparian areas.

### Strategy 2: Reduce the impact of existing biological stressors.

- 2a. Maintain or improve the ability of forests to resist pests and pathogens.
- 2b. Prevent the introduction and establishment of invasive plant species and remove existing invasives.
- 2c. Manage herbivory to protect or promote regeneration.

### Strategy 3: Protect forests from severe fire and wind disturbance.

- 3a. Alter forest structure or composition to reduce risk or severity of fire.
- 3b. Establish fuelbreaks to slow the spread of catastrophic fire.
- 3c. Alter forest structure to reduce severity or extent of wind and ice damage.

### Strategy 4: Maintain or create refugia.

- 4a. Prioritize and protect existing populations on unique sites.
- 4b. Prioritize and protect sensitive or at-risk species or communities.
- 4c. Establish artificial reserves for at-risk and displaced species.

### Strategy 5: Maintain and enhance species and structural diversity.

- 5a. Promote diverse age classes.
- 5b. Maintain and restore diversity of native tree species.
- 5c. Retain biological legacies.
- 5d. Restore fire to fire-adapted ecosystems.
- 5e. Establish reserves to protect ecosystem diversity.

This menu of adaptation strategies for forest management is drawn from the *Forest Adaptation Resources* document (Swanston and Janowiak 2012; [www.nrs.fs.fed.us/pubs/40543](http://www.nrs.fs.fed.us/pubs/40543)). These actions can be applied in combinations across a landscape or project area. Many of these items are already business as usual for sustainable forest management.

# Real-world examples

*Case studies to help the whole community learn*



## Climate Change Response Framework

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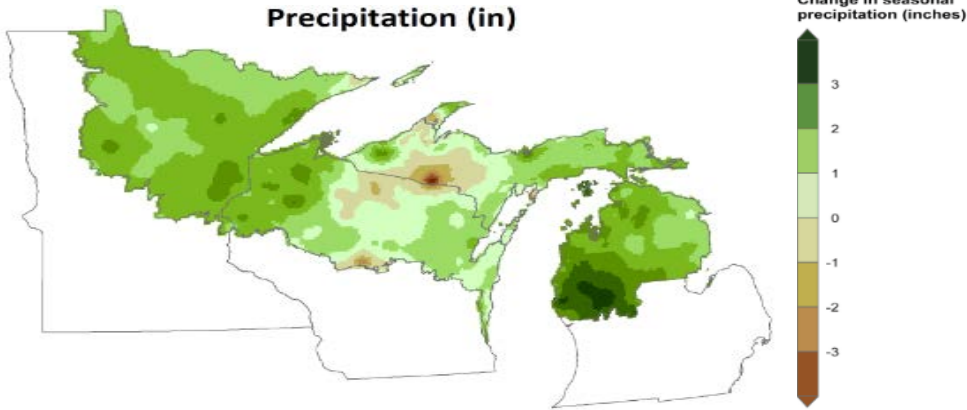
# Project Location



## Florence County Forest

- 36,000+ acres in northeastern Wisconsin
- Multiple uses: timber production, hunting, fishing, camping, and other recreation
- Dual certification – SFI and FSC

# The Problem



**Observed Precipitation Change, 1901-2010**

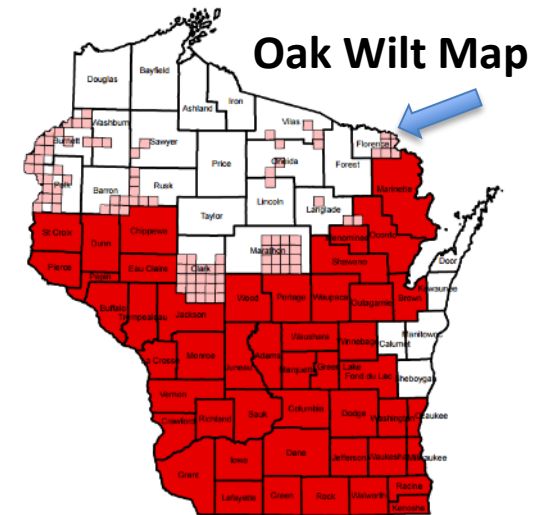
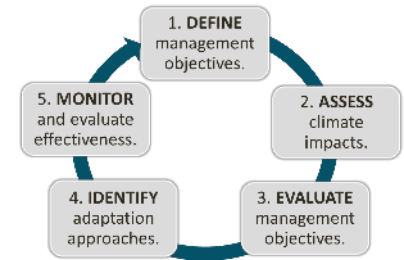


# Project Purpose

1. Look at the current condition of the county forest and make decisions based on anticipate future conditions.
2. Provide for sustainability of timber on the Florence County Forest, while providing for multiple uses.
3. Look for options to increase survivability and increase growth on seedlings through soil amendments.

# Project Planning

1. Develop a strategy based on NIACS Adaptation Workbook
2. Develop a project based on major climate risks
  - A. Drought risk
  - B. Pests and diseases
3. Apply for grant funding

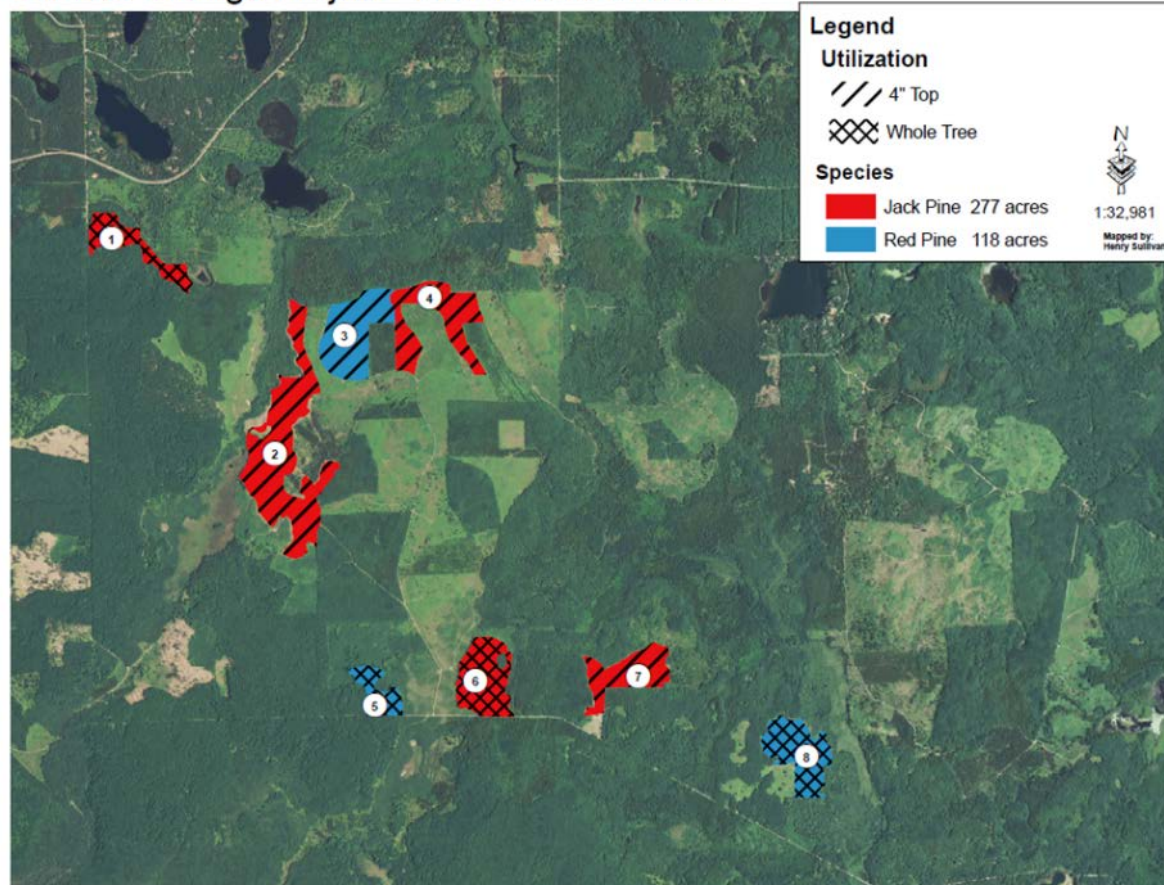


# Carrying out the Project

1. Site Preparation for planting. Approx 400 acres disc trenched fall of 2014
2. Order Trees- 435,000 Red and Jack Pine
3. Coordinate ash & biochar delivery and application
4. Baseline soil tests
5. Conduct tree planting through a contractor

# Carrying out the Project

Climate Change Project - Florence Co. Forest



# Carrying out the Project



# Carrying out the Project



# Carrying out the Project



# Carrying out the Project



# Progress and Next Steps

- 435,000 red and jack pine planted
- Soil and tree monitoring underway
  - 1<sup>st</sup>-year publication submitted to *Jour. of Forestry*
- Replanted one site in 2016
- Continue monitoring

# Soil Amendments: Experimental Plot Design and Initial Results



- **Robbie Richard**<sup>1</sup>, Lynette Potvin<sup>2</sup>, and Evan Kane<sup>1,2</sup>
- <sup>1</sup>School of Forest Resources and Environmental Science, **Michigan Tech** University, Houghton MI
- <sup>2</sup>Northern Research Station, USDA Forest Service, Houghton MI



**Michigan  
Technological  
University**



# Summer Undergraduate Research Fellowship (SURF)

- Research Proposal
- Funding
- Training

## Initial Impact of Forest Derived Soil Amendments on Soil Properties and Forest Productivity

By: Robert Richard Advisor: Dr. Evan Kane

### INTRODUCTION

Biochar and wood ash have been used as agricultural soil amendments, but to our knowledge, have not been studied for suitability in forestry practices in the Great Lakes region. Biochar is organic matter transformed by pyrolysis to consist of recalcitrant organic carbon in aromatic form, with long persistence in the environment (Lehmann and Joseph, 2009). The biochar influences soil fertility by affecting mycorrhizae and microbiota niche potential, cation exchange capacity, and soil alkalization (Atkinson et al., 2010; Lehmann and Joseph, 2009). Wood ash is burned biomass, and in sandy soils it has been shown to increase tree growth, soil pH, cation exchange capacity, base saturation, and extractable Ca, K, NO<sub>3</sub><sup>-</sup>, NH<sub>4</sub><sup>+</sup>, and P (Reid and Watmough, 2013; Pathan et al., 2002; Kahl et al., 1996). These forest derived soil amendments may have great potential in contemporary and future forest management.

The sandy, glacially-transported soils of the upper Great Lakes region often exhibit poor fertility, low water holding capacity, and are prone to nutrient loss. The climate change predictions for northern forests are warmer temperatures with more precipitation occurring as rain during the winter, and longer periods of drought in the summer (Handler et al., 2014). With increasingly droughty conditions, forest managers will need adaptation techniques to improve soil moisture and fertility. Biochar and/or wood ash soil amendments could lead to the development of new forest biomass derived products, more local demand for biomass to produce the amendments, and improved forest regeneration and restoration abilities.

A multi-agency project in Florence, Wisconsin will employ wood ash and biochar as soil amendments in the spring of 2015, prior to planting of jack pine and red pine seedlings, which are predicted to thrive in a drier climate. The goal is to restore a resilient forest cover to ~400 acres of degraded scrub oak forests. The project presents a valuable and rare opportunity for the forestry community to analyze the appropriateness of biochar and wood ash as a soil amendment. The proposed research capitalizes on the author's previous and continued working relationship with the Florence County Forestry and Parks Department, and further leverages the support of the US Forest Service Northern Research Station.

The collaborative agencies working on this project are mainly interested in long-term effects; we propose to document the initial effects of the amendments on soil properties, and on seedling productivity after one growing season. The soil is nutrient poor and no fertilizers will be used in conjunction with the amendments. Current results from experimentation with biochar are mixed – with some studies showing improved growth (Robertson et al., 2012) and others no effect or even declines in production when biochar alone is added (McElligot et al., 2011; cf. Mikan and Abrams, 1995). It could be that initially, increased CEC and C:N ratio actually serve to tie up nutrients, rendering them unavailable to plants in the early phases of regeneration, but this has not been tested directly (Chan and Xu, 2009). Our over-arching question is to identify the benefits of biochar and wood ash amendments in the absence of fertilizer. We hypothesize that biochar and wood ash amendments will differ in their initial effects on the soil properties (Table 1). We hypothesize that the wood ash will immediately increase productivity owing to direct additions of base cations, which will also affect soil properties as the base components become soluble (Table 1). The initial effects will shed light on contradictory results observed in other short-term studies and provide mechanistic insight on long-term effects in the next phase of research.



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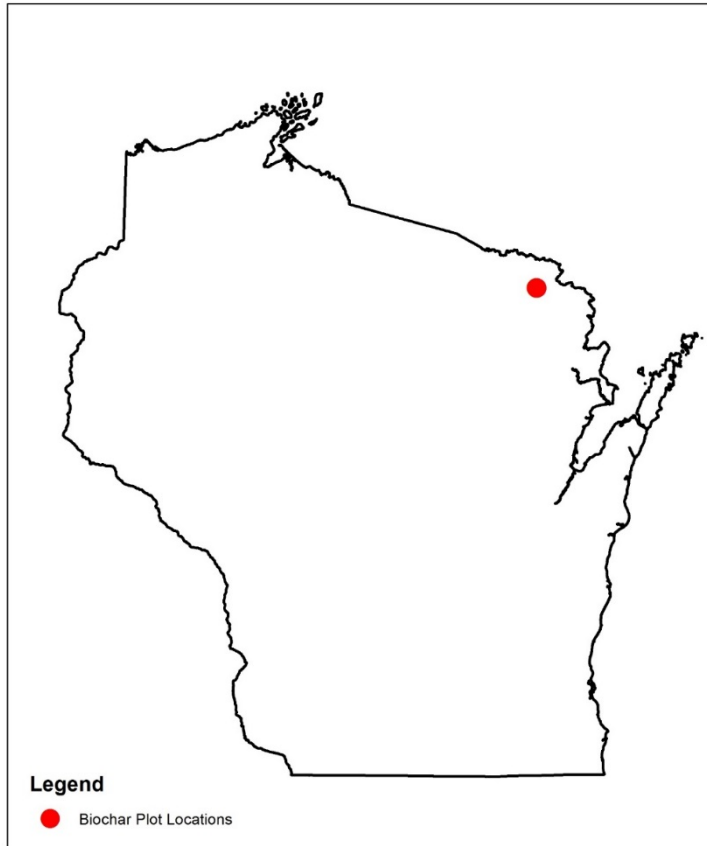
# SURF Research Objectives

- Evaluate short term effects of soil amendments in droughty soils
- Establish long term monitoring plots

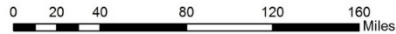


# Project Location

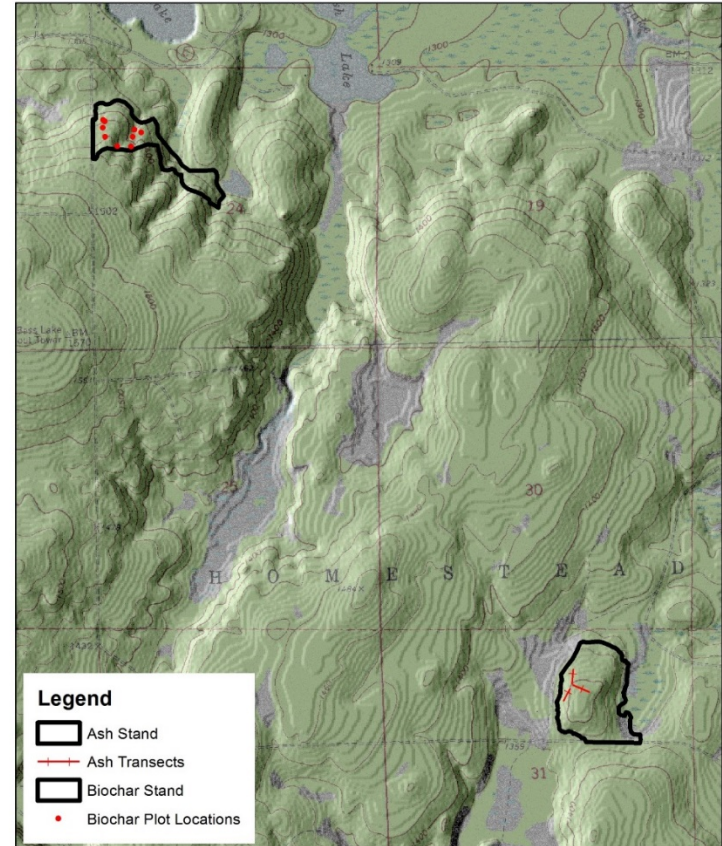
## Biochar and Ash Stands Florence, WI



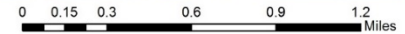
Coordinate System: NAD 1983 UTM Zone 16N  
Author: Robert Paul Richard  
Date: 10/05/2016



## Biochar and Ash Stands Florence, WI

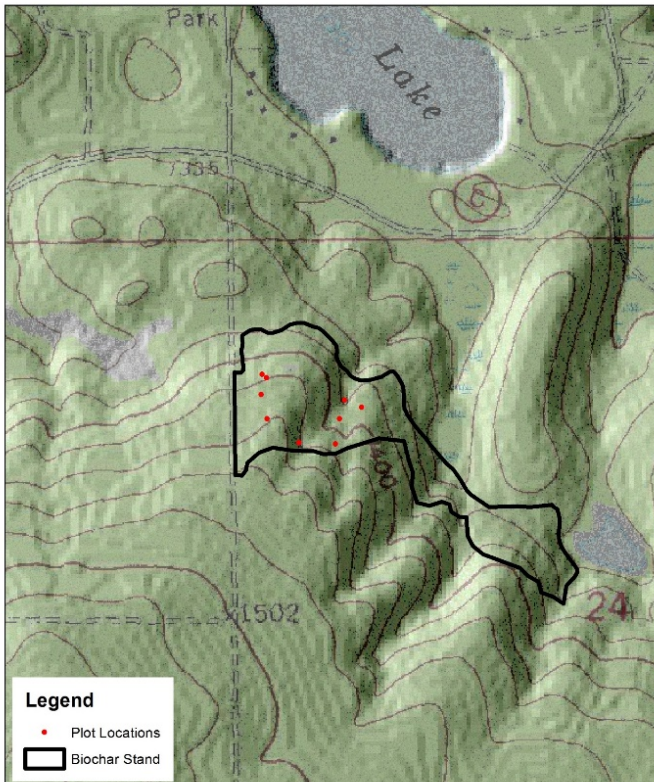


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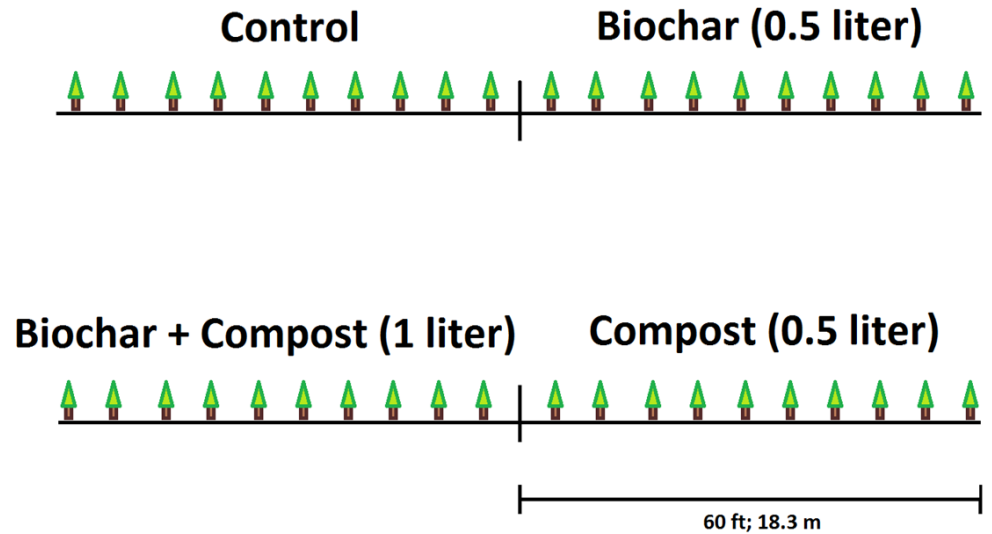
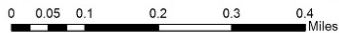


# Biochar Experimental Design

## Biochar Stand Location Florence, WI

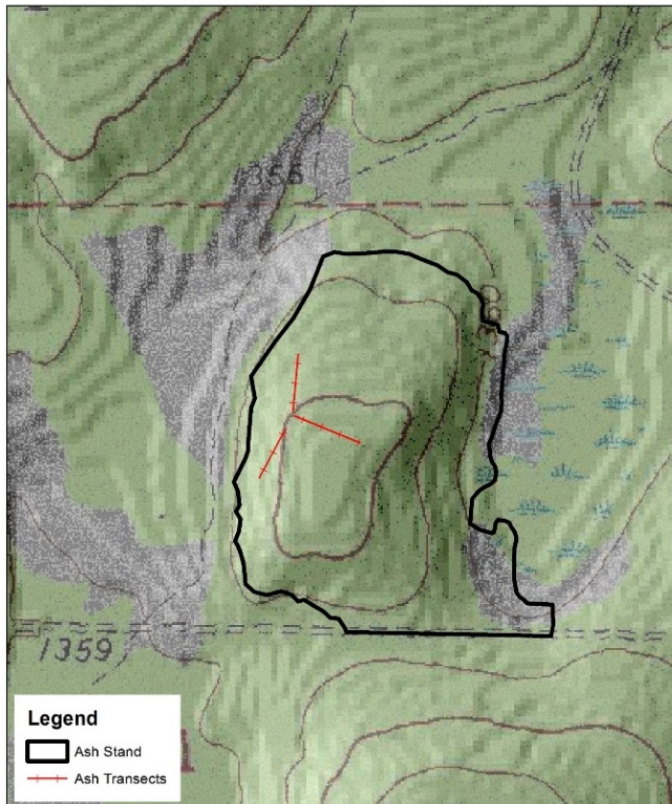


Coordinate System: NAD 1983 UTM Zone 16N  
Author: Robert Paul Richard  
Date: 10/05/2016



# Wood Ash Experimental Design

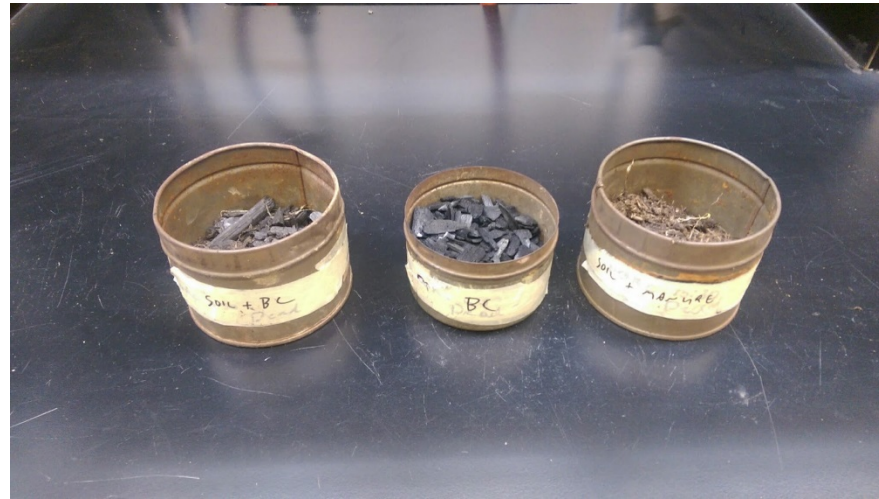
## Ash Stand Location Florence, WI



- Three transects, 100 meters length
- Soil sampling pre- (December 2014) and post-application (July 2015)



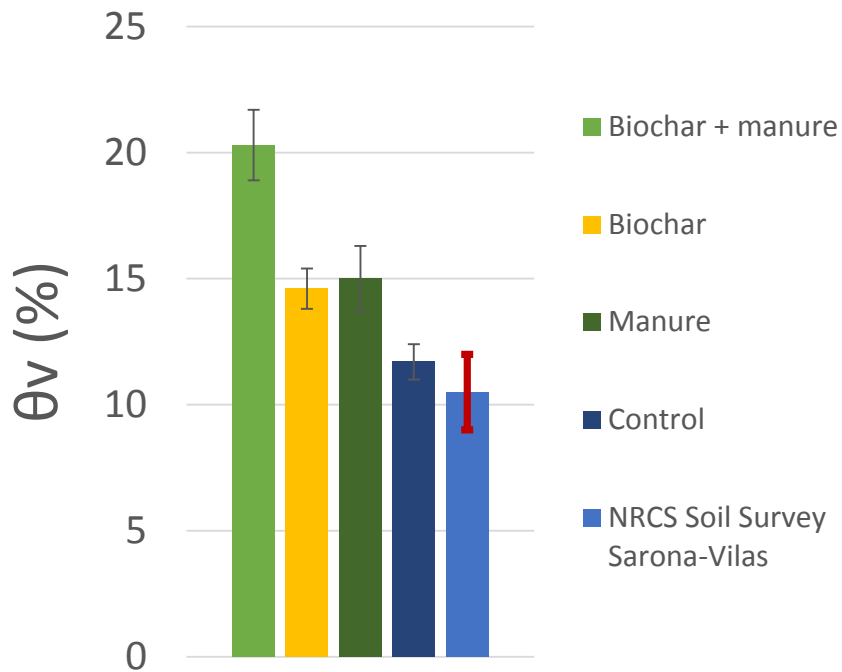
# Methods



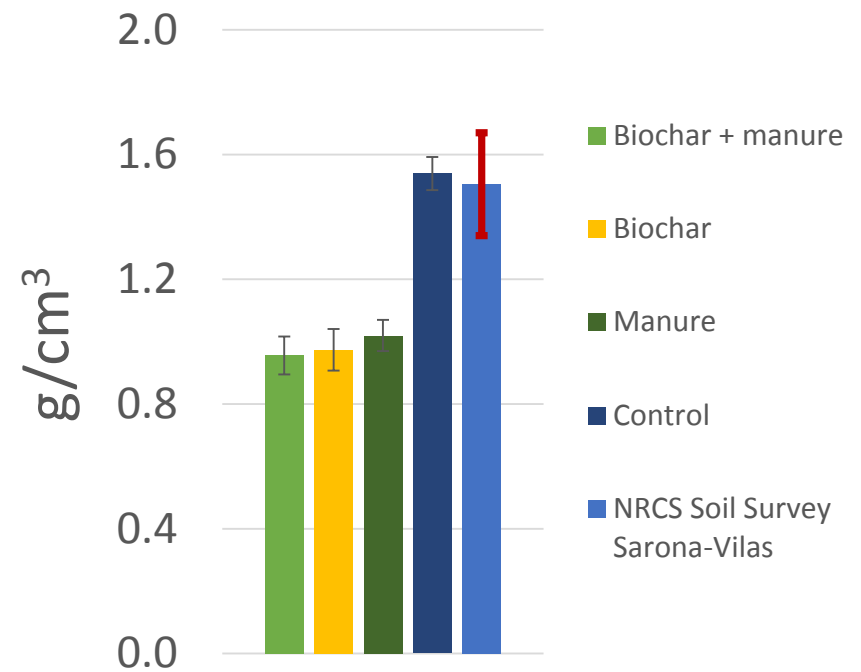
- Soils were analyzed for:
- pH
  - Water volume
  - Bulk density
  - Cation exchange capacity (CEC)

# Results - Biochar

## Water Volume

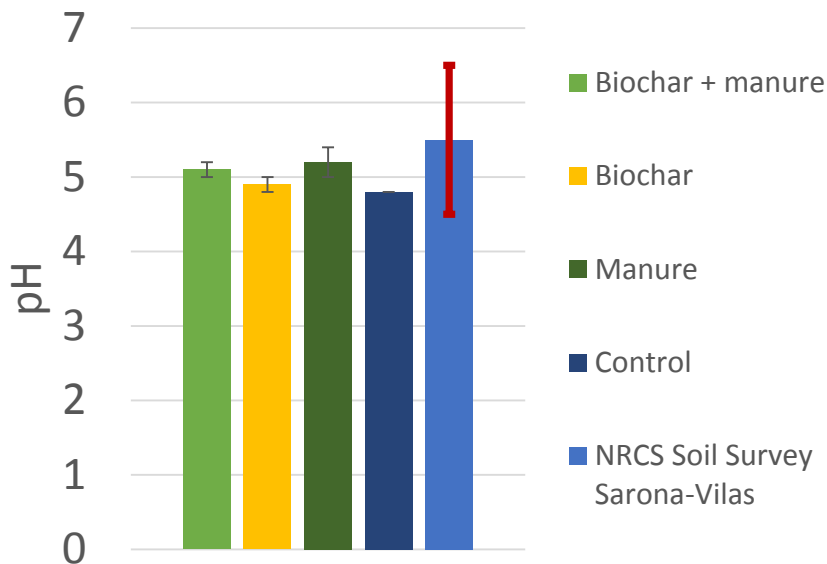


## Bulk Density

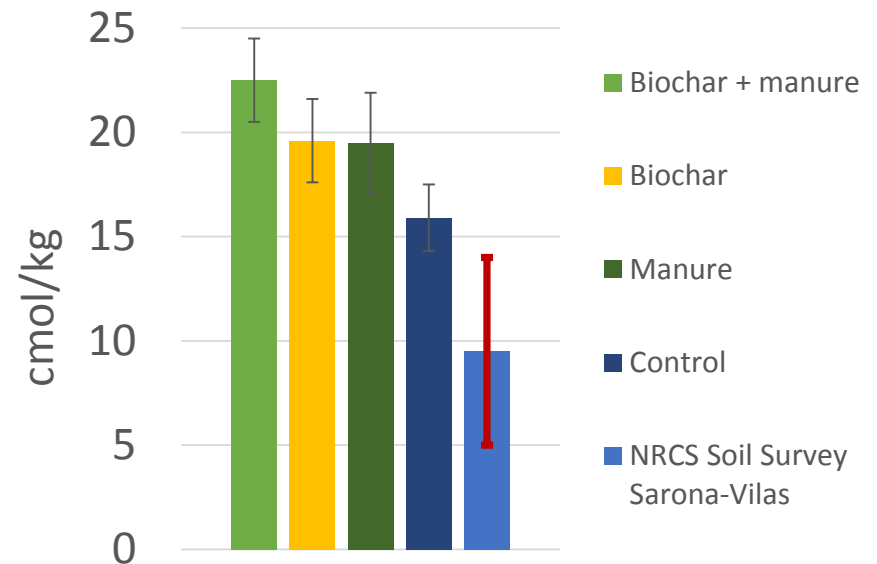


# Results – Biochar (cont.)

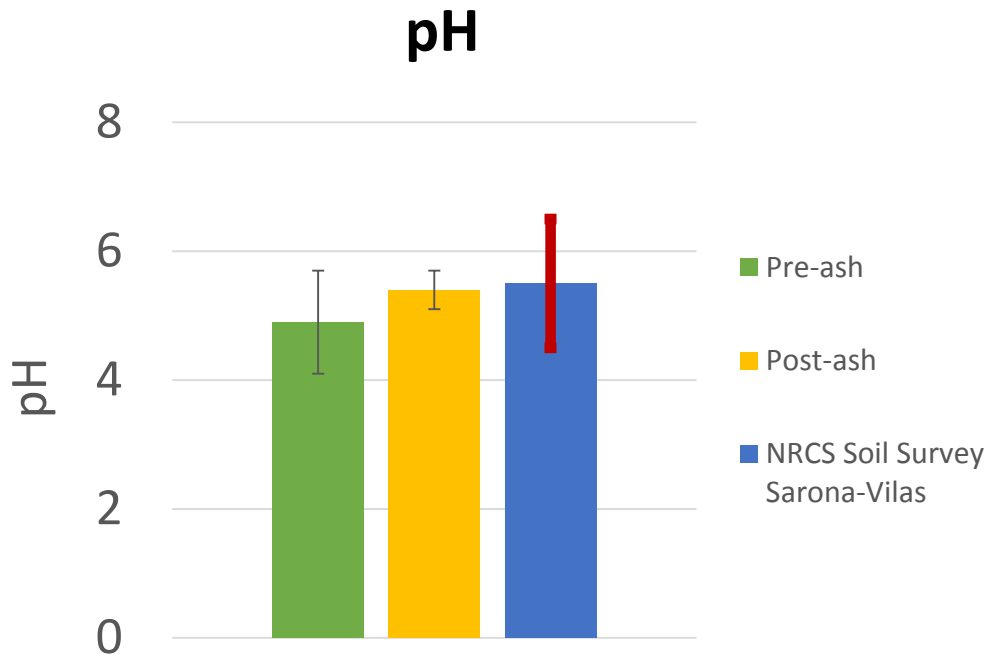
## pH



## Cation exchange capacity



# Results – Wood Ash



## Other results

- No significant difference in Bulk Density
- CEC not analyzed (yet)
- Water volume not calculated

# Discussion – Management Implications

- Wood-ash
- Increased pH

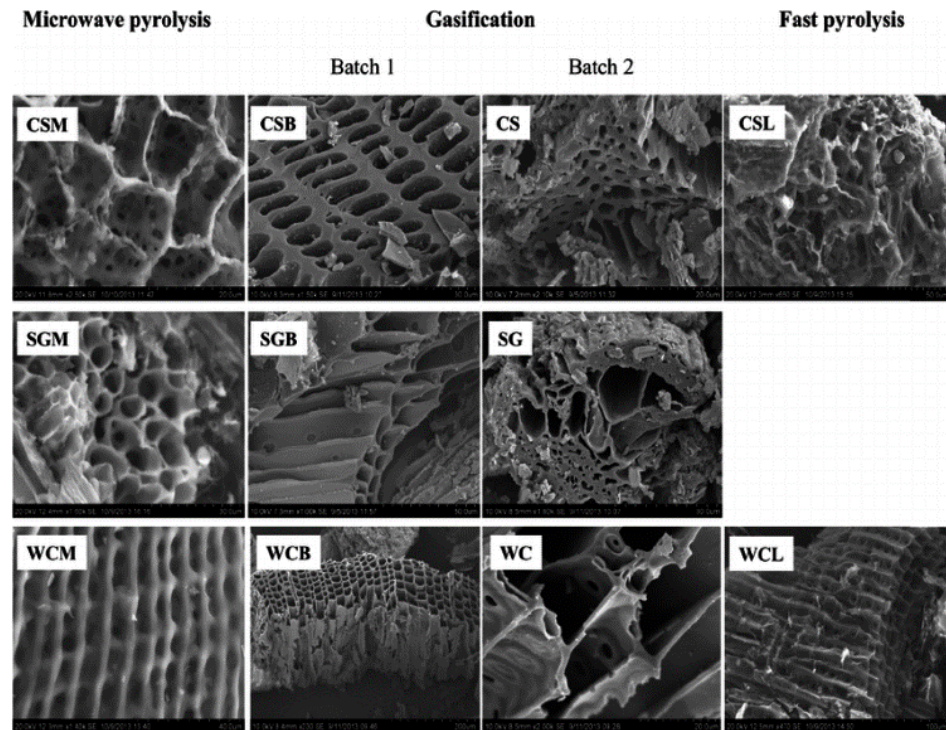


- Biochar
- Increased water holding capacity and cation exchange capacity
- Lowered soil bulk density
- Need for improved application method



# Discussion – Management Implications (cont.)

- Diversity of biochar
- Destructive sampling issues



[https://www.researchgate.net/profile/David\\_Clay/publication/263804114/figure/fig1/AS:293198372716544@1446915347754/fig-1-Scanning-electron-microscope-SEM-images-of-biochar-materials-at-various.png](https://www.researchgate.net/profile/David_Clay/publication/263804114/figure/fig1/AS:293198372716544@1446915347754/fig-1-Scanning-electron-microscope-SEM-images-of-biochar-materials-at-various.png)

# Discussion – Future research & USFS application studies

- Northern Minnesota, similar project using biochar in the works across 3 different soil types
- USFS Rocky Mountain Research Station and Missoula Technology Development Center – Biochar Spreader
  - <https://youtu.be/Ro5wgtoXUUu>
- ❖ Long term monitoring to continue at Florence County

# Discussion – Future application research



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# Thank you!

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